



PCSIR

RESEARCH & DEVELOPMENT PROGRAMME 2025 - 2026



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PAKISTAN COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH



PCSIR
Research & Development
Programme

2025-2026

Pakistan Council of Scientific and Industrial Research
Head Office, 1-Constitution Avenue, Sector G-5/2, Islamabad

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Compiled/Edited/Composed and Formatted/Proofread by:

Dr. Naheed Kausar, Member (Science)
Dr. Aneela Fatima, Director (R&D)
Dr. Gul-e-Rana, Director (SIC)

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Phone: (021)99261916, 99261949
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Foreword

The Pakistan Council of Scientific and Industrial Research (PCSIR), the country's largest R&D organization, plays a vital role in strengthening the national innovation ecosystem. Aligned with the Science, Technology & Innovation Policy of the Ministry of Science and Technology, PCSIR integrates emerging technologies across key economic sectors.

The PCSIR R&D Programme 2025–2026 aims to foster innovation, enhance scientific capacity and provide sustainable solutions to industrial, environmental and societal challenges. PCSIR's scientists and engineers are committed to translating cutting-edge research into practical solutions, bridging the gap between science and application and promoting both import substitution and export-oriented growth.

PCSIR's infrastructure, equipped with advanced instruments and methodologies, is continuously upgraded through the Public Sector Development Programme (PSDP), Self-Generated Income (SGI) and Export Development Fund (EDF). These enhancements strengthen research capabilities, support economic growth and advance high-potential projects.

Through science diplomacy, Technology Transfer Centers, Business Incubators, and Science & Technology Parks, PCSIR fosters international collaboration, attracts private investment and provides start-ups with advanced facilities, mentorship and market linkages.

Establishment of greenhouses for Cultivation Medicinal & Industrial Cannabis and processing them to obtain variety of value added products in the domain of pharmaceuticals, cosmetics, food, textile and paper industries etc., development of analytical methods for testing of cannabinoids and other specific active ingredient of developed products in order to control product quality and commercialize developed technology, development and production of Recombinant Ovalbumin and Pectate lyase from yeast through recombinant DNA technology are some mile stones that achieved through execution of the on-going PSDP projects.

The research and development activities have yielded significant outcomes, reflecting the organization's strong commitment to innovation and scientific advancement. A total of 15 patents have been filed and two patents are accepted in the F.Y. 2024-2025, demonstrating continuous efforts to translate research into practical and commercially viable technologies. Out of these, marking a tangible achievement in intellectual property generation.

In addition to technological innovations, the R&D team has made substantial contributions to the literature, with 122 research papers published in International Journals and 43 papers in National Journals. These publications highlight the global and national recognition of the organization's scientific work and its active role in advancing research across multiple disciplines. Collectively, these accomplishments underscore the organization's impact in promoting innovation, fostering knowledge dissemination and contributing to the country's scientific and industrial development.

Moreover, PCSIR supported 490 M.Phil. and Ph.D. scholars from 53 Universities across Pakistan, particularly from less-developed regions, by providing access to advanced research instruments for capacity building and human resource development.

We hope the current R&D Programme 2025–2026 is expected to strengthen Pakistan's industrial base, drive scientific innovation and contribute to a knowledge-driven, technology-led future for the nation.

(Dr. Syed Hussain Imam Abidi)
Chairman

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Public Sector Development Projects (PSDP)

PSDP No. 731

Name of Laboratory/ Centre/ Unit:

Pakistan Council of Scientific & Industrial Research
Laboratory Complex Ferozepur Road, Lahore

Title of Project: Cultivation & Processing of Medicinal & Industrial Cannabis on Experimental Fields and Establishment of Testing and Product Development Facilities (PCSIR & Arid Agriculture University)

Name & Designation of Project Director:

Dr. Qurat ul Ain Syed, Project Director

Name & Designation of Project Associate(s):

Mr. Jehangir Shah, DG PLC
Dr. Hafiz Rab Nawaz, DG KLC
Dr. Muhammad Zia-ur-Rehman, CSO
Dr. Muhammad Zaheer, SSO

Area(s) of Research:

Phytochemistry

Duration:

3 Years (Extended for 02 Years)

Date of Initiation:

13.07.2021

Project Brief:

Cannabis is a variety of the hemp plant species that is grown specifically for the industrial uses of its derived products. It is one of the fastest growing plants and was one of the first plants to be spun into usable fiber 50,000 years ago. It can be refined into a variety of commercial items, including pharmaceuticals, food items, cosmetics, paper, textiles, biodegradable plastics, building materials, bio fuel and animal feed. Through efficient cultivation, processing and product development, raw cannabis can be converted into

highly valuable products owing to its huge hidden potential.

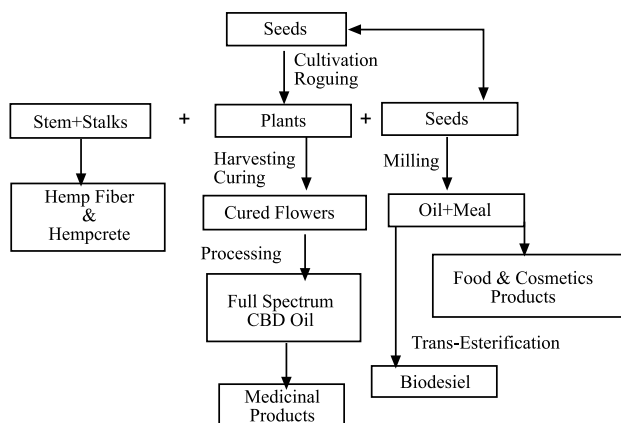
Currently, cannabis is only known as an abusive plant due to its narcotic use in Pakistan. However, it contains a lot of natural constituents including cannabinoid like CBD, CBDA, THC, THCA, CBG, CBGA, CBN along with terpenes, flavonoids etc. Besides, its seeds, fiber and other biomass can also be utilized in the products of different fields. By effective use of this commodity through research and innovation, it can be converted to valuable products.

Cannabis is considered as a multipurpose crop and almost all of its parts can be utilized in different type of products. Its flowers and buds are rich source of cannabinoids which are used in pharmaceutical industry. CBD oil/ extract is considered to have many pharmacological activities like anti-depressant, anti-rheumatic, anti-spasmodic, muscle relaxant and anti-oxidant activities. Similarly, tetrahydrocannabinol (THC) possesses enormous potential as a material of legalized export to earn huge foreign exchange.

Its seeds are a rich source of proteins, carbohydrates in the form of fibers and fats. Due to abundance of beneficial fatty acids and essential omega-3 fatty acids, it can be used in a variety of food products. Besides flowers and seeds, its stalk and shoots are fibrous and may be utilized to develop hemp fiber for textiles and hempcrete as building material. The objectives of the project are as follows:

- To develop experimental fields/ land for cultivation of industrial cannabis.
- To cultivate industrial cannabis on experimental fields and its processing.
- To develop extraction techniques for cannabinoids from cannabis flowers.
- To develop and validate analytical methods for testing of industrial cannabis.
- To conduct research for product development from cannabis.
- To provide state-of-the-art analytical services to the exporters and industry of cannabis products.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

PSDP

Cost:

Rs. 1896.820 Million

Tangible Outcome:

- Technology development for cultivation of high-quality cannabis crops in ANF approved green houses at LLC, KLC & PLC
- Technology development for the extraction of cannabinoids
- Establishment of modern facilities for the analysis of cannabis constituents and related products
- Collection of baseline data for cultivation and processing of cannabis for replication in other parts of the country
- Development of cannabis-based products
- Human resource development

Achievements:

- Development of ANF Approved Green Houses for Hemp Cultivation at LLC, KLC & PLC equipped with control systems for temperature, humidity, air circulation, light and drip irrigation system for fertigation.
- Development of open field for Industrial Hemp cultivation.
- Establishment of fully controlled Indoor Grow room for temperature, full spectrum lights, and humidity.
- Issuance of Post entry quarantine (PEQ) certificate from plant protection to import foreign variety seeds

to PCSIR.

- Six successful high-quality crops were harvested from LLC green house.
- Optimization of the climatic and edaphic condition for cultivation of organic medicinal cannabis.
- Production of feminize seeds for medicinal cannabis at LLC green house.
- Development of the procedure for cannabis multi-crop at LLC green house.
- Successful cultivation of high CBD & THC cannabis variety at LLC green house.
- Development of the Cannabis curing facility at LLC for cannabis flowers.
- Development of methodology and its optimization for cannabis processing unit operations including Drying, Grinding, Decarboxylation and Extraction (with Solvent Extraction and SCFE methods), winterization and Molecular Distillation to get concentrated full spectrum CBD oil.
- Establishment of ISO 17025 analytical laboratories accredited from PNAC for testing of cannabinoids at Lahore & Karachi and Peshawar equipped with instruments including HPLC, LCMS/MS, GC-MS etc.
- Development of analytical methods for testing of cannabinoids (CBD, CBDA, THC, THCA, CBN, CBL, THCV, CBGA & CBG, GC-MS profiling etc.) from cannabis biomass is developed. For quality assurance measurement / 3rd party evaluation was successfully qualified through Proficiency Testing participation by LGC UK in LLC, KLC & PLC.
- 40 products in the domain of pharmaceuticals, cosmetics, food, textile, Agri-construction paper etc. are developed through R&D.



PSDP No. 732

Name of Laboratory/ Centre/ Unit:

PCSIR Head Office, Islamabad

Title of Project: Data Repository of Scientific Instrumentation

Name & Designation of Project Director:

Dr. (Mrs.) Naseem Rauf, CSO/ Project Director

Name & Designation of Project Associate(s):

Dr. Muhammad Farooq, SO

Area(s) of Research:

Food safety & security, health, environmental protection, biotechnology, metallurgy, etc.

Duration:

03 Years (Extended for 02 Years)

Date of Initiation:

27-08-2021

Project Brief:

This project was assigned to PCSIR by the Planning Commission of Pakistan on the recommendation of the then Task Force on Science and Technology in 2021 with cost of Rs. 300.00 million and duration of 03 years. The project was initiated in August 2021 due to limited or no access of researchers/ students to the sophisticated laboratory equipment. The scope of the project is to support M. Sc./ Ph.D. scholars enrolled in different public sector universities of Pakistan to complete their research projects in the emerging fields of national interest by providing access to high-tech scientific instruments which at present facing difficulties to analyze/ evaluate their research data. The main objective are:

- To provide funds for instrumental access to the research institutions, universities, R & D organizations, and strategic research centers of Pakistan to carry out sample analysis.
- To facilitate faculty and research staff of newly developed, as well as existing institutions that lack scientific instrumental facility for conducting their research through the above cited grant.
- To create an online data base of scientific instruments available in research centers, institutes, and industries of Pakistan.
- To design a nationwide mechanism for enabling ease of access to instrumentations facility present in different R & D, and academic institutions of the country.
- To provide a much-needed support to the research and academic institutions of Pakistan to overcome difficulties due to unavailability of high technology instruments.

- To assist people working in different institutions of Pakistan by providing them access to much needed instruments.

Funding Source (PSDP/SGI/RD&I/etc):

PSDP

Cost:

Rs. 300.00 Million

Tangible Outcome:

- Supporting research activities at national level and improving the productivity of research institutions.
- Enhancing the image of universities, and research centers as significant players in high-end research and innovation.
- Supporting a national culture of innovation and development of scientific knowledge.
- Producing skilled human resource to fulfill national requirement.
- To strengthen collaboration between the university and industry in the areas of research and development, and to create value through maximizing collaboration between academia, private, and public sector entities.
- Effective use of available equipment and resources.
- Saving in purchasing of new equipment.

Achievements:

- Supporting Research Activities and Producing Skilled Manpower: Award letters have been issued to 490 students of around 53 universities/ institutes all over the country, especially, located in less developed areas of Balochistan, Sindh, KPK, Punjab, AJK, and Gilgit-Baltistan for instrument access in connection with their M. Phil./Ph.D. Synopsis.
- Effective Utilization of available Equipment and Resources: One of the major problems of our educational institutes is the lack of effective use of available equipment and resources. PCSIR has provided access to several students of different universities/ institutes to state-of-the-art sophisticated instruments such as, SEM, TEM, EDX, AAS, NMR, TGA, XRD, DNA Sequencer, GCMS, HPLC, UICPMS, etc.
- Revamping R&D in Laboratories: The project has

resulted in operationalization of equipment and machinery and activation of research activities of labs/ service providers including PCSIR Labs, NUST, LUMS, HEJ, COMSATS, NIAB, HDIP, etc.

- 326 Applications amounting to Rs. 97.749 million are under evaluation process.
- Database has been developed with the information of instruments/testing facilities available in the research organizations/ Educational Institutes of the country.



PSDP No. 733

Name of Laboratory/ Centre/ Unit:

Industrial Biotechnology Laboratory & Biomolecules Purification & Testing Laboratory and Fermentation Pilot Plant/FBRC/PCSIR, Lahore. Instrumentation control and Computer Complex/ICCC/PAEC, Islamabad.

Title of Project: Development of Computer Controlled Fermenters and Production of Biochemicals and Bioproducts

Name & Designation of Project Director:

Dr. Rubina Nelofer, PSO
Dr. Ulfat Jafri, CS, PD ICCC.

Name & Designation of Project Associate(s):

Dr. Muhammad Nadeem, PSO (Co-PD)
Dr. Farzana Bashir, PSO
Dr. Ammara Hassan, SSO
Ms, Shaggufta Naz, SSO

Area(s) of Research:

Industrial Biotechnology/ Applied Microbiology/ Biochemistry/ Biotechnology

Duration:

5 Years (2021-2026)

Date of Initiation:

07-09-2021

Project Brief:

The project is focused on the development of indigenous computer-controlled fermenters and

production of bioproducts to meet both industrial and research needs. By establishing advanced laboratory infrastructure and pilot-scale facilities, the project seeks to reduce reliance on imported technologies and provide cost-effective local solutions. The initiative also emphasizes technology transfer and capacity building to strengthen Pakistan's position in the field of bioproduct development. Currently, country faces a shortage of locally designed fermentation equipment and indigenous biochemical production. Heavy dependence on imported fermenters, media components, and bioproducts leads to increased costs. This gap also hinders the commercialization of locally developed processes. Technical Information/Scope of the present project includes:

- Design and development of indigenous computer-controlled fermenters by ICCC/PAEC.
- Production and optimization of selected bioproducts, including enzymes, biofertilizers, Microbial Derived Protein (MDP), Lovastatin, and Penicillin G Acylase (PGA), using cost-effective and locally available agro-industrial substrates.
- Scale-up of laboratory processes to pilot-level for industrial validation and applicability.
- Establishment of infrastructure for fermentation, downstream processing and product quality testing.
- Technology transfer and industry collaboration to ensure commercialization and adoption of developed products and processes.
- Human resource development and training, equipping researchers and technical staff with hands-on expertise in modern fermentation technology.

Objectives:

- Establish a design and manufacturing facility for computerized automated fermenters and associated equipment and systems for a variety of volume sizes that could be used by a wide range of facilities from lab pilot scale to commercial/industrial manufacturing.
- Develop indigenous capability in terms of R&D, design, development and subsequent commercial production of biochemicals, biopharmaceuticals and bioproteins etc.
- Leveraging existing commercial activities, this endeavor could create and open up new vistas of

biotechnology related businesses for the country, thus moving towards knowledge-based economic growth.

- Develop and upgrade the existing essentially required facilities and infrastructure at PCSIR and ICCCI/ PAEC. Thus, providing establishment of national level integrated bio-processing infrastructure.
- Build capacity by conducting trainings, workshops, seminars and research capability in advanced techniques in development of large sized computer-controlled fermenters/ bioreactors and biochemical production. Thus, providing technical services by utilizing indigenous resources and saving precious foreign exchange in future.
- Produce local biotechnology industry needs for socio-economic growth of the country and associated spin-off technologies thereof.

research applications.

- Establishment of optimized fermentation process for scaling up microbial processes from laboratory to pilot scale.
- Development of Microbial Derived Protein (MDP) from agro-industrial wastes (e.g., rice polish, NAKU) as a sustainable feed enhancer.
- Lovastatin production through fermentation technology for use as a cholesterol-lowering drug.
- Penicillin G Acylase (PGA) production and immobilization protocols for enzymatic conversion of Penicillin G to 6-APA, a key intermediate in semi-synthetic antibiotics.
- Formulation and particle size-standardized biofertilizers for soil and crop productivity enhancement.
- Optimized microbial processes for Baker's Yeast & Ethanol.
- Universities, R&D organizations, and research

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
PSDP

Cost:
1981.607 Million

Tangible Outcome:

- Development of indigenous computer-controlled fermenters (lab-scale and pilot-scale) with automation features suitable for industrial and

institutes will gain access to indigenous fermenters and standardized microbial processes for training, research, and innovation.

- Pharmaceutical, feed, food, and agriculture industries will benefit from cost-effective bioproducts and locally available fermentation technology.
- Reduced import dependence, cost savings in foreign exchange, employment generation, and development of local expertise in biotechnology.

Achievements:

- Renovation of four laboratories & pilot plant and 2 offices under 1st civil work tender.
- Construction of prefabricated boiler room under 2nd Civil work tender.
- 42 out of 70 (60%) of PC-I approved equipment are procured and installed.
- Successful completion of TOT from Coway International under services tender and its reproduction at PCSIR is in progress.
- Laboratory-scale R&D of Penicillin G Acylase (PGA) successfully developed and validated.
- Consumables, chemicals & contingent items were purchased as per requirement through respective tenders/EPAD.
- One product was developed up to the 100 L, 2 products were developed at Lab. Scale.
- 90% of the project staff have been appointed and actively engaged in research and development activities aligned with the project objectives.
- Successfully conducted an International “Seminar on Bioindustry: Future Industry of Pakistan” to promote the role bioindustry in national economic growth, awareness and collaboration.
- Two 100L fermenters have been developed by ICCG and will be installed before June 2025.
- Provision of testing and analytical services to national industries including Engro Fertilizer and PSQCA, 12 test methods were developed.
- More than 80 people were trained in the project including project contract staff, interns, daily wagers and university students.



PSDP No. 734

Name of Laboratory/Centre/ Unit:
PCSIR Head Office Islamabad

Title of Project: Digital Transformation, Strengthening and Automation of PCSIR

Name & Designation of Project Director:
Engr. Fida Ullah Khan, Project Director

Name & Designation of Project Associate(s):
Engr. Muhammad Ibraheem, Co-Project Director

Area(s) of Research:

IT Infrastructure

Duration:

05 Years

Date of Initiation:

25 Aug, 2021

Project Brief:

PCSIR, being the country’s leading R&D institution, faced challenges due to outdated IT infrastructure, manual processes, and limited digital connectivity. These gaps caused inefficiencies, lack of transparency, weak industry collaboration, and delayed decision-making. Restrictions on hardware imports, LCs and budget limitations further delayed the transition to modern systems.

The DTSA project aims to establish a fully digital infrastructure within PCSIR, enabling faster, more transparent and more efficient scientific and industrial research services. With automated systems like ERP, SIMS, LMS and digital dashboards. By the help of these centralized dashboards, PCSIR will be in a stronger position to respond to community problems using technology, promote a paper-free environment, and contribute directly to improved quality of life, public service delivery and industrial productivity. In addition, the automation and digitization of PCSIR will streamline public services by making scientific and research data more accessible to the general public, academia and industry, contributing directly to transparency and efficiency in R&D outputs. The main objectives include:

- Leverage new digital and information technology and systems, such as enterprise-wide information systems, data analytics, knowledge repository, to enhance efficiency and effectiveness of PCSIR.
- To implement a modern digital organizational network through replacing existing/ obsolete IT equipment with modern I.T. equipment including servers, routers, switches, computers etc. at PCSIR.
- To make PCSIR hardware and network infrastructure ready for implementation of e-Office services to be acquired from NITB.
- To develop Key software/ applications with data driven management dashboards to make a digital

automated system for PCSIR to increase transparency, productivity, efficiency and revenue generation.

- To strengthen technical manpower in managing, operating and delivering improved IT services in MoST and PCSIR.
- To provide on-demand services such as material testing, product validation, and technical consultancy through integrated digital platforms.
- To enhanced digital communication channels that bridge the gap between public sector research and private sector industrial needs, encouraging partnerships and knowledge transfer.

Funding Source (PSDP/SGI/RD&I/etc.):

PSDP

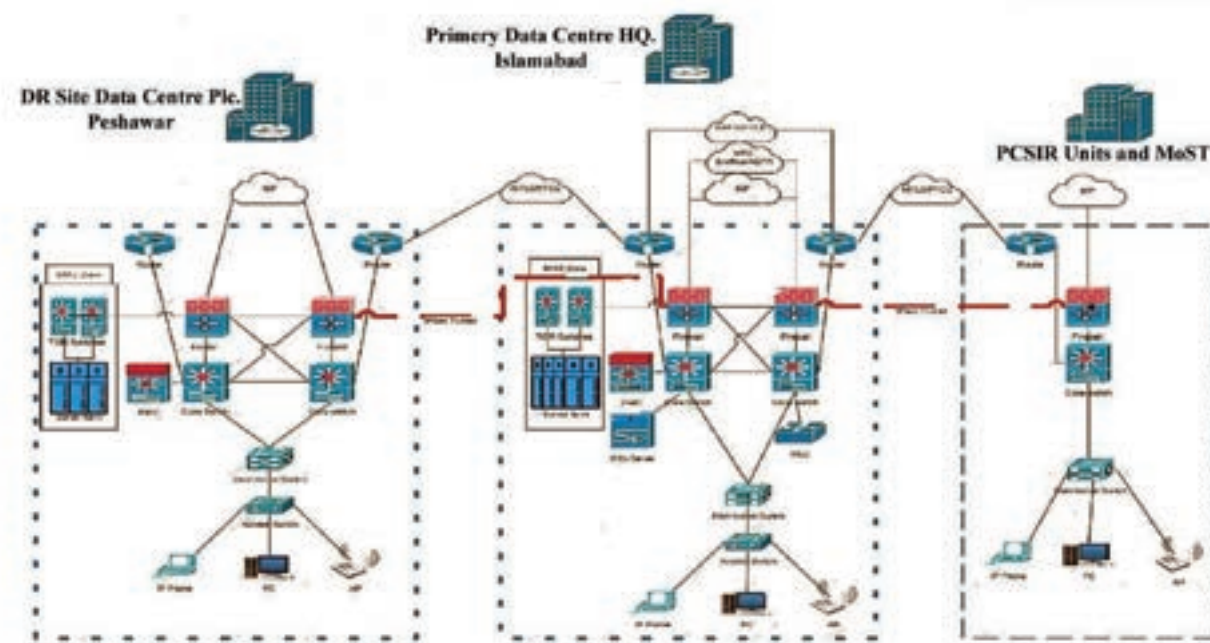
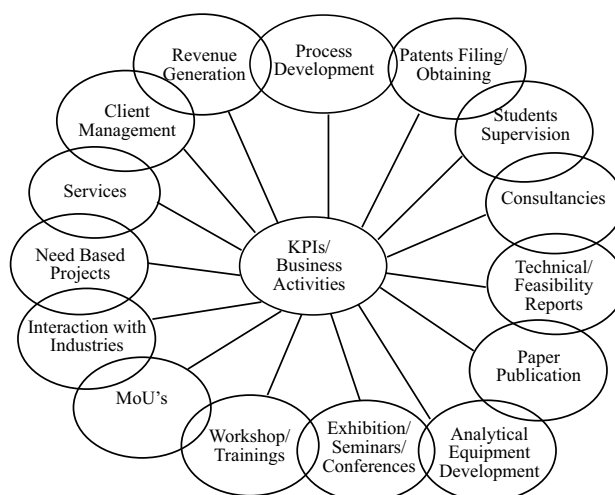
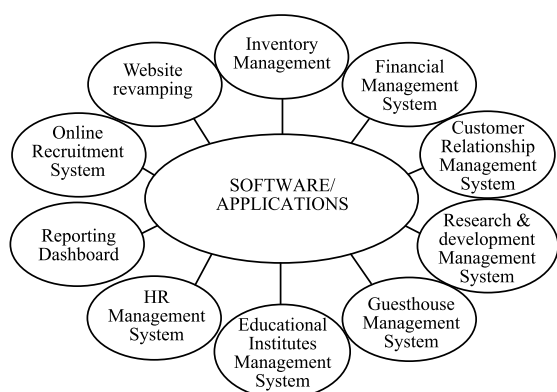
Cost:

960.71 Million

Tangible Outcome:

- Data Centers established at PCSIR Head Office (Islamabad) and PCSIR Labs Complex (Peshawar) for secure data storage, disaster recovery and digital services.
- Nationwide network infrastructure deployed across all PCSIR units, enabling automation, transparency,

Graphical Abstract/Project Layout:

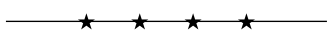


efficiency and increased revenue generation.

- Automated systems (ERP, SIMS, LMS, PCSIR apps, e-Office) implemented to reduce manual work, improve reporting and support paperless operations.
- Capacity building through staff training (CCNA, Azure, MCSE, etc.) ensuring sustainability of systems.
- Service provision to other organizations via Data Centers and IT services, creating new revenue streams and positioning PCSIR as a digital hub.
- Beneficiaries include PCSIR scientists and staff, Industrial sector (through faster R&D services), Public sector (transparent e-governance) & students/researchers (digital access to labs & services).

Achievements:

- Data Center (PCSIR Head Office, Islamabad): Energized with 125 TB storage & 1.2 TB memory.
- Committee Room: Fully upgraded for modern collaboration.
- Passive Infrastructure: Ethernet cabling & rack installation completed across units.
- Equipment Installed: Servers, IBM storage, routers, switches, video walls, access points, printers, scanners.
- Software Development: NESPAK consultancy completed (Inception, BRD, BPD); RFP awarded to Biafotech, which delivered FSD, SDD and prototype.
- Network Connectivity: MPLS by PTCL established at major PCSIR units; ~90% fiber deployment completed nationwide.
- Human Resource: 31 new IT staff recruited (Project Director, administrators, developers, technicians).
- Fiber Laying: ~80% work completed within PCSIR premises.



PSDP No. 735

Name of Laboratory/ Centre/ Unit:
 PCSIR Labs Complex, Peshawar & Karachi

Title of Project: Establishment of Materials Resource Centre and Development of Additive Manufacturing & Reverse Engineering Centre at PCSIR

Name & Designation of Project Director:

Engr. Sohail Ameer Marwat, Project Director/
 Member (Technology), PCSIR

Name & Designation of Project Associate(s):

Engr. Haris Ikram, Sr. Engineer at PCSIR
 Head Office.
 Engr. Muhammad Younus, Principle Engineer at
 PCSIR Labs Complex, Peshawar
 Mr. Sheikh Kamal Ud Din, Sr. Scientific Officer
 at PCSIR Labs Complex, Karachi

Area(s) of Research:

1. Additive Manufacturing & Reverse Engineering /3D Printing.
2. Advanced Materials including Electrical/ Electronic, magnetic, Optical/Spectroscopic, Nano technology and Building Materials etc.

Duration:

03 Years (Extended for 02 Years)

Date of Initiation:

03-08-2021

Project Brief:

The rapid advancement of materials science and additive manufacturing has transformed global industries by enabling innovation, reducing costs and fostering technological independence. To strengthen Pakistan’s industrial and research capabilities, the Pakistan Council of Scientific & Industrial Research (PCSIR) has initiated the establishment of two state-of-the-art facilities:

1. Material Resource Center (MRC) at PCSIR Labs Complex, Karachi
2. Additive Manufacturing & Reverse Engineering (AM&RE) Center at PCSIR Labs Complex, Peshawar

These centers aim to provide cutting-edge R&D, testing, characterization and prototyping facilities in areas such as advanced engineering materials, nanotechnology, battery technologies, sensors, smart devices and 3D printing. The project aims to strengthen industry-academia linkages, promote import substitution, support indigenous product development, and enhance Pakistan's competitiveness in sectors like aerospace, automotive, medical, defense, oil & gas, and electronics.

Pakistan currently faces a significant technological gap due to the lack of state-of-the-art R&D infrastructure for advanced materials characterization, additive manufacturing and reverse engineering, leading to heavy reliance on imports, limited indigenous product development and reduced industrial competitiveness across strategic sector. The project establishes two integrated facilities under PCSIR to provide practical, industry-driven R&D, testing and prototyping solutions.

A. Material Resource Center (MRC) – Karachi

The MRC aims to serve as a national hub for material characterization, testing and R&D to support industries, academia and strategic sectors by providing following key services:

- Material Characterization & Testing for structural, chemical, mechanical, optical, magnetic and electrical properties.
- Nanomaterials & Energy Materials Development including Synthesis and testing of graphene, CNTs, solid-state batteries, fuel cells and capacitors.
- Reverse Engineering & Failure Analysis.
- Industrial Quality Assurance/ Certification and quality testing of local products to meet export standards.

B. Additive Manufacturing & Reverse Engineering (AMRE) Center – Peshawar

The AMRE Center will establish a state-of-the-art 3D printing and prototyping facility to accelerate

product development and import substitution by providing following key facilities and services:

- High-end metal, polymer, composite and biomedical 3D printing for functional parts and prototypes.
- Development of complex geometries and customized components using advanced design tools.
- 3D scanning and reproduction of high-value imported parts to support local manufacturing.
- Prototyping and component manufacturing for aerospace, automotive, defense, medical, oil & gas and consumer products.

The core objectives of the project are given below:

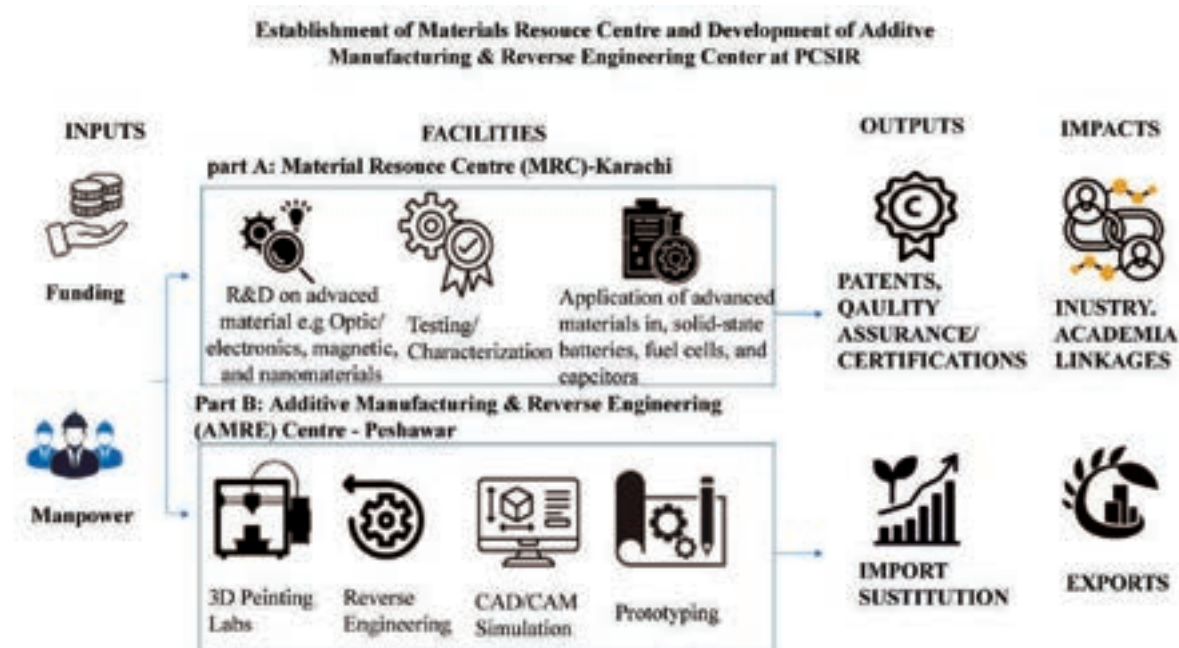
A. Material Resource Center (MRC) – Karachi

- i. Establish a state-of-the-art center for materials R&D, testing and quality assurance.
- ii. Focus on advanced engineering, electronic, magnetic, optical, nano and building materials.
- iii. Develop indigenous materials and processes through reverse engineering to promote import substitution.
- iv. Strengthen industry-academia linkages and support innovation.
- v. Facilitate product certification to enhance exports and industrial competitiveness.

B. Additive Manufacturing & Reverse Engineering (AM&RE) Center – Peshawar

- i. Set up a modern 3D printing and prototyping facility for rapid product development.
- ii. Support aerospace, automotive, defense, oil & gas, consumer, industrial and medical sectors.
- iii. Enable local manufacturing of critical components to reduce import dependency.
- iv. Enhance PCSIR's technical capabilities with advanced prototyping and design facilities.
- v. Foster innovation, self-reliance and industrial growth through additive manufacturing.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
PSDP

Cost:
Rs. 1951.683 Million

Tangible Outcome:

- Revenue generation through Analytical Services.
- Started Prototype part manufacturing for 08 different public / private industries/ institutes including, Mark Pvt Ltd, North West Hospital Hayatabad Peshawar, Centralized Resource Laboratory Peshawar University, M/s. Shareef Arms & Ammunition SIE Peshawar, Centralized Resource Laboratory Peshawar University, AMF, PAC Kamra parts printing on FDM 3D printer (V Shapper), Printed part of obsolete HPLC machine (Peshawar University) and PIPOS, Trans-femoral prosthesis parts printing on FDM 3D printer (V Shapper).
- MoU signed with M/s Paraplegic, M/s Mehboob Medical and with PIAM3D, PIPOS, Trojan, PAF Kamra, Mark Pvt Ltd. another MoU is under consideration/ Process.
- Collaboration Meetings/ Visits with PIAM3D, PIPOS, Trojan, PAF Kamra, National Aerospace Science and Technology Park (NASTP), Aero

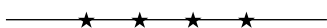
Vision Technologies (Pvt) Ltd., Pak Renewables (Pvt) Ltd., Pakistan machine tools factory Ltd., etc are under review/consideration.

- 03 Paper published (01 international and 02 local).
- 04 Patent submitted.
- 01 project completed and 01 on-going Project in PCSIR R&D.
- 02 projects accepted in PCSIR R&D (2024-2025).
- Trainings provided to 60 students of different Institutes and Universities.
- Consultancy Provided to 50+ industries with collaboration of EDB and PSQCA.

Achievements:

- Establishment of Additive Manufacturing & Reverse Engineering (AMRE) Center Peshawar (09 3D printers delivered and a scanner procured and installed, civil works completed).
- Establishment of Material Resource Center (MRC) Karachi (civil works completed).
- MoUs signed and in process with industries/ institutes (Paraplegic, Mehboob Medical, PIAM3D, PIPOS, Trojan, PAF Kamra, Mark Pvt Ltd., etc.).
- Collaboration meetings/visits with NASTP, Aero Vision Technologies, Pak Renewables, Pakistan Machine Tools Factory Ltd., etc.
- QA/QC testing services in Karachi.

- Provided opportunities for youth training, internships and R&D projects.
- Training and courses on our 3D Centers.
- Enhanced PCSIR's role as a national hub for materials testing and 3D printing.



PSDP No. 739

Name of Laboratory/ Centre/ Unit:

- PCSIR Laboratories Complex Lahore
- University of Agriculture Faisalabad

Title of Project: Gene Editing of Biological Agents for Nutritional, Bio-chemicals and Therapeutic Purposes

Name & Designation of Project Director:

Dr. Qurat ul Ain Syed, Project Director

Name & Designation of Project Associate(s):

Dr. Sultan Habibullah khan (UAF), Project Manager
 Dr. Yasar Saleem (PCSIR), Project Coordinator

Area(s) of Research:

Biotechnology/Genetics

Duration:

03 Years (Extended for 02 Years)

Date of Initiation:

26.04.2021

Project Brief:

PCSIR

- To establish advance Microbial Gene Editing Facility at PCSIR for nutritional and therapeutic purposes
- To develop indigenous microbial strains using genetic engineering capability for production of bio-foods, bio-chemicals, bio-pharmaceuticals, bio-fertilizers, bio-pesticides: Single Cell Proteins, Vitamin A, Omega-3, Bio-Butanol, Industrial

Enzymes etc.

- To develop Quality Assurance Services of developed bio-products and their subsequent commercialization.
- Capacity building by conducting trainings, workshops, seminars and research capability.

UAF

- To develop CRISPR/Cas based Genome Edited Laboratories for climate resilient crops with better grain quality and yield.
- To develop in vitro CRISPR/Cas based human healthcare laboratory for drug resistant pathogens.
- To develop genome editing based novel diagnostic tool for human diseases.
- To initiate capacity building of public and private sector in adaptation of genome editing technology.

Funding Source (PSDP/SGI/RD&I/etc):

PSDP

Cost:

Rs. 1799.598 Million

Tangible Outcome:

- Customization of four labs, Gene Editing, Molecular Biology, Bioanalytical and Advanced Computing and data processing at PCIR LLC - completed.
- Customization of Bioinformatics, Genomics, Culturing labs, Growth rooms, BSL-3 facility at UAF - completed.
- Technology for Lysine, DHA (Omega-3), Beta-Carotene – completed.
- Genetically edited wheat, cotton, soybean, tomato – Completed.

Achievements:

Achievements by PCSIR:

- Four state of the art labs, Gene Editing, Molecular Biology, Bioanalytical and Advanced Computing and data processing at PCSIR LLC has been completed at PCSIR LLC with 106 No. equipment commissioned.

- ToT from China for Lysine DHA, Beta Carotene and N Butanol completed.
- Production technology for 3 bioproducts developed at indigenous level:
 - i. Lysine, ii. DHA (Omega-3), iii. Beta-Carotene
- Development and production of Recombinant Ovalbumin and Pectate lyase from yeast through recombinant DNA technology.
- 350 consultancies provided to various clients including PSQCA, Punjab Food authority, customs, SMEs and other clients.
- 15 No Process developed.
- Chemical and consumables has been procured.
- 07 National/ International trainings conducted.
- Ten testing services developed.
- Feed grade lysine production technology has been optimized and downstream processing of Lysine-Hydrochloride is in process.

Achievements by UAF:

- Bioinformatics, Genomics, Culturing labs, Growth rooms, BSL-3 facility - Completed.
- Gene Edited cotton, wheat, citrus, soybean, tomato-completed.
- Different targeted gene edited crops including wheat, citrus, cotton, soybean, tomato, potato was developed, soybean was cultivated at 100 acres of land.
- Different national and international workshops.



PSDP No. 741

Name of Laboratory/ Centre/ Unit:

Immunodiagnostic Unit, MEDICen, Peshawar

Title of Project: Medical Equipment & Devices Innovation Center (MEDICen)

Name & Designation of Project Director:

Engr. Ghulam Shabbir, Project Director, MEDICen

Name & Designation of Project Associate(s):

Mrs. Mohsina Andaleeb, Designation: Focal Person, MEDICen, Islamabad
 Dr. Muhammad Qaiser, Designation: Focal Person, MEDICen, Peshawar Labs Complex (PLC)

Area(s) of Research:

Antibody Engineering/Biomedical Devices & Diagnostics/Medical Imaging & Digital Health/ Indigenous design and prototyping of medical equipments.

Duration:

04 Years (Extended for 01 Years)

Date of Initiation:

09th November, 2021

Project Brief:

The Medical Equipment & Devices Innovation Center (MEDICen) is envisioned as Pakistan’s first limited facility for antibody engineering and medical device development, dedicated to advancing affordable, indigenous healthcare solutions. The Immunodiagnostic Unit (IDU) at Peshawar will establish capabilities for the engineering and production of monoclonal and recombinant antibodies, supporting both diagnostic and therapeutic applications. Core activities will include antibody discovery through hybridoma and phage display technologies, the development of diagnostic reagents for ELISA and lateral flow assay applications and the establishment of scalable, GMP-compliant production platforms using mammalian, microbial and yeast expression systems. Alongside antibody research and development, MEDICen will help to the designing/development of AI/IOT based design and local production of essential healthcare technologies such as diagnostic devices, surgical tools, imaging systems and assistive technologies in collaboration with academic and industry. MEDICen will also play a vital role in supporting Pakistani medical and surgical manufacturers through applied research and development, following the Triple Helix Model of

collaboration between academia, industry and government.

Aligned with Pakistan's vision of building a knowledge economy and promoting the "Made in Pakistan" brand, the IDU-center will adopt an open-source strategy to accelerate innovation, foster technology transfer and ensure broad accessibility of healthcare solutions. It will also encourage an entrepreneurship culture, particularly in digital health and IoT-enabled medical solutions, creating opportunities for startups and local innovators. By enhancing academia–industry linkages, MEDICen will strengthen translational research, ensuring that scientific advancements are quickly converted into practical healthcare applications.

Pakistan faces a critical gap in the availability and local production of advanced biomedical solutions, particularly in the areas of antibodies and medical equipment. At present, the country depends heavily on imported diagnostic kits, biological and medical devices, leading to high costs, limited accessibility and vulnerability to global supply chain disruptions. This dependency not only burdens the healthcare system but also restricts timely responses to infectious diseases outbreaks and rising cases of chronic conditions such as cancer and autoimmune disorders. Besides, the lack of indigenous manufacturing capability and capacity in both antibody development and medical equipment production limits innovation, technology transfer and opportunities for local industry growth.

The Medical Equipment & Devices Innovation Center (MEDICen) scope will encompass research to commercialization, covering indigenous production of diagnostics, surgical tools, imaging systems and smart healthcare technologies. It will promote the *Made in Pakistan* brand and expand its reach globally by offering affordable, innovative healthcare solutions. MEDICen is equipped with the following advanced platforms and infrastructure.

a. Antibody Engineering & Production Platform

- Hybridoma technology for monoclonal antibody generation.
- Phage display and recombinant DNA platforms for antibody discovery.
- Mammalian, microbial and yeast expression

systems for scalable antibody and protein production.

- GMP-compliant upstream (bioreactors) and downstream (chromatography, purification) facilities.
- Assay development units for ELISA, lateral flow assays and molecular diagnostics.

b. Medical Equipment & Device Manufacturing Units

- Precision machining and prototyping labs (CNC, 3D printing, microfabrication).
- IoT integration labs for smart healthcare device development.
- AI and software development modules for predictive diagnostics and device interfacing.

c. Analytical & Testing Facilities

- Biosafety level (BSL-2) labs for infectious disease research.
- Quality control labs for chemical, mechanical and biological validation.

The core objectives of the present project are as follows:

- Establish indigenous capacity to produce antibody libraries and diagnostic kit assemblies for infectious and non-communicable diseases.
- Assist Pakistani medical and surgical manufacturers in R&D and device innovation through the Triple Helix Model of academia–industry–government collaboration.
- Advance Pakistan's knowledge economy and promote the Made in Pakistan brand in healthcare technology.
- Encourage an open-source innovation ecosystem to accelerate collaborative research.
- Develop an entrepreneurship culture in IoT-enabled healthcare solutions.
- Build strong academia–industry–R&D linkages for translational research and commercialization.
- Boost the usage of artificial intelligence in diagnostics and device development.
- Promote data sharing and integration across research and healthcare sectors.

Project Layout:



The diagram illustrates the end-to-end pathway of the MEDICen project, highlighting its progression from research to market deployment

Funding Source (PSDP/SGI/RD&I/etc):

Ministry of Science and Technology (MoST), Islamabad

Cost:

Rs. 1,989.52 Million

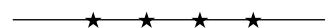
Tangible Outcome:

- Pakistan’s biomedical and healthcare innovation ecosystem will be strengthened.
- Antibody libraries, diagnostic kits (ELISA, LFA, molecular assays) to support the National health programs, diagnostic labs, the biotech industry, and patients.
- Transfer of Technology for antibody production & infectious disease kits to local biotech industry, public health sector and pharma industry.
- Medical device prototypes (surgical tools, diagnostic equipment, assistive technologies) for Hospitals, surgeons, patients and medical device companies.
- IoT/AI-enabled healthcare devices & platforms.
- Process development & design improvement for medical devices to benefit local manufacturers, R&D institutes and quality testing labs.
- Trained manpower in medical devices, biotechnology and diagnostics.

Achievements:

MEDICen has recorded substantial progress in its implementation, with notable achievements outlined below:

- Equipment for the Immunodiagnostic Unit (IDU) has been delivered and the installation, commissioning and training completed.
- BSL-II Lab Established.
- Technology Transfer/Services for IDU at PCSIR, Peshawar completed.
- CIVIL Work for Medical Device Unit at PCSIR Islamabad Completed.
- Tender for medical device testing equipment is in the pipeline.
- Stakeholder consultations successfully held with DESTO, PCSIR and HMC (Hayat Abad Medical Complex), Peshawar.
- 22 project staff hired on a contract basis.
- Rs. 566.318 Million utilized till 30.06.2024.
- Hands-on training sessions conducted on advanced analytical equipment for capacity building of scientists and technical personnels from different stakeholders.
- **MoUs has been signed with Quaid-e-Azam University and MS Silkway Chemicals/ Nutraceuticals** to strengthen academia–industry linkages and foster collaborative R&D in respective area.



PSDP No. 749

Name of Laboratory/ Centre/ Unit:
PCSIR Laboratories, Islamabad

Title of Project: Research, Development and Technology Transfer of Selected Active Pharmaceutical Ingredients (APIs) for Import Substitution

Name & Designation of Project Director:
Dr. Aneela Fatima, Project Director

Name & Designation of Project Associate(s):
Dr. Amir Haider, Consultant
Dr. Nafeesa Qudsia Hanif, PSO
Dr. Anila Fariq, SSO
Dr. Bushra Arshad, SSO
Ms. Anum Goraya, SO
Mr. Muhammad Mustafa, SO
Mr. Safi ullah, LA

Area(s) of Research:
Pharmaceutical Biotechnology

Duration:

02 Years (Extended for 01 Years)

Date of Initiation:

01-08-2023

Project Brief:

Pakistan’s pharmaceutical market has grown rapidly, from Rs. 189.2 Billion (US\$ 2.03 Billion) in 2012 to about US\$ 3.2 Billion by 2020. This growth is driven by rising population, longer life expectancy, and better access to healthcare. More than 600 pharmaceutical manufacturers are registered in the country, of which around 25 are multinationals. Market share is concentrated, with the top 50 companies controlling nearly 80% of sales, while GlaxoSmithKline remains the largest supplier. This concentration highlights the strong presence of multinational firms in the domestic market.

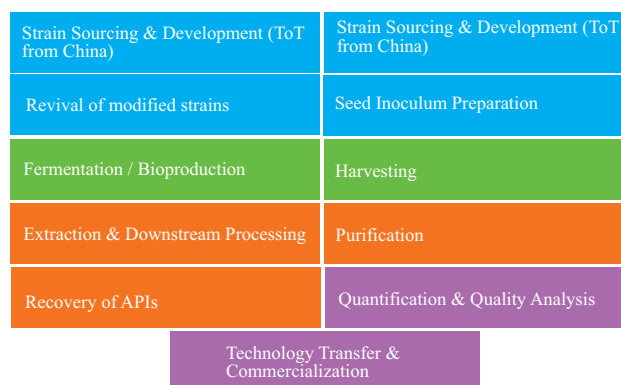
The pharmaceutical industry in Pakistan produces a wide range of formulations, including tablets, capsules, syrups, suspensions, creams, ointments, eye drops, infusions, vaccines, inhalers and insulin. Nearly 78,000 pharmaceutical products are registered, the majority of which are generic medicines that serve local demand. However, some larger domestic firms are starting to invest in advanced and high-value products. Despite these advances, the sector remains import-dependent, particularly for raw materials, which creates challenges for cost control and supply stability.

Currently, about 95% of the Active Pharmaceutical Ingredients (APIs) required by the local industry are imported from Europe, Japan, Korea, South America and Southeast Asia. This heavy reliance increases production costs and exposes the sector to global supply chain disruptions. Pakistan’s pharmaceutical sector is valued at over USD 3.2 Billion and continues to grow, yet it remains heavily dependent on imports for Active Pharmaceutical Ingredients (APIs). In 2020, pharmaceutical imports reached Rs. 158 Billion compared to exports of only Rs. 33 Billion, clearly reflecting an import-reliant industry. At present, nearly 95% of the country’s API requirements are met through imports, creating a significant burden on the trade balance and exposing the sector to frequent supply chain disruptions.

Despite having more than 600 registered manufacturers and a strong domestic market, the lack of indigenous API production is a critical bottleneck that restricts Pakistan’s pharmaceutical industry from achieving self-reliance and export competitiveness. To address this gap, there is an urgent need to develop local capacity for API manufacturing using advanced approaches such as metabolic engineering and biocatalysis, supported by PCSIR’s technical infrastructure and expertise. The core objectives of the present project are as follows;

- Development of high-yield microbial strains for API production.
- Optimization of fermentation, downstream processing and purification.
- Pilot-scale studies leading to industrial-scale manufacturing.
- Establishment of quality analysis and regulatory compliance framework.
- Technology transfer to local pharmaceutical industry for commercialization.
- Reduction of import dependency and strengthening of national healthcare security.

Flow Diagram:



Funding Source (PSDP/SGI/RD&I/etc):

PSDP

Cost:

Rs. 1067.639 Million

Tangible Outcome:

Transfer of Technology (TOT) to Local Industries:

- Production of key APIs at PCSIR.

- Import substitution and to save foreign exchange.
- Self-reliance.
- Promote R &D with academia and pharmaceutical industry.

Achievements:

- Labs have been renovated for production of APIs at Laboratory/ pilot scale.
- Successful installation of a pilot plant facility at PCSIR Labs, Islamabad, for in-house production of Vancomycin, Cyclosporine A and Vitamin B12.
- Training given by COWAY China for the production of Vancomycin, Cyclosporine A and Vitamin B12 has been completed.
- Efforts have been initiated for signing MoUs/ transfer of technology with potential pharmaceutical companies, including:
 - 11 industries for Vancomycin
 - 7 industries for Cyclosporine A
 - 79 industries for Vitamin B12
 multiple companies have shown interest in exclusive and non-exclusive tech acquisition.
- Training and capacity-building activities initiated for PCSIR staff and selected pharma industry & academia in microbial fermentation and GMP practices.
- Revenue model finalized, with technology transfer projected to earn PCSIR 3% royalty per transfer, ensuring long-term revenue generation.



PSDP No. **750**

Name of Laboratory/ Centre/ Unit:

- Ministry of Science & Technology, Islamabad (for National Industrial Hemp & Medicinal Cannabis Authority)
- PCSIR Laboratory Complex, H-9, Islamabad (National Hemp & Medicinal Cannabis Analytical Lab.)
- PCSIR Laboratories Complex, Karachi (greenhouse, extraction/distillation, testing)
- PCSIR Laboratories Complex, Lahore (greenhouse, extraction/ distillation, testing)
- PCSIR Laboratories Complex, Peshawar (greenhouse, extraction/distillation, testing)

- PCSIR Laboratories, Skardu (greenhouse, extraction/distillation and testing)

Title of Project: Establishment of Medical Cannabis Greenhouses For Biotechnology Derived Bio-products, National Hemp & Cannabis Analytical Laboratory and National Industrial Hemp & Medicinal Cannabis Authority

Name & Designation of Project Director:

Engr. Sohail Ameer Marwat, Project Director/ Member (Technology), PCSIR

Area(s) of Research:

Hemp Cultivation, Processing, Analysis for Medicinal and Industrial Use.

Duration:

03 Years

Date of Initiation:

17-08-2023

Project Brief:

The global Industrial Hemp and Medicinal Cannabis industry is expected to grow from current US\$ 25 Billion to approximately US\$ 100 Billion by 2026, recording a Cumulative Annual Growth Rate (CAGR) of 34%. Pakistan needs to act swiftly to join this rapidly growing industry and earn foreign exchange worth Billions of dollars. Additionally, hemp cultivation will create thousands of jobs in a variety of industries, it is critical to leverage governance to maximize the likelihood of successfully implementing this hemp policy at the national level by CCRA.

Industrial Hemp and Medicinal Cannabis are both cultivars of the *Cannabis sativa* plant that are genetically and chemically distinct. The plants are covered with tiny hairs called trichomes that produce a resin containing chemical compound called cannabinoids. These plants contain hundreds of Cannabinoids including Cannabidiol (CBD) and Tetrahydrocannabinol (THC). CBD is a non-psychoactive phytocannabinoid, whereas, THC is the psychoactive component of cannabis that generates the euphoric

‘high’, associated with its usage. Industrial Hemp is the cultivar of *Cannabis sativa* having a THC content of less than 0.3% and a higher content of CBD. On the other hand medicinal cannabis contains THC more than 0.3%. THC is used medicinally for the treatment of certain medical conditions.

The primary significance of this project is to create a vehicle for implementation of National Industrial Hemp & Medicinal Cannabis Policy and support Cannabis Control & Regulatory Authority (CCRA) through establishment of a state-of-the-art cannabis production greenhouse in Skardu and the downstream and analytical services facilities at Islamabad/Peshawar to render end-to-end analytical services to the entire value chain. The core objectives are as follows:

- Establishment of state of the art green house facilities each at PCSIR Labs Complexes Karachi, Lahore, Peshawar and Skardu to cultivate medicinal cannabis under controlled conditions for herbal and medicinal use.
- Biotechnology based fermentation technology to produce multiple cannabinoids (CBD, THC, CBG, CBC etc.) under good manufacturing practices (GMP).
- Indigenize production of industrial hemp and medicinal cannabis seeds in collaboration with private sector.
- Establishment of a National industrial hemp and medicinal cannabis analytical laboratory in PCSIR Laboratories Complex, Islamabad.
- Seed capital for the establishment and operation of Industrial Hemp and Medicinal Cannabis Authority in the existing premises of Ministry of Science and Technology.
- To provide state-of-the-art analytical services to the exporters and industry of cannabis products.

Funding Source (PSDP/SGI/RD&I/etc):
PSDP

Cost:
Rs. 1946.014 Million

Tangible Outcome:

- This project will result in having state-of-the-art greenhouses at four locations that will be able to act as a nursery and controlled facility for

production of medicinal cannabis.

- Creation of a national analytical laboratory for medicinal cannabis and industrial hemp would be a premier analytical and testing services facility in the country to ensure high quality medicinal cannabis and downstream products.
- Microbial fermentation would help in fast tracking the production of medicinal cannabis using biotechnology techniques.
- It will increase export earnings for the country as well as reduce imports of some pharmaceuticals.

Achievements:

- Layout plan and other requirement for Greenhouses are in process and tender will be launched once it is finalized.
- Equipments have been procured and delivered at Analytical Laboratory (PCSIR Laboratories Islamabad)
- Installation/ Commissioning/ Training of above mentioned equipment is in process.
- Analytical Laboratory established and services will be provided once the Installation/ Training completed.



PSDP No. 743

Name of Laboratory/ Centre/ Unit:
PCSIR Head Office, Islamabad

Title of Project: Research, Development and Innovation (RD&I) in PCSIR

Name & Designation of Project Director:
Dr. Sarwat Ismail, CSO/Project Director

Name & Designation of Project Associate(s):
Engr. Zafar Shahzad, PE/ DPM
Dr. Shafqat Ullah, SSO
Mr. Imran Baig, SEO

Area(s) of Research:
Biotechnology, Electric & Electronics, Advanced Agriculture, Food, etc.

Duration:

02 Years (Extended for 03 Years)

Date of Initiation:

August, 2021

Project Brief:

PSDP project titled “Research, Development and Innovation in PCSIR” was approved by the Planning Commission dated 27-05-2021 with a cost of Rs. 1500.00 Million to ensure the availability of a continuous stream of funds to support RD&I-funded projects allied to upstream and downstream initiatives for supporting businesses, sustainable industrialization and socio-economic development. Creation of R&D endowment fund would enable PCSIR to diversify its funding sources leading to financial stability and self-sustainability. The core objectives of the project include:

- To establish an RD&I Programme facility for a variety of purposes in the domain of scientific/ technological/ industrial research such as new technology initiatives, cutting-edge/ advanced R&D, commercialization, digitalization, marketing, industrial-business linkups/partnerships, etc. leading to indigenous commercial/industrial ecosystem.
- Creation of an Endowment Fund Facility to create a continuous source for funding for innovative research.
- Develop linkages to facilitate cooperation between research and development facilities at PCSIR, industrial businesses, technology producers and investment platforms.
- Leveraging commercial activities, the RD&I Programme could provide new vistas of industrial technology related businesses for the country, thus moving towards knowledge-based economic growth.
- Provide support to sustain and improve the essentially required facilities and activities at PCSIR by creating an environment of continuous services for the technological initiatives carried out in collaboration with PCSIR (Public & Private) Partners.

Funding Source (PSDP/SGI/RD&I/etc):

PSDP

Cost:

Rs. 1500.00 Million

Tangible Outcome:

- The project strategically fosters innovation and technological advancements, addressing the core mandate of PCSIR in supporting research and development activities.
- By addressing financial challenges, the project ensures sustainable funding for internal R&D programs, critical for PCSIR's operational and developmental goals.
- Establishing an endowment fund ensures a steady income stream for ongoing and future R&D projects, reflecting strategic financial management.
- The project emphasizes capacity building via trainings, workshops, and seminars, enhancing industrial research and supporting capabilities in advanced technologies.
- The initiative strengthens linkages between academia, industry and PCSIR, facilitating resource synergy and translating academic research into practical industrial applications

Achievements:

- 10 demand-driven research projects are under execution out of which 05 are near completion
 - Efficient Canola Seed Processing and Value Addition Byproducts.
 - Production of Natural Fruits Vinegar.
 - Extraction, purification, characterization of Eugenol and synthesis of Methyl Eugenol (ME).
 - Installation of Vertical Hydroponics Growing System for Fruits, Vegetables and Medicinal Herbs and Development of Various Products.
 - Establishment of Testing Facility for Electric Motors.
 - Micropropagation and Mass-Multiplication of Cannabis Sativa Through Tissue Culture Techniques.
 - Development of facility and ISO-17025 Accreditation of Method: Test for systematic toxicity.
 - Establishment of Re-circulating Aquaculture System (RAS) for Karachi – Sindh/ Baluchistan Coastal Areas.

- Sustaining and Establishing New Calibration Facilities at PCSIR Karachi.
- Designing and Implementing Un-interruptible Power Supply Systems Using Sustainable Green Energy Solutions at PCSIR.
- R&D based process/ products/ technologies developed.
- 13 processes/ products have been developed.
- 02 technologies naming; vertical hydroponics for growing system for fruits, vegetables & herbs and mass propagation through tissue culture technique.
- 01 technology, Re-Circulating Aquaculture System (RAS) is under establishment.
- 01 testing facility for electric motor have been established.



Sub Projects of RD&I

Name of Laboratory/ Centre/ Unit:

APC&IC/PCSIR Laboratories Complex, Karachi

Title of Project: Establishment of Testing Facility for Electric Motors

Name & Designation of Project Director:

Mr. Arif Karim, PSO

Name & Designation of Project Associate(s):

Mr. Faisal Ghazanfar, SSO

Mr. Naseem Ahmed, SEO

Dr. Abid Karim, SSO

Mr. Kashif Husain, TO

Mr. Noman Saeed, TO

Area(s) of Research:

Testing & Analysis in the Field of Electric Motors Performance Evaluation, Instrumentation

Duration:

03 Years (Extended for 1 Year)

Date of Initiation:

2022

Project Brief:

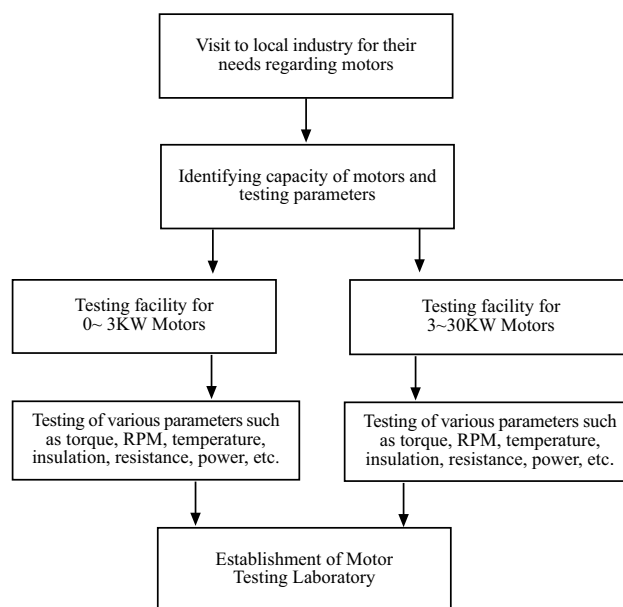
Electric motors play a vital role in industry and home appliances. About 60~70 percent of electricity consumption in industry is due to electric motors. An efficient motor will therefore reduce electricity consumption many folds, in addition the pay-back period of motors will also be reduced. The testing of efficiency of motors is therefore a pressing need of our industry. In this connection PSQCA placed motors in their mandatory list for compliance of IEC standards IEC 60034(x). Similarly, Karachi Shipyard and Engineering Works (KS&EW) contacted PCSIR for developing testing facility especially for high power motors. In addition, the domestic motors used in fans, pumps, refrigerators (Compressors), air conditioners (Compressors) washing machines, exhaust etc are low power having range up to 8HP. Furthermore, there is another need of mobile-testing lab for onsite (In-Situ) motor testing under load and in process, however, this project is aimed at developing in-house testing facility

for the range of 0.5~30KW electric motors.

There is a great need of high efficient motors for energy conservation. It requires testing of its various parameters as per international standard. The local and imported motors need to be verified for their efficiency ratings and specifications. In addition, the local industry needs to be supported for technically for producing and testing high efficient motors. Presently, there is limited facility of testing in Pakistan (up to 6kW), this project will extend testing range up to 30kW (40HP), thus helping local industry regulators and importers. The main objectives are as follows:

- Development of indigenous facilities and expertise for testing various parameters of Electric-Motors.
- The testing range may be of 0.5~30KW.
- Quality control and assurance for the imports / export as well as for domestic use.
- Consultancy to public / private sector / industries / universities for the Energy audits for their Electrical motors and plant machines.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

RD&I

Cost:

Rs. 45.64 Million

Tangible Outcome:

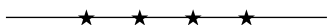
- It will help in regulation and control of under rated motors for its local production as well as its import, thus, leading to energy conservation.
- It will help in energy conservation by identifying under efficient motors in process plants which will eventually lead to low cost products in the market.

Achievements:

- The Test benches and related instruments have been received and installed successfully.
- Various in house motors have been tested for its various parameters. Similarly, an onsite 40-HP motor (PCSIR water pump) have been tested utilizing the portable instruments.
- A promotional video have been made and sent to the stock holder for marketing.
- PSQCA, EDB and NEECA have been contacted and informed about the facility.

Status:

On-Going



Name of laboratory / Centre/ Unit:

CL/ PCSIR Labs. Complex, Karachi

Title of Project: Sustaining and Establishing New Calibration Facilities at PCSIR Karachi

Name & Designation of Project Director:

Syed Zain ul Ibad, PSO

Name & Designation of Project Associate(s):

Mr. Atif Aziz, SEO
 Mr. M. Shamshad, SSO
 Mr. Wasim uddin, SSO
 Engr. Naveed Ahmed, SE

Area(s) of Research:

Metrology (Calibration)

Duration:

04 Months

Date of Initiation:

March, 2025

Project Brief:

Calibration Lab. was established in the year 1998 and awarded accreditation against ISO 17025 standard in the year 2004. Calibration lab was strengthened under BMR and ILP projects, receiving last equipment in the year 2006. Since then all equipment were used in calibrating of customer equipment. After years of satisfactory performance of equipment, random error may be generated at any time and a serious threat to existing accreditation against ISO/IEC-17025 standard. This project is designed to innovate new calibration facilities and to strengthen the existing facilities by considering potential demand in different public and private sectors. This project is also helpful to maintain and sustain accreditation from Pakistan National Accreditation Council (PNAC) against ISO-17025 Standard vide Lab Code 002.

The project is expected to cover all industries working under CPEC Project. Keeping in view customer demand, we have set new objectives, to increase our capabilities in different fields of calibrations like, Force, Pressure, Volumetric and Electrical parameters. At present Calibration Lab of KLC is providing calibration services to public and private sectors including, Pakistan Navy, Pakistan Army, DESTO, Peoples Steel, KANUPP, Atomic Energy, PSQCA, SGS, Textile Sector, Pharmaceutical Sector, Pathology Labs and other inspection and certification bodies.

ISO/IEC-17025 is the only International standard applicable to calibration labs to ensure the competence in respective fields. Calibration lab of PCSIR Karachi is the only accredited lab available in whole Sindh region that provides calibration services to public and private organizations in following fields.

- Mass/Balance Calibrations
- Electrical/Electronic equipment Calibrations
- Thermal Equipment Calibrations
- Dimensional Equipment Calibrations
- Pressure Equipment Calibrations
- Glassware Calibrations

The objectives of the present project are given below:

- To innovate new calibration facilities
 Electrical (up to 100 kVA)
 Force (up to 1000 kN)
 Pressure (up to 15000 psi)
 Humidity (5-95 %RH)

pH (2-11 pH)/ Conductivity (84 and 1413 μ S)/ TDS Measurements (2000 mg/L)

- To strengthen existing calibration facilities with better precision and accuracy.
- To get accreditation for new innovated calibration facilities to meet the requirements of ISO/IEC 17025: 2017 Standard.
- To save foreign exchange of the country by providing calibration services locally.
- To work as 3rd party lab to resolve any disputes on calibrations.

Work Plan:

- Method review and selection
- Preparation of Tender Documents
- Installation/Commissioning and Operational Training
- Extension of Accredited Scope

Funding Source (PSDP/SGI/RD&I etc.):

RD &I

Cost:

Rs. 93.4218 Million

Tangible Outcomes:

After the completion of project, expected tangible and quantifiable outcomes in terms of revenue and scope extension are as under:

- Revenue may be increased by Rs. 15.0 Million per annum by increasing clientage about 40-50%.
- New facilities in the fields of Electrical, Force, Pressure, Dimensional, Thermal and Volumetric
- Sustainability of current facilities.
- ISO/IEC-17025 scope extension for the following parameters
 - Electrical (AC/DC Current (up to 1000 ampere), Frequency (up to 1000MHz)
 - Force (up to 1000 kN)
 - Torque (up to 1000 Nm)
 - Pressure (up to 15000 psi)
 - Humidity (5-95 %RH)
 - pH 02-11 pH
 - Conductivity 84 & 1413 μ S
 - TDS Measurements 2000 mg/L

Achievements:

- Principal Investigator and his team conducted

standard method review (OIML) and identify requirements to establish new calibration facilities and to sustain existing calibration facilities to meet the requirements of ISO/IEC-17025 standard.

- Procurement process has been started.

Status:

New Project



Name of Laboratory/Centre/Unit:

CES/PCSIR Labs. Complex, Karachi

Title of Project: Extraction, Purification, Characterization of Eugenol and Synthesis of Methyl Eugenol (ME)

Name & Designation of Project Director:

Dr. Sohail Shaukat, SSO

Name & Designation of Project Associate(s):

Engr. Nazir Ahmed Tunio, PE

Area(s) of Research:

Agriculture & Irrigation Technologies/Environment

Duration:

03 Years

Date of Initiation:

2022

Project Brief:

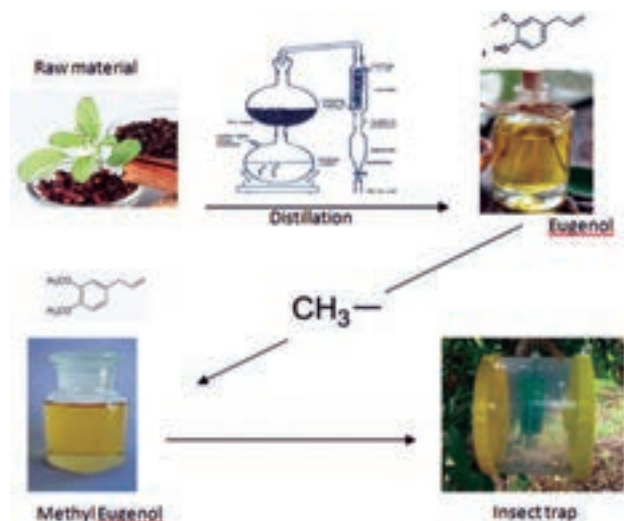
Methyl eugenol (ME) is a molecule which shows insect pheromone activity for fruit flies (especially for mango farming and generally for other fruits and vegetables), although it is believed not to be the natural pheromone itself. If present in sufficiently high concentration, it will immediately deter the herbivore from further feeding on the affected part. ME acts as a deterrent or repellent. No harm is expected from use of this substance as pesticide products. It is one of many compounds that are attractive to males of various species of orchid bees, which apparently gather the chemical to synthesize pheromones, it is commonly used as bait to attract and collect these bees for study

or disruption. It also attracts female cucumber beetle. Its derivative form, Methyl Eugenol (ME), was found to be the most active attractant for the oriental fruit fly, *Bactrocera dorsalis*.

In Pakistan, ME is used extensively especially in mango farming and being imported from abroad. Up to the best of our knowledge, it is not produced in Pakistan; therefore, the growers have to purchase it from importers/distributors. This creates a burden over them in terms of finances and in time supply. Thereby, the grower community is seeking for the local production. This project is designed to explore some economically feasible options indigenously for ME production. The pilot plant for Eugenol extraction and ME synthesis will result in value addition of indigenous sources (non-hazardous) of pest control. It will help to optimize the process of Eugenol extraction and derivatization of Eugenol. Objectives are:

- Establishment of pilot plant facility for extraction and derivatization of Eugenol.
- Process optimization to achieve economically feasible level yield in Eugenol extraction and derivatization from plant sources.
- Development of a unique research cum production facility on the subject matter at PCSIR KLC.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):
RD&I

Cost:
Rs. 11.5 Million

Tangible Outcome:

- Product Development (Methyl Eugenol).
- Pilot Scale Process Development for ME production.

Achievements:

- Synthesis of Methyl Eugenol via different processes completed.
- First phase of Methyl Eugenol field experiments is completed.
- Designed the reaction chamber for pilot scale synthesis of Methyl Eugenol.
- Preparation of reaction chamber is complete.

Target:

- Optimization of process for Synthesis of Methyl Eugenol at pilot scale.
- Second phase of Methyl Eugenol field experiments.

Status:

On-Going



Name of Laboratory/ Centre/ Unit:

FMRC/PCSIR Labs. Complex, Karachi

Title of Project: Micropropagation and Mass-Multiplication of Exotic Cannabis Varieties to Produce Higher Medicinal Value Plants

Name & Designation of Project Director:

Dr. Beena Naqvi, PSO

Name & Designation of Project Associate(s):

Dr. Shazia Yasmeen, PSO
Engr. Mohammad Ashaf, SE

Area(s) of Research:

Plant Biotechnology

Duration:

03 Years (Extended for 1 Year)

Date of Initiation:

2023

Project Brief:

Cannabis sativa is an annual herbaceous flowering plant indigenous to eastern Asia but now cultivated widely because of economically important medicinal compounds. The flowers of *Cannabis sativa* are unisexual and plants are most often either male or female. It has been cultivated as a source of industrial fiber, seed oil, food, recreation, religious and spiritual moods and medicine. *Cannabis sativa* seeds are chiefly used to make hempseed oil which can be used for cooking, lamps, lacquers, or paints. Historically, tinctures, teas and ointments have also been common preparations. In traditional medicine of India in particular *C. sativa* has been used as hallucinogenic, hypnotic, sedative, analgesic and anti-inflammatory agent.

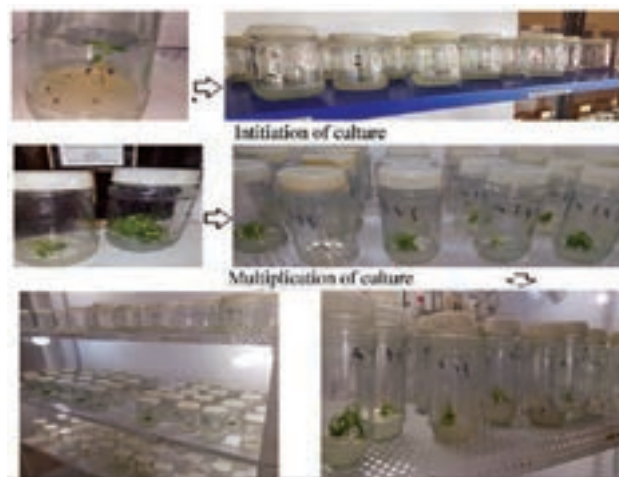
Pakistan needs to act swiftly to join this rapidly growing industry and earn foreign exchange worth Billions of Dollars through export of non-narcotics cannabis products such as Cannabidiol (CBD) oil, fiber and dozens of other products. Till now only PCSIR has the permission to cultivate cannabis under strict security control of ANF. Developing the facility for cannabis production can be viable for economic uplift of the country.

Tissue culture multiplication has become important in producing medically important clones. Micro-propagation of *Cannabis sativa* L. is an emerging area of research for genetic storage a uniform, true-to-type and large-scale production of clean planting material. Micropropagation is an alternative approach for vegetative propagation that eliminated many risks like cross pollination, variety contamination, infection by pests, disease and viruses. With an effective *in vitro* protocol, many genotypes can be maintained using significantly less space while providing a consistent supply of clean plants. Recently focus on cannabis tissue culture has increased, addressing many aspects including regeneration and screening for elite cultivars. Significant challenges still exist in Cannabis research and recent *in vitro* studies using medicinal Cannabis have only assessed a few cultivars, with most developed using a single genotype. It is also used to provide enough plantlets for planting from a stock plant of desired quality. Objectives are:

- Micro-propagation of *Cannabis sativa* through tissue culture technique.

- Mass-multiplication of true to type plant of our interest all-round the year.
- To enhance the quantity of commercially important compounds (Plants Metabolites).

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
RD&I

Cost:
Rs. 4.00 Million

Tangible Outcome:

- Micropropagation of *Cannabis sativa* L. will enable us to supply uniform, true-to-type plants in large-scale throughout the year.

Achievements:

- Micro-propagation of exotic, non GMO *Cannabis* varieties from USA has been initiated and multiplied through tissue culture technique.
- Study on optimization of acclimatization conditions of two varieties in winter had been done in green house.
- Procurement of approved items at the cost of 3.049 Million is completed.

Status:
On-Going



Name of Laboratory/Centre/Unit:

FMRC/PCSIR Labs. Complex, Karachi

Title of Project: Establishment of Re-Circulating Aquaculture System (RAS) for Karachi-Sindh/Baluchistan Coastal Areas

Name & Designation of Project Director:

Dr. Farman Ahmed, PSO

Name & Designation of Project Associate(s):

Dr. Samee Haider, PSO

Engr. Baitullah Kibzai, SE

Area(s) of Research:

Marine Aquaculture

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

Re-Circulating Aquaculture System (RAS) is a technique that uses mechanical and biological purification to eliminate suspended particles and metabolites from water before recycling and reusing it. This technique uses the least amount of water and land feasible to breed several species of fish in greater density. The RAS may be useful in this aspect. Because it allows fish to be farmed in net cages or tanks rather than open-air ponds and it enables farms to be built in areas where groundwater is scarce and in urban areas where chlorine-free municipal water is used. Moreover, RAS based fish farms are proved to be major source of extraction of Vitamin E, Omega-3 Fatty Acids and Fish oil. Which have numerous benefits like Blood pressure control, increases immunity, cure to skin disease, reduces the risk of depression, dementia, diabetes, eyesight problem, asthma, allergies and etc. Due to these numerous benefits, the establishment of RAS farms in Karachi can be the course of aquaculture as a cost-effective solution with minimal environmental impact, as well as a source of revenue generation for the state treasury and the farmer in both the domestic and international markets.

Setting up a RAS can be complex but offers significant benefits, such as efficient water use, reduced environmental impact and the ability to control growing conditions. Proper planning, management and maintenance are crucial for success. The growing demand for sustainable sea food production has led to an increased interest in innovative aquaculture systems, particularly Re-Circulating Aquaculture Systems (RAS). These systems offer a controlled environment for fish farming, minimizing water use and reducing environmental impact. Objectives include:

- Achieve a system design that ensures at least 80% water recirculation efficiency.
- Achieve a fish growth rate that meets or exceeds industry benchmarks for the chosen species.
- Minimize waste discharge by implementing a waste recycling system that reduces the volume of waste sent to disposal by 70%.
- Reduce the risk of disease outbreaks by maintaining water quality and biosecurity measures, resulting in healthier fish populations.
- Establish contracts or agreements with at least 2 distributors or retailers within the first year after implementation.

Work Plan:

- **Equipment Procurement (Phase I)**
 - Order tanks, filtration systems, pumps and monitoring equipment.
- **Construction and Installation (Phase I)**
 - Set up tanks and plumbing for water circulation.
 - Install filtration, aeration and heating/cooling systems.
- **System Cycling and Initial Setup (Phase II)**
 - Run the system without fish to establish biological filtration (4-6 weeks).
 - Monitor water quality parameters regularly.
 - Develop feeding schedules and waste management plans.
 - Create standard operating procedures (SOPs) for daily operations.
- **Stocking and Initial Production (Phase III)**
 - Fish Stocking:
 - Gradually introduce fish to the system.

- Monitor acclimatization and health.
- o Operational Monitoring:
 - Begin regular water quality checks, feeding and health assessments.
 - Adjust feeding and management practices based on fish response.
- o Performance Review:
 - Analyze growth rates, health and water quality data.
 - Identify areas for improvement in operations.
- o Market Launch:
 - Begin marketing and sales efforts. Establish distribution channels for product delivery.

Funding Source (PSDP/SGI/RD&I/etc.):

RD&I

Cost:

Rs. 102.69 Million

Tangible Outcome:

- Higher Yields: Due to optimized stocking densities and controlled environments, the system produces more fish per unit area and volume compared to traditional methods.
- Consistent production cycles, resulting in multiple harvests per year regardless of seasonal changes.
- Reduced Water Usage: Significant reduction (up to 80%) in water consumption compared to open pond or flow-through systems, as water is continuously filtered and reused.
- Lower Mortality: With better disease control and optimal water quality, fish health is improved, leading to higher survival rates.
- Reduced Disease Outbreaks: Tangible decrease in diseases and pathogen transmission due to advanced filtration and sterilization techniques.

Achievements:

- The civil infrastructure (Shed Construction has almost been completed. The remaining work does expect to complete subject to the installation of Machinery.
- The vendor/supplier of machine/equipment has

been asked for following:

- o Unpack Components – Several essential items remain packed and require proper handling for unpacking.
- o Install of Machinery & Equipment– Ensure the proper installation of all supplied items.
- o Operationalize the System– Facilitate the commissioning and functional testing of the installed equipment.

Status:

On-Going



Name of Laboratory/ Center/ Unit:

MBC/PCSIR Labs. Complex Peshawar

Title of Project: Installation of Vertical Hydroponics Growing System for Fruits, Vegetables and Medicinal Herbs and Development of Various Products

Name & Designation of Project Director:

Dr. Hina Fazal, SSO

Name & Designation of Project Associates:

Mrs.Farina Kanwal, PSO

Area of Research:

Horticulture/Hydroponics

Duration:

03 Years

Year of Initiation:

April, 2021

Project Brief:

Pakistan is a net food exporter, except in occasional years when its harvest is adversely affected by droughts. Following the poor harvest in nineties, the government has been introducing agriculture assistance policies, including increased support prices for many agricultural commodities and expanded availability of agricultural credit. Agricultural reforms play a central role in the government economic reform package. In this

connection adoption of advanced farming techniques is the call of the day.

Vertical farming includes the method of growing crops in stacked layers. It incorporates controlled-environment agriculture, optimizes plant growth and utilizes soilless farming techniques like hydroponics, aquaponics, or aeroponics. Herein, through this project the installation of vertical hydroponics growing system was carried out with an aim to increase the yield of fruits especially strawberry, Lettuce and medicinal herbs including Mints, Rosemary, Sage, Oregano, Basil, Tulsi, Stevia, Lemon balm, Achillea etc. that are usually resistant to severe environmental conditions of Pakistan. As a result of successful cultivation, the herbal extracts of the grown plants are produced and are being subjected to various analytical techniques, process/product development and phytochemical standardization to exploit them for their utilization in food, therapeutic herbal and cosmaceutical products. To cut short, the proposed idea will help Pakistan enhance the production of food, herbal and cosmaceutical products as well as will lessen the import of standardized extracts to an adequate level. Moreover, by the introduction of advanced cultivation technologies and by domestication of different medicinal herbs will lessen the burden on collection of these plants from their natural repositories and will add in *in situ* conservation of highly valued medicinal plants.

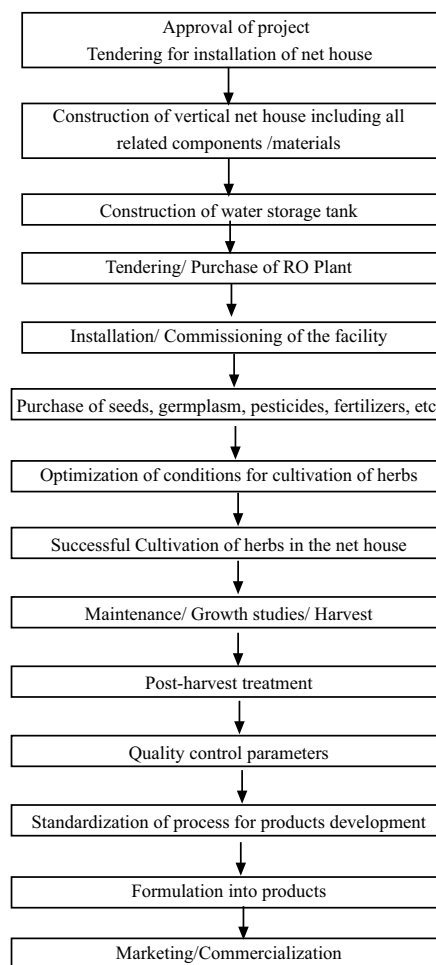
Pakistan being an agricultural country requires extensive exploitations in the area of cash crops development. Therefore, cultivation of fruit, vegetables and variety of medicinally important plants on sustainable basis is the need of the day. The successful establishment of hydroponic system and development of cultivation technologies will lead to the commercial cultivation and production of fruits, vegetables and herbal raw material, which will be helpful in fulfillment of their market demands.

Farming creates opportunities to lift people out of poverty especially in developing nations, by creating more jobs, beginning with farmers and continuing with farm equipment makers, food processing plants, transportation, infrastructure and manufacturing. Vertical farming methods negate the need for harmful chemical fertilizers and pesticides thus reduce health risks. There is less exposure to chemicals and disease. The execution of the proposed project would possibly enhance the

fresh fruits and medicinal herbs production at low cost, environmental friendly and recyclable manner. The successful execution of the project will open up new horizons for the researchers of PCSIR, and other organizations of Pakistan to pursue their research (of choice) in growing targeted crops, efficiently fruits and herbs. Main objectives are as;

- To save land and to enhance an efficient, and low cost crop production via recyclable protocol.
- To organize R&D activities pertaining to better utilization of the natural resources i.e. fruits, vegetables and medicinal herbs available in the country.
- To install a system for better utilization of available water resources by saving loss of water expected in conventional farming.
- To develop indigenous technologies for value addition to curb imports and enhance exports of the developed products.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
PSDP (RD&I in PCSIR)

Title of Project: Production of Natural Fruits Vinegar

Cost:
Rs. 35.994 Millions

Name & Designation of Project Director:
Dr. Arshad Hussain, PSO

Tangible Outcomes:

- The execution of the project enhanced the medicinal herbs production at low cost, environmental friendly and recyclable manner.
- The successful execution of the project has provided interaction and collaboration prospects to the researchers, farmers, collectors, herbalists and other stakeholders
- Moreover, the developed raw material/product/processes has provided opportunities to pharmaceutical, food and cosmaceutical industries/entrepreneurs for establishment of fruit and herbal based products.
- Based on the literature, green vertical farming potentially emit 70% less CO₂ as compared to open field farming, with additional benefits of 95% less land use and 80-90% less water use.

Name & Designation of Project Associates:

Mr. Zia Ur Rehman, ST
Ms. Hina Tariq, JSO

Area of Research:

Food Microbiology/Biotechnology

Duration:

01 Year

Date of Initiation:

2022

Project Brief:

Vinegar from the French *vin aigre*, meaning “sour wine” can be made from almost any fermentable carbohydrate source, including wine, molasses, dates, sorghum, apples, pears, grapes, berries, melons, coconut, honey, beer, maple syrup, potatoes, beets, malt, grains and whey. Initially, yeasts ferment the natural food sugars to alcohol. Next, acetic acid bacteria (*Acetobacter*) convert the alcohol to acetic acid. The wide variety of vinegars available today is nothing new. Vinegar is commonly used as food ingredient but also for its medicinal properties and for its physiological effects such as invigorating, regulator of blood pressure, diabetes mellitus regulator, appetite stimulator, digestion and absorption of calcium. Natural vinegar is a superior food additive over synthetic vinegar as it carries essential amino acids from its fruit source and is reported to act as a medicine for aches and gastric troubles. Consequently, acetic acid bacteria cause an important industrial interest as well as lactic acid bacteria and yeast.

The National priority area of this project is production process for value added natural fruits cider vinegars by utilizing indigenous raw material. This will in turn replace synthetic vinegars based on chemical additives. This research work is needed to develop natural fruit cider vinegars for local consumers. PCSIR will also provide consultancy in this regard. Our

Achievements:

- Successfully installed and commissioned net house with vertical hydroponic System (4 kanals) including covering material, ground cover, containers, gutters, coco peat, drip irrigation, monitoring system, installation etc.
- Construction of room covering the storage tank and RO plant.
- Project Completed: June 2025.
- Products developed: 04 products, Herbal Teas (10).
- Processes developed for above herbal products.
- Technology of Cultivation of Medicinal Herbs developed through hydroponics technique.
- Students training: 65
- Amount earned: 1.2 Million
- Equipment installed: Reverse Osmosis Water Plant.
- Publications: 04
- Seminar organized: 01

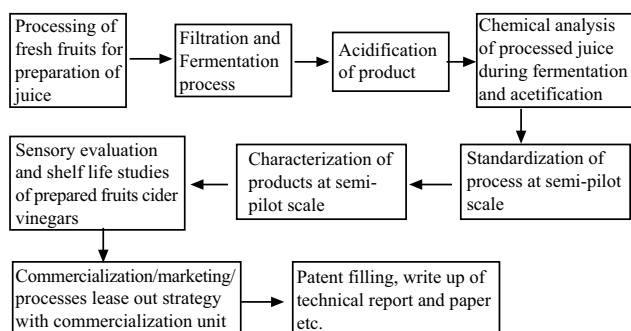


Name of Laboratory/ Center/ Unit:
FTC/PCSIR Labs. Complex Peshawar

developed products will also be the substitute for costly imported branded natural vinegars available in local market. It will help PLC to increase the number of clients from different food, herbal and nutraceutical industries to enhance their business. The objectives are:

- Effective utilization of apple, dates, raisins and apricot by preparation of natural cider vinegars; it will in turn will reduce to some extent the wastage of the selected fresh fruits from our Northern and Chitral areas.
- Utilization of low grade cheap fruits for production of good quality valuable product.
- Based on nutritive values of these fruits, development of value added, nutritive and cost effective process for production of cider vinegars at semi pilot scale level.
- Standardization and characterization of the products for semi pilot scale in bulk quantity.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
RD&I

Cost:
Rs. 9.40 Million

Tangible Outcomes:

- This will substantially contribute towards enhancement of the competency of potential commodities for their utilization into valuable products.
- Replacement or substitute of low quality, costly and imported branded natural vinegars available in local market.
- Production in bulk quantity in less time as compared

to lab/bench scale production.

- Based on semi pilot scale products development, will ease the commercialization of natural fruits cider vinegar. It will fulfill the satisfaction of the customers for lease out of the product.

Achievements:

- Procurement of Machinery/Equipment.
- Fermentor purchased under equipment head of project.
- Installation and commissioning of Fermentor has been finalized.
- Purchased raw material.
- Purchased miscellaneous items.
- Purchased some chemicals, media and standards.
- Commercialization/propagation of product.
- Processes Developed:
 - Process for the production of Apple Cider Vinegar pilot scale.
 - Process for the production of Grapes Cider Vinegar pilot scale.
 - Process for the production of Apricot Cider Vinegar at pilot scale.
 - Process for the production of Dates Cider Vinegar at pilot scale.
 - Process for the production of Raisin Cider Vinegar at Lab Scale.



Name of Laboratory/ Centre/ Unit:
FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Efficient Canola Seed Processing and Value Addition Byproducts

Name & Designation of Project Director:
Dr. Asma Saeed, CSO/Head-FBRC

Name & Designation of Project Associates:
Dr. M. Zia-ur-Rehman, CSO, Head-ACRC
Mrs. Shumaila Usman, SSO
Mrs. Shabana Kauser, SSO
Engr. Ali Imran, SE, Head-UMW
Engr. Faisal Ahmad, PE

Area of Research:

Nutritional Science

Duration:

01 Year

Date of Initiation

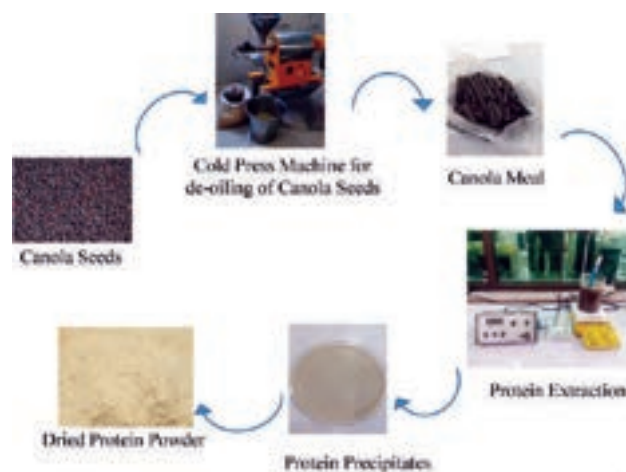
April, 2022

Project Brief:

The rapeseed is traditional oilseed crops and is being grown in Pakistan for centuries. The crop was grown on an area of about 272,100 ha with a production of 230,000 tons annually with average yield of 812 kg/ha. Rapeseed is a rich source of oil and contains 44-46% good quality oil. In addition, its meal has 38-40% protein that has a complete profile of amino acids including lysine, methionine and cystine. The meal from canola quality rapeseed varieties is an excellent feed for animals and birds especially for poultry. The oil extracted from canola varieties is nutritionally more desirable for human health and meal is better animal feed particularly for poultry. Canola protein isolate has been suggested as an alternative to other proteins for human food use due to a balanced amino acid profile and potential functional properties such as emulsifying, foaming, and gelling abilities. In Pakistan either very little or no work is reported regarding the extraction of protein from canola meal for its utilization in feed. The disposal of canola meal after oil extraction is a serious environmental problem. The project deals with the development of continuous industrial process for the extraction of edible oil from canola seeds and recovery of high quality proteins from canola cake/meal as food source. Utilization of canola meal waste for the extraction of high quality proteins will be useful for the manufacturing of high quality feed. The proposed project will produce an environment friendly and cost effective process to recover high quality proteins of food grade and production of high fiber diet for animal consumption. The following are the main objectives of the project:

- To develop a continuous cyclic process for the utilization of canola seeds.
- Easy to operate process for the extraction of proteins from canola meal.
- Use of residue as animal fodder.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

RD&I

Cost:

Rs. 20.5 Million

Tangible Outcome:

Important outcomes of the project are:

- Technology development for the extraction of protein from Canola meal.
- Development of Product like Canola protein & Canola meal.
- Process leased out.

Achievements:

- Ultrafiltration/Nanofiltration unit has been successfully installed and operational.
- Basket centrifuge successfully installed.
- Canola seed varieties were purchased.
- Extraction of oil from canola seeds.
- Protein extraction parameters successfully optimized at laboratory scale.
- NIR has been installed and calibrated successfully and now operational for R&D activities.
- Pilot scale production of Canola protein and proximate (wet lab) analysis has been done successfully.
- NIR of extracted protein performed successfully.
- Quality assurance and percentage purity of extracted protein has been completed.
- Rotor stator has been successfully installed.
- Technical report of the project has been submitted.

- A process for the extraction of protein from different varieties of mushrooms by the use of technology developed for Canola protein extraction has been leased out to M/s The Clinic Care.



Name of Laboratory/ Centre/ Unit:

TPSL/PCSIR Labs. Complex, Lahore

Title of Project: Development of Facility and ISO 17025 Accreditation Method: Test for Systematic Toxicity

Name & Designation of Project Director:

Ms. Shamma Firdous, PSO

Name & Designation of Project Associate(s):

Dr. Quratul Ain Syed, Director General
 Dr. Asma Saeed, CSO, Head-FBRC
 Dr. Muafia Shafiq, SSO

Area(s) of Research:

Medical Devices

Duration:

03 Years

Date of Initiation:

2023

Project Brief:

All medical devices that contact the human body undergo biocompatibility safety assessments prior to market release. Pre-clinical research undertaken to address pre-market questions raised about the biocompatibility of medical devices is multidisciplinary and encompasses the use of biological evaluation and toxicological risk assessment technologies including novel *in vitro*, *ex vivo*/*in vivo* testing and computational/*in silico* methodologies.

Problems related to medical devices can have serious consequences for consumers. Relatively recent examples in the media that have caused severe patient injuries and deaths include metal-on-metal hip implants; pacemakers, defibrillators and associated leads; stents; endoscopes; surgical mesh and power morcellators. The metal-on-metal hip has “been implanted in millions of patients, many of whom suffered serious harm and as a result, needed additional procedures to replace the

device. The Biocompatibility and Toxicology Program (BTP) addresses the biological and toxicological safety of the broad spectrum of medical devices currently on the market and emergent technologies. Cytotoxicity, sensitization, irritation, systemic toxicity, subchronic toxicity, genotoxicity, implantation and hemo-compatibility are the required tests for various categories of the medical devices.

Acute systemic toxicity tests identify short-term toxic effects that appear soon after a substance is swallowed (oral toxicity tests), absorbed through the skin (dermal toxicity tests), or inhaled (inhalation toxicity tests). Toxicology lab at PCSIR Labs., Lahore has started working in 2017 with limited resources/facilities including an animal house, an experimental lab and a necropsy room. During a short period, Toxicology lab became the first ISO 17025 certified laboratory of Pakistan and has provided services to a number of clients associated with Surgical industries and in the business of agrochemicals and evaluated more than hundreds of products for toxicity studies.

Tests for systematic toxicity (ISO10993-11) also part of biological evaluation of medical devices and required for the medical devices categorized as external communicating device and implant devices. These testing facilities are not available in Pakistan. Establishing such facilities at toxicology laboratory will be a big initiative to combat the problems of future. The aim of toxicity studies are:

- To ensure safety of the chemical compounds and medical devices before they can be used, as well as to determine the toxic effects of test substances.
- One important part of this task is the identification of the organ first or most affected by a toxic agent; this organ is defined as the “target organ”.



Funding Source (PSDP/SGI/RD&I/etc):

RD&I

Cost:

Rs. 06.00 Million

Tangible Outcome:

- Availability of facility for systemic toxicity studies at Toxicology Lab LLC
- Accredited test facility regarding systemic toxicity will be available
- Development of the facility will open the new door for surgical industry of Pakistan to export their medical devices to the European countries

Achievements:

- Renovation of the Lab. has been completed to sustain area for the acute systemic toxicity testing.
- Preparation and approval of tenders documents and placing order for the purchase of equipment
- After procurement of the equipment method will be validated, required records will be prepared and Lab will proceed for accreditation process.



Name of Laboratory/ Centre/ Unit:

PCSIR Labs Complex, Lahore

Title of Project: Designing and Implementing Un-interruptible Power Supply Systems Using Sustainable Green Energy Solutions at PCSIR

Name & Designation of Project Director:

Engr. Haris Ikram, SE

Area(s) of Research:

Sustainable Energy /Batteries/ Renewable Energy

Duration:

01 Year

Date of Initiation:

May, 2025

Project Brief:

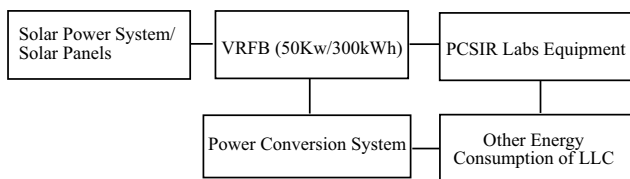
This project focuses on the implementation of a 50 kW/300 kWh Vanadium Redox Flow Battery (VRFB)-based Un-Interruptible Power Supply (UPS) system integrated with solar infrastructure at PCSIR Labs Complex, Lahore. The initiative aims to ensure

uninterrupted power supply for sensitive laboratory equipment, minimize reliance on grid electricity and reduce operational costs. By introducing a clean, durable and scalable energy storage solution, the project not only enhances PCSIR’s research capacity but also sets a precedent for adopting sustainable green energy technologies in Pakistan’s industrial and commercial sectors. 550KW, 1.2MW and 1.3MW solar systems are already installed at PLC, KLC and LLC. However, the units currently operate without an integrated energy storage solution, relying on direct solar energy production during the day and grid electricity during off-peak hours. The absence of a battery system results in energy losses due to underutilization of excess solar generation. Current supply is limited to real-time solar energy production, leaving a substantial dependency on the grid for the remaining energy needs.

Without a storage solution, excess solar energy during the day cannot be stored for nighttime use, creating a gap, which widens annually due to increasing demand. The grid dependency leads to inefficiencies and higher operational costs. The proposed Vanadium Storage Battery system will add a 300KWh capacity with a total storage capacity of up to 1.09MWh/year. This system will cover the current supply–demand gap by enabling 24/7 solar energy usage at pilot scale, ensuring energy needs are met from renewable sources and will reduce grid reliance by up to 70%, offering significant cost and energy savings. Initially the project is aimed to be started for solar system of LLC, however upon successful execution, is expected to expand for other units as well. Here are some objectives;

- To establish a reliable pilot scale energy storage solution using vanadium redox flow batteries (VRFBs) that efficiently stores surplus energy generated from solar power systems.
- To integrate the VRFB system with existing solar infrastructure for better energy distribution, enabling consistent power supply during peak demand and low sunlight conditions.
- To conduct feasibility analysis/ competitive analysis with already available energy storage alternates.
- To support clean energy initiatives by reducing dependency on non-renewable energy sources and minimizing greenhouse gas emissions.
- To lower electricity costs by maximizing solar energy utilization and reducing reliance on grid energy.
- To ensure uninterrupted laboratory operations by providing a backup energy source during outages or system fluctuations.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
RD&I

Cost:
Rs. 127.00 Million

Tangible Outcome:

- A 50 kW/300 kWh VRFB-based green UPS system with integrated Battery Management System (BMS).
- Process for integration of VRFB with solar energy systems for continuous 24/7 renewable power supply.
- Establishment of a feasibility and operational framework for deploying VRFB technology in Pakistan
- Establishment of a replicable model for green energy storage in Pakistan, enabling expansion to other PCSIR units and industrial sectors.
- Contribution to reduced carbon emissions and environmental sustainability, supporting national renewable energy goals.

Achievements:

- Tender process for procurement of vanadium batteries has been completed.



Name of Laboratory/ Centre/ Unit:
PCSIR Laboratories Complex, Peshawar

Title of Project: Augmentation of Mineral Testing Laboratory at PCSIR Laboratories Complex Peshawar

Name & Designation of Project Director:
Mrs. Mohsina Andleeb, SSO

Name & Designation of Project Associate(s):
Mr. Noor Faraz, JE

Area(s) of Research:
Mineral Testing and Analysis

Duration:
06 Months

Date of Initiation:
November, 2025

Project Brief:

The project aims to establish advance Mineral Testing Laboratory at PLC. KPK region is rich in valuable mineral resources including quartz, feldspar, mica, aquamarine, topaz, tourmaline, garnet and other minerals Therefore it is imperative to establish state of art facility for mineral testing /analysis.

The existing facility is inadequate for the industry demand and R & D requirements.

- To establish fully functional up to date mineral testing facility, including mineral characterization and quality grading services.
- To support geological surveys and mining exploration.
- Human resource capacity building and skill development regarding mineral testing & / analysis.
- To reduce dependency on external testing facility.
 - Renovate existing infrastructure and establish separate units for
 - a) sample collection,
 - b) sample crushing /grinding,
 - c) sample preparation / wet lab analysis
 - d) Sample analysis using advance techniques.
 - Procurement / Installation of mineral testing and analytical instruments/ equipment's.
 - Development of mineral testing protocols.
 - Enhance existing testing scope and parameters.

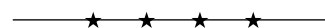
Funding Source (PSDP/SGI/RD&I/etc):
RD&I

Cost:
Rs. 550 Million

Tangible Outcome:

- Rise in local value addition to minerals before export.
- Facilitate and uplift mineral based industry in region.
- Enhance academic and research capabilities in geology.
- Expand collaboration with private and public sector related to minerals.

Achievements:
Project Started in Nov-2025.



MoST Funded Project

Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories Islamabad

Title of Project: Up-gradation of PCR Facility for Identification of Plants, Bacteria, Viruses and Animals at Islamabad Labs

Name & Designation of Project Director:

Engr. Sohail Ameer Marwat, Chief Engineer/
Member (Technology)

Name & Designation of Project Associate(s):

Dr. Uzma Rashid, SSO
Mr. Asif Qayyum, SO
Dr. Sanam Islam Khan, SSO (EMCG&NHCAL)
Ms. Zunaira Zulfiqar, SO (EMCG&NHCAL)

Area(s) of Research:

Molecular Biology

Duration:

01 Year

Date of Initiation:

February, 2025

Project Brief:

Over the past few decades, there has been a significant global interest in traditional and alternative medicine, particularly herbal products. However, adulteration or contamination of herbal medicinal products poses a serious threat to consumer safety, emphasizing the importance of accurate identification of medicinal plants and their derivatives. Similarly, the precise identification of bacteria and viruses is also very important, particularly in healthcare and microbiology. It is crucial for diagnosing infectious diseases, controlling the spread of antimicrobial resistance and ensuring food safety by detecting harmful pathogens in food and water. In industrial applications, bacteria play an integral role in producing enzymes, biofuels and bioplastics, where their accurate identification guarantees optimal efficiency and product quality. In the context of animal species, the identification of donkeys, horses and dogs meat is essential for confirming food authenticity and preventing adulteration in the meat supply chain. PCR technology

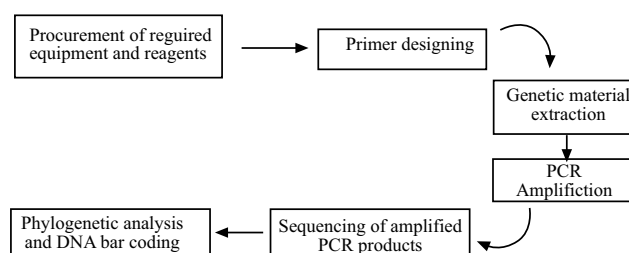
provides a reliable and efficient method for detecting and identifying the genetic material of these animals in food products, thereby safeguarding consumer rights and public health.

The existing PCR facility at PCSIR Laboratories, Islamabad lacks the crucial equipment like sample preparation equipment, PCR reagents and kits which are necessary to meet the growing demands for accurate and efficient identification of medicinal and industrial plants, bacteria, viruses and animal species and current setup is insufficient to address the increasing need for sample analysis in research, conservation and industrial applications. Upgrading the PCR facility is essential to expand the lab’s operational capacity to address regional and national needs effectively. This project seeks to upgrade the existing facility, to enhance capabilities of organism’s identification to support in-house R&D projects and testing capabilities of lab.

Currently, PCR facility lacks genetic material extraction system, gel electrophoresis, gel documentation system and necessary PCR reagents such as; primers, probes and enzymes that are specific to the species being identified. The automated sample preparation system will reduce contamination risks, improve throughput and ensure consistent sample preparation.

- To enhance the capacity of lab for detection of medicinal plants and bacterial species and their products, safeguarding quality control and consumer safety.
- To establish reliable methods for identifying animal species, including donkeys, horses and dogs, ensuring food authenticity and preventing meat adulteration.
- To strengthen the collaborations with research institutions, industries and regulatory bodies by offering state-of-the-art molecular diagnostic services.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

R&D funds from M/o Science & Technology

Cost:

Rs. 75.00 Million

Tangible Outcome:

- The lab will gain the capability to identify a broad range of organisms, including adulterants in medicinal plants, pathogens in food and water and authenticity of animal-derived products like meat.
- PCR facility at PCSIR labs Islamabad will be better equipped to support research, conservation efforts and industrial needs.
- The proposed up-gradation will also enhance the lab's capacity for collaboration with academic, industrial and governmental stakeholders.

Achievements:

- Equipments have been installed.
- Training has been provided to the staff.
- Testing facilities have been developed as per scope of Project.



SGI Funded Project

Name of Laboratory/ Centre/ Unit:

Food Division/ PCSIR Lab. Quetta

Title of Project: Green House with Automation for Cultivation of Hemp at PCSIR Laboratories Quetta

Name & Designation of Project Director:

Ms. Hiba Amanat Ali, SO

Name & Designation of Project Associate(s):

Mr. Khurram Shehzad, SO
Mr. Amir Raza, EO

Area(s) of Research:

Pharmaceutical

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

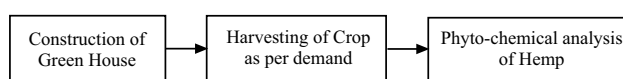
Medicinal cannabis accounts for the majority share of the cannabis market. Many countries have legalized the usage of cannabis for medicinal purpose such as Australia, Canada, Chile, Colombia, Germany, Greece, Israel, Italy, Netherlands, Peru and Uruguay among others. Global marketing is projected to grow by over \$ 950 million by 2025, driven by a revised compounded annual growth rate (CAGR) of 9.6%. The growth in this market is mainly driven by legalization of medical cannabis coupled with the growing of cannabis testing laboratories.

Cannabis as a drug and industrial cannabis both derived from the species *Cannabis sativa* and is a main source of THC and CBD. CBD has vast uses especially in pharmaceutical industry. In order to reduce THC contents in extraction (less than 0.3 percent) controlled environment and scientific approach is required.

Green house are built provide ideal environment to the crop for growing while focusing entirely on maximizing products efficiencies and yield of the plant. The green house will serve two purpose i.e. growth of cannabis in controlled secured facility and avoiding the cross contamination of other spices that are likely to impact the yield of crop in concern. The main objectives are as follows:

- To develop dedicated green house facilities for breeding of hybrid varieties of cannabis with male and female plant.
- Optimized the varieties of CBD.
- To conduct research for product development from cannabis.
- To produce hemp year-round in controlled environment facilities.
- To optimize growing conditions for hemp cultivars to enhance crop yield.

Graphical Abstract:



Work Plan:

- Selection of location within PCSIR Labs Quetta.
- Ground Leveling.
- Installation of Green House and water reservoir.
- Automation of Green House.
- Cultivation and Harvesting Cannabis/Hemp.
- Extraction and isolation of CBD and THC.
- Chemical Analysis.

Funding source (PSDP/SGI/RD&I etc.):

SGI

Cost:

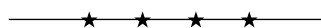
Rs. 28.41 Million

Tangible Outcomes:

- Provision of controlled green house facility for growing hemp throughout the year.
- Self reliance in hemp crop production.
- The developed raw material/product/processes will provide opportunities to pharmaceutical, fiber and cosmaceutical industries/entrepreneurs for establishment of oil and herbal based products.

Achievements:

- Procurement of equipment has been done.
- Ground leveling for installing of greenhouse automation is in progress.
- Installation of greenhouse has been completed.



Others Sponsored Projects

Name of Laboratory/Centre/Unit:

PCSIR Labs Complex, Karachi

Title of Project: Strengthening of PCSIR-Karachi Accredited (ISO-17025) Laboratory for Fruits & Vegetables Testing to Enhance Export

Name & Designation of Project Director:

Dr. Sohail Shaukat, SSO

Name & Designation of Project Associate(s):

Dr. Farman Ahmed, PSO

Area(s) of Research:

Agri-Export

Duration:

02 Years

Date of Initiation:

January, 2025

Project Brief:

Microbiology, Mycotoxin & Pesticide & POPs lab, PCIR-KLC are the leading lab of Pakistan in the area of food safety as well as these are specific labs of Pakistan having ISO-17025 accreditation in the testing of Mycotoxin, *E. Coli*, Salmonella & Aflatoxin etc. Although the labs are providing the basic facilities in its area of Pesticide, Mycotoxins, Microbiology and POPs testing, however, it is also facing challenges of future expansion and increasing requirements by International and National stakeholders. Few of these challenges are as follows:

- List of pesticides, in terms of numbers and properties is increasing continuously (2).
- More than 2000 pesticide products are registered with Department of Plant Protection Pakistan (DPP) having more than 200 different types of pesticide compounds (3). Codex Alimentarius also specify more than 200 different type of pesticides but no lab is offering more than 50 pesticide compounds accredited testing facilities in Pakistan. The lab's current facilities are not enough to handle these challenges; therefore, the survival of the lab is based upon its up-gradation and modernization. Besides making the business (revenue generation)

for a public sector organization, it is also important for our national interest as the business of Pakistani exports as well as a long chain of associated stake holders are depending on our services.

Due to the older techniques, most of the time, the labs do not meet the required permissible limits of Codex Alimentarius, European Commission, FDA and other international regulators (even the ranges of PT providers).

Customer (generally exporters) are demanding for reduction of turnaround time (TAT) and testing charges. This is not possible till multiple tests are required to come up for a single test report.

No pesticide screening facility is available in Pakistan as offered by some international standard labs.

POPs lab's current instruments are at least 15 years old thereby costing more (repair and maintenance issues, rework etc.) with reducing sensitivity. The lab's current facilities are not enough to handle these challenges; therefore, the survival of the lab is based upon its up-gradation and modernization. Besides making the business (revenue generation) for a public sector organization, it is also important for our national interest as the business of Pakistani exports as well as a long chain of associated stake holders are depending on our services. Scope of the project is as under:

- Screening of Pesticides in all commodities including Fruits & Vegetables.
- Quantitative analysis of Pesticides (MRL) including Fruits & Vegetables.
- Polyaromatic Hydrocarbons Testing.
- Detection of Foodborne Pathogens. Determination of Mycotoxins (Ochratoxin A, Patulin etc).
- Detection of Microbial growth in Fruits & Vegetables.
- GMO/non-GMO.
- Toxic Metals determination.

Objectives:

- To extend the Lab's ISO-17025 scope for analysis of hazardous chemicals used/present in agriculture & food products, Fruit & Vegetables by upgrading with advance analytical equipment to improve the sensitivity of detection.
- To upgrade existing Pesticide, POPs, Hazardous Metal Analysis lab, Mycotoxin & Microbiological

- Analyses in line with current international standards.
- To provide the required/complete range of agri-food testing facilities to the exporters (importers as well).
- To provide training cum research facilities to academia, industry and other organization associated with food safety.



Funding Source (PSDP/SGI/RD&I/etc):

Export Development Fund (EDF), Ministry of Commerce, Govt. of Pakistan

Cost:

Rs. 408 Million

Tangible Outcome:

- Reduced testing charges on per compound basis.
- Reduced Testing Time (approx. half to that of present).
- Provision of required testing facilities for fruit & vegetable export as per international requirements by June, 2027.

Achievements:

- Phase 1 equipment received and installed (RT-PCR with nucleic acid extractor & micro-spectrophotometer, centrifuge, rotary, tissue homogenizer, Fume hood).
- Trial testing on phase 1 equipment initiated.
- PO for phase 2 equipment issued (GC MS MS & UPLC with FD and DAD).



Name of Laboratory/ Centre/ Unit:

Leather Research Center/ PCSIR, Karachi

Title of Project: Development of Surfactant from Leather Wastes on Pilot Scale Product to Reduction of Environmental Pollution Impact. (Pakistan Leather Traceability, Cleaner Production and Circularity)

Name & Designation of Project Director:

Mr. Barkat Ali Solangi, PSO

Name & Designation of Project Associate(s):

Dr. Farman Ahmed, PSO
 Ms. Uzma Nadeem, SEO
 Mr. Muhammad Zeeshan, PT

Area(s) of Research:

Leather

Half Yearly (1)	Half Yearly (2)	Half Yearly (3)	Half Yearly (4)
Tendering for the equipment (phase 1)	<ul style="list-style-type: none"> Tendering for the equipment (phase 2) Receiving, installation & Training of phase 1 equipment 	<ul style="list-style-type: none"> Tendering for the equipment (phase 3 & 4) Receiving, installation & Training of phase 2 equipment Trial Testing PT Participation Customer services 	<ul style="list-style-type: none"> Receiving, installation & Training of phase 3 & 4 equipment Trial Testing PT Participation Customer services

Duration:

15 Months

Date of Initiation:

October, 2024

Project Brief:

Leather industry has been categorized as one of the highly polluting industries and there are concerns that leather-making activity can have adverse impact on the environment. Animal hide and skin contain proteins (90–95% of solids, 35% by weight.), carbohydrates, lipids, water and mineral salts. trimmings, shaving, splitting and buffing dust) mainly contain 30%–35% collagen protein. It's dumped in a waste bin or thrown in a landfill, which creates pollution. The disagreeable odor emanating from the decomposition of proteinous waste material and the presence of sulphide, ammonia and other volatile organic compounds are also associated with tanning activities.

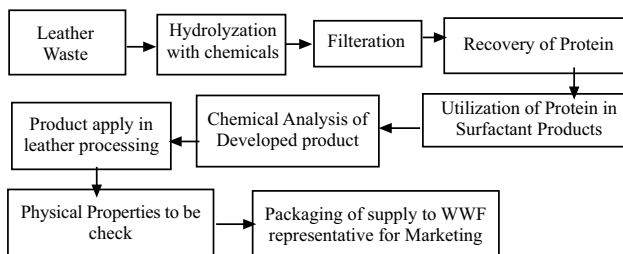
Gelatin is an animal by-product, the partially hydrolysed collagen tissue of various animal parts. Before the leather processing in the tannery, unwanted parts of hides and skins were trimmed to save on chemicals and other overhead charges. These parts go to waste and contain a high amount of proteineous material, according to a literature survey.

Protein-based surfactants have drawn particular interest because of their potent antibacterial action and hydrophilic emulsifying group, which is non-toxic to biological systems. Protein-based surfactants have therefore been researched for significant uses in a variety of fields, including foods, cosmetics and pharmaceutical formulations. However, high-tech purification is required for such complex products, which could have an impact on pricing. In this study, we looked into the straightforward and secure side application of this collagen hydrolyse protein that was extracted, modified with ester, to create a surfactant product for cow split leather. Thus, due to demand, it is a good project for Pakistan industry to earn from wastes to wealth. The objectives are:

- To develop biobase surfactant from leather wastes

- To check chemical parameters as per leather industry requirement.
- To check physical application on leather

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

This project funded by WWF-Pakistan

Cost:

Approx. Rs. 10.0 Million

Tangible Outcome:

- Process developed.
- Production of Bio-based surfactant on lab scale from leather waste, promoting circular economy.
- Product Development on Semi pilot Scale upto 300kg.
- Product may support ZDHC/MRSL compliance and strength Pakistan’s eco-leather export credentials.
- Publication.

Achievements:

- A lab-scale process for production of Bio-based surfactant has been developed.
- The surfactant showed significant reduction in COD/BOD compared to conventional auxiliaries.
- Glassware, instruments have been received from WWF.
- Semi pilot plant under fabrication along with experimental leather processing.



Name of Laboratory/Centre/Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Nutritious Fruit Bars to Alleviate Malnutrition for under Nourished Children in Pakistan

Name & Designation of Project Director:

Dr. Shahid Masood, SSO

Name & Designation of Project Associate(s):

Dr. Ijaz Ahmed, Director General

Dr. Asma Saeed, CSO

Ms. Alim-un-Nisa, PSO

Mr. Faizullah Khan, SSO

Dr. M. Ashraf, SSO

Dr. Shabana Kauser, SSO

Dr. Asma Sheikh, SSO

Dr. Saima Nazir, SSO

Area(s) of Research:

Food Science & Technology

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

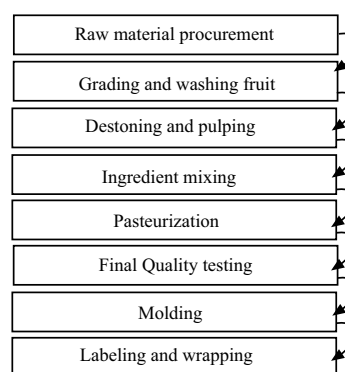
Pakistan has the third-highest proportion of stunted children globally. A 2018-2022 UNICEF report points out that 38% of children in Pakistan are suffering from stunting otherwise known as chronic malnutrition (UNICEF, 2019). Nearly half of the deaths among children under the age of five are linked to under nutrition. Pakistan’s economy is also contributing to the increase in malnutrition among children. The ongoing economic crisis, inflation and poverty have worsened access to food and affordability, leading to nutritional deficiencies in children. Rising prices of staple foods and unemployment have forced families to cut back on nutritious food, relying instead on cheaper, less nutritious options. The government of Pakistan, alongside international organizations, has initiated several nutrition programs (UNICEF & Government of Pakistan, 2022). Nutrition-specific

interventions and social protection schemes have been shown to help address both mother and child malnutrition.

While these efforts are combating the rising rates of malnutrition, their implementation remains inconsistent and coverage is often inadequate in rural areas. Despite ongoing efforts, the malnutrition crisis in Pakistan continues to persist and requires sustained interventions focusing on food security, healthcare. Nutritious Fruit Bars aimed at revolutionizing the fruit value chain in Pakistan. The Nutritious Fruit Bar project, aims to tackle malnutrition by developing and promoting healthy fruit-based snack bars, particularly targeting low-income consumers in Pakistan. Malnutrition remains a significant challenge in many parts of the world. The project is designed to strengthen Pakistan’s food value chain, best utilization of surplus fruit and provide affordable, nutritious options to vulnerable populations, especially school-aged children and their parents. The objectives of the project are:

- Utilization of surplus fruit.
- Product standardization as per local regulation.
- Development of nutritious fruit bar.
- Overcome malnutrition.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Procurement of raw material and recipe development	Production trial	Product standardization as per local regulation	Shelf life testing/study

Funding Source (PSDP/SGI/RD&I/etc):

GAIN

Cost:

Rs. 0.5 Million

Tangible Outcome:

- To utilize seasonal fruits to develop value added product.
- Prevention of fruits from postharvest losses.
- To develop and set criteria for products with standard nutritional values.
- Train people to manufacture standardized product wherever required.

Achievements:

- Nutritious fruit bar has been developed as per specifications shared by gain Pakistan.
- Nutritional, microbiological and organoleptic evaluation has been completed.
- Shelf life study is under progress.



In-House New R&D Projects PCSIR Labs. Complex, Lahore

Name of Lab/Centre/Unit:
ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Process for the Refinement of Slack Wax

Name & Designation of Project Director:
Dr. Zafar Iqbal, SSO

Name & Designation of Associate(s):
Mr. Muhammad Usman Sabri, SSO
Mrs. Mubeen Akhtar, SSO

Area(s) of Research:
Petrochemicals

Duration:
01 Year

Date of Initiation:
July, 2025

Project Brief:

Slack wax is a complex combination of hydrocarbons obtained from a petroleum fraction by solvent crystallization (solvent de-waxing) or as a distillation fraction. It consists predominantly of saturated straight and branched chain hydrocarbons having carbon numbers predominantly greater than C₂₀. Slack Wax is yellow to brown in color and having 10-30% oil contents. Its color and smell are due to residual impurities. Refined slack wax is used in candle making, rubber and tire manufacturing, as finishing agent to provide a soft and smooth feel of fabrics, as conditioner for leather, as water resisting agent for papers, etc.

Color and bad odor of slack wax due to sulfur containing compounds and other impurities makes it unusable for commercial application. Refinement of slack wax will be carried out by removing oil and sulfurous compounds. Followed by neutralization, fuller's earth bleaching and filtration. Analysis of slack wax will be performed by measuring kinematic viscosity

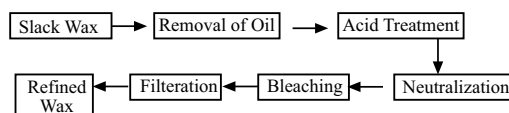
@ 100 °C, flash point, specific gravity, oil contents, congealing point and drop point.

Slack wax in refined form (melting point 50-65 °C) is being imported from various sources for application in textile, adhesives, leather, paper industries on reasonable high cost. During 2023-2024, Pakistan imported 2474 shipments of wax from various sources and it was increased by 13% from previous year. After development of this process, local industries will be encouraged by its commercialization.

Objective are:

- Process/Product Development.
- Import Substitution.
- Utilization of local raw material.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Designing of process by literature review and procurement of raw materials i.e. slack wax, sulfuric acid, sodium hydroxide, fuller's earth, etc.	Experimental trials for the refinement of slack wax by using various concentration of materials	Optimization of Process for the refinement of slack wax	Product evaluation by advance analytical techniques and efforts for its commercialization/process lease out

Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Tangible Outcome:

- Refinement of slack wax.
- Process will be leased to the industries for application in textile finish, candle making, leather finish, rubber and tire manufacturer etc.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PC SIR Labs. Complex, Lahore

Title of Project: Production of Azelaic acid from Indigenous Castor Oil and Development of Medicated Formulation for ACNE Disease

Name & Designation of Project Director:

Dr. Muhammad Zaheer, SSO

Name & Designation of Project Associate(s):

Dr. M. Naem, SSO
Dr. Naqi Hussain, SSO

Area(s) of Research:

Pharmaceutical

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Azelaic acid (AzA) is a naturally occurring dicarboxylic acid which is found naturally as an active ingredient in castor oil. It maintains pores, clean and stops acne-causing germs from proliferating on the skin. Because of its antimicrobial and anti- antibacterial properties on the epidermis, it is being used in different formulations for the treatment of acne vulgaris. Global World imported 1,957 shipments of Azelaic Acid during Mar 2023 to Feb 2024. These imports were supplied by 320 to 408 Global, marking a growth rate of 49% compared to the preceding twelve months. Within this

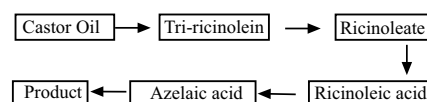
period, in Feb 2024 alone, World imported 155 Azelaic Acid shipments. This marks a year-on-year growth of 14% compared to Feb 2023. Pakistan has also imported azelaic acid, 34900kg in 2019 and 80,612kg in 2021.

Pakistani market is flooded with low quality skin care products and Drug Regularity Authority of Pakistan has identified the falsified product Askinoren Gel (Azelaic acid 15%) dated 10 December, 2024. Azelaic acid has gained attraction to be used in recent pharmaceutical/cosmetic formulations due to its properties to treat the skin pigmentation and acne.

This project focuses on producing of azelaic acid from readily available castor oil. Castor oil contains a large amount of ricinoleic acid. It will be converted to azelaic acid by a series of chemical reactions. This process is environmentally friendly since it employs renewable resources and produces less trash. The objectives are:

- Production of indigenous, economically feasible and effective raw material for skin conditions such as acne and melisma.
- To support the pharma industry.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Designing of process by literature review, procurement of raw materials and their quality evaluation	Experimental trials	Optimization of unit processes involved	Product evaluation by advance analytical techniques and efforts for its commercialization/ process lease out

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Process/product will be developed.
- Indigenously developed product will be available to local industries.
- Import substitution.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Different Shining Formulations for Leather

Name & Designation of Project Director:

Mrs. Asma Inayat, PSO

Name & Designation of Project Associate(s):

Dr. Shahid Rehman Khan, SSO

Area(s) of Research:

Leather

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Different leather shining formulations are used in the commercial market for dressing and protecting finished leather and leather goods to make them attractive. These formulations are based on waxes, solvents, emulsified creams without as well as with solvents, oils and pigments. Faded leather goods can be restored back using shining materials along with imparting them with glossy finish.

Different shining materials are available in the market for use as creams and shiners. Most of these locally available shiners are unstable with lower shelf life. Also, mostly available creams and shiners do not produce results as per requirement of the customers.

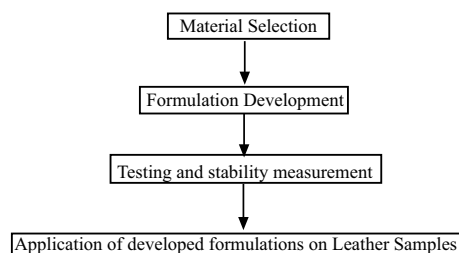
So due to the aforementioned problems associated with the locally available shiners/creams, there is a need for development of sustainable and stable leather shining formulations to fulfill the requirements of local customers. The research project will focus on development of different types of formulations like:

- Development of wax and solvent based pastes.
- Solvent free emulsified creams consisting of waxes and aqueous media.
- Emulsified creams containing waxes, aqueous media and environment friendly organic solvents.

The main objective of this project will focus on:

- Development of creams and shining formulations using different waxes, solvents and pigments available in the local market.
- Optimization of process for the development of stable formulations as required by the customers.
- Evaluation of the developed formulations after their application on leather and their goods.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Material Selection • Identify potential materials suitable for required development after consulting literature.	Formulation Development • Experiments with various combinations of waxes, solvents & pigments.	Testing and Evaluation • Assessment of the adherence, and durability of developed formulations on leather samples.	Commercialization and Publication • Preparation of scientific papers • Leasing out of Process to Private Sector.

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	<ul style="list-style-type: none"> • Optimization of formulation parameters (e.g., concentration, pH, viscosity) for desired stability. 		

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of shining formulations for leather, along with optimized application methods.
- Implementation of formulations as shiners in leather and their made ups.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PC SIR Labs. Complex, Lahore

Title of Project: Development of Eco-friendly Starch-based Films for Packaging Materials

Name & Designation of Project Director:

Dr. Amina Mumtaz, SSO

Name & Designation of Project Associate(s):

Dr. Rabia Nazir, PSO

Area(s) of Research:

Industrial Materials

Duration:

01 Year

Date of Initiation:

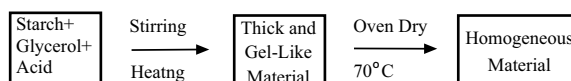
July, 2025

Project Brief:

The accumulation of high amounts of petro-based plastic films is a growing environmental devastation issue, leading to the urgent need to innovate eco-safe packing materials. Among different substitutes, starch-based types and their different ratios are considered an innovative and smart material alternative. The rising and growing importance of designing starch-based films from different sources for packing material is ongoing research.

Environmental pollution due to plastic waste taking too long to decompose has become a global problem. There have been numerous solutions proposed, one of which is the use of bio-plastics. The use of potato starch as the main ingredient in the manufacture of bio-plastics shows great potential as a diverse range of starch-producing plants. Plastic waste poses a risk to human health and the environment. Waste plastic has become an environmental problem around the world because it takes a long time to degrade in nature. Bio-plastics can help to reduce the problem of plastic waste because it is easy to make it and there are abundant and affordable raw materials.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Designing of process by literature review, procurement of raw materials and their quality evaluation	Experimental trials	Optimization of unit processes involved	Product evaluation by advance analytical techniques and efforts for its commercialization/ Publication

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of biodegradable film.
- Import Substitution.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PC SIR Labs. Complex, Lahore

Title of Project: Development of Skin Friendly Hair Colorants

Name & Designation of Project Director:

Dr. Saima Siddique, SSO

Name & Designation of Project Associate(s):

Dr. Zahida Parveen, PSO

Area(s) of Research:

Applied Chemistry

Duration:

01 Year

Date of Initiation:

July, 2025

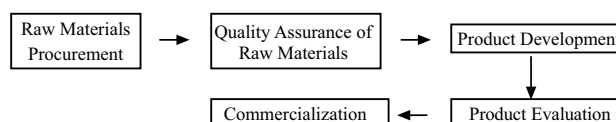
Project Brief:

Hair coloring is often driven by cosmetic reasons like covering the grey hair, enhancing the appearance and boosting self-confidence. Natural and quick hair coloring formulations are trending, driven by a growing preference for healthier, more sustainable beauty options. Consumers are increasingly seeking alternatives to traditional chemical dyes, with a rise in popularity for Synthetic dyes, while offering a wider color spectrum and potentially longer-lasting results, require careful consideration due to potential health risks. Quick hair color formulations can be developed using a combination of natural and synthetic ingredients, offering both effective coloration and potentially reduced risks compared to traditional synthetic dyes. Developing skin-friendly hair color formulations involves the use of natural ingredients and the avoidance of harsh

chemicals commonly found in traditional dyes. Herbal hair dyes, such as those made with henna and indigo, are increasingly popular as safer alternatives. Other beneficial herbs include amla, bhringraj, reetha, shikakai, hibiscus and jatamansi which can contribute to colour, hair health and shine. These formulations can be further improved with ingredients like Aloevera gel, which acts as a natural mordant and helps protect hair from damage. Additionally, minimizing or eliminating the use of harsh chemicals like ammonia and phenylenediamines can significantly reduce the risk of skin irritation and allergic reactions. Objectives are:

- Development of skin friendly, quick hair colorants.
- Development of cost effective products.
- Advisory and quality control services to manufacturers, processors and consumers.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Designing of process, procurement of raw materials and their quality evaluation	Experimental trials	Optimization of unit processes involved	Product evaluation by advance analytical techniques and efforts for its commercialization/ Publication

Funding Source (PSDP/S GI/RD&I/etc):

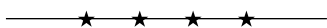
In-House

Tangible Outcome:

- Herbal / organic hair dyes production.
- Patent/technology transfer to local industry.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Exploitation of Ginger Root Extract as a Magical Ingredient in Anti-Wrinkle Skin Care Products

Name & Designation of Project Director:

Dr. Zahida Parveen, PSO

Name & Designation of Project Associate(s):

Dr. Saima Siddique, SSO

Area(s) of Research:

Applied Chemistry

Duration:

01 Year

Date of Initiation:

July, 2025

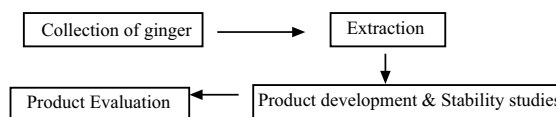
Project Brief:

In the quest for healthy, radiant skin, natural ingredients have emerged as a powerful ally. The potency of botanical extracts, with their abundant antioxidant and anti-inflammatory properties, continues to revolutionize skincare. Among these natural wonders, ginger root extract has gained significant attention for its remarkable benefits in dermatology. Ginger extract possesses therapeutic properties that can transform the health and appearance of skin. From its ability to combat free radicals and soothe inflammation to its potential in enhancing skin elasticity and brightening the complexion, ginger root extract stands as a promising ingredient in the pursuit of healthy and vibrant skin. Commercially available anti-wrinkle products typically contain active ingredients like retinol, peptides and alpha hydroxy acids. With consistent, long-term use, these ingredients can help reduce the appearance of

fine lines and improve overall skin texture but may also lead to skin irritation, dryness, redness and itching. In this study, ginger extract will be prepared by modern techniques like supercritical fluid extraction for maximum recovery of active ingredients. The objectives are as follows:

- Preparation of ginger root extract by modern techniques.
- Stability studies of ginger root extract.
- Development of anti-wrinkle and anti-aging cream.
- Technology transfers to local manufacturer.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Designing of process, procurement of raw materials and extraction	Experimental trials	Optimization of unit processes involved	Product evaluation by advance analytical techniques and efforts for its commercialization/ Publication

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of skin friendly market viable product.
- To support the pharmaceutical industry.

Achievements:

New project



Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Flame-Retardant Wood Polymer Composite Material for Furniture Industry

Name & Designation of Project Director:

Mr. Atif Latif, SSO

Name & Designation of Project Associate(s):

Mr. Ehsan Ul Haq, PSO

Mr. Hamood Ur Rehman, SSO

Area(s) of Research:

Furniture Industry

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Use of wood polymeric composite materials rises due to their good mechanical properties, chemical and corrosion resistance behaviors; however, their low fire resistivity raises serious safety concerns. Chemically, almost all polymeric materials are comprised of hydro-carbon chains and when exposed to fire, burn rapidly with the release of high amount of heat, flame and smoke.

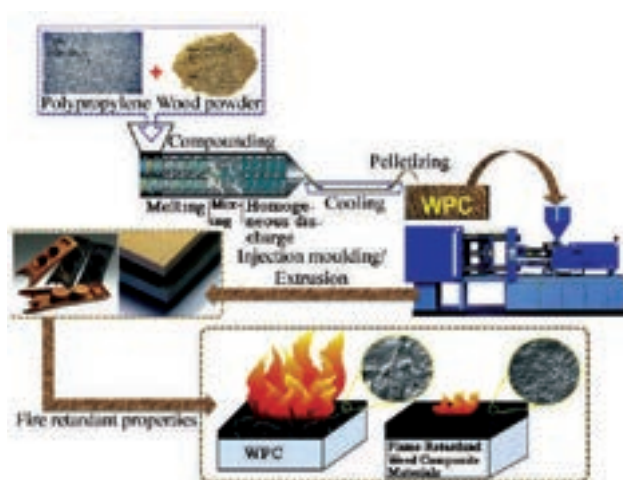
Wood-based polymer composite materials, such as plywood, particle board and medium-density fiber board (MDF) are widely used in construction, furniture and interior applications due to their cost-effectiveness, sustainability and mechanical properties. However, their high flammability poses a significant fire hazard, leading to rapid fire spread, structural damage and safety concerns in residential and commercial buildings. This project aims to develop flame-retardant wood polymer composite materials using eco-friendly, non-toxic and efficient flame-retardant additives while ensuring minimal impact on the mechanical and physical properties of the material.

Flame retardant treatment for wood polymer composite material is very essential for safety point of view. Wood-based polymer composite materials are

widely used in construction, furniture and packaging due to their sustainability, affordability and mechanical properties. However, their inherent flammability presents a significant safety concern, particularly in applications requiring fire resistance. The development of flame-retardant wood polymer composite materials aims to enhance fire safety while maintaining mechanical strength, durability and environmental compatibility. The objectives are:

- To enhance Fire Resistance.
- To maintain Mechanical and Physical Properties.
- Eco -Friendly Formulation.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	Preparation of different types of Flame-retardant wood polymer composite materials by mixing wood powder with polypropylene / polyethylene, polyvinyl chloride and various types of flame-retardant agents, (ammonium poly-phosphate, zinc borate, boric acid, aluminum trihydrate and melamine etc.) and making their pallets
2nd Quarter	Injection moulding / Extrusion of Flame-retardant wood polymer composite materials to form sheets of different thickness

3rd Quarter	Characterization of flame-retardancy of wood polymer composite materials
4th Quarter	Technology transfer and its commercialization

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Strengthening the local Furniture and construction industry of Pakistan.
- Produce indigenous raw material to save national foreign exchange.
- Technology transfer and its commercialization, thereby increasing productivity.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Silicon Based Sealers for Water Proofing

Name & Designation of Project Director:

Mr. Ehsan ul Haq, PSO

Name & Designation of Project Associate(s):

Mr. Hamood Ur Rehman, SSO

Area(s) of Research:

Applied Chemistry

Duration:

01 Year

Date of Initiation:

July, 2025

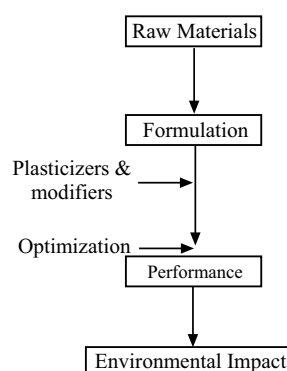
Project Brief:

Waterproofing is a critical aspect of construction and building maintenance. Silicon-based sealers have emerged as a promising solution due to their excellent adhesion, flexibility, durability and resistance to

environmental factors. These sealants provide an effective solution for sealing gaps, joints and cracks, ensuring long-term protection against environmental factors. This project aims to develop and analyze the effectiveness of silicon-based sealers for water proofing. Water damage and leakage are significant concerns in construction and building maintenance, leading to structural deterioration, safety hazards and costly repairs. Sealers play a critical role in enhancing the durability and performance of structures and products. However, traditional sealants, such as polyurethane and acrylic-based ones, have limitations in terms of durability, resistance to extreme weather conditions and environmental impact. Silicon-based sealants offer superior performance but require further evaluation in terms of formulation, application methods and long-term effectiveness in different environmental conditions. This research aims to investigate the properties, performance and application of silicon-based sealers for waterproofing with goal of developing effective and sustainable solutions for construction industry. This project focuses on the formulation, testing and evaluation of silicon-based sealers for applications in building construction. The objectives are as follows:

- To develop a silicon-based sealant with enhanced durability and adhesion properties.
- To assess the performance of silicon-based sealants in various environmental conditions.
- To compare silicon-based sealants with conventional alternatives in terms of strength, flexibility and longevity.
- To evaluate the economic feasibility and environmental impact of silicon-based sealants.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Study of existing sealant technologies and their properties • Identification of key performance parameters for silicon-based sealants • Selection of appropriate silicon compounds and additives 	<ul style="list-style-type: none"> • Development of different formulations for comparative analysis • Application of sealants to various surfaces and evaluation of adhesion properties 	<ul style="list-style-type: none"> • Tests for flexibility, water resistance, and weather stability • Checking of sustainability and biodegradability • Assessment of production costs and market feasibility 	Data Analysis and Conclusion

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of a silicon-based sealer formulation with enhanced waterproofing properties and durability.
- Enhanced resistance to environmental conditions compared to traditional sealants.
- Development of cost-effective and eco-friendly water proofing sealer for local market.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PC SIR Labs. Complex, Lahore

Title of Project: Development of Sustainable Fire Protective Coating for Fabrics

Name & Designation of Project Director:

Ms. Filza Zafar Khan, PSO

Name & Designation of Associate(s):

Syed Faheem Shah, EO

Area(s) of Research:

Textile Chemical

Duration:

01 Year

Date of Initiation:

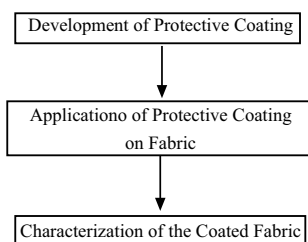
July, 2025

Project Brief:

Fire protective finishes provide textiles with an important performance characteristic. Protection of consumers from unsafe apparel is only one area where fire retardancy is needed. Fire fighters and emergency personnel require protection from flames as they go about their duties. The requirement for a commercially successful fire-retardant textile product have been given as meeting flammability requirements: having little or no adverse effect on the textile’s physical properties; retaining the textile aesthetics and physiological properties; being produced by a simple process with conventional equipment and inexpensive chemicals; and being durable to repeated home launderings. The present study is focused on balancing effectiveness with cost, ease of application and maintaining textile feel and performance. The objectives are:

- Development of technology for lab scale preparation of “Fire Protective Coating”.
- Application of the fire protective coating to small textile samples for evaluating fire retardant performance of developed coating using standard test like ASTM D1230.
- Development of a cost-effective and ecofriendly fire protective coating that can be applied to textiles without significantly increasing production costs.

Graphical Abstract:



Name & Designation of Project Director:

Mr. Mahroze Ahmed Khan, SSO

Area(s) of Research:

Dye Casting Industry

Duration:

01 Year

Date of Initiation:

July, 2025

Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Development of protective coating	Development of protective coating & application studies of coated fabric	Application & characterization studies of the coated fabric	Compilation of technical/feasibility report

Project Brief:

Iron Casting industry uses a number of synthetic and semi-synthetic compounds for mold preparation.

Among these, resole resins belong to synthetic thermosetting agents obtained by the reaction of phenols with formaldehyde. Sometimes the precursors include other aldehydes or other phenol. Resole resins are mainly used in the production of circuit boards and molded products including pool balls, laboratory countertops and die casting industry.

Resole resin formed by a step-growth base-catalyzed polymerization reaction. Phenol, formaldehyde, water and catalyst are mixed in the desired amount, depending on the product to be formed and are then heated the rate depends on temperature and pH. Optimization of reaction conditions are of great concern to get desired characteristics of product.

The main objectives of present study are:

- This project relates to development and optimization of reaction conditions for the production of the required compound.
- Optimization of process and evaluation of product.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of a cost-efficient and eco-friendly fire protective coating that aligns with environmental trends and provides a viable commercial product.
- Development of a feasible process to be sold to the local industry.

Achievements:

New Project

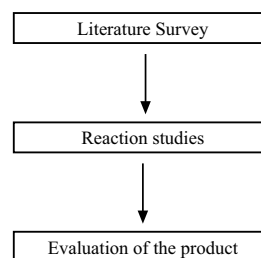


Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Die Casting Agent for Steel Industry

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Literature survey and arrangement of chemicals	Laboratory scale studies	Physico-chemical analysis	Commercialization

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of technology for production of die casting agent will increase utilization of indigenous resources and labour.
- The technology will be quite helpful for local industry.

Achievements:

New Project



Name of Lab / Centre / Unit:

ACRC/PCSIR Labs. Complex, Lahore

Title of Project: Evaluation of Phytochemical, Pharmacological & Toxicological Activities of Extract Containing Cannabidiols

Name & Designation of Project Director:

Dr. Naqi Hussain, SSO

Name & Designation of Project Associate(s):

Dr. Hussain Imam Abidi, Chairman PCSIR
 Dr. Quratulain Syed, CSO
 Dr. Muhammad Zia-ur-Rehman, CSO
 Dr. Muhammad Naeem, SSO
 Dr. Muhammad Zaheer, SSO

Area(s) of Research:

Pharmacology

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Plants are being used for medicinal purposes since ago the dawn of time and remain among the main sources of active ingredients, providing multiple therapeutic effects for various problems and diseases. *Cannabis sativa* contains over 500 chemical compounds, including more than 120 cannabinoids and a wide variety of terpenes and other bioactive molecules. The most well-known cannabinoids are Δ^9 -tetrahydrocannabinol (THC) and cannabidiol (CBD), but the plant also contains minor cannabinoids such as cannabigerol (CBG), cannabichromene (CBC), and cannabidivarin (CBDV), each contributing to its pharmacological profile. Primary pharmacological effects of *Cannabis sativa* are mediated through the endocannabinoid system, particularly the CB1 and CB2 receptors. THC acts as a partial agonist at CB1 receptors, producing psychoactive effects, pain relief, appetite stimulation and anxiety modulation. CB2 receptor activation, often by other cannabinoids, is linked to anti-inflammatory and immune-modulating effects.

While *Cannabis sativa* has significant therapeutic potential, high concentrations of THC can cause adverse effects such as dizziness, drowsiness, cardiovascular changes and in severe cases, neurological symptoms. Chronic use may lead to dependence, tolerance and other health risks, especially with recreational use. Therefore, it is important to define evidence-based therapeutic doses for particular pharmacological activities including anti-diabetic, anti-emetic, analgesic and anti-inflammatory properties, making them promising for pain relief, including chronic and neuropathic pain along with improving overall health status by using appropriate *in-vivo* and *in-vitro* models. The main objectives are to conduct pharmacological studies using appropriate *in-vivo* (animal models) and *in-vitro* models to obtain detailed and evidence-based insight of their therapeutic effects.

Quarter Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Preparation of various extracts of cannabis • Phytochemical analysis of prepared extracts 	Isolation of cannabinoids and identification of fractions [Δ^9 -tetrahydrocannabinol (THC) and cannabidiol (CBD)] of these extracts	<ul style="list-style-type: none"> • Procurement of animals and their screening and breeding to obtain healthy and in-house breed for experimentation • Pharmacological activities 	Data collection & report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- To ensure evidence-based therapeutic effects leading to accurate and appropriate dosage of cannabis extracts for local industry to benefit.

Achievements:

New Project



Name of Laboratory/Centre/Unit

APC&IC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Instrumental Solutions and Standards

Name & Designation of Project Director:

Dr. Zeeshan Ali, CSO

Name & Designation of Project Associate(s):

Mr. Rashid Mahmood, PSO
 Dr. M. Lattif Khosa, PSO
 Ms. Uzma Sattar, SSO
 Mr. Hamid Iqbal, SSO

Area(s) of Research:

Instrumentation

Duration:

01 Year

Date of Initiation:

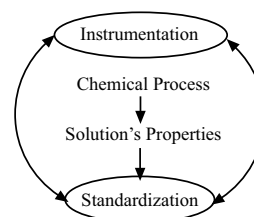
July, 2026

Project Brief:

The physicochemical properties of solutions for the development of standards are essential for calibrations of industrial and clinical laboratory instruments. The analytical measurements i.e. photometry, conductometry, viscometry, voltametry, thermo gravimetry, turbidimetry etc. are frequently used in industrial, clinical labs and instrumental standardizations are common practices. The research work is being initiated for development of standards for import substitutions, eventually foreign exchange being spent for imports.

The Center is already engaged in providing industrial calibrations and metrology of basic parameters; temperature, pressure, weights/mass, volumes, dimensions, electrical, time and frequency. The extended scope would have a commercial impact and on industrial services. The main objective is development of standards range for pH, Conductometers, Viscometers, Turbidity meter, Moisture analyzers etc.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Arrangements & Experimental studies	Data analysis and standards developments	Accreditation of methods under ISO 17025	Product commercialization and calibration services

Funding Source: (PSDP/SGI/RD&I/etc)

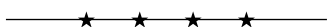
In-House

Tangible Outcome:

- Standard reagents for instruments.
- Calibration of instruments.
- Application for industrial & clinical labs.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

APC&IC/PC SIR Labs. Complex, Lahore

Title of Project: Solar Chemical Process Design & Development of Biofuels

Name & Designation of Project Director:

Dr. Zeeshan Ali, CSO

Name & Designation of Project Associate(s):

- Dr. M. Lattif Khousa, PSO
- Mr. Tanvir Ahmed, SSO
- Dr. Abdul Qayyume, SSO
- Dr. Khalid Rasheed, SSO
- Mr. Muhammad Munir, SSO
- Mr. Hamid Iqbal, SSO
- Mr. Usman Alvi, SO
- Mr. Khalil ur Rehman, SO

Area(s) of Research:

Solar Energy

Duration:

01 Year

Date of Initiation:

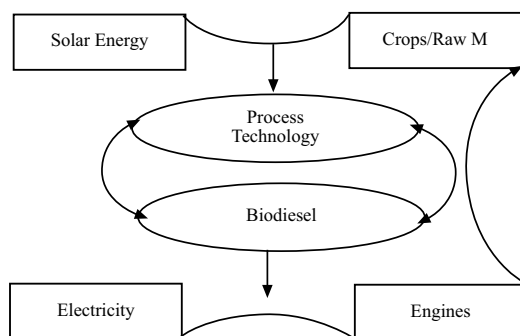
July, 2025

Project Brief:

The world fossil fuels are continuously decreasing, the fluctuating oil prices and environmental impacts have intensified the search for alternative biofuels as a renewable, biodegradable/eco-friendly fuels. The chemical process design and development for biofuels is vital for techno feasible production of fuels at rural areas. The detailed work on biodiesel production through chemical process of fixed oils/fats is being optimized. The work on solar energy assisted chemical process design and development is initiated to minimize the process energy cost and availability of agri-based fuels at remote and rural areas. The objectives are:

- Low cost fuel production technology.
- Eco friendly fuel for diesel engines.
- Fuel production for agricultural equipments/ machineries.
- Agro based fuel production for rural developments.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st-Year	Optimization of conventional process parameters	Experimental arrangements & process development	Product evaluations, energy and prefeasibility studies	Process leasing/ commercialization

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Low cost technology for rural areas and agricultural farms applications.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Upcycling Banana Stalk Waste: Green Extraction of Banana Stalk Fiber (BSF) and its Chemical Modification for Sustainable Applications

Name & Designation of Project Director:

Dr. Shabana Kauser, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO

Dr. Asma Sheikh, SSO

Area of Research:

Biowaste Management/ Bioresource Utilization

Duration:

1^{1/2} Years

Year of Initiation:

August, 2025

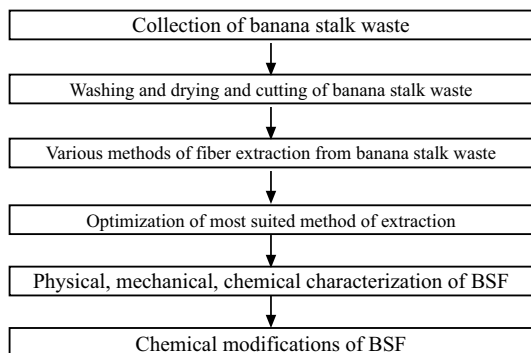
Project Brief:

Mankind has been strongly dependent on plant fibers for all kind of purposes. In earlier days, natural fibers served a crucial role to mitigate the everyday needs in a wide range of uses. According to the Food and Agriculture Organization (FAO) and Pakistan Bureau of Statistics agricultural reports, Pakistan produces approximately 154,000 MT of bananas

annually (as of recent data). On average, the pseudostem constitutes about 90-95% of the total biomass of the banana plant, while the fruit bunch makes up only 5-10%. Banana cultivation generates significant amounts of biowaste, primarily from pseudostems, leaves and fruit peels, which are often discarded or burned, contributing to environmental pollution. For every 1 ton of bananas harvested, approximately 10-20 tons of pseudostem waste is generated. The production of high-quality natural fibers from banana stalk is as much of an art and science. This research proposes a sustainable and innovative approach to managing banana waste by extracting natural fibers and its chemical modification to enhance its hydrophobicity and tensile strength for high-value applications. Banana stalk fiber (BSF) is one of the biodegradable and eco-friendly sources of natural fiber. The yearly banana plant waste (the trunk) will always be on the increase as a result of banana growth, plantation and the high demand for banana. There is, therefore, a need to convert this waste to wealth by extracting the fibers from banana trunk and its chemical modification. The chemical modifications of natural BSF will lead to enhanced hydrophobicity, mechanical strength and thermal stability enhancing its utilization potential as a recyclable alternative to be used in textiles, paper production, reinforcements and composites, as well as polymer matrix composite materials as a replacement to synthetic polymer content. The project aligns with sustainability goals, such as reducing waste, promoting renewable resources and supporting circular economies. The main objectives of the project are:

- To develop an efficient and eco-friendly extraction method for obtaining banana fibers from pseudo-stem waste.
- To characterize the extracted fibers in terms of their physical, chemical and mechanical properties.
- Chemical modifications of BSF to enhance its mechanical properties.
- To explore potential applications of the modified fibers in textiles, composites, handicraft and packaging.

Graphical Abstract:



Tangible Outcome:

- Standardized method for extraction of banana stalk fiber (BSF).
- Reduction of agricultural waste by converting banana pseudo-stems into valuable fiber.
- Modified natural fiber with enhanced mechanical strength.
- High-quality fibers ready for further processing or application development.
- Development of products showcasing the versatility of banana fiber (Textiles, packaging, composites, handicrafts, etc.).

Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter
<ul style="list-style-type: none"> • Collection of banana stalk waste • Washing and drying for fiber extraction • Utilization of different methods for extraction of fiber from banana waste 	Optimized extraction protocol with defined parameters (concentration, temperature, time)	Fiber Characterization (Physical, mechanical, chemical)
4th Quarter	5th Quarter	6th Quarter
<ul style="list-style-type: none"> • Chemical modifications of banana stalk fiber • Characterization of modified BSF (Physical, mechanical, chemical) 	Development of modified banana stalk fiber products	Report submission Paper drafting/ submission

Achievements:

New Project



Name of Laboratory Centre/Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of the Process Technology for Isolation and Purification of Functional Nutrients from Bovine Milk Secretions

Name & Designation of Project Director:

Dr. Salman Saeed, PSO

Name & Designation of Project Associate(s):

Dr. Khurram Shahzad, CSO
 Dr. Shaista Nawaz, SSO
 Dr. Abdul Ahid Rashid, SSO

Area of Research:

Functional Food/ Nutraceutical

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Pakistan is among the top milk producers globally, with a rapidly growing dairy sector. The country's

Funding Source (PSDP/SGI/RD&I/etc):

In-House

abundant livestock resources, predominantly consisting of cows and buffaloes, provide a substantial milk supply. The annual milk production in Pakistan exceeds 50 Million tons, making it a crucial component of the national economy and diet. While Pakistan has a substantial milk production capacity, the dairy industry faces challenges related to milk quality and value addition. The development of process technology for the isolation and purification of functional nutrients from bovine milk offers a significant opportunity to enhance the value of this commodity. By focusing on the isolation and purification of functional nutrients such as proteins, lipids and bioactive peptides, this project aims to address some key challenges like substantially increase the value of its dairy production by processing and purifying milk components for use in higher-value products such as functional foods, dietary supplements and pharmaceuticals.

This research project aims to develop advanced process technology to extract and purify these valuable components, which can have a wide range of applications in the food, pharmaceutical and nutraceutical industries. Objects are as follows:

- Developing efficient and cost-effective techniques for the isolation and purification of essential components in bovine milk, such as proteins, lipids and bioactive peptides.
- Evaluating the nutritional and functional properties of the isolated compounds and their potential applications in various industries, including food, pharmaceuticals and nutraceuticals.
- Enhancing the value chain of Pakistan's dairy industry by facilitating the production of high-value products with global market potential.
- By producing high-quality functional nutrients from bovine milk, Pakistan can tap into international markets and export value-added dairy products, contributing to economic growth.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
Comprehensive literature review on the importance, issues and processing technologies for milk fractionation	Benchmarking of isolation & purification techniques (membrane filtration, chromatography, enzymatic hydrolysis, etc.).	Identification of internationally and locally available technological resources for lab and pilot scale studies.	Integration and optimization, of isolation + purification methods into a semi-continuous lab-scale process.
2nd Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Procurement of chemicals, consumables, membranes, and basic lab scale set up / facilities.	<ul style="list-style-type: none"> • Experimentation and products development • Optimization of throughput, reproducibility and cost-efficiency • Mass balance studies to assess recovery rates 	<ul style="list-style-type: none"> • Develop HPLC and FTIR-based analytical methods for quantifying functional nutrients. • Evaluate stability of isolated nutrients during storage. 	<ul style="list-style-type: none"> • Quality assurance/ Testing • Writing of the technical report demonstrating feasibility & cost-effectiveness. • Cost-benefit analysis for scale-up to commercial production.

Funding Source (PSDP/SGI/RD&I/etc):

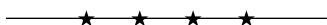
In-House

Tangible Outcome:

- To create value-added products like milk protein concentrates and isolates, lactose and milk fat with significant health and economic benefits.
- To represent Pakistan as a competitive player in the global dairy industry while improving the nutritional quality of its dairy products.
- To support the dairy industry.

Achievement:

New Project



Name of Laboratory/Centre/Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Development of Low-Glycemic-Impact Sucrose (LGI-Sucrose): Process, Product & Clinical Validation

Name & Designation of Project Director:

Ms. Shamma Firdous, PSO

Name & Designation of Project Associate(s):

- Dr. Asma Saeed, CSO
- Dr. Muafia Shafiq, SSO
- Dr. Sajila Hina, SSO
- Dr. Ammara Yasmeen, SSO

Area of Research:

Food Technology

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

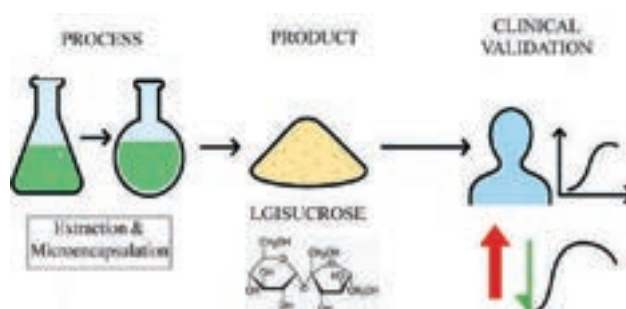
Conventional sucrose has a high glycemic index (~65), contributing to rapid spikes in blood glucose and insulin levels, which are linked to diabetes, obesity and metabolic disorders. Current artificial sweeteners (saccharin, aspartame, sucralose) face challenges such

as off-taste, limited functional use in food processing, safety controversies and consumer distrust. Natural low-calorie sweeteners (stevia, monk fruit) also have sensory limitations and restricted applications. There is a strong need for a sucrose-like sweetener that is safe, affordable, retains bulk functionality but has a lower glycemic impact. The scope of this project covers the design, development, validation and pilot-scale production of a novel low glycemic index sucrose prototype with industrial and clinical relevance.

Conventional sucrose drives rapid glycaemia. There is unmet demand for a drop-in sweetener with sucrose-like sensory/functional properties but lower glycemic impact ($\leq 30\%$). We will develop and validate LGI-Sucrose via three orthogonal strategies and down-select to the best performing, scalable option.

- Create LGI-Sucrose.
- Match sweetness intensity.
- Demonstrate industrial feasibility.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Identify best sugar sources (cane, beet, enzymatic modification) • Optimize extraction/purification for desired low-GI properties 	<ul style="list-style-type: none"> • Establish enzymatic/chemical pathways to modify sucrose digestion properties. • Conduct small-batch laboratory trials 	<ul style="list-style-type: none"> • Sensory evaluation (taste, texture, after-taste) • Glycemic index assay (in-vitro). 	<ul style="list-style-type: none"> • Compile results from clinical trials. • Validate LGI claim through peer-reviewed methodology

Funding Source:

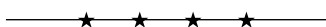
In-House

Tangible Outcome:

- Product development.
- Scientific & technical validation.
- Clinical validation.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

FBRC/PC SIR Labs. Complex, Lahore

Title of Project: Sustainable Nutrient Solutions for High-Yield and Water-Efficient Rice Cultivation

Name & Designation of Project Director:

Ms. Shamma Firdous, PSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO
 Dr. Muafia Shafiq, SSO
 Dr. Sajila Hina, SSO

Area(s) of Research:

Agriculture

Duration:

03 Years

Date of Initiation:

July, 2025

Project Brief:

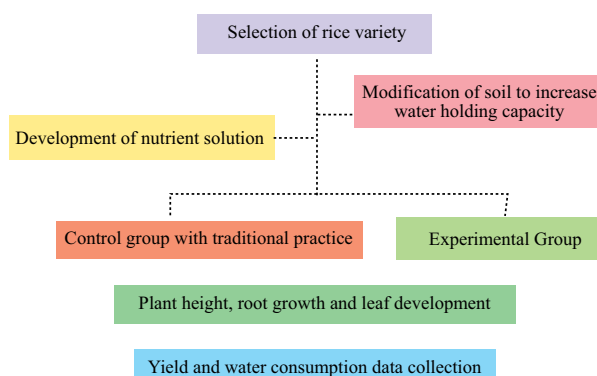
Rice (*Oryza sativa*) is one of the most important food crops globally, serving as a staple diet for more than half of the world's population. It provides a significant source of calories and nutrition, especially in Asia, where it forms the backbone of economies. Rice is not only crucial for food security but also plays a vital role in the livelihoods of millions of farmers. Its cultivation supports rural economies, while its diverse varieties offer unique flavors and health benefits, making it an essential crop in the fight against hunger and malnutrition.

Rice is one of the most water-intensive crops, consuming nearly 30% of global freshwater resources.

With increasing water scarcity and climate change concerns, developing sustainable agricultural practices is crucial. Traditional flooding-based rice cultivation leads to high water usage, inefficient nutrient absorption and methane emissions. Traditional rice farming practices rely heavily on chemical fertilizers and excessive water use, leading to soil degradation and water scarcity. The inefficient use of nutrients contributes to greenhouse gas emissions and reduces long-term soil fertility. There is an urgent need to develop and implement sustainable nutrient management strategies that enhance productivity while minimizing ecological harm. This project seeks to bridge the gap between high-yield rice production and sustainable agricultural practices by integrating innovative nutrient and water management solutions. By using advanced agricultural technologies, precision nutrient management and increasing water holding capacity of the soil, this research will provide a sustainable approach to rice farming. The optimized nutrient solution will maximize nutrient uptake efficiency, reduce dependency on excessive fertilizers and support water-efficient rice farming. The objectives are:

- Formulating customized, sustainable nutrient management solutions that optimize the use of fertilizers and organic amendments, improving crop productivity.
- To reduce water consumption in rice cultivation by integrating nutrient management with water-saving soil amendment techniques.
- Implementing field trials to test the effectiveness of the proposed nutrient solutions and water-efficient practices.
- Compilation of results/Data Analysis.
- Transfer of technology.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Soil and water profiling (nutrient status, pH, EC, organic matter, irrigation quality)	Development of customized nutrient formulations (balanced NPK, micronutrients, slow-release)	Preparation of plots for testing nutrient-water combinations	<ul style="list-style-type: none"> Evaluate plant growth, root development and water use efficiency Record baseline yield and water productivity
2nd Year			
5th Quarter	6th Quarter	7th Quarter	8th Quarter
<ul style="list-style-type: none"> Adjust protocol for field experiment Field experiment to meet the objective 	<ul style="list-style-type: none"> Deploy optimized nutrient solutions Compare with conventional fertilizer and irrigation methods 	Evaluate nutrient use efficiency and water use efficiency	Refine nutrient blends and irrigation recommendations
3rd Year			
9th Quarter	10th Quarter	11th Quarter	12th Quarter
Final plot experiments to address the shortcomings observed during previous experiments	Data collection of crop health, plan growth and overall production yield	Evaluate impact on grain quality (protein, micronutrients, heavy metal uptake).	<ul style="list-style-type: none"> Compile 3-year dataset into a comprehensive model and best-practices package Publish scientific papers and extension manuals

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Develop a balanced and efficient nutrient solution for rice.
- Identify the optimal macro and micronutrient composition for various growth stages.
- Enhance nutrient uptake efficiency and improve plant health.
- Increase yield and quality of rice production.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

FBRC/PC SIR Labs. Complex, Lahore

Title of Project: Development of Low Glycemic Index Food Products Using Indigenous Sources

Name & Designation of Project Director:

Ms. Shumaila Usman, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO
 Dr. Saima Nazir, SSO
 Dr. Ammara Yasmeen, SSO

Area of Research:

Food Science & Nutrition

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Glycemic Index (GI) is ranking of carbohydrates on a scale from 0 to 100, based on how quickly they raise blood glucose levels after eating. Foods with a

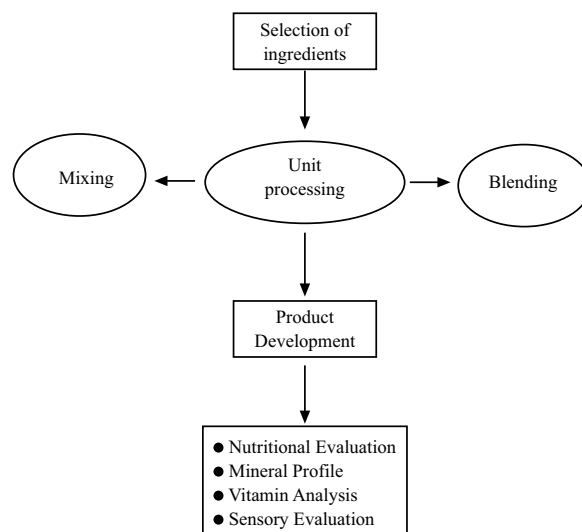
low glycemic index (55 or less) cause a slower and more gradual rise in blood sugar, which helps maintain steady energy, supports weight control and reduces the risk of type II diabetes and heart diseases. A low glycemic index breakfast is especially important because it sets the tone for the day. After the overnight fast, the first meal influences blood sugar control, appetite regulation and mental focus. By choosing low GI foods such as whole grain, fruits rich in fiber, nuts and seeds, individuals can avoid sudden sugar spikes, reduce mid-morning hunger and improve overall health.

Modern dietitians often recommend a low GI breakfast because it may prevent overeating later in the day. Low GI foods help the body respond to insulin more effectively. Slow releasing carbohydrates provide steady fuel for the brain and muscles, which is especially helpful for controlling hunger, reducing energy crashes and more helpful to focus work and performance. For a diabetic patient, a low GI breakfast is crucial because it helps control blood sugar right from start of the day. Morning is the time when many diabetics experience higher blood sugar and low GI foods help counter this effect. Stable blood sugar helps control appetite, which is beneficial for weight management that is key part of type II diabetes control.

Low GI Foods including oats, whole wheat, eggs, yogurt, nuts and fruits releases glucose slowly, preventing sudden increases blood sugar after eating. Low GI food ingredients are rich in protein, fiber and minerals and lower in carbohydrates having positive impact on sugar release causing diabetes. The main objectives of the research are:

- Nutritional management strategy that optimize the use natural sources like whole grains, nuts and fruits.
- To explore the sources of low GI breakfast as well as practical recipes that can be incorporated in daily life.
- Low GI breakfast formulations help to reduce risk of type II diabetes in population.
- Product development will help industry to improve use of organic strategies.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection of selected ingredients and other material	Incorporation of ingredients to develop designed formulations following all unit processes	Evaluation of developed formulations including nutritional, microbiology and aflatoxin	Application of formulations to subjects and GI measurements

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcomes

- Process development.
- Technical Report submission.
- Paper publication.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Biochar Production from Biowaste and its Practical Implementation as Soil Amendment for Enhancement of Crop Yield

Name & Designation of Project Director:

Dr. Muafia Shafiq, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO

Ms. Shamma Firdous, PSO

Dr. Sajila Hina, SO

Area(s) of Research:

Environmental Waste Reduction, Agriculture, Food Security

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Biochar, the by-product of thermal decomposition of organic materials in an oxygen-limited environment, is increasingly being investigated due to its potential benefits for soil health, crop yield, carbon (C) sequestration and greenhouse gas (GHG) mitigation. It has significant application in agriculture to enhance crop production, soil condition, nutrient uptake and carbon sequestration due to its unique characteristics like high surface area and pore volume that is directly link with high water holding capacity. Mostly, biochar is produced from feedstock such as agricultural wastes, animal manures and paper products. The importance of these wastes for the production of biochar is an efficient way to turn waste to useful and value-added substance. Previous research showed that biochar as an agricultural additive to enhance crop productivity and improve soil health and the potential benefits as a material for growth media and composting, which enhances the growth of high-value food crops to meet the increased food demand. Biochar is a marketable bio-product, which can be used in industries and energy sector. Thus, biochar production can enhance soil

property and provide opportunities for additional income. Pakistan's soil quality varies across the country and is often deficient in nutrients like phosphorus, potash, zinc, boron and iron. Phosphorus and potash deficiency affects 75–92% and 20–60% of cultivated soil, respectively. Recently, there has been a lot of focus on using biochar to improve soil health, mitigate soil degradation, reducing soil nutrient leaching losses, increasing agricultural productivity, reducing bioavailability of environmental contaminants and subsequently, becoming a value-added product sustaining bioeconomy and control soil and water pollution. Unique physical and chemical characteristics of biochar, like large surface area, high pore volume, high cation exchange capacity and functional groups, make it suitable as an amendment to enhance crop productivity.

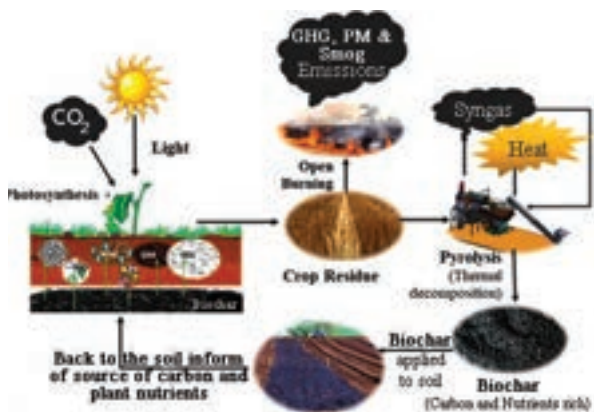
Biochar is a marketable bio-product, which can be used in, industries and energy sector. Thus, biochar production can enhance soil property and provide opportunities for additional income. With an increasing population worldwide, there appears to be an increasing demand for quality food and fodder to ensure environmental safety. Although chemical fertilizers and pesticides are widely used to increase crop yield and plant protection, the unauthorized and injudicious use of chemicals negatively affects native flora and fauna and depletes natural soil fertility, culminating in quality loss, climate crisis and global warming. The utilization of biowaste to produce biochar could solve the disposal and management of agricultural waste like sugarcane bagasse, rice husk, wheat straw etc. Unique physical and chemical characteristics of biochar, like large surface area, high pore volume, high cation exchange capacity and functional groups, make it suitable for a wide range of applications. The utilization of biowaste to produce biochar could solve the disposal and management of agricultural waste like sugarcane bagasse, rice husk, wheat straw etc. Biochar production from agriculture residue starts with biomass feeding into the combustion chamber in the absence of air. There are mainly five production stages: drying, conditioning, torrefaction, exothermic pyrolysis and endothermic pyrolysis at different temperatures. The objectives of the current project are:

- The utilization of agriculture waste to produce biochar.
- Production of biochar from biowaste would be helpful in management and disposal of agricultural

waste, reduction of air pollution and greenhouse gases that produced due to burning of biowaste.

- To use the biochar as soil amendment to reduce nutrient deficiency of soil and enhance soil fertility.
- To grow selected crops in soil, amended with biochar and record the crop productivity regarding fruit yield.
- Spread the awareness of potential benefits of biochar.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

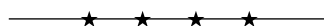
In-House

Tangible Outcome:

- Production of biochar from biowaste would be helpful in management and disposal of agricultural waste, reduction of air pollution and greenhouse gases that produced due to burning of crop residues.
- Amendment of biochar in soil will improve the soil health and enhance the crop yield.
- Nutritional rich food will ultimately affect the health of living beings.
- Economic development.

Achievements:

New Project



Name of Laboratory Center/ Unit:

FBRC/PC SIR Labs. Complex, Lahore

Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • To collect Biowaste like rice husk, wheat straw, tea spent etc and subjected to pyrolysis for biochar preparation. • The produced biochar will be analyzed for various physiochemical properties like water holding capacity, bulk density, nutrient concentration etc. 	<ul style="list-style-type: none"> • Practical implementation of biochar as soil amendment will be carried out and selected crops (e.g. Canola etc) will allow to grow in experimental fields • Data will be recorded regarding crop oil yield and nutritional value in comparison to control group 	<ul style="list-style-type: none"> • Effects of produced biochar will be analyzed on vegetables e.g. tomatoes etc • Data will be recorded regarding necessary parameters of crop 	<ul style="list-style-type: none"> • The recorded data will be compiled and analyzed for enhanced nutritional value in comparison to control group as well as on soil structure • Product development and spread awareness to farmer

Title of Project: Fortification of Whey with Probiotics: A Nutritional Strategy for Combating Malnutrition in Pakistan

Name and Designation of Project Director:

Dr. Ammara Hassan, SSO

Name and Designation of Project Associate(s):

- Dr. Salman Saeed, PSO
- Dr. Shahid Masood, SSO
- Dr. Shabana Kauser, SSO
- Ms. Shumaila Usman, SSO
- Dr. Muhammad Ashraf, SSO
- Ms. Shaghuftha Naz, SSO
- Dr. Abdul Ahad Rashid, SSO

Area of Research:

Food Microbiology

Duration:

01 Year

Date of Initiation:

February, 2025

Project Brief:

This project explores the utilization of whey, a byproduct of cheese and yogurt production, by fortifying it with probiotics and developing Whey based functional and nutritious product. Whey is highly nutritious liquid rich in proteins, vitamins and minerals. Despite its valuable nutritional content, whey is often discarded or underutilized, contributing to food waste in the dairy industry. In recent years, the global population has become increasingly concerned with health and wellness, leading to a greater demand for functional foods that support overall well-being. Among these, probiotics and functional dairy products have emerged as key areas of interest.

By incorporating probiotics, this project aims to enhance the health benefits of whey, particularly in improving gut health and boosting immunity. The goal is to develop sustainable, marketable whey-based products that contribute to both nutritional wellness and environmental sustainability. Simultaneously, the importance of probiotics—live microorganisms that confer health benefits when consumed in adequate amounts—has garnered attention for their role in improving gut health, boosting immunity and even enhancing mood. Probiotic fortification of food products has become a widespread approach to delivering these benefits, especially in dairy products. This initiative seeks to provide a practical solution to the growing demand for probiotic-rich foods while reducing waste in the dairy industry. The main objectives of the project include the following key aspects:

- To reduce the waste of cheese industry and promoting sustainability; whey is a byproduct of cheese production and instead of being discarded; it can be repurposed for a variety of uses.
- To fortify whey with probiotics to create a functional dairy beverage that enhances gut health and provides additional health benefits.
- To Choose locally isolated probiotics with proven health benefits, such as *Lactobacillus* or *Bifidobacterium* strains, which are known to support the gut microbiome.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Collection of Whey from all across Pakistan • Whey purification 	<ul style="list-style-type: none"> • Inoculation of whey with prebiotics • Fermentation of whey drinks and fortification • Preparation of different probiotic-enriched whey beverages, powders and dairy products 	Quality assurance of the final product in terms of nutritional and microbiological evaluation	<ul style="list-style-type: none"> • Shelf life studies • Technical report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- To create a sustainable, nutritious product that not only provides essential nutrients but also offers a

practical solution to both food waste and the increasing need for probiotics in the diet.

Achievements:

New Project



Name of Laboratory / Centre / Unit:

CDLE/PCSIR Lab. Complex Lahore

Title of Project: Design and Development of Temperature Control Ball Mill at Lab Scale

Name & Designation of Project Director:

Mr. Pir Bukhsh Khan, SSO/Head-CDLE

Name & Designation of Project Associate(s):

Mr. Faisal Mushtaq, JTO
 Syed Junaid Raza Tirmizi, JTO
 Mr. Muhammad Aftab, Sr. Tech

Area(s) of Research:

Instrumentation

Duration:

01 Year

Date of Initiation:

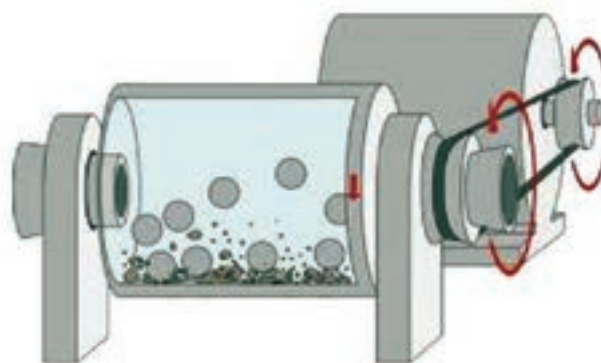
August, 2025

Project Brief:

A ball mill is a grinding machine that uses balls to grind and remove material. It has a hollow compartment that rotates along a horizontal or vertical axis, with balls bouncing around and striking the enclosed material, grinding it into a finer medium. Ball mills are different from traditional milling machines in several ways, including that they don't have a cutting tool and that they support materials like ore, ceramics and paint, while traditional milling machines support large work pieces. The conventional method is used for the grinding of different materials due to which a mesh size of the material is not possible to reduce up to Nano particle.

This design of ball mill (capacity: 1 kg lab scale, timer: up to 99 Hrs., Heating power: 220 VAC 50 Hz, Motor power: ½ Hp, Voltage: 220V/50HZ Single phase, Size of drum(mm): 1'x6", Temperature: Ambient-550C) will be comprising a temperature control system and so far none has designed this type of ball mill with temperature control system. The main objective of this project to design and development of an import substitutes.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Literature survey Design and development of initial design of the equipment Market survey for procurement of necessary materials 	<ul style="list-style-type: none"> Fabrication of designed equipment will be started after receiving funds Fabrication of heating system of the equipment 	<ul style="list-style-type: none"> Assembling of Mechanical parts Assembling of Electrical parts Conducting test run 	Obtaining the required parameters after testing

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Updated modern technology /methods for designing and fabrication of lab equipment.
- Use calibrated instruments for testing and performance check of fabricated equipment.
- To provide the backup service and consultancy on time.
- Delivery of equipment to client within given time frame.

Achievements:

New Project



Name of Laboratory / Centre / Unit:

CDLE/PCSIR Lab. Complex Lahore

Title of Project: Design and Development of High Temperature Chamber Furnace-1400°C

Name & Designation of Project Director:

Mr. Pir Bukhsh Khan SSO, Head-CDLE

Name & Designation of Project Associate(s):

Mr. Faisal Mushtaq, JTO
 Syed Junaid Raza Tirmizi, JTO
 Mr. Muhammad Aftab, Sr. Tech

Area(s) of Research:

Instrumentation

Duration:

01 Year

Date of Initiation:

August, 2025

Project Brief:

The 1400°C muffle furnace uses polycrystalline mullet’s fiber lining, which has low thermal conductivity, high strength and excellent thermal insulation and energy-saving effects. The furnace shell adopts a double-layer air-cooled structure, the surface temperature is lower than 60°C and the furnace top structure is solid to ensure long life and avoid collapse during continuous operation. This furnace is a special equipment specially developed for the sintering, melting, and analysis of metals, non-metals and other composite materials in universities, scientific research institutes laboratories and industrial and mining enterprises.

The High temperature Furnaces are not being design at lab scale in Pakistan. High-temperature chamber furnaces are essential in various industrial applications such as metal heat treatment, ceramics sintering, glass processing and material testing. These furnaces are designed to operate at extreme temperatures, often exceeding 1400 °C, to achieve specific material properties. However, their use presents several operational challenges. The core objectives are:

- To develop furnaces by using indigenous technology and to operate a high-temperature chamber furnace that delivers consistent thermal performance while minimizing energy consumption, ensuring safety and extending equipment lifespan under demanding industrial conditions.
- Design and Development of low cost equipment of an import substitutes to save the revenue.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Literature survey • Design and development of initial design of the equipment • Market survey for procurement of necessary materials 	<ul style="list-style-type: none"> • Fabrication of designed equipment will be started after receiving funds • Fabrication of heating system of the equipment 	<ul style="list-style-type: none"> • Assembling of Mechanical parts • Assembling of Electrical parts • Conducting test run 	<ul style="list-style-type: none"> • Obtaining the required parameters • Report will be submitted after complete test run of the equipment

Funding Source (PSDP / SGI/RD&I) etc.:

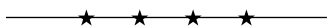
In-House

Tangible Outcome:

- Use updated modern technology /methods for designing and fabrication of lab equipment.
- Use calibrated instruments for testing and performance check of fabricated equipment.
- To provide the backup service and consultancy on time.
- Delivery of equipment to client within given time frame.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PITMAEM/PC SIR Lab. Complex Lahore

Title of Project: Fabrication and Characterization of Reduced Graphene Oxide/Fluorhydroxyapatite Composites for Bio-Medical Applications

Name & Designation of Project Director:

Dr. Sumaira Nosheen, SSO

Name & Designation of Project Associate(s):

Mrs. Farzana Habib, PSO

Engr. Bilal Waseem, JE

Area(s) of Research:

Advanced Engineering Materials/Biomaterials

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

With the aging population, the number of patients with osteoporosis will increase, so there is a need for better treatments for the patient and the affected bones.

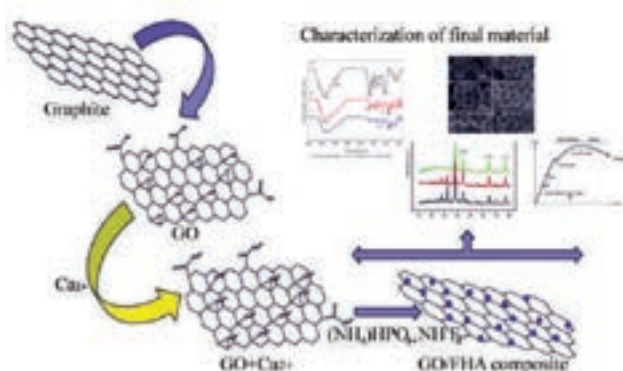
About 70% of the bone ingredients contain calcium phosphate, so calcium phosphates are good materials for repairing damaged bones. Bone substitutes are made from a variety of biomaterials, including ceramics, polymers, metals and composites. The type of biomaterial used depends on the purpose of the bone substitute and the clinical application. These materials have good biocompatibility and bioactivity. Among these Fluorapatite (FHA) is good choice due to fluoride substitution which can improve the chemical stability of HA, but the mechanical properties of FHA after implantation are not still satisfying.

To overcome the weak mechanical properties of pure FHA, various reinforcing materials can be incorporated with biomaterial to form high-performance composite materials. Recently, graphene and its derivatives have found wide acceptance as reinforcement or filling materials in ceramic matrices because of their extraordinarily high mechanical properties such as Young's modulus (up to 1 TPa) and intrinsic strength (approximately 130 GPa). Thus, reduced graphene oxide will be incorporated in small quantity to improve the mechanical properties of FHA.

In-situ mode of synthesis will be used to fabricate reduced graphene oxide (rGO) reinforced hydroxyapatite nano-tube (nHA) composites. The composites will be characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) enabling confirmation of the synthesis and reduction of the FHA and rGO, respectively. The structure of the synthesized powder and cell attachment on the sintered sample will be confirmed by scanning electron microscopy (SEM). The effects of the rGO on the mechanical properties and the in vitro biocompatibility of the nHA based ceramic composites will be investigated using simulated body fluid and bovine albumin serum. The objectives include:

- Development of FHA/rGO composites.
- Study of elastic modulus and fracture toughness of the sintered samples.
- Biocompatibility studies using SBF and BSA.
- Study of mechanical properties of nano composite before and after sintering and by changing the filler (rGO) percentage.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Literature survey And availability of chemicals etc	Collection of raw material and start of experimental work	Experimental work (different trials) and optimization of process parameters	Characterization, Report writing and final submission

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Improvements in both their biological and mechanical properties.
- One international publication.
- The process will be developed for the said R & D work.

Achievements:

New Project



Name of Laboratory/Centre/ Unit:

PITMAEM/PCSIR Lab. Complex Lahore

Title of Project: Comparative Study of Mechanical and Morphological Aspects for the Life Assessment of Domestic LPG Composite Cylinders

Name & Designation of Project Director:

Mr. Muhammad Fayyaz, SSO

Name & Designation of Project Associate(s):

- Engr. Muhammad Irfan, PE
- Engr. Farooq Iftikhar, SE
- Engr. Badaruddin Soomro, SE
- Syed Zaheer Abbas, SSO
- Mrs. Farzana Habib, PSO

Area(s) of Research:

Advanced Engineering Materials

Duration:

06 Months

Date of Initiation:

July, 2025

Project Brief:

This project seeks to evaluate the life expectancy and structural integrity of various LPG composite cylinders through mechanical testing and morphological analysis. The study focuses on assessing the degradation patterns, failure mechanisms and long-term performance under simulated environmental and loading conditions. By analyzing the material properties and behavior over time, the project will contribute to the safer and more efficient use of composite LPG cylinders in domestic and industrial applications. The objectives of the present study are:

- To compare the mechanical properties (e.g., tensile strength, impact resistance, fatigue behavior) of different LPG composite cylinders.
- To conduct morphological studies using techniques such as SEM (Scanning Electron Microscopy) to observe surface degradation, micro cracks and delamination Glass Fibre pattern.

- To simulate aging conditions (thermal, UV exposure, pressure cycling) and evaluate their effects on cylinder lifespan.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter
Comparison and Optimization of properties of different LPG composite cylinders	Interpretation of results and technical report writing

Funding Source (PSDP/SGI/RD&I/etc):

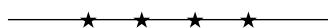
In-House

Tangible Outcome:

- A comparative life assessment of different composite LPG cylinders with respect to their production process.
- Recommendations for design improvements and quality improvement during manufacturing process.
- Technical and Quality validation support for local manufacturer and regulatory authorities (OGRA) within the country.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PITMAEM/PCSIR Lab. Complex Lahore

Title of Project: Development and Characterization of Synthetic Biodegradable Polymers for Bone Repair

Name & Designation of Project Director:

Mr. Muhammad Fayyaz, SO

Name & Designation of Project Associate(s):

Mrs. Farzana Habib, PSO

Engr. Waqas Iqbal, JE

Area(s) of Research:

Advanced Engineering Materials/Biomaterials

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Biodegradable polymers are a class of polymers that will degrade and therefore resorb once they are in contact with tissues and fluids of the body. The main advantages of these polymers are:

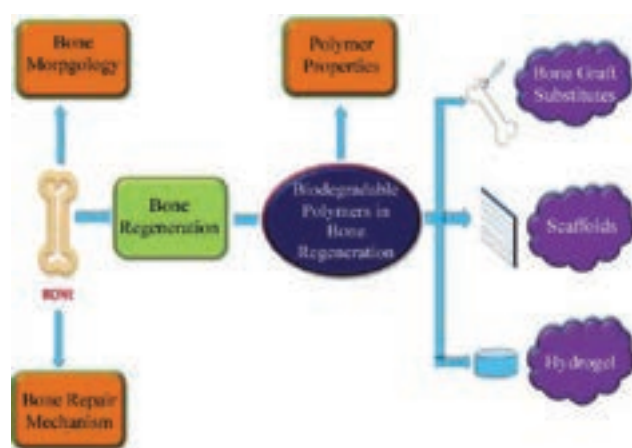
- Once their function has been accomplished, they will disappear.
- The tissue will grow after their disappearance. In addition to the potential problem of toxic substances leaching from the implant (residual monomer, initiators), potential toxicity of the degradation products is another problem.

A biodegradable polymer may be derived from either natural or synthetic sources. Natural polymeric materials, such as collagen and heparin, have been used as medical devices. However, the use of synthetic polymers in general offers greater advantages over natural materials in that they can be tailored to give a wider range of properties and have more predictable lot-to-lot uniformity than materials from natural sources. Also, a more reliable source of raw materials is obtained with synthetic polymers that are free of the concerns of immunogenicity.

Most of the have functional groups that are sensitive to hydrolytic processes such as ester, carbonate, anhydride, urethane, orthoester or amide. The mostly used are the polymers that contain esters of carboxylic acids, such as poly (lactic acid) (PLA) or poly (glycolic acid) (PGA). Their applications range from suture materials to osteosynthesis materials (needles, screws, or plaques). Objectives are given below:

- Development of biodegradable polymer for bone repair.
- Mechanical Study of developed material.
- Biocompatibility studies using SBF.

Graphical Abstract:



Quarterly Work Plan:

Year (2025-26)	1st Quarter (July-Sep, 2025)	2nd Quarter (Oct-Dec, 2025)	3rd Quarter (Jan-Mar, 2026)	4th Quarter (Apr-June, 2026)
	Literature survey of material. Collection of material	Development and Optimization of material	Characterization of developed different compositions	Report writing and final submission

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- The process will be developed for the said R & D work.

- Technical Report/ publication.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

MPRC/PCSIR Lab. Complex Lahore

Title of Project: Platinum Group Metals (PGM) Extraction from Indigenous Ores Using Suitable Techniques

Name & Designation of Project Director:

Dr. Irfan Hafeez, PSO

Name & Designation of Project Associate(s):

Mr. Muhammad Arif Bhatti, PSO

Area(s) of Research:

Minerals

Duration:

02 Years

Date of Initiation:

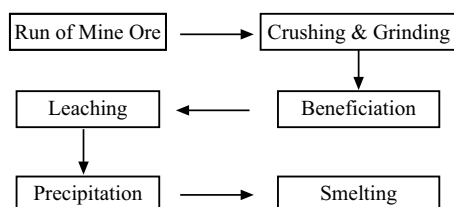
July, 2025

Project Brief:

PGMs, are noble metals employed in numerous applications, from fountain pens to aircraft turbines, from cell phones to catalytic converters, from ceramic enamels to precious jewelry. In Pakistan, various minerals deposits having precious metals are being explored by government as well as by private parties. Recently presence of gold/ precious metals along with base minerals has also been reported in Indus river sand. Balochistan province is already famous for their copper-gold deposits in Chaghi and Saindak area. Platinum Group Metals (PGMs), often associated with gold are present in an ore deposit at economically extractable levels. These metals classified as precious and critical due to their scarcity and wide industrial use. (PGMs) are of major commercial significance, it may be conventionally recovered from high-grade concentrates. In present investigation efforts will be made to extract (PGMs) from their base ores like copper.

Sample evaluation, crushing grinding, beneficiation (up-gradation), leaching, purification and extraction of metals are included. The main objective is to develop a suitable process for PGM extractions from its ores.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Selection of ores having PGM & their procurement.	Composition Analysis/ Chemical evaluation of Ore Samples	Direct leaching approach to platinum group metals extraction will be conducted	Leaching medium like bacterial strains, acids and alkali will be investigated for leaching experiments.
2nd Year	Concentrates would also produced for leaching experiments to improve the recovery of product like froth flotation, gravity separation, as well as magnetic separation.	Hydro-metallurgy, electrolytic extraction and pyro-metallurgy will be also used for the extraction of metals.	Efforts would be made to separate the metals by electrolytic processing procedure.	Technical report will be written on the bases of lab scale trials.

Funding Source (PSDP/SGI/RD&I/etc.)

In-House

Tangible Outcome:

- On completion of the project PCSIR will be able to estimate the PGM present in ore samples.

- Process for the extraction of PGM like Platinum, Palladium and Rhodium will be possible.
- Technical report as well as publication may be submitted on the bases of lab scale results.

Achievements:

New Project



Name of Laboratory / Centre/ Unit:

BMRC/ PCSIR Labs. Complex, Lahore

Title of Project: Investigations on Possible Use of Fly Ash as Raw Material in Ceramic Industries

Name & Designation of Project Director:

Mr. Akhtar Shahnaz, SSO

Name & Designation of Project Associate(s):

Dr. Phool Shahzadi, SSO

Area(s) of Research:

Ceramics

Duration:

01 Year

Date of Initiation:

July, 2025

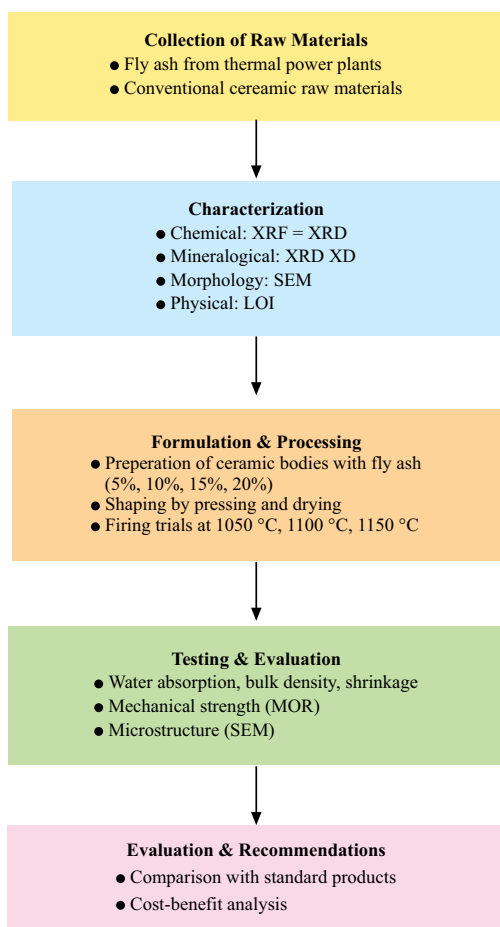
Project Brief:

Fly ash, a by-product of coal combustion in thermal power plants, poses significant disposal and environmental challenges in Pakistan. Its chemical composition rich in silica, alumina and iron oxides makes it a potential raw material for ceramic production. This project will explore the suitability of locally available fly ash as a substitute in ceramic formulations to reduce natural resource consumption and promote sustainable waste utilization. Pakistan's growing reliance on coal-based power generation has resulted in large amounts of fly ash, most of which remains underutilized, creating environmental and disposal challenges. In Pakistan, coal-based power plants produce thousands of tons of fly ash annually. The majority is dumped in ash ponds or landfills, leading to land degradation,

water contamination and dust pollution. Meanwhile, the ceramic industry imports significant quantities of fluxing materials and filler minerals. This project aims to explore whether locally generated fly ash can be economically and technically incorporated into ceramic products such as tiles, sanitary ware and refractories thereby reducing environmental load and lowering the cost of raw materials and products. This aligns with the circular economy approach, turning waste into value-added products. The objectives are:

- To chemically, physically and mineralogical characterize local fly ash.
- To determine its effect on ceramic body properties (plasticity, drying shrinkage, firing behavior).
- To assess its impact on final product quality mechanical strength, water absorption, surface finish.
- To recommend optimum usage levels for industrial applications.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection and characterization of materials & Investigation of its suitability as a raw material in various ceramic bodies.	Formulation and processing	Trial Firing and testing	Data analysis and recommendation

Funding Source (PSDP/SGI/RD&I/etc):

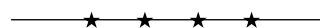
In-House

Tangible Outcome:

- Optimum fly ash content for quality ceramic production.
- Cost reduction potential through partial replacement of natural materials.
- Sustainable utilization of industrial waste, reducing environmental hazards.

Achievements:

New Project



Name of Laboratory / Centre/ Unit:

GCRC/PCSIR Lab. Complex Lahore

Title of Project: Development of Cordierite Mullite Based Crucibles for the Melting of Special Type Glasses

Name & Designation of Project Leader:

Dr. Phool Shahzadi, SSO

Name & Designation of Project Associate(s):

Mr. Akhtar Shahnaz, SSO

Area(s) of Research:

Ceramics and Glasses

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Specialty glasses such as borosilicate, high silica, lead-free optical and bioactive glasses are widely used in optics, electronics, medical devices and aerospace applications. These materials require high-purity, thermally stable and corrosion-resistant crucibles for their melting processes. Conventional silica, alumina, or zircon-based crucibles often fail due to thermal shock during repeated heating-cooling cycles. Corrosion by molten glass, especially with high alkali or high boron compositions. Contamination, altering glass optical or chemical properties. Cordierite–Mullite composites offer an inimitable solution by combining:

- Low thermal expansion (cordierite) excellent thermal shock resistance.
- High refractoriness and strength (Mullite) mechanical stability at high temperatures.
- Chemical inertness reduced contamination of specialty glasses.

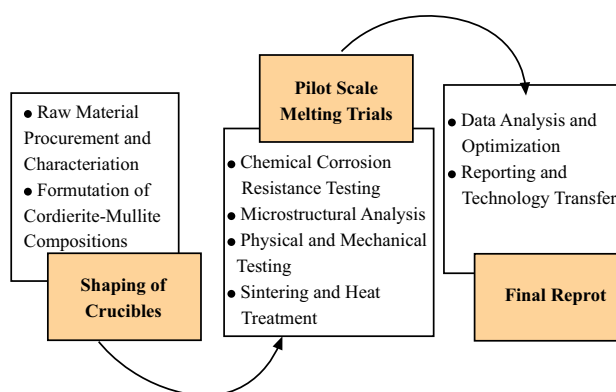
This project aims to develop, optimize and pilot-produce cordierite–mullite based crucibles for industrial melting of specialty glasses in Pakistan, reducing import dependence and improving production quality. The melting of specialty glasses such as borosilicate, high-silica and optical glasses demands crucibles with exceptional thermal shock resistance, high-temperature strength and chemical inertness. In Pakistan, glass manufacturers rely heavily on imported alumina, zirconia, or silica-based crucibles, which are not only costly but also suffer from limited service life when exposed to aggressive molten glass compositions containing high alkali or boron content. The absence of locally developed, high-performance crucibles tailored for specialty glass melting has created a technological gap in the country’s glass industry. This dependency on imports limits production scalability, raises manufacturing costs and constrains the development of advanced glass products.

Therefore, there is an urgent need to develop cordierite–mullite based crucibles that combine low thermal expansion, high refractoriness and chemical

stability offering a cost-effective, long-lasting, and contamination-free solution for Pakistan’s specialty glass industry. The objectives of the present study include:

- Develop cordierite–mullite compositions with optimal thermal, mechanical and chemical properties.
- Investigate raw material sources (local clays, alumina, magnesia, silica).
- Fabricate prototype crucibles using slip casting / pressing and controlled firing.
- Evaluate crucible performance in laboratory and pilot glass-melting trials.
- Establish production parameters for technology transfer to industry.

Graphical Abstract:



Quarterly Work Plan:

1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Literature review	Procurement of Raw materials and characterization.	Raw mix Design formulation	Moulds for crucible fabrication
2nd Year	Green body preparation and bisque firing	Sintering of green body and parameter optimization	Physical and mechanical testing	Data analysis and Report writing

Funding Source (PSDP/SGI/RD/&I/etc):

In-House

Tangible Outcome:

- Optimized cordierite/mullite composite compositions with tailored thermal and mechanical properties.
- Microstructural control ensuring fine and evenly distributed phases.
- Cost-effective processing route suitable for scale-up.
- Potential application in kiln furniture, refractory linings, and heat-resistant components.

Achievements:

New Project



Name of Lab / Centre / Unit:

UMW/PCSIR Labs. Complex Lahore

Title of Project: A Compact, End-to-end Blueprint for Car Radar Design & Development (77–81 GHz FMCW), Tuned for Practical Engineering, Procurement, and Validation.

Name & Designation of Project Director:

Engr. Ali Imran, SE/Head-UMW

Name & Designation of Project Associate(s):

Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
Mr. Muhammad Atif, Sr. Tech

Area(s) of Research:

Industrial Research, Automobile

Duration:

03 Years

Date of Initiation:

September, 2025

Project Brief:

The global automotive industry is rapidly transitioning toward intelligent transportation systems, with Advanced Driver Assistance Systems (ADAS) and autonomous driving as central pillars. Among enabling technologies, radar sensors play a pivotal role by providing reliable detection of surrounding vehicles,

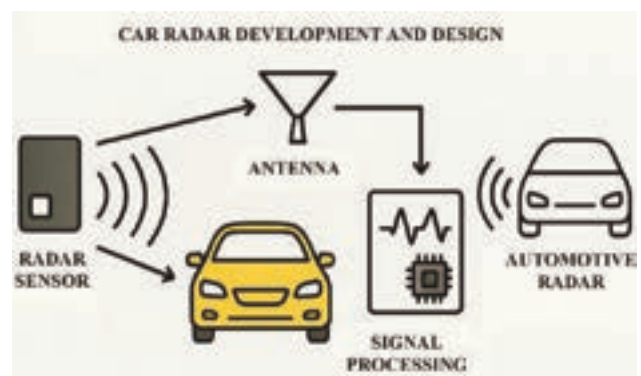
pedestrians and obstacles under varying environmental conditions. Unlike optical sensors (cameras, LiDAR), radar is robust against fog, dust and rain, making it indispensable for collision avoidance, adaptive cruise control, blind spot monitoring and autonomous navigation. This research aims to design and develop a low-cost, high-performance automotive radar operating in the 77–81 GHz frequency band with enhanced detection, classification and integration capabilities. While current commercial automotive radar systems face limitations including:

- Limited angular resolution for object classification.
- High cost of 4D imaging radar technology.
- Interference between radars in congested environments.
- Challenges in compact integration with vehicle ECUs.

Thus, there is a pressing need for a cost-effective, high-resolution automotive radar system with robust performance across diverse driving conditions. The primary objectives of this research are:

- To design and fabricate a compact radar module operating at 77–81 GHz for automotive applications.
- To develop signal processing algorithms for accurate range, velocity and angular detection.
- To implement object classification methods using AI/ML techniques for distinguishing vehicles, pedestrians and static obstacles.
- To ensure robust performance under adverse weather and high-traffic interference conditions.
- To validate the developed system in real-world driving scenarios and benchmark against existing commercial solutions.

Graphical Abstract:



Quarterly Work Plan:

1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	<ul style="list-style-type: none"> • Conduct extensive literature review on automotive radar systems. • Identify research gaps and establish methodology. • Define project objectives, scope, and expected outcomes. 	<ul style="list-style-type: none"> • Begin simulations of radar waveforms and signal propagation. • Select appropriate simulation tools (MATLAB, CST, HFSS, etc.). • Initial design concepts for antenna and RF front-end. 	<ul style="list-style-type: none"> • Refine simulations for antenna performance (gain, beamwidth, side-lobes). • Start schematic design of RF front-end circuits. • Compare design alternatives through simulations. 	<ul style="list-style-type: none"> • Finalize optimized antenna and RF front-end design. • Prepare Year-1 progress report. • Identify hardware/software resources for prototyping phase.
2nd Year	<ul style="list-style-type: none"> • Procure components for hardware prototyping. • Begin fabrication of antenna and RF front-end. • Develop initial DSP framework. 	<ul style="list-style-type: none"> • Test hardware modules individually (antenna, RF, ADC). • Implement basic DSP algorithms for radar signal processing. • Initiate AI-based approach for target detection. 	<ul style="list-style-type: none"> • Integrate hardware modules into prototype radar unit. • Enhance DSP algorithms for noise reduction & object tracking. • Train AI models with simulation/collected dataset. 	<ul style="list-style-type: none"> • Validate prototype performance in lab environment. • Refine AI algorithms for accuracy. • Submit Year-2 report and prepare for field deployment.
3rd Year	<ul style="list-style-type: none"> • Conduct controlled environment field tests (short-range, long-range). • Collect and analyze real-world radar data. • Identify system weaknesses. 	<ul style="list-style-type: none"> • Optimize hardware (antenna tuning, RF adjustments). • Improve DSP and AI algorithms based on test data. • Begin integration with vehicle ECU (CAN bus, diagnostics). 	<ul style="list-style-type: none"> • Final field trials with ECU-integrated radar system. • Validation against automotive standards (ISO, IEEE). • Draft technical papers for conferences/journals. 	<ul style="list-style-type: none"> • Complete thesis writing and submission. • Publish final research outcomes. • Project closure & final presentation.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- **National Interest:**
 - Import substitutes: Renown brands of different vehicle are showing interest in the assembling and manufacturing of vehicle in Pakistan will provide local developed product as import substitute.
 - Export Enhancement: Automotive radar Sensor as an important part of vehicle have high demand in china and other countries will enhance export of the country.
- **Prototype Development**
 - A fully functional 77–81 GHz automotive radar sensor designed, fabricated and tested under real-world driving conditions.
- **Hardware Deliverables**
 - Compact antenna array module with beamforming capability.
 - RF front-end and PCB hardware suitable for vehicle integration.
 - Test-bench setup for radar calibration and validation.
- **Software & Algorithms**
 - Signal processing toolkit for range-Doppler and angle estimation.
 - Object detection and tracking algorithms for vehicles, pedestrians and static obstacles.
 - AI/ML-based classification model integrated with radar data.
- **Validated Performance Benchmarks**
 - Detection range = 250 meters under clear and adverse weather conditions.
 - Angular resolution = 1°, velocity resolution = 0.1 m/s.
 - Comparative validation against commercial ADAS radars.
- **Industrial/Commercial Relevance**
 - Technical report for automotive industry

- adoption.
- Collaboration opportunities with local automotive manufacturers for ADAS integration.
- Potential for technology transfer to public and private transport sectors.
- **Human Resource Development**
 - Training of graduate students and engineers in advanced radar and AI technologies.
 - Creation of a specialized lab setup for RF, automotive electronics and intelligent transportation systems.

Achievements:

New Project



Name of Lab / Centre / Unit:

UMW/PCSIR Labs. Complex, Lahore

Title of Project: Development of Semi-Automatic ZOLL AED Plus Defibrillator

Name & Designation of Project Director:

Engr. Ali Imran, SE, Head-UMW

Name & Designation of Project Associate(s):

Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
Mr. Muhammad Atif, Sr. Tech.

Area(s) of Research:

Industrial Research, Emergency and Medical Care

Duration:

01 Year

Date of Initiation:

August, 2025

Project Brief:

Sudden Cardiac Arrest (SCA) is the abrupt cessation of cardiac activity resulting from a catastrophic electrical malfunction within the heart. This event renders the

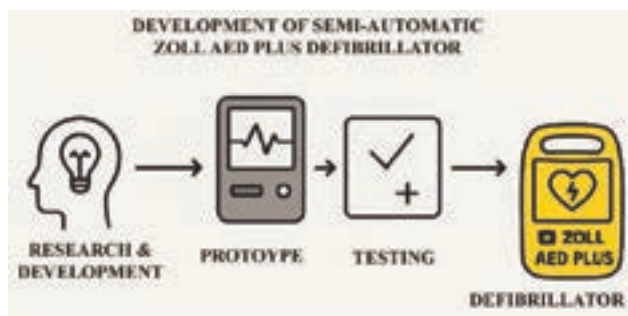
victim unresponsive, without normal breathing and with no signs of circulation. SCA is a significant public health crisis and a leading cause of death; in the out-of-hospital setting, between 70% and 90% of victims die before reaching a hospital. The pathophysiology of SCA underscores the extreme time-sensitivity of intervention. Within three minutes of collapse, the lack of blood flow begins to cause irreversible brain damage, and after ten minutes, the probability of survival is exceptionally low.

In response to this critical challenge, the medical community has conceptualized the "Chain of Survival," a sequence of interdependent actions that, when performed effectively, maximize the chance of a positive outcome. First formally incorporated into American Heart Association (AHA) guidelines in 1992, the modern adult out-of-hospital Chain of Survival comprises six critical links:

- Recognition of cardiac arrest and activation of the emergency response system.
- Early cardiopulmonary resuscitation (CPR) with an emphasis on chest compressions.
- Rapid defibrillation.
- Advanced resuscitation by Emergency Medical Services (EMS).
- Post-cardiac arrest care.
- Recovery.

The efficacy of this system is predicated on the strength of every link; a delay or failure in any one step significantly diminishes the chance of survival. While all links are vital, rapid defibrillation is often cited as the single most important intervention for shockable rhythms, as it is the only definitive treatment that can terminate the underlying chaotic electrical activity and allow the heart to restart a perfusing rhythm. Concurrently, high-quality CPR is paramount, as it provides artificial circulation that maintains perfusion to the heart and brain, extending the window for successful defibrillation. Immediate CPR can double or triple a person's chance of survival. The main objective is to empower untrained bystanders, who are often the first on the stage, the initial links have been simplified into the "Call-Push-Shock" mantra: Call 911, perform hands-only CPR and use an AED.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Finalize project objectives, scope, and deliverables. Conduct literature review / market research. Assemble project team and assign responsibilities. Develop detailed project timeline and budget. Initial procurement of resources, tools and materials. 	<ul style="list-style-type: none"> Begin prototype development / experimental phase. Conduct initial tests and collect performance data. Mid-project review meetings with stakeholders. Risk assessment and mitigation updates. 	<ul style="list-style-type: none"> Full-scale testing / pilot implementation. Analyze results and identify improvements. Incorporate stakeholders and expert feedback. Document technical and operational issues. 	<ul style="list-style-type: none"> Final validation and verification of outcomes. Develop user manuals/training materials (if applicable). Final stakeholder review and approvals. Submission of final project report. Dissemination of results (publication, presentation, or implementation).

Tangible Outcome:

- Indigenous Prototype of a semi-automatic AED (Automated External Defibrillator) comparable to ZOLL AED Plus.
- Reduced dependency on imports of AEDs through local design and manufacturing.
- Integration of voice and visual prompts for guiding rescuers during cardiac emergencies.
- Enhanced battery management system with rechargeable/long-lasting power solutions.
- Compact, user-friendly design suitable for public and institutional deployment.
- Compliance with international standards (IEC, ISO, FDA/CE guidelines for defibrillators).

Achievements:

New Project



Funding Source (PSDP/SGI/RD&I/etc):

In-House

On-Going Projects

Name of Laboratory/ Centre/ Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of the Project: Development of Techniques/ Methods for Shelf Life Study and Enhancement of Different Food Products

Name and Designation of Project Director:

Dr. Khurram Shahzad, CSO

Name and Designation of Project Associate(s):

Dr. Salman Saeed, PSO

Dr. Shaista Nawaz, SSO

Dr. Abdul Ahid Rashid, SSO

Area of Research:

Food Preservation/Safety

Duration:

04 Years

Date of Initiation:

July, 2022

Project Brief:

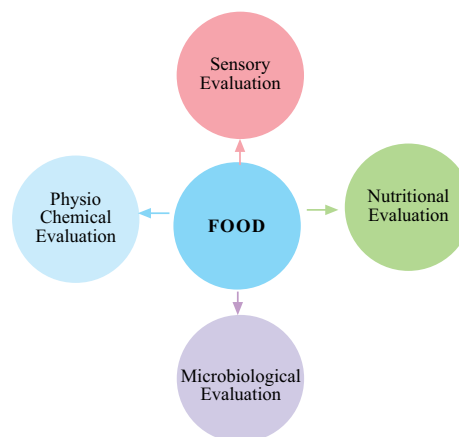
Food products are mostly perishable with a short shelf life. Part of the product development cycle is to set its suitable shelf life. Due to ever increasing population, the demand for microbiologically safe, convenient food with a long shelf life is increasing on daily basis. Food safety and product shelf life are inextricably linked. Shelf life is a guide for the consumer for the period of time that food can be kept in defined storage conditions before it starts to deteriorate. Shelf life testing describes how long a food will retain its quality during storage. A separate shelf life study needs to be carried out for each type of food product. Two main methods used are direct (real-time study model) and indirect (accelerated storage or predictive microbiological modeling) methods.

Most of the local manufacturers/SMEs do not have the basic infrastructure for quality assurance as well as shelf life assessment of their products. One of the main objectives of PCSIR is to help the local industry, this project was designed to establish a facility to estimate a realistic shelf life and date mark for a food product by developing new techniques/methods, which may help to ensure the safety and quality with an increased shelf life of valued food products. The main

objective of this project is to establish a facility to estimate a realistic shelf life and date mark for a food product by developing new techniques/methods, which may help to ensure the safety and quality of valued food products sold with the following main features;

- Meet any nutritional claims provided on the label by keeping its appearance, odor, texture and flavor intact.
- Long shelf life with defined stability under recommended storage conditions.
- 100% natural, with no preservatives or additives added.
- Convenient and easy handling.
- Less likely to carry disease-causing bacteria.
- Ready to use with less transportation cost.
- Vast export as well as local market potential.

Graphical Abstract:



Quarterly Work Plan:

1st Year

1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Literature review on the procedures for shelf life studies. • Selection of components for shelf life study 	Shelf life studies of bakery products and potato chips etc	Shelf life studies of bakery products and potato chips etc (Continued)	<ul style="list-style-type: none"> • Shelf life studies of bakery products and potato chips etc • Technical report compilation

2nd Year

1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
Literature review for shelf life studies of salt etc.	Design of parameters of Shelf life studies for pink salt etc	Shelf life studies of pink salt	<ul style="list-style-type: none"> • Shelf life studies of pink salt (Continued) • Technical report compilation

3rd Year

Literature review for shelf life studies of ready to use food products (RUTF) and fruit juices etc	Selection and design of parameters of Shelf life studies for RUTF products	Shelf life studies of RUTF	<ul style="list-style-type: none"> • Shelf life studies of RUTF (Continued). • Technical report compilation
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4th Year

Literature review/selection of procedure for shelf life studies of carbonated drinks	Selection and design of parameters of Shelf life studies for carbonated drinks	Shelf life studies carbonated drinks	<ul style="list-style-type: none"> • Shelf life studies of carbonated drinks (Continued). • Technical report compilation
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Funding Source, (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- As shelf life of the food products is one of the important parameters for their keeping quality, this project may be helpful for the Establishment/Up gradation of the facility for developing techniques/ methods for shelf stability estimation as well as

enhancement of different food products manufactured by local industry to provide their consumers with safe and quality packed products with long shelf life.

Achievements:

- Since the initiation of the project, a total of 15 processes regarding shelf life studies/ enhancement of different food products have been developed and leased out to the concerned Clients (List as under). An amount of 1.79 Millions was earned for PCSIR by providing services to various industries through shelf life studies/Technical Reports/ process leased out. One process regarding Shelf life Studies/ enhancement of Phalsa Extract as Functional Food with Health promoting Natural compounds in Sachet packaging was completed and the developed process was leased out to the client. Recipe development, Lab scale production and Shelf life study/enhancement of Ready to use Therapeutic Food (RUTF) Supplement for children is completed and the process thereby developed was be leased out to the client. Shelf life with consistent Quality of 4 flavors of carbonated Beverages was completed.
- Shelf life studies of Indigenous sweets, Khoya Kulfi, whey products, Nutrition fruit bar and Whey drinks had been completed and processes leased out. While the Shelf Life Studies of confectionary products is under progress.



Name of Laboratory/Centre/Unit:

FBRC/ PCSIR Labs. Complex, Lahore

Title of Project: Efficacy Study of Bio-Preservatives in Extending Shelf Life of Spices

Name & Designation of Project Director:

Dr. Naseem Zahra, SSO

Name & Designation of Project Associate(s):

Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
 Dr. Asma Saeed, CSO
 Dr. Qurat-ul-Ain Syed, CSO
 Dr. M. Khalid Saeed, PSO

Area(s) of Research:

Food and Environment

Duration:

01 Year

Date of Initiation:

2025

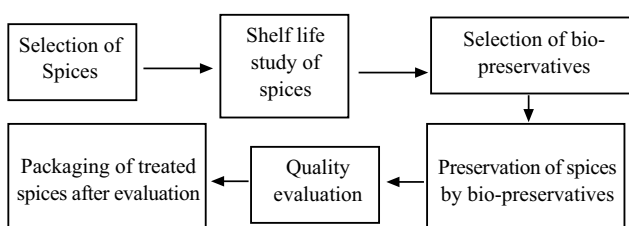
Project Brief:

Spices play an important role in daily meal to improve the flavor, color and appearance of food. Good quality spices will stay fresh for longer if stored properly. Moisture, light, heat is the enemies which may reduce the quality, color and essential oil contents of spices. Spices preservation usually involves preventing the growth of bacteria, fungi (such as aflatoxins) or any other micro-organisms, as well as retarding the oxidation of fats that cause rancidity thereby ensuring the spices safety. In modern years, a wide variety of packages and approaches have been employed to interact with the food and provide desirable effects. There are so many methods to extend shelf life of spices but the safest is the use of bio-preservatives (Mustard oil, salt, and vinegar). Bio-preservatives may play an important role in extending shelf life of spices.

Storage of spices is the main issue which spice industry is facing these days. Numerous physical, chemical and biological changes in spices may spoil spice quality if not properly stored. The bio-preservatives may provide protective veneer or barricade during processing, storage and handling. These may not only retards deterioration of spices but may also enhance its quality. Appropriate packaging can slow the worsening rate and also may extend spices shelf life. The objectives of present study include:

- To study shelf life study of different spices.
- To enhance shelf stability of various spices with bio-preservatives/packaging techniques.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection & selection of different spices	<ul style="list-style-type: none"> • Selection of biopreservatives • Preservation of spices by biopreservatives 	<ul style="list-style-type: none"> • Shelf life study of spices • Quality evaluation of spices 	<ul style="list-style-type: none"> • Packaging of spices after treatment • Report submission, patent and paper writing, etc.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible outcome:

- Different spices thereby preserved by undisruptive bio-preservatives after their shelf stability studies.
- These treated spices will have a long shelf life under normal storage conditions with nutritional and microbial safety, convenient and easy handling, ready to use, reduced transport costs and large export potential and local market potential.
- Dissemination of study regarding shelf stable and safe spices by utilizing different bio-preservation techniques and processes for various spice industries through reports, patent, process commercialization and papers.

Achievements:

- Initial trials to preserve whole red chillies for a period of three months have been completed. Aflatoxin analysis before and after treatment with black seed oil, mustard oil, vinegar and turmeric has been done. The microbiological results showed no fungal contamination in red chillies.
- 02 research Papers published in renowned journals.
- Process for the quality assurance of different spices has been leased to M/s Rashid Foods, Faisalabad.
- A technical report entitled “Biopreservation of Chillies” has been submitted.



Name of Laboratory/ Centre/ Unit:

FBRC/ PCSIR Labs. Complex, Lahore

Title of Project: High- Performance Bating Agents for Soft, Flexible and Firm Hides as an Import Substitute.

Name & Designation of Project Director:

Dr. Shabana Kauser, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO

Dr. Asma Sheikh, SSO

Area(s) of Research:

Bating of Hides/Leather Production

Duration:

1 ½ Years

Date of Initiation:

2024

Project Brief:

Pakistan is considered to be the hub of producing high quality leather and leather products and there are about 800 tanneries in the country actively engaged in producing best quality finished leather of cow, buffalo, sheep and goat skins. Pakistan is rich in agricultural products and has a large livestock population which plays an important role in the economy of Pakistan by producing around 13.0 Million Hides and 47.4 Million Skins per annum (2022-23). Hides, which are the raw skins of animals such as cattle, sheep, goats undergo a series of processes to transform into leather. The production process consists of approximately 23 stages including preparation of hides, soaking, liming, fleshing, bating, tanning, dyeing and fat liquoring and finally the finishing. The leather produced from hides is valued for its durability, natural beauty and versatility, making it a popular choice for a wide range of applications. Although all the stages are important for the production of good quality leather from hides, Bating is a crucial step in the leather tanning process that contributes to the overall success of leather production, improving the quality of the leather and ensuring consistency in

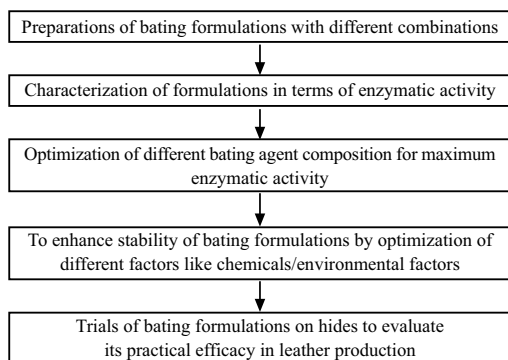
the final product. Bating involves the use of enzymes and bating agents that facilitate the breakdown of non-collagenous proteins, fats and other unwanted substances present in the hides, leading to cleaner, softer and more receptive hides for subsequent tanning processes. Proteolytic enzymes such as proteases and peptidases are commonly used in bating to break down proteins and fats present in the hides. Proteolytic enzymes in combinations with other materials like surfactants, chelating and buffering agents and some synergistic additives can be used to make different bating compositions to ensure optimal conditions for the bating process and prevent fluctuations that could affect enzyme performance.

Our Leather is higher in the prices at international market of Leather than rest specially neighboring competing countries, which is around 15 – 20%. Moreover, Pakistan's leather industry relies on imports of various chemicals including bating agents to support its leather processing operations, with suppliers sourced from international markets such as the United States, European countries and China based on factors such as cost, availability and quality. The only way to be compatible is to bring leather products at par with international leather products in terms of quality and price. Pakistan's leather sector ought should have grown and generated significant foreign exchange earnings for the country.

The present project is designed to prepare bating formulation which are compatible to imported bates in performance but are cheaper, therefore, ultimately decreasing the overall cost of good quality leather production. These bating formulations are potential import substitute contributing to the foreign exchange earnings for the country. The main objectives of the proposed project include:

- Preparation of different bating formulations as per requirement of the bating process.
- To optimize all the conditions like pH, temperature, storage for the best performance of the bating agents.
- To improve the shelf life of bating formulations with optimum activity retained.
- To prepare cost-effective bating formulations that can serve as import substitute.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Literature survey regarding various formulation Suitable Enzyme assay for bating activity 	<ul style="list-style-type: none"> Preparation of different bating formulation To study the effect of different agents (surfactants, chelating agents, buffers) on the performance of proteolytic enzymes 	<ul style="list-style-type: none"> Optimization of environmental factors to enhance stability of bating compositions. 	<ul style="list-style-type: none"> Shelf life studies of most optimized bating formulation Practical trials of optimized bating formulation on the hides
2nd Year			
<ul style="list-style-type: none"> Practical trials of optimized bating formulation on the hides during the leather production process will be continued to evaluate the products. 			

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- An import substitute has been proposed through this project keeping in mind the low cost, environment friendly technology for preparing bating agents for production of leather that will save foreign exchange.
- Use of locally available raw material is cost effective and will be helpful to develop cheaper product.
- The bating formulations will be highly beneficial for leather industry in terms of production cost of leather.
- The product has a high potential to be commercialized.
- Patent/report.

Achievements:

- Proteolytic enzyme (Protease) from different sources (Fungal and bacterial) has been obtained and their activity assay is optimized.
- Protease from bacterial origin was selected for preparation of bating formulations because of better activity (1900 Units/g/min). Different bating formulations were prepared using 0.1% to 0.5% enzyme in combination with Amm. Sulphate, NaCl, Sucrose and sorbitol.
- Enzymatic activity was assayed in all formulations.
- The effect of inhibitors (EDTA at different concentrations 0.001M – 0.02M) was studied and 0.02M EDTA totally inhibited the enzymatic activity.
- Effect of different chemical with metal ions was also studied. Enzymatic activity was totally inhibited in the presence of Sodium sulphide and Calcium carbonate caused a reduction of 45% in its activity while the potassium ions caused an increase in enzyme activity by 60%.
- Bating formulations showing maximum activity are finalized for trials on hides to evaluate their practical efficacy in leather production.



Name of Laboratory/ Centre/ Unit:

FBRC/PCSIR Labs. Complex, Lahore

Title of Project: Preparation of Different Ready-to-Use Shilajit Drinks Enriched with Bioavailable Minerals and Antioxidants**Name & Designation of Project Director:**

Dr. Shabana Kauser, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO

Dr. Asma Sheikh, SSO

Dr. Muhammad Ashraf, SSO

Dr. Shahid Masood, SSO

Mr. Faizullah Khan, SSO

Area(s) of Research:

Food Sciences & Pharmaceutical Industry

Duration:

02 Years

Date of Initiation:

June, 2024

Project Brief:

Shilajit, a complex natural biologically active resinous substance found mainly in Himalayan regions and is formed over centuries through the decomposition of plant matter under high pressure and temperature conditions. It is rich amalgamation of organic compounds (60-80%), minerals (20-40%) and trace elements (5 %) making it veritable treasure for human wellness. While it is often marketed and used in traditional medicine systems like Ayurveda, there is ongoing debate about its precise composition and medicinal properties. It contains a complex mixture of organic and inorganic compounds, approximately 80 bio-active components including fatty acids, benzoic acid, resin and waxy materials, albuminoids, gums, humic acids and fulvic acid. Amino acids, phenolic lipids, minerals like silica, iron, antimony, lithium, manganese, calcium, copper, molybdenum, phosphorus, sodium, zinc, selenium and small amounts of dibenzo- α -pyrones.

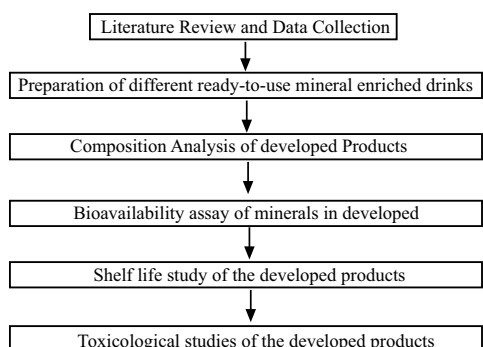
Mineral malnutrition, also known as micronutrient

deficiency or hidden hunger, occurs when an individual's diet lacks essential minerals required for proper bodily functions. Micronutrients, such as iron, zinc, calcium and various vitamins, play crucial roles in metabolism, immune function, growth and overall health. Mineral malnutrition can have severe health consequences, including stunted growth, impaired cognitive development, weakened immune function, anemia and increased susceptibility to infections and chronic diseases.

The minerals in shilajit play vital roles in metabolism, enzyme function, bone health, immune function and overall well-being. However, the concentration of these minerals in shilajit can vary, so initial determination of minerals is a prerequisite for its utilization. Mineral-fortified ready-to-use products are food items that have been supplemented with additional minerals to enhance their nutritional content. These products are designed to provide consumers with a convenient way to increase their intake of essential minerals, particularly those that may be lacking in their diets. The aim of the current project is to prepare different ready-to-use drinks fortified with refined shilajit as a source of minerals and antioxidants to overcome the problem of mineral malnutrition at indigenous level. Mineral fortification of ready-to-use drinks with shilajit is attractive, technically feasible and potentially effective as the nutrient stability in the products is good. The product cost is not much increased as there often no need for changes in manufacturing process and above all these products would offer a replacement of imported fortified products. The main objectives of the project are:

- Utilization of shilajit as a source of minerals and antioxidants.
- Preparation of different minerals enriched ready-to-use drinks to meet the RDI of minerals.
- To study the shelf life of minerals enriched ready-to-use drinks.
- To study the bioavailability of minerals in shilajit enriched ready-to-use drinks.
- To optimize the quantity of shilajit in the drinks to maintain taste acceptance of developed products along with fulfillment of required minerals quantity.
- To conduct the toxicological studies of the shilajit enriched drinks.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Literature survey regarding the procedures etc. formulation Composition Analysis of raw material 	<ul style="list-style-type: none"> Preparation of Different ready-to-use drinks enriched with salajeet Composition Analysis of products 	<ul style="list-style-type: none"> Preparation of Different ready-to-use drinks enriched with salajeet Composition Analysis of products (Conitued) 	<ul style="list-style-type: none"> Preparation of Different ready-to-use drinks enriched with salajeet Composition Analysis of products (Conitued)
2nd Year			
Shelf Life Study of the product	<ul style="list-style-type: none"> Shelf Life Study of the product Toxicological studies of the developed products. 	<ul style="list-style-type: none"> Shelf Life Study of the product Toxicological studies of the developed products. (Continued) 	<ul style="list-style-type: none"> Shelf Life Study of the product Toxicological studies of the developed products. (Continued)

Funding Source (PSDP/SGI/RD&I/etc):

In-House

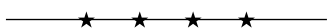
Tangible Outcome:

- Preparation of ready-to-use drinks enriched with minerals using shilajit.
- Product development to overcome the mineral malnutrition.
- To develop a cost- effective, technically feasible and efficient technology.
- The products developed have high potential to be commercialized.
- To replace the imported fortified products/ supplements.
- Patent.

Achievements:

- Compositional Analysis of raw material (Mango pulp, refined shilajit etc.) for the estimation of minerals (sodium, potassium, calcium, iron, zinc, magnesium) and vitamins (water soluble vitamins like vitamin C, B-complex, folic acid) is completed.
- Antioxidant activity of raw materials (mango fruit pulp and Shilajit) is done. Shilajit showed good antioxidant activity (>90%) because of presence of fulvic acid in good quantity (4.80%).
- Ready-to-use mango-shilajit drink fortified with different concentrations of shilajit (0.1% to 1%) has been prepared. Organoleptic evaluation, compositional analysis for minerals and antioxidant activity of the drink has been done. The mango-shilajit drink with 0.3% added shilajit showed acceptable organoleptic properties and minerals were also found within RDI for each mineral like calcium, iron, zinc, sodium and potassium.
- Technical report on “preparation and quality assurance of ready-to-use mango-shilajit drink enriched with minerals and antioxidants” has been submitted.
- Bioavailability assay of the products has been completed.
- Shelf life of mango-shilajit drink has been estimated to be two months with retention of specific characteristics.

- Process for the production of shilajit honey drinks and its quality assurance has been developed and leased out to M/s Ashraf naturals.
- Orange drinks fortified with different amount of shilajit are prepared.
- Nutritional and antioxidant analysis is under progress.



Name of Laboratory/ Centre/ Unit:

PITMAEM/PC SIR Labs. Complex, Lahore

Title of Project: Development of Environment Friendly GO/HAP Hybrid Composites for Biomedical Applications

Name & Designation of Project Director:

Ms. Sumaira Nosheen, SSO

Name & Designation of Project Associate(s):

Mrs. Farzana Habib, PSO
Engr. Bilal Waseem, JE

Area(s) of Research:

Advanced Engineering Materials/Biomaterials

Duration:

01 Year

Date of Initiation:

December, 2024

Project Brief:

Hydroxyapatite (HA) has been widely used in fields of materials science, tissue engineering, biomedicine, energy and environmental science and analytical science due to its simple preparation, low-cost and high biocompatibility. To overcome the weak mechanical properties of pure HA, various reinforcing materials can be incorporated with HA to form high-performance composite materials. Due to the unique structural, biological, electrical, mechanical, thermal and optical properties, graphene has exhibited great potentials for supporting the biomimetic synthesis of HA. Graphene has attracted great attention in the fabrication of various novel nanomaterials due to its

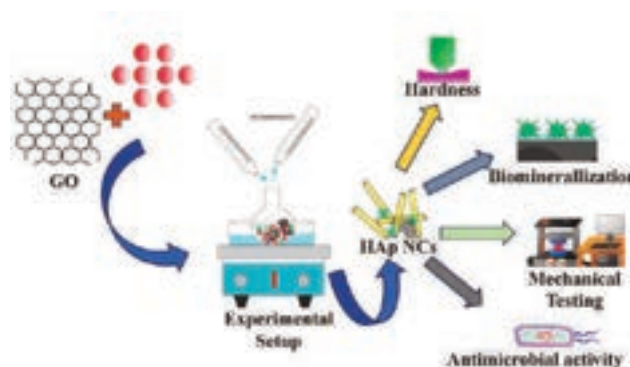
unique two-dimensional (2D) structure and innovative biological, electrical, mechanical, thermal and optical properties.

To overcome the weak mechanical properties of pure HA, various reinforcing materials can be incorporated with HA to form high-performance composite materials. Due to the unique structural, biological, electrical, mechanical, thermal and optical properties, graphene has exhibited great potentials for supporting the biomimetic synthesis of HA.

As a result of the growing interest in the biological and mechanical performance of hydroxyapatite (HA)–graphene nano-sheets (GNs) composite systems, reduced graphene oxide (rGO) reinforced hydroxyapatite nano-tube (nHA) composites will be synthesized in situ using a simple hydrothermal method in a mixed solvent system. The composites will be characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) enabling confirmation of the synthesis and reduction of the nHA and rGO, respectively. The structure of the synthesized powder and cell attachment on the sintered sample will be confirmed by scanning electron microscopy (SEM). The effects of the rGO on the mechanical properties and the *in vitro* biocompatibility of the nHA based ceramic composites will be investigated. The objectives of present study are:

- Development of nHA/rGO polymer composites.
- Study of elastic modulus and fracture toughness of the sintered samples.
- Study of Cell culture and viability.
- Study of mechanical properties of nano composite before and after sintering and by changing the filler percentage.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Development of nHA/rGO polymer composites 	<ul style="list-style-type: none"> • Study of elastic modulus and fracture toughness of the sintered samples. Study of Cell culture and viability 	<ul style="list-style-type: none"> • Study of mechanical properties of nano composite before and after sintering and by changing the filler percentage 	<ul style="list-style-type: none"> • Characterization and report writing

Funding Source (PSDP/SGI/RD&I/etc):

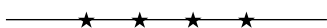
In-House

Tangible Outcome:

- Improvements in both their biological and mechanical properties.
- The process will be developed for the said R & D work.

Achievements:

- Successful fabrication of nHA/rGO polymer composite by varying %age of filler material to get product with optimized properties.
- Study of mechanical properties has been completed.
- One Technical Report of project has been submitted.



Name of Laboratory/ Centre/ Unit:

PITMAEM/PC SIR Labs. Complex, Lahore

Title of Project: Development of Excavator Bucket Tooth Material and Optimization of Heat Treatment Process for Wear Properties

Name & Designation of Project Director:

Engr. Farooq Iftikhar, SE

Name & Designation of Project Associate(s):

Engr. Muhammad Irfan, SE
 Engr. Muhammad Nouman, JE
 Engr. Ahmed Raza, JE

Area of Research:

Material Development

Duration:

01 Year

Date of Initiation:

December, 2024

Project Brief:

Excavators are essential pieces of heavy machinery used in construction, mining and other earth moving operations. The excavator bucket attached to the end of the excavator’s arm play a critical role in these operations by allowing the machine to scoop, dig and move large quantities of material. One of the key components of an excavator bucket is its teeth, which significantly affect the bucket’s performance and efficiency. These teeth are crucial for breaking into hard materials and providing a gripping surface for the bucket to scoop up material. Given the demanding conditions they operate in bucket teeth are subject to significant wear and impact. Excavator bucket teeth are typically made from high-strength steel alloys (Boron Steel, Manganese Steel (Hadfield Steel) & Low alloy Steel) due to their excellent combination of hardness, toughness and wear resistance.

Currently the excavator bucket teeth used in our construction and mining operations are imported from foreign suppliers. This reliance on imported components presents several challenges such as high cost, supply chain dependence, limited customization options and long lead times. Moreover, the development of excavator bucket teeth material faces several critical challenges (including wear resistance, Impact resistance, toughness etc.) that need to be addressed for further advancement. The core objectives of the present project are as follows:

- To investigate and develop an advanced alloy tailored specifically for excavator bucket teeth material.
- To identify the optimal combination of alloying

elements to enhance properties such as hardness toughness and wear resistant crucial for extended performance in abrasive environments.

- Advanced metallurgical techniques including alloy design, heat treatment and microstructural evaluation will be explored to achieve the desired material characteristic.

Graphical Abstract:



- Import substitute.
- Technology transfer to the local industry.
- Lease out the process developed.

Achievements:

- Collection of excavator bucket teeth of excavator bucket tooth.
- Sample cutting & Characterization of excavator tooth received.
 - Chemical analysis.
 - Hardness testing.
 - Tensile testing.
 - Impact testing.
- Material selection. Including standard grade and raw materials (type of scrap and ferro alloys).
- Study for Melting route & Heat treatment cycles.

Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Literature survey and reverse engineering of material (Mechanical and Metallography)	Collection of raw material and compile & analysis of reverse engineering data	Experimental work (different trials) and optimization of process parameters	Characterization, Report writing and final submission



Name of Laboratory/Centre/Unit:

UMW/ PCSIR Labs. Complex, Lahore

Title of Project: Design and Development of Hemp Fiber Extractor

Name & Designation of Project Director:

Engr. Ali Imran, SE/Head UMW

Name & Designation of Project Associate(s):

Dr. Syed Imam Hussain Abidi, Chairman-PCSIR
 Dr. Quratulain Syed, Director General-LLC
 Mr. Muhammad Atif, Sr. Tech.
 Dr. Awais Ali, Hemp Consultant

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- The resulting alloy will contribute to improve the durability and efficiency of excavator equipment leading to cost savings and increased productivity in various industries reliant on earth moving operations. Moreover, this study will contribute towards the indigenous production of excavator bucket tooth.

Area(s) of Research:

Feed Industry

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

Hemp, also known as industrial hemp, is a variety of *Cannabis sativa* cultivated primarily for its fiber, seeds and oil rather than for psychoactive effects. Unlike other cannabis varieties, industrial hemp contains negligible levels of tetrahydrocannabinol (THC), making it safe and legal for industrial use. Historically, hemp has been an essential resource, used as a source of fiber, oil and nutrition for thousands of years. Archaeological evidence suggests its use as early as 8,000 BC, making it one of the oldest cultivated plants for fiber production.

In recent years, hemp has gained global attention due to its sustainability and environmental benefits, positioning it as a key material for carbon-neutral industries. Hemp fiber is lightweight, breathable and three times lighter than cotton or wool, making it ideal for fashion and textile applications. It also exhibits water resistance and UV protection, which enhances fabric durability and longevity.

For a country like Pakistan, where agriculture forms the backbone of the economy and the textile sector contributes over 25% to GDP, hemp presents a unique opportunity. However, despite having favorable climatic conditions and agricultural resources, Pakistan significantly lags in the commercial utilization of hemp by-products, especially hemp fiber.

The development of a hemp fiber processing machine will not only promote local hemp cultivation but also strengthen the textile industry, reduce reliance on imported fibers and position Pakistan as a key player in sustainable, eco-friendly textile production. Currently, Pakistan’s textile industry is heavily dependent on cotton and synthetic fibers, both of which have environmental drawbacks and economic limitations. Cotton cultivation requires high water consumption and pesticide use, while synthetic fibers contribute to plastic pollution and carbon emissions. Although hemp is a viable alternative due to its low environmental footprint, high fiber yield and versatile applications, there are no locally developed machines or systems for efficient hemp fiber extraction and processing in Pakistan. Imported hemp processing machines are

expensive, difficult to maintain and unsuitable for local farming practices, making hemp cultivation and processing commercially nonviable. This project is designed to meet the following objectives:

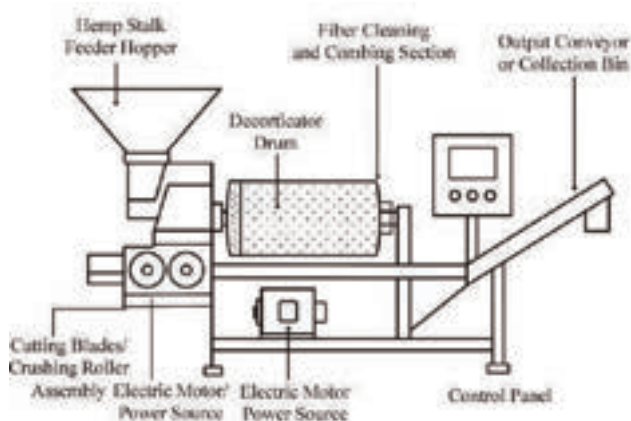
- To design and develop an indigenous hemp fiber processing machine that is cost-effective, efficient and suitable for local hemp varieties and support the growth of Pakistan’s green textile industry.
- To reduce the heavy reliance on imported raw materials for textile production.
- To develop a carbon-negative, sustainable textile value chain.
- Analyze local hemp stalks for fiber content, strength and processing requirements.

Machine Design & Development:

Develop a mechanical system for decortication (fiber separation from stalks).

Integration of cutting, crushing and combing units into a single machine.

Optimize for low power consumption and scalability.



Performance Evaluation:

Test for fiber quality, production capacity and energy efficiency.

Compare results with international benchmarks. Environmental and Economic Assessment:

Evaluate potential carbon savings and environmental benefits.

Cost analysis to assess feasibility for small-scale farmers and industries.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Literature review on hemp fiber extraction techniques. Study existing machines and identify design gaps and market survey for raw materials Generate multiple design concepts using CAD. 	<ul style="list-style-type: none"> Evaluate designs for efficiency, cost and safety. Select optimal design for prototype. Identify materials for critical components 	<ul style="list-style-type: none"> Procurement of raw materials, motors and control units. Vendor finalization for outsourcing specialized parts. Fabrication of core machine components 	<ul style="list-style-type: none"> Assembly of the initial prototype. Conduct no-load and load tests with hemp stalks. Identify performance gaps (fiber damage, throughput issues).

2nd Year			
1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Develop and integrate a control panel for monitoring speed and power. Incorporate safety mechanisms. Optimize energy efficiency. 	<ul style="list-style-type: none"> Conduct rigorous field tests. Evaluation studies. Collect farmer/industry feedback. 	<ul style="list-style-type: none"> Finalize machine design based on test results Prepare user manual and technical specifications. Conduct training workshops 	<ul style="list-style-type: none"> Manufacture 2-3 pilot units Prepare final report and presentation to stakeholders. Evaluate project outcomes.

Funding Source (PSDP/SGI/RD&I etc):

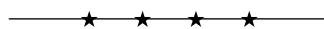
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Tangible Outcome:

- Machine Development through Indigenous Resources.
- Technical Report & Patent filling.
- Basic Hemp Fiber Extraction Process Development.

Achievements:

- Machine Designing completed.
- Fiber extracted ways under analysis stage.



Name of Laboratory/Centre/Unit:

UMW/PCSIR Labs. Complex, Lahore

Title of Project: Piezo Enhanced Activity for Waste Water Treatment from BNT/KNN Ceramics

Name & Designation of Project Director:

Engr. Ali Imran, SE/Head-UMW

Name & Designation of Project Associate(s):

Mr. Muhammad Atif, Sr. Tech.

Area(s) of Research:

Advance Engineering Materials

Duration:

02 Years

Date of Initiation:

August, 2024

Project Brief:

In recent years, the demand for environmentally friendly and high-performance materials has grown rapidly, particularly in the field of electronic components. Traditional Lead Zirconate Titanate (PZT) ceramics have been widely used due to their exceptional piezoelectric, ferroelectric and dielectric properties, making them essential for actuators, sensors, energy storage devices, capacitors, nano-positioning systems and energy harvesting technologies. However, the toxicity of lead (Pb) has raised serious concerns globally. Lead exposure poses significant environmental and health risks during mining, PbO evaporation during calcination and sintering and final disposal of lead-based materials. These risks have led to strict regulations and a strong push toward developing lead-free alternatives that are safe, sustainable and compatible with large-scale commercial applications. Lead-free ceramic materials such as $K_{0.5}Na_{0.5}NbO_3$ (KNN) and $Bi_{0.5}Na_{0.5}TiO_3$ (BNT) have emerged as promising candidates to replace PZT. These materials possess a perovskite crystal structure and exhibit desirable properties such as:

- Residual polarization (Pr).
- Piezoelectric coefficient (d33).
- Coercive field (Ec).
- Curie temperature (Tc).
- High piezoelectric strain and energy density.
- Excellent thermal stability.

To further enhance the properties and processability of these lead-free ceramics, doping with CuO has been explored to improve sintering behavior and tailor the structure-property relationship for application-specific performance.

The project focuses on the development, doping, characterization and evaluation of lead-free ceramic materials. The research is divided into several technical stages:

- Base materials: $K_{0.5}Na_{0.5}NbO_3$ (KNN) and $Bi_{0.5}Na_{0.5}TiO_3$ (BNT).
 - Doping agent: CuO for enhanced sintering and improved structural integrity.
 - Target composition optimized for high piezoelectric and dielectric performance.
- The key objectives of this research are:
- To develop and optimize lead-free ceramics (KNN and BNT) with CuO doping for enhanced sintering and electrical properties.
 - To study the structure-property relationship through impedance analysis and other advanced characterization techniques.
 - To design application-specific components with targeted piezoelectric and dielectric performance.
 - To provide environmentally safe, cost-effective alternatives to lead-based ceramics such as PZT.
 - To support industrial adoption by demonstrating the commercial viability of these materials for large-scale applications.

Quarterly Work Plan:

1st Year

1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Review literature and market survey • Material analysis and planning 	<ul style="list-style-type: none"> • Material synthesis doping • Sintering and pellet formation 	<ul style="list-style-type: none"> • Analysis of synthesized material • Structural characterization • Application study 	<ul style="list-style-type: none"> • Waste water setup development. • Select Parameters of product evaluation • Waste water quality evaluation

2nd Year

<ul style="list-style-type: none"> • Piezo-catalytic testing, • Compilation of data 	<ul style="list-style-type: none"> • Stabilities studies. • Data analysis 	<ul style="list-style-type: none"> • Stabilities studies. (Continued) 	<ul style="list-style-type: none"> Stabilities studies (Conitued) • Final report and publications
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Funding Source (PSDP/SGI/RD&I etc):

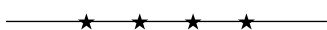
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Tangible Outcome:

- Development of Piezoelectric Material.
- Utilization in Wastewater Treatment.
- Technical Report & Paper Writing.

Achievements:

- Experimentation in Process.
- Review Paper writ up completed and Submitting for Publication.
- Grinding ball mill designed for mixing and blending the precursors.
- Grinding ball mill fabrication under process.



Name of Laboratory/Centre/Unit:

UMW/PCSIR Labs. Complex, Lahore

Title of Project: Shrimp Farming by Biofloc Technology (BFT): A Sustainable Approach to Aquaculture

Name & Designation of Project Director:

Engr. Ali Imran, SE/Head-UMW

Name & Designation of Project Associate(s):

Dr. Imam Hussain Abidi, Chairman-PCSIR
 Dr. Quratulain Syed, Director General-LLC
 Dr. Awais Ali, Consultant
 Engr. Muhammad Aatif, Sr. Tech.

Area(s) of Research:

Biofloc Aquaculture Forming

Duration:

03 Years

Date of Initiation:

July, 2025

Project Brief:

Aquaculture has become one of the fastest-growing food production sectors, playing a critical role in

addressing the increasing global demand for animal protein. With over 800 Million people suffering from chronic malnourishment and the global population expected to reach 9.6 Billion by 2050, sustainable food production methods are essential to ensure global food security while preserving natural resources for future generations.

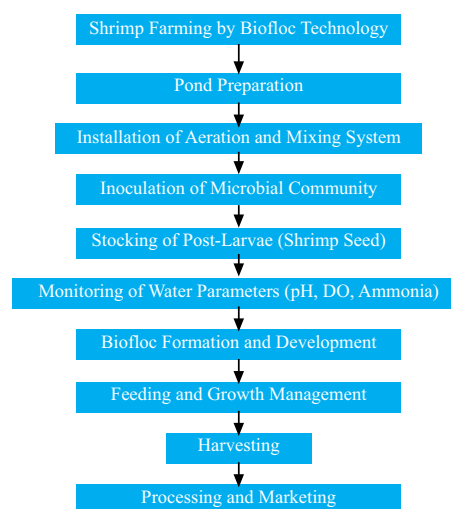
Biofloc Technology (BFT) is widely recognized as the new "Blue Revolution" in aquaculture. It represents an innovative and eco-friendly farming technique that promotes sustainable shrimp production by recycling nutrients, improving water quality and reducing the need for water exchange. This technology enables high-density farming in small areas, making it ideal for countries with limited water and land resources.

Biofloc Technology represents a groundbreaking advancement in sustainable aquaculture, offering a solution to the challenges faced by the global shrimp farming industry. By recycling nutrients, improving water quality and reducing external feed dependency, BFT enables high-density shrimp production with minimal environmental impact. Main objectives of the project are as follows:

- To improve food security, increased farmer income.
- Environmental sustainability in Pakistan in the field of aquaculture.

Graphical Abstract:

The shrimp farming process using biofloc technology can be illustrated in the following steps:



Quarterly Work Plan:

1st Year

1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
Project Planning & Literature Review	System Design & Construction	Biofloc Formation & Optimization	Biofloc Formation & Optimization(Continued)
2nd Year:			
Stocking & Growth Trials	Mid-Term Evaluation & Optimization	Second Cycle of Shrimp Production	Data completion and evaluation
3rd year:			
Training & Capacity Building	Commercial Scale Demonstration	Commercial Scale Demonstration (continued)	Final Documentation & Dissemination

Funding Source (PSDP/SGI/RD&I etc):

In-House

Tangible Outcome:

- Increase production per unit area compared to conventional systems. Production of high-quality shrimps to cope malnutrition.
- Minimize waste discharge and protect surrounding ecosystems.
- Provide affordable, high-quality protein to meet growing population demands.
- Enhanced productivity and reduced costs lead to higher profitability.
- A replicable system for expansion in other regions. Role model for small and medium aquaculture farmers.

Achievements:

- Already have 42000 Liter Tank.
- Production of high-quality shrimps is underway.
- Aeration System Installed.



Name of Laboratory/Centre/Unit:

UMW/PCSIR Labs. Complex, Lahore

Title of Project: Fast Breeding of Pangasius (Pangasius sp.) for Large-Scale Aquaculture Development in Pakistan

Name & Designation of Project Director:

Engr. Ali Imran, SE/Head UMW

Name & Designation of Project Associate(s):

Dr. Imam Hussain Abidi, Chairman-PCSIR
 Dr. Quratulain Syed, Director General, LLC
 Dr. Awais Ali, Consultant
 Engr. Sheraz Yousaf (Sr. Tech.)

Area(s) of Research:

Bio Flocc Aquaculture Forming

Duration:

03 Years

Date of Initiation:

July, 2023

Project Brief:

Pangasius sp., commonly known as river catfish, silver-striped catfish, Siamese shark, sutchi catfish or swai catfish, is a freshwater fish species endemic to the Mekong Basin. It belongs to the family Pangasiidae and is known for its rapid growth rate, making it one of the most commercially important aquaculture species worldwide. Globally, *Pangasius* ranks as the third most important freshwater fish group within the aquaculture sector. It is widely cultured in countries such as Vietnam, Thailand, India, Bangladesh, Nepal, Myanmar, Indonesia, Cambodia, Laos and more recently Pakistan. Its popularity stems from its:

- Fast growth rate under controlled farming conditions.
- High market demand for its meat.

- Adaptability to different culture systems.
- Ability to tolerate low dissolved oxygen (DO) levels due to its air-breathing capability.

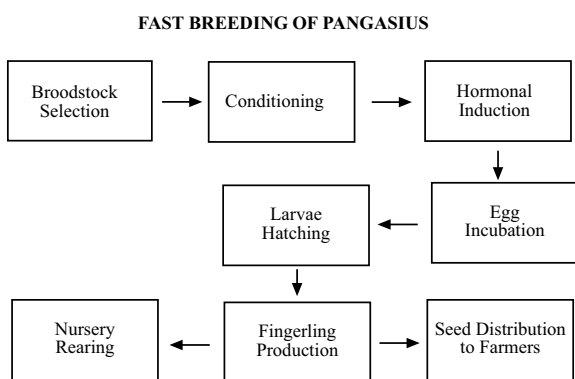
Pangasius can be cultured in ponds, concrete tanks, fish cages or pens, making it suitable for small and large-scale farming operations. With proper environmental management, it exhibits high survival rates and efficient feed conversion, making it ideal for commercial aquaculture.

Despite the potential of *Pangasius* culture, Pakistan’s aquaculture sector remains under developed. Local fish farmers have limited options for species diversification, which hinders the overall growth of the industry. Although *Pangasius* has been introduced in some regions, it has not yet gained widespread popularity due to several challenges like lack of awareness, unavailability of quality seed & high cost of imported seed. These issues create a barrier to entry for farmers, preventing large-scale *Pangasius* culture and limiting the economic growth of Pakistan’s aquaculture industry. Without access to affordable and locally produced seed, farmers cannot take advantage of this highly profitable species. The main objectives of this project are:

- To develop sustainable, cost-effective & efficient artificial breeding technology for *Pangasius*.
- To promote large-scale *Pangasius* culture in Pakistan through the development of local, breeding technology.
- To establish hatchery infrastructure, training technical staff and producing high-quality seeds at low cost to promote *Pangasius* farming across Pakistan.

Graphical Abstract:

The following flowchart illustrates the overall process of fast breeding and seed production:



Quarterly Work Plan:

1st Year

1st Quarters	2nd Quarter	3rd Quarter	4th Quarter
Project Planning & Literature Review (Continued)	System Design & Construction	Biofloc Formation & Optimization	Biofloc Formation & Optimization

2nd Year

Stocking & Growth Trials.	Mid-Term Evaluation & Optimization	Second Cycle of <i>Pangasius</i> culture	Data completion and evaluation of <i>Pangasius</i> culture
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3rd Year

Training & Capacity Building	Commercial Scale Demonstration	Commercial Scale Demonstration (continued)	Final Documentation & Dissemination
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Funding Source (PSDP/SGI/RD&I etc):

In-House

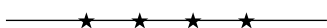
Tangible Outcome:

- Reduction in seed cost will make *Pangasius* culture financially viable for small-scale farmers.
- Widespread farming of *Pangasius* will boost total aquaculture output in Pakistan.
- Creation of new jobs in hatchery management, seed distribution and fish farming.
- Strengthening of the aquaculture sector and rural economies through commercial fish production.
- Increased availability of nutritious and affordable fish for local consumption.
- The successful implementation of this project will reduce dependency on imported seed, increase fish

production and enhance food security, ultimately making Pakistan a key player in the global *Pangasius* aquaculture market.

Achievements:

- Already have 100,000 Liter Tank.
- Successfully trialed the *Pangasius* fish in RAS.
- Aeration System Installed.
- More then 3 Kg weight has been achieved by the *Pangasius* that is raring at LLC.
- Ready for breeding trails.



Completed Project

Title of Project	Achievements
Development of Process for the Production of Phthalate Free Plasticizer for PVC-Based Products (ATBC)	<ul style="list-style-type: none"> • Process development for the production of Phthalate Free Plasticizer for PVC-based products (ATBC) is completed. • Process will be leased out to paints and coatings, PVC coating, Inks manufacturer, Cosmetic and food industries.
Synthesis of 2-Ethoxyethanol Acetate, a Versatile Solvent	<ul style="list-style-type: none"> • Process is developed for Synthesis of 2-Ethoxyethanol Acetate, a Versatile Solvent. • Process has been Leased out.
Desulfurization, Deodorization and Decolorization of Kerosene Oil	<ul style="list-style-type: none"> • Process developed for Desulfurization, Deodorization and Decolorization of Kerosene Oil. • Process is leased out to two clients.
Development of Sunblock Formulation with Different Sun Protection Factors	<ul style="list-style-type: none"> • Process is developed for Sunblock Formulation with different Sun Protection Factors. • Process Leased out.
Edge Color Coating Formulations for Leather Finishing	<ul style="list-style-type: none"> • Process is developed for Edge Color Coating Formulations for Leather Finishing. • Process Leased out.
Development of Protein Enriched, Gluten Free Flour and other Therapeutic Food Products from FABA Beans	<ul style="list-style-type: none"> • Four products developed i.e. <ol style="list-style-type: none"> i. Lactose free faba bean milk. ii. Faba bean meat. iii. Protein enriched baby food. iv. Gluten free protein enriched cookies. • Organoleptic, proximate, mineral and vitamin analysis of developed products (Lactose free faba milk, Faba bean meat and protein enriched baby food) completed. • Shelf life study of developed products is completed.
Extraction, Isolation of Natural Flavonoids from Various Indigenous Sources and its Application as a Antioxidants and Bio-Preservative	<ul style="list-style-type: none"> • Extraction of natural flavonoids from lemon peel as bio-preservative is completed. • 04 research papers have been published in the reputed journals. • A technical report entitled “Development of garlic turmeric tea and its antioxidant potential” was submitted.

<p>Development of Value Added Products for Dogs and Cats by using Indigenous Resources</p>	<ul style="list-style-type: none"> • Different cats and dogs food products have been developed alongwith their complete proximate/nutritional analyses (moisture, protein, fat, fiber, carbohydrates and energy). • Formulation of cat and kitten food has been developed and leased to M/s Shining Star Enterprises, Lahore. • Following technical reports have been submitted: <ol style="list-style-type: none"> i. "Preparation of biscuits for cats". ii. "Nutritional and Aflatoxins analysis of dog food". iii. "Quality assurance for proximate contents and aflatoxins levels in puppy food". • 02 research papers have been published in the reputed journals.
<p>Development of Halal Pancreatin from Slaughter House Waste</p>	<ul style="list-style-type: none"> • Production of powdered Pancreatin utilizing freeze drying technology (Temp. -10 to 0°C). • Quality assurance of the developed product (Nutritional Analysis) and enzyme assay was performed in comparison with standard to check bioavailability of various enzymes and found satisfactory.
<p>High Entropy Alloys (HEAs) Coatings for Extreme Environment Applications</p>	<ul style="list-style-type: none"> • The coating has been developed. • Process Leased out to M/s Sitara Chemical Industry, Faisalabad. • Technical report is under process.
<p>Development of Indigenous Technology to Produce High Fuel from Agro Industrial Waste.</p>	<ul style="list-style-type: none"> • Project was successfully completed with the production of Refuse Derived Fuel (RDF) through a low-cost and locally adaptable process. • RDF was successfully tested in stove, where it demonstrated efficient burning, steady heat release and reduced smoke emissions compared to raw biomass.
<p>Affectivity of Nano Composite for Treatment of Industrial Effluent.</p>	<ul style="list-style-type: none"> • Project was completed successfully. • 03 Papers have been published in the reputed journals. • Five studens of Education University of Lahore completed M Phil. Research.
<p>Green Technology for Strategic Modification of Desert Land and Sustainable Agriculture</p>	<ul style="list-style-type: none"> • Trial with focusing on controlled pot studies and selected land experiments to evaluate the potential of green technologies for desert soil improvement were completed successfully.

	<ul style="list-style-type: none">• Promising results in terms of soil fertility enhancement, moisture retention and crop performance under simulated desert conditions were observed during evaluation studies.• One patent application No 70/2025 dated 11-3-2025 was filed to protect the innovative methodology developed during the course of the project.
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PCSIR Labs. Complex, Karachi

PCSIR Labs. Complex, Karachi

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Innovations in Crop Protection: Developing Complexed Copper Fungicides to Address Fungal and Bacterial Pathogens

Name & Designation of Project Director:

Dr. Tahir Rafique, PSO

Name & Designation of Project Associate(s):

Dr. Saima Imad, PSO

Ms. Sheraz Shafiq, SSO

Mr. Ghulam Fareed, EO

Area(s) of Research:

Fungal Control, Product Development

Duration:

02 Years

Date of Initiation

July, 2025

Project Brief:

Copper-based fungicides, widely utilized in agriculture are copper-containing chemical compounds that effectively inhibit the growth of fungi and bacteria. They are effective against a variety of fungal diseases, such as Anthracnose, Botrytis rots, Downy mildews, Fusarium rots, Powdery mildews, Rusts, Rhizoctonia rots, Sclerotinia rots and Sclerotium rots. The fungicidal mechanism involves the release of copper ions, which disrupt the cell membranes of fungal spores and bacteria, leading to cell death.

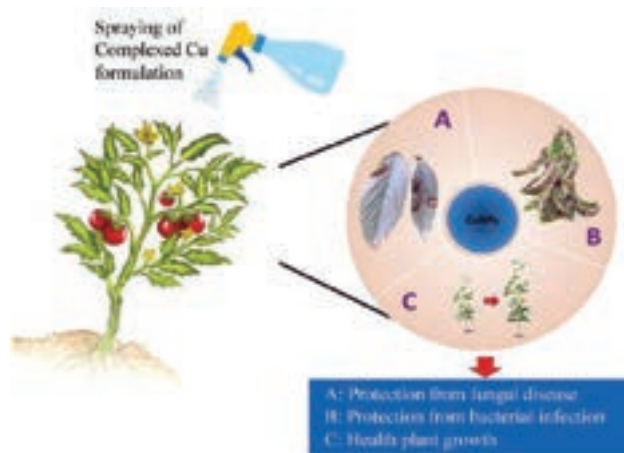
Copper fungicides are available in various formulations, including copper sulfate, copper hydroxide and copper oxychloride etc. However, traditional formulations have limitations such as phytotoxicity, environmental persistence and reduced effectiveness under certain conditions. However, complexed copper fungicides represent an advanced formulation designed to address these challenges and represent a significant advancement in crop protection. These advanced formulations involve binding copper ions to inorganic or organic molecules (ligands), enhancing stability, bioavailability and efficacy. By releasing copper ions in a controlled manner, complexed copper fungicides

effectively disrupt the cellular processes of pathogens while reducing adverse effects on plants and the environment. Complexed copper fungicides provide improved efficacy, lower environmental impact and enhanced plant safety, making them a crucial tool for sustainable agriculture.

This project explores the development, practical applications and future potential of complexed copper fungicides in modern agriculture, emphasizing their role in overcoming the limitations of traditional formulations and promoting sustainable crop protection practices. The objectives are given as:

- Designing and development of complexed copper formulations by binding copper ions to inorganic or organic ligands to enhance stability, bioavailability and targeted delivery.
- Propose pathways for commercialization of developed formulations for adoption by farmers to promote sustainable and eco-friendly agriculture practices.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Literature review & Planning	Formulation Design & Synthesis		Characterization of novel copper complexes
2nd Year	In vitro Testing	Formulation Optimization and Field Trials		Data analysis, Reporting & Commercialization

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- To design and patent cutting-edge complexed copper fungicides with enhanced stability and bioavailability to address problems associated with crop diseases.
- To collaborate with agrochemical companies for the commercialization of technology of copper fungicide, ensuring widespread adoption in farming systems.
- To translate laboratory innovations into practical, scalable solutions that sustainably tackle regional crop protection requirements in a sustainable manner and have a quantifiable on-farm impact.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

CES/PC SIR Laboratories Complex, Karachi

Title of Project: Impacts of Climate Change on Agriculture, Groundwater Resources and Coastal communities in Sindh

Name & Designation of Project Director:

Dr. Aijaz Ali Panhwar, PE

Name & Designation of Project Associate(s):

Mr. Shahid Ahmed Bhutto, PSO

Area(s) of Research:

Climate Change/Environment

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Sindh, a province in southern Pakistan, is grappling with the dual challenge of rapid climate change and

socio-economic vulnerability. Agriculture, a key sector in Sindh, employs a significant portion of the population and contributes substantially to the region’s GDP. However, climate change-induced variability in temperature, rainfall patterns and extreme weather events (such as floods and droughts) pose serious threats to agricultural productivity. Additionally, groundwater resources, which are essential for irrigation, are becoming increasingly saline due to rising sea levels and irregular precipitation, further exacerbating the challenges faced by farmers. Sindh’s coastal communities, particularly those along the Arabian Sea, are witnessing increased frequency and intensity of storms, coastal erosion and loss of biodiversity, which disrupt the livelihood of local populations. The impacts of these environmental shifts are not isolated but interrelated, leading to long-term sustainability concerns. This research aims to investigate the multifaceted impacts of climate change on agriculture, groundwater resources and coastal communities in Sindh, with a focus on how these interconnected issues can be addressed for sustainable development.

Sindh is experiencing significant climate change effects that threaten its agricultural sector, degrade groundwater resources and disrupt coastal communities. These threats are exacerbated by the region's socio-economic vulnerabilities and reliance on traditional practices. As agriculture relies heavily on groundwater for irrigation, changes in climate are increasing water scarcity, reducing crop yields and leading to soil salinization. Coastal communities are witnessing the intrusion of saltwater into freshwater sources and the loss of arable land due to rising sea levels. This multifaceted environmental stress is threatening food security, economic stability and the livelihoods of Millions in Sindh. Despite these growing concerns, there is insufficient comprehensive data and understanding of the precise impacts of climate change across these interconnected sectors. Furthermore, there is a lack of effective adaptation strategies that integrate the complex interactions between agriculture, water resources and coastal management. This research aims to fill these gaps by providing evidence-based insights into the severity of these impacts and formulating

integrated strategies for mitigating climate change's adverse effects on the region.

The research will cover the following areas:

- **Agriculture:**
 - Assess the impacts of changing rainfall patterns, temperature variations and extreme weather events on crop yields and productivity.
 - Evaluate the vulnerability of key crops, such as wheat, rice, cotton and sugarcane to these climatic shifts.
 - Analyze the effectiveness of existing agricultural practices and technologies in mitigating climate impacts.
- **Groundwater Resources:**
 - Investigate the effects of climate change on groundwater recharge rates, particularly in relation to reduced rainfall and higher evaporation rates.
 - Study the salinization of groundwater and its impacts on irrigation and agricultural sustainability.
 - Examine the extent of over-extraction of groundwater and its interaction with climate-induced changes.
- **Coastal Communities:**
 - Evaluate the effects of rising sea levels and increasing storm intensity on coastal ecosystems and infrastructure.
 - Study the loss of biodiversity, including impacts on fishery resources, which are crucial to the livelihoods of coastal populations.
 - Investigate how changes in the coastal environment are influencing migration patterns, economic activities and food security.
- **Integrated Impact Assessment:**
 - Analyze the interconnectedness of climate change impacts on agriculture, groundwater and coastal communities.

The objectives of the present study are as follows:

- To assess the impacts of climate change on agricultural productivity in Sindh by analyzing historical climate data and correlating it with crop yield variations in different regions of the province.
- To understand the effects of climate change on

groundwater resources through hydrological modeling, including an evaluation of groundwater recharge, salinization and the sustainability of current water management practices.

- To investigate the vulnerability of coastal communities to climate change, particularly in terms of sea level rise, saltwater intrusion and extreme weather events and their impacts on local economies, migration and food security.
- To develop integrated, evidence-based adaptation strategies that address the interconnected impacts of climate change on agriculture, groundwater resources and coastal communities, with a focus on resilience-building measures and sustainable development.
- To enhance public awareness and policy dialogue on the urgent need for climate adaptation in Sindh, promoting both local and regional-level action in response to these emerging environmental challenges.

Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Literature Survey	Visit of Coastal areas (Karachi) to collect the information and data of coastal communities	Visit of Coastal areas (Excluding Karachi) to collect the information and data of coastal communities	Coordination with relevant departments/organization to collect the data

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- A comprehensive report on the specific impacts of climate change on agriculture, groundwater resources and coastal communities in Sindh by MATLAB & ORIGIN.

- Creating a set of practical solutions that are adapted to the specific challenges of the region.
- Enhanced capacity for local communities and policymakers to address climate change, with an emphasis on resilience and sustainability.
- Contribution to the global discourse on climate change adaptation in vulnerable regions.

Achievements:

New Project



Name of Laboratory / Center/ Unit:

ESC/PCSIR Labs. Complex, Karachi

Title of Project: Formulation & Development of Highly Potential Cost Effective Agrochemical Fertilizers

Name & Designation of Project Director:

Dr. Nighat Sultana, CSO

Name & Designation of Project Associate(s):

Engr. Muhammad Ali Imran, SE
Mr. Umair Ihsan, SEO

Area of Research:

Agro-chemical Product Development

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

In the latter half of the 20th century, increased use of nitrogen fertilizers (800% increases between 1961 and 2022) has been a crucial component of the increased productivity of conventional food systems as part of the so-called "Green Revolution". Modern agricultural practices, fertilization focuses on three main macro nutrients: nitrogen (N), phosphorus (P) and potassium

(K) with occasional addition of supplements like rock flour for micronutrients. These fertilizers apply in a variety of ways: through dry or pelletized or liquid application processes.

Despite Pakistan's extensive fertilizer nutrients, many are still imported from other countries because here isn't a proper infrastructure for processing them into standardized finished fertilizer products, i.e, liquid and granule powder. The present study deals with the investigation of the fertilizer components primarily supply macronutrients (N, P, K), secondary nutrients (Ca, Mg, S) and micronutrients (Fe, Zn, Cu, B, Mo, Mn). Nitrogen sources are natural and Industrial. The phosphorus sources are natural Rock phosphate. The potassium sources are naturally in Potash ores and processed sources is Muriate of potash, sulfate of potash. Micronutrient Sources are Zinc, ZnSO₄, ZnO. Determining the sources of fertilizer components is essential for quality control, economic feasibility and environmental sustainability. This study will focus on the development of fertilizers like Nitrophos granule fertilizer, Bio-Organic Phosphate fertilizer, Liquid Potash 30% fertilizer, Sulfate of Potash fertilizer, Zinc Chelated 5% granule fertilizer. Source determination ensures fertilizer quality and compliance with standards. Proper formulation of products like Nitrophos, bio-organic phosphate, liquid potash, Sulfate of Potash and Zinc Chelated 5% granule fertilizer ensures targeted nutrient delivery.

The fertilizer sector in Pakistan currently comprises of 4 companies.

- Fauji Fertilizer Company Limited (FFC) = 2.5MMT per annum of Urea & 7% of DAP.
- Engro Fertilizers Limited (EFERT) = 2.3MMT per annum of Urea & 18 % DAP.
- Fauji Fertilizer Bin Qasim Limited (FFBL) = 53% DAP.
- Fatima Fertilizer Company Limited (FATIMA) = 2.0MMT per annum of Urea, CAN and NP & 7% of DAP.

The fertilizer industry in Pakistan, with US\$ 3.74 Billion per year in sales, now stands at a crossroads where, after an initial substantial contribution in boosting crop productivity, its future potential is being challenged.

There are two major seasons of crops, Kharif and Rabi which significantly affect the demand of fertilizers as different nutrients are required for different types of crops. Kharif crops are dependent on the monsoon, e.g., rice, cotton, sugarcane, maize, pulses and their crop season is from April-July. Rabi crops are sown after the monsoon season in the winter from October-January like wheat, barley, oil seeds. During the Kharif season nitrogenous fertilizers e.g., urea is in high demand because it promotes leafy growth and early development. During the Rabi season phosphoric and potassium fertilizers are in high demand as they promote overall health of the crops. As different types of fertilizers are in demand for the different seasons of the year, fertilizer companies plan their production accordingly. Objectives are given as:

- To develop fertilizer formulations.
- Substitute of imported standardized fertilizers (Nitrophos, Bio organic phosphate, Liquid potash, Sulphate of potash, Zinc Chelated 5%) for agricultural and agrochemical Industries.
- Method development of cost effective Innovative Fertilizers.
- Adjust the dosage of fertilizer for various plants.
- To develop trial operation for different agriculture field and improve Soil fertility, germination and plant growth nutrients.
- To introduce the granule technology on pilot scale studies for these potential standardized fertilizer and their finished form of granule powder.

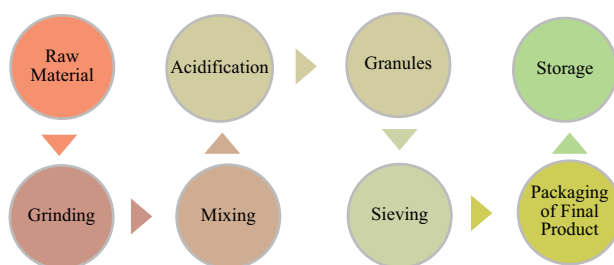
Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Source determination of Components of Fertilizers and Significant Role in Soil Fertility and Nutrient Cycling.	Method development of the following Fertilizers, <ul style="list-style-type: none"> • Nitrophos • Bio organic phosphate • Liquid potash • Sulphate of potash • Zinc 5% chelated 		Mechanisms/ Effects of Fertilizers on Soil fertility

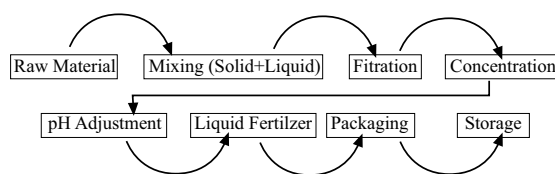
Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2nd Year	Comparative Analysis of Innovative Fertilizers.	Challenges and Limitations after applying of fertilizer on fields	Future Directions for Research and Practical Implications	<ul style="list-style-type: none"> • Production of potential fertilizer • Final fertilizer will be patented for potential commercial use

Graphical Abstract:

Method - 01 (Granular Form)



Method – 02 (Liquid Form)



Funding Source (PSDP/SGI/RD&I):

In-House

Tangible Outcome:

- Development & Production of agrochemical fertilizers.
- To save foreign exchange of the country as substitute of import products.
- Utilization of indigenous material within the country thus promoting industrial growth of the country.
- It will improve the agriculture business as well as result in an increase in the employment generation.
- Project will be beneficial for local agriculture industries as the product develop with least side effects, economically bearable & easily approachable for a common man/ farmers.

- Training & consultancies will be provided to clients.
- Final fertilizer will be patented for potential commercial use.

Achievement:

New Project



Name of laboratory / Centre/ Unit:

PRC/ PCSIR Labs. Complex Karachi

Title of Project: Development of an Efficient Formulation for Enhancing Water Solubility of Boron to 20% from Low-Availability Boron Complexes (e.g., Borax 11%)

Name & Designation of Project Director:

Dr. Amir Ahmed, PSO

Name & Designation of Project Associate(s):

Dr. Kamran Ahmed Abro, SSO
Mr. Irshad Ahmed Khan, EO

Area(s) of Research:

Agrochemical

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Boron is a critical micronutrient in agriculture, playing a vital role in various physiological and biochemical processes in plants. Its importance cannot be overstated, as it directly impacts crop growth, development, yield and quality.

It's specially play role in plant hormone and influences the synthesis and activity of plant hormones like auxins, which regulate growth and development. It helps in cell division and elongation, particularly in meristematic tissues (e.g., root tips, shoot tips). The ~22 Million ha soils of Pakistan are predominantly calcareous and low in organic matter. Boron (B)

deficiency is prevalent in 40–78% areas under field crops causing yield, produce quality and economic losses.

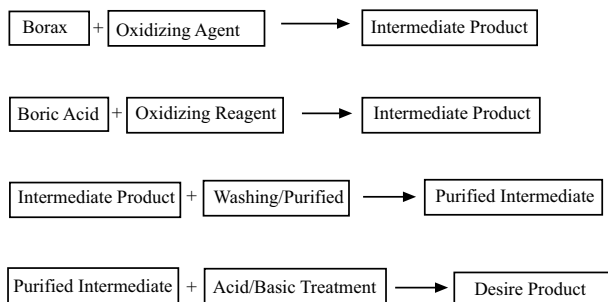
Boron deficiency in Rice and Wheat in Pakistan is a serious constraint to productivity and grain quality in Pakistan. Despite being categorized as tolerant to B deficiency, yield increases with Boron use have been observed. Boron deficiency is a common micronutrient issue in agriculture that can significantly affect crop yield and quality. Boron is essential for various plant functions, including cell wall formation, membrane integrity, reproductive development and nutrient transport.

This project aims to develop a novel formulation or process to increase the water solubility of boron to 20% from low-availability boron sources such as borax (11% boron). The goal is to create a cost-effective and environment friendly method to improve boron's bioavailability for agriculture. The project will involve chemical modification, solubility testing and optimization of the formulation to achieve the desired solubility while maintaining stability and usability. The primary objectives of this project are:

- To produce locally develop low-cost foliar fertilizer and reduce the dependence of imported high-cost fertilizer and save the foreign exchange.
- To revolutionize boron fertilization in agriculture by providing a highly soluble, cost-effective and environmentally friendly solution. This will address boron deficiency challenges, improve crop productivity and support sustainable farming practices.

Graphical Abstract:





Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Chemical reaction on easily available boron salt like borax and boric acid	Increase the solubility of salt by chelating with various agent	Continuou s activity	Development of Technology

Funding Source (PSDP/SGI/RD&I etc.):

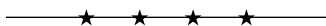
In-House

Tangible Outcome:

A low cost highly soluble 20% boron complex product will be developed.

Achievements:

New Project



Name of Laboratory Centre/Unit:

PRC/ PCSIR Labs. Complex Karachi

Title of Project: Nutraceutical Based Antiviral Immune Booster Preparation for Prevention of Periodic Viral Infections

Name & Designation of Project Director:

Dr. Kauser Siddiqui, PSO

Name & Designation of Project Associate(s):

Dr. Saeeda Bano, PSO
 Dr. Samina Iqbal, SSO
 Dr. Kanwal Abbasi, SSO

Area of Research:

Biochemistry and Clinical Nutrition

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Nutraceuticals are biologically active molecules naturally found in foods that may enhance human health and wellbeing by inhibiting certain diseases or improving human performance. Many of these nutraceuticals have the viability to act as antiviral agents and may therefore be candidate to be incorporated into medical foods for preventing or treating certain types of viral diseases. There is no definite treatment available for common viral infections, available vaccinations are less effective as well as have harmful side effects. Research evidences support that development of antiviral nutraceutical can be the effective way to treat and manage viral infections by boosting immune responses.

The mechanism of anti-viral activity of the product will be two ways first by boosting of immune system by reducing the ROS (reactive oxygen species) generated by virus and second by self contained inhibitors that kill the virus encoded proteases. The objective include:

- To formulate a unique research based product having anti-viral activity for prevention and convalescence of periodic and recurrent viral infections utilizing different food sources including Malus pumila, Petroselinum crispum, Prunus avium, Glycyrrhiza glabra and Vitis vinifera.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Different fruits and Herbs will be screened for antioxidant potential.	Profiling of medicinal foods as per their efficacy and fruits and herbs will be selected on the basis of efficacy	Formulations will be prepared	Biochemical analysis of formulated product will be conducted
2nd Year			
Biological studies will be carried out	Clinical study on human subjects	Stability study of formulated product	Commercialization process

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

Unique Nutraceutical Formulation for prevention

and convalescence from common viral infections for Pakistani citizens.

Achievements:

New Project



Name of laboratory / Centre/ Unit:

PRC/ PCSIR Labs. Complex Karachi

Title of Project: Phytochemical Evaluation and Anti-inflammatory Mediated Anti-hemorrhoidal Activity of *Alhagi camelorum* in Animal Model

Name & Designation of Project Director:

Dr. Tehmina Sohail, SSO

Name & Designation of Project Associate(s):

Dr. Abdul Hafeez Laghari, SSO

Dr. Hina Imran, SMO

Dr. Salman Tariq Khan, SSO

Dr. Rashid Ali Khan, CSO

Area(s) of Research:

Herbaceuticals

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Hemorrhoids, also known as piles, are a common condition affecting the rectal and anal area. In healthy individuals, these are referred to as anal cushions, which are made up of rectal blood vessels, muscles and elastic fibers. When these cushions become swollen, they can lead to symptoms such as bleeding, constipation, itching and severe pain in the anus. The primary cause of hemorrhoids is the inflammation of

these anal cushions. Inflammatory mediators like neutrophils, TNF- α and IL-6 are thought to play a significant role in the development of this condition. This study aims to carry out *in-vitro* and *in-vivo* anti-hemorrhoidal activity of plant *Alhagi camelorum* (ethanolic extract of roots and flowers).

Hemorrhoids have become a common health issue in the local population, largely due to poor diet, imbalanced nutrition and sedentary lifestyles. However, due to stigma, many individuals avoid professional medical advice and instead use over-the-counter (OTC) herbal remedies, which are often marketed with minimal regulatory oversight. These products are typically developed without scientific evaluation or clinical trials, leading to limited effectiveness and potential health risks. The root of *Alhagi camelorum*, known for its wound-healing properties, has been patented for its therapeutic potential and its flowers are traditionally used to treat hemorrhoids. Lupeol a triterpenoid, is a major bioactive compound present in this plant. It shows diverse medicinal properties against various diseases. Reported activities include antioxidant, wound-healing and anti-inflammatory effects

This study aims to develop a scientifically validated herbal remedy for hemorrhoids using parts of *Alhagi camelorum*, ensuring authenticity and safety in its formulation. Herbal ointments for hemorrhoids have anti-inflammatory, analgesic, vasoconstriction and healing properties which promote tissue regeneration and help to reduce the healing time of hemorrhoidal lesions. With the rise in demand for natural health products, herbal ointments are becoming more popular in the herbal and natural healthcare markets. The objectives of this study are:

- To formulate a cost-effective herbal medicine with superior safety, efficacy and with less side effects.
- Product from locally available raw material will discourage the import substitution and will boost up the economy.
- Being the indigenous product, it will be easily approachable to end user.

Graphic Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection of the plant during its flowering season to ensure optimal yield of bioactive compounds. Selected plant material will be processed to obtain extracts through appropriate solvent extraction methods with a focus on preserving its medicinal properties for further analysis.	The extract will undergo preliminary phytochemical screening to identify key bioactive compounds, followed by optimization of extraction conditions to maximize yield and potency.	Phytochemical analysis of the extract will be performed using techniques such as HPLC, GC-MS and UV spectroscopy. Initial pharmacological trails of extract(s).	<i>In-vitro</i> anti-inflammatory studies of extract will be conducted

2nd Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Skin Toxicity study will be conducted followed by setting appropriate concentration of extract in final product (i.e. ointment).	Hemor-rhoidal model of albino rats will be developed followed by toxicity studies.	Continuation of efficacy study of anti-hemorrhoidal ointment will be conducted in albino rats. Improvement of product will be done if required after initial trials.	Data Completion for publication/patent. Supply/Technology transfer of developed product.

Area(s) of Research:

Agricultural Chemistry

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

The global agricultural sector is increasingly challenged to meet the growing food demand driven by a population projected to reach 9.7 Billion by 2050. Although projections indicate a 70% increase in food production is necessary, the growth rate of agricultural output has slowed in recent years. The outlook for the next decade is less optimistic compared to previous years. Despite the sufficient production of feed to meet basic nutritional requirements, food insecurity and hunger remain widespread, primarily due to economic crises and inefficient distribution. Currently, approximately one Billion people are estimated to be undernourished, underscoring the pressing need for a significant increase in agricultural production. A key contributor to this challenge is the depletion of essential micronutrients in soils, caused by repeated crop cultivation, particularly in regions like the subcontinent due to increasing population and reduction of water resources. These deficiencies hinder optimal crop growth and productivity. Certain essential metals, such as copper, zinc and manganese, are vital micronutrients that support various enzymatic activities in plants, including chlorophyll production and seed development. These metals are especially crucial for key crops like tomato and onion, which require elevated levels of micronutrients for healthy growth and high yields by increasing biomass. A lack of these micronutrients can lead to disease susceptibility and substantial yield losses. This project focuses on developing a metal-based complex to address micronutrient deficiencies in soils. By improving the bioavailability of these essential metals through the chelation process, this project aims to enhance the growth and yield of crops like tomato and onion. The development of safe chelated products will provide an innovative solution to mitigate

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcomes:

- Development of formulation/product.
- Publication/Patent.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PRC/ PCSIR Labs. Complex Karachi

Title of Project: Development and Evaluation of Chelated Micronutrients-Based Formulation for Enhanced Growth and Yield of Key Crops

Name & Designation of Project Director:

Dr. Salman Tariq Khan, SSO

Name & Designation of Project Associate(s):

Dr. Abdul Hafeez Laghari, SSO

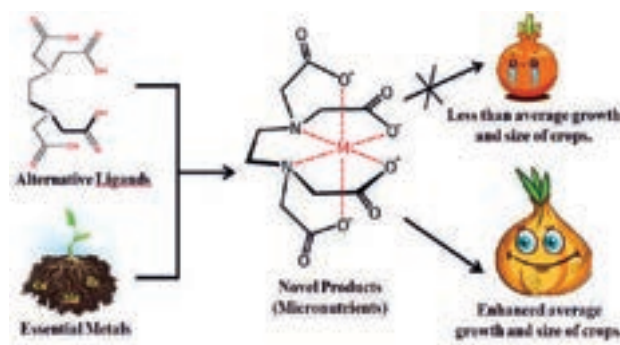
micronutrient deficiencies and improve crop productivity, contributing to better food security and sustainable agricultural practices.

Essential metals (copper, zinc and manganese etc.) deficiency in soil can significantly affect crop yields, especially in vegetables like tomato and onion. Conventional metal salts (such as copper salts in the form of copper sulfate) become unavailable to plants due to chemical reactions with soil compounds. This project addresses the need for a more effective method of delivering micronutrients to crops, ensuring that copper is readily available for plant uptake without harming the environment. At present metal supplements for agriculture sector are available in markets but these are very expensive. The proposed metal chelating process is very convenient and cost effective and required chemicals are easily available in the market.

The project aims to develop chelated micronutrient products based on essential metals to enhance their bioavailability for plant uptake. Chelating agents such as EDTA, citric acid and DTPA will be evaluated for their capacity to form stable metal complexes that facilitate more efficient absorption by plants. The efficacy of these chelated complexes will be assessed in terms of their impact on plant growth, with particular emphasis on crops like onion and tomato. In addition, the project will examine the environmental implications of these chelating agents, with a focus on their biodegradability and sustainability. Following the field application of the developed products, the biomass will be analyzed to determine the metal content and assess its compliance with permissible limits, ensuring that the final products meet safety standards for agricultural use. The objective are given below:

- To develop chelated micronutrient products based on essential metals to enhance their bioavailability for plant uptake.
- To improve the growth and yield of key crops, such as onion and tomato, by optimizing nutrient absorption.
- To ensure the environmental sustainability and safety of the chelation process, with a focus on biodegradability.
- To assess the impact of metal chelation on plant growth performance and enhanced biomass.

Graphic Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Selection of ligands and metals for lab scale trial of synthesis of micronutrients.	Characterization of synthesized micronutrients	Synthesis of micronutrients at lab scale followed by pilot scale	Synthesis of micronutrients at lab scale followed by pilot scale
2nd Year	Field trial of synthesized micronutrients for application on crops	Field trial of synthesized micronutrients for application on crops	Analytical testing of control crops (where micronutrients are not applied) and treated crops (grown after the application of micronutrients) to evaluate metal uptake.	Data compilation for publication. Supply in bulk/ Technology transfer of developed effective product(s).

Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Tangible Outcome:

- Development of chelated micronutrient products

that enhance the bioavailability of essential metals like copper, zinc and manganese for plant uptake.

- Improved growth, yield and biomass production in key crops such as onion and tomato, resulting in higher agricultural productivity.
- Increased soil fertility and sustainable agricultural practices through the efficient use of chelated nutrients which increase the biomass of key crops to provide higher yields.
- Development of a cost-effective and convenient metal chelating process for agricultural use, resulting in affordable metal supplements using readily available chemicals.
- The beneficiaries of product include farmers, agricultural industries.

Achievements:

NewProject



On-Going Projects

Name of Laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Development of Formulation for Commercially Valuable Chemicals:

- a) **Blood Stain Remover**
- b) **Glue/Adhesive Remover**

Name & Designation of Project Director:

Dr. Sofia K. Alvi, CSO

Name & Designation of Project Associate(s):

Dr. Saima Imad, PSO
 Ms. Seema Firdous, SSO
 Mr. Muhammad Aijaz, SSO
 Syed Junaid Mehmood, SO

Area(s) of Research:

House Hold Cleaning Agents

Duration:

02 Years (Extended for 01 Year)

Date of Initiation:

July, 2024

Project Brief:

Pakistan is importing various chemical formulation used as general purpose cleaning agents. These formulations contain more than 90% solvent which is most of the time water, alcohol or other materials available in the country. If the composition is estimated accurately the same product may be developed locally with available sources/chemicals. It may save foreign exchange and also reduce tax burden on the importers. During last 2 years, a number of requests has been received for development of formulations of different materials which are now difficult to import due to rise in foreign exchange rate and/or ban on imports. The target of present research is the development of two products to support our SMEs. The first product is blood stain remover; this product is used in hospitals and diagnostic labs for removal of blood stains from furniture, linen and beddings, floor etc. A local entrepreneur approached our lab with a target to estimate its chemical composition. The results of preliminary examination showed that the product can be developed locally. The product found to contain more than 90%

water which means we are purchasing distilled water on account of foreign reserves. The second product is a cleaning agent used to remove any adhesive materials. This product is in phase of preliminary examination and chemical composition is almost estimated. The solvent base is kerosene oil which is available at much cheaper price as compared to the value of the product itself. Client for these two formulations are available, however R&D is required to develop and evaluate these products. Meanwhile reverse engineering of any other commercially viable product may also be carried out to develop them locally. The objectives of the present study are:

- Development of formulation of Blood Stain Remover.
- Development of formulation of glue/adhesive remover.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Estimation of approximate composition of Blood Stain Remover and adhesive remover received from client	Identification and quantification of chemical constituents via FTIR and other physical and chemical methods	Development of formulation	Characterization of the product

2nd Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Estimation of approximate composition of any other cleaning agent imported for routine use.	Identification and quantification of chemical constituents via FTIR and other physical and chemical methods	Development of formulation	Characterization of the product

Funding Source (PSDP/SGI/RD&I etc.):

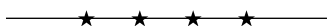
In-House

Tangible Outcomes:

- Development of formulation of blood stain remover.
- Development of formulation of glue/adhesive remover.

Achievements:

- The formulation of Blood Stain remover is reverse engineered. It was found to contain around 95% water. The other solvent present in the formulation is isopropyl alcohol. It was also found to contain acetic acid, wetting agents and surfactants in different ratios.
- Several trials were conducted to formulate the solution. Difficulties were experienced in the homogenization of the product. The issue was resolved by adjusting the order of mixing, speed, time and temperature during homogenization. The product is now under observation to assess its stability. Performance trials will be conducted soon after the stability check.



Name of Laboratory /Centre/ Unit:

ACRC/PCSIR Labs. Complex Karachi

Title of Project: Synthesis and Characterization of Chitosan and its Application

Name & Designation of Project Director:

Dr. Sofia K. Alvi, PSO

Name & Designation of Project Associate(s):

Dr. Razia Sultana, CSO
 Dr. Saima Imad, PSO
 Dr. Tahir Rafique, PSO
 Mr. Muhammad Aijaz, SSO
 Mr. Sheraz Shafique, SSO
 Syed Junaid Mehmood, SO

Area(s) of Research:

Chemical Sciences / Industrial Chemistry, Advance Materials / Polymeric Based Composites Materials

Duration:

03 Years

Date of Initiation:

July, 2023

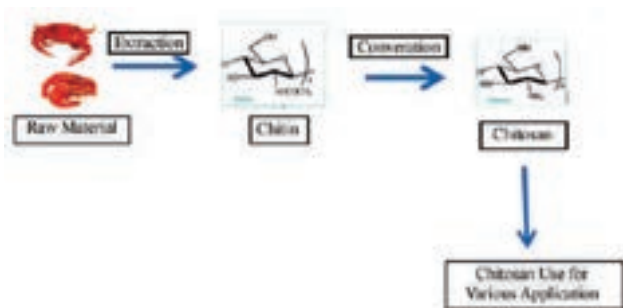
Project Brief:

Chitin is one of the most abundant natural linear polysaccharide made up of β -(1,4)-linked-N-acetyl-D-glucosamine units. Its main source of exploration is marine crustaceans. Chitin extraction from waste of shrimps and other crustaceans is economically feasible. Many valuable products like pigments and protein are also recovered which are utilized as additives in aquaculture, nutraceuticals etc. Purified chitin is converted to chitosan by hydrolysis of acetamide groups of chitin under alkaline condition. Generally, the reaction is carried out under inert atmosphere to avoid depolymerization and to prevent chain degradation. Chitosan is a bioactive polymer and it is characterized by its degree of deacetylation, molecular weight, appearance, purity, crystallinity, solubility, turbidity of polymer solution, ash content etc.

The wide varieties of applications of chitosan are due to its functional properties, unique cationic nature, its biocompatibility and biodegradability. It is soluble in acidic aqueous media and has wide range of applications mainly in food, agriculture and agro-chemistry, aquaculture, cosmetics, pharmaceutical

industries, textile and fiber industries, paper industry, wastewater treatment etc.

Graphical Abstract:



Funding Source: (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- A valuable product chitosan will be synthesized.
- Applications of Chitosan in nano-fertilizer synthesis.

Achievements:

- Chitosan production at Pilot Plant Scale from shrimp shells has been started. The process of demineralization and hydrolysis was optimized to obtain good quality and quantity of Chitosan.
- Based on nutraceutical value of chitosan, it is expected to be a good product for marketing in Pakistan as import substitute and can also be considered as a potential for valuable export item. Following is the technical Data of the developed product.
 - Appearance: Off white powder
 - Degree of Deacetylation: 90-94 %
 - Molecular Weight: 10-20 KDa
 - Ash Content: 1-2 %
 - Moisture Content: 7-9 %
 - Insoluble Matter in Acetic Acid: 2 %
 - Heavy Metals as Lead: 10 ppm
- The process of synthesis of Chitosan from Shrimp Shells is ready to be leased out.

- Our next target is to develop and optimize a Urea-Chitosan nano hybrid foliar fertilizer for the commercial application of Chitosan. A fertilizer solution has been developed and the particle size distribution has been estimated using a Zetasizer.



Name of laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Design and Fabrication of Impact Tester for Pipes as per Pakistan Standard and (45° Cantilever) for Bending Resistance PVC Material as per JIS 1096

Name & Designation of Project Directors:

Dr. Nighat Sultana, CSO
Dr. Sofia K. Alvi, CSO

Name & Designation of Project Associate(s):

Dr. Saima Imad, PSO
Engr. Amanullah Lakho, PE
Engr. Adeel Ahmed, JE
Syed Junaid Mehmood, SO
Mr. Rehan, TO
Mr. Mazhar Ali, TO

Area(s) of Research:

Testing Services of Polymeric Materials

Duration:

01 Year

Date of Initiation:

July, 2024

Project Brief:

Plastic Polymer Section of ACRC is involved in routine test analysis services. We often receive testing requirements of certain materials based on specialized

equipment which are not available locally, however their design is simple and they can be developed and fabricated at workshop facility of KLC. Recently we have received testing protocol for bending resistance PVC material as per JIS 1096. The test required wooden equipment (45° Cantilever) with specialized design mentioned in the testing protocol which can be fabricated at carpentry shop of KLC.

Similarly, the Impact tester as per Pakistan standard requires a mechanical equipment with variable masses and length to evaluate the resistance of pipes against dynamic impact energy. This equipment can also be fabricated at very low cost at our Engineering Service Workshop (ESC).

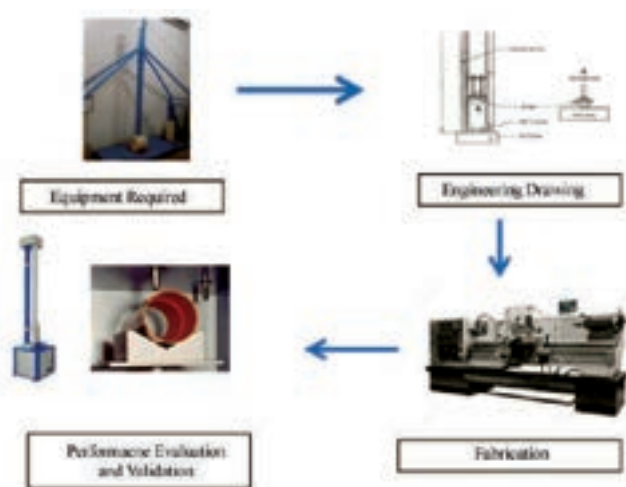
This project intends to develop this equipment locally from available resources. The polymer section will facilitate the design requirements and also provide technical evaluation support to Engineering Services Center so that these equipment would develop locally.

Objectives:

Design and fabrication of:

- 45° Cantilever as per JIS 1096
- Impact tester for Pipes as per Pakistan Standard.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter & 4th Quarter
1st Year	Designing of 45° Cantilever	Fabrication of 45° Cantilever and its evaluation	Evaluation of developed equipment
2nd Year	Designing of Impact Tester	Fabrication of Impact Tester and its evaluation	Evaluation of developed equipment

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- 45° Cantilever as per JIS 1096.
- Impact tester for Pipes as per Pakistan Standard.

Achievements:

- Designed, developed and fabricated the product and is currently conducting testing which has been found satisfactory with applicable standards.
- Development of Impact Tester is in progress.



Name of Laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Development of Coolant Formulations for Vehicles

Name & Designation of Project Director:

Dr. Saima Imad, PSO

Name & Designation of Project Associate(s):

- Dr. Sofia Khalique Alvi, CSO
- Dr. Tahir Rafique, PSO
- Ms. Seema Firdous, SSO

Mr .Muhammad Aijaz, SSO
Mr. Muhammad Shahzad, Tech.

Area(s) of Research:

Industrial Chemistry, Advance materials

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

A coolant is a substance, typically liquid, that is used to reduce or regulate the temperature of a system. An ideal coolant has high thermal capacity, low viscosity is low-cost, non-toxic and chemically inert and neither causes nor promotes corrosion of the cooling system. While the term "coolant" is commonly used in automotive and HVAC applications, in industrial processing heat transfer fluid is one technical term more often used in high temperature as well as low-temperature manufacturing applications. The term also covers cutting fluids. Industrial cutting fluid has broadly been classified as water-soluble coolant and neat cutting fluid. Water-soluble coolant is oil in water emulsion. It has varying oil content from nil oil (synthetic coolant).

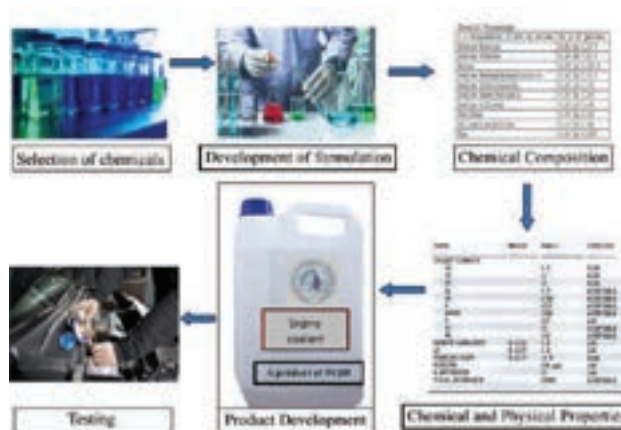
Coolant (or antifreeze) protects mechanical parts from freezing while defending components against corrosion. It is the combination of many constituents like antifreeze, pH stabilizers, dye, foam reducer, emulsifiers etc. depends on application. It plays a critical role in sustaining engine heat balance by removing heat. In a heavy-duty diesel engine, only one-third of the total energy produced works to propel the vehicle forward.

During previous years ACRC received many requests from clients to develop different coolants due to import restrictions and high cost. This project intends to develop coolant formulations locally to provide substitute for imported products. These products may be commercialized to support industry. The objectives

include:

- Development of methods for testing of coolants in Lab.
- Collection and testing of coolants available in market.
- Development of formulations of coolants.
- Comparison of properties of different coolants.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Market survey and collection of imported and local coolant.	Method development of testing parameters and identification of chemical constituents	Development of formulations	Estimation of developed coolants via physical methods
2nd Year	Characterization of the finished product.	Trials in vehicles	Pilot scale trial production	Compilation of results and publication/ patent

Funding Source (PSDP/SGI/RD&I etc.):

In-House

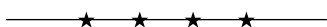
Tangible Outcomes:

- Development of coolants for import substitution

- Publication/Patent

Achievements:

- Different formulations of the coolants have been prepared in the lab and their analysis has been completed. Two products were finalized based on their properties. The stability study is currently in progress and performance trials will be conducted once the stability check is completed.
- Product stability study is in progress.



Name of Laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Development and Characterization of Nano Crystalline Cellulose Using Fabric and Paper Waste Materials

Name & Designation of Project Director:

Mr. Muhammad Farhan, SSO

Name & Designation of Project Associate(s):

- Dr. Saima Imad, PSO
- Mr. Muhammad Aijaz, SSO
- Mr. Kamran Ahmed, SEO
- Mr. Mansoor Iqbal, SO

Area(s) of Research:

Chemical Sciences / Industrial Chemistry, Advance Materials / Polymeric Based Composites Materials

Duration:

02 Years

Date of Initiation:

July, 2024

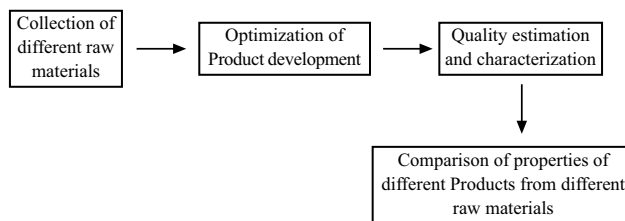
Project Brief:

Nano Crystalline Cellulose (NCC) also known as nano structured cellulose or cellulose nano fibers (CNF). It is pseudo-plastic and inhibits the property of gel or fluid that is thick (viscous) under the normal conditions.

The fibrils are isolated from any cellulose containing source like wood-based fiber (pulp fibers), paper waste, agro waste and fabric waste using different physical operations and chemical processes.

The project is designed to produce an import substitute. The aerospace and automotive industries have demand of NCC as ingredients for light weight, high-strength composite material. Nano-crystalline cellulose is an important valuable product in pharma, food, cosmetic and other industries and is used as texturizer, an anti-caking agent, a fat substitute, an emulsifier and bulking agent in food industries and also as alternate of carboxyl methyl cellulose (CMC) and as tabulating aid in pharma industries. A bulk quantity of nano-crystalline cellulose is being imported. A large amount of foreign exchange can be saved by producing this valuable product. The core objective is the development of valuable eco-friendly product, Nano-crystalline Cellulose from paper and fabric waste.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection of different raw material and optimization of process for Development of Nano crystalline Cellulose (NCC)	Development of Nano Crystalline Cellulose with an identified raw material i.e. paper waste	Quality estimation/characterization of the developed NCC from paper waste.	

2nd Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Development of Nano Crystalline Cellulose with an identified raw material i.e. fabric.	Quality estimation /characterization of the developed NCC from fabric waste	To conclude the results and preparation of report	

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- Nano crystalline cellulose (NCC) development as an import substitute from indigenously available raw material.

Achievements:

- A product has been developed in powder form with paper waste.
- Quality estimation/characterization of the developed NCC from paper waste is under process.



Name of laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Synthesis of Nano Acid Dyes and Evaluation of Fastness Properties on Nylon & Wool Fabric

Name & Designation of Project Director:

Mr. Kamran Ahmed, SEO

Name & Designation of Project Associate(s):

- Dr. SaimaImad, PSO
- Mr. Muhammad Farhan, SSO
- Mr. Mansoor Iqbal, SO
- Dr. Zeeshan Akhtar, Associate Professor KU

Area(s) of Research:

Textile dyes, Analytical, Synthetic and Surface Chemistry.

Duration:

01 Year

Date of Initiation:

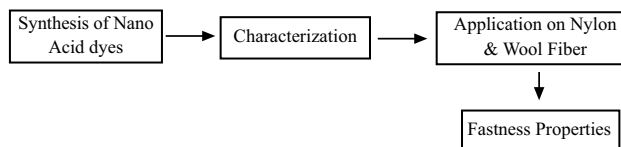
July, 2024

Project Brief:

Acid dyes are a large class of dyes and comprises various constitution. Most important are sulfonic acid derivatives of azoic dyes. The practical uses of these dyes are characterized by their capacity to dye protein and polyamide fibers. Under certain condition they may be used for dyeing poly-acrylonitrile fibers. Similar to direct dyes, they are anionic dyes with a general formula of RSO_3Na but they do not dye or poorly dye cellulosic fiber without consuming color fastness. Acid dyes are water soluble anionic dyes, bright in colors and have good washing fastness properties. Acid dyes contain a chromophoric group and an acidic group, usually $-SO_3H$, in the form of sodium salt, that are soluble in water. Objective are given below:

- Synthesis of nano acid dyes.
- Application and evaluation of fastness property of nano acid dyes on nylon and wool.

Graphical Abstract:



Quarterly Work Plan:

1st Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Identification of different intermediates to make Nano particles	Optimization of different reactions. Finished Nano Acid dyes synthesized at lab scale with identified intermediates	Quality estimation and characterization of the Nano Acid dyes	Evaluation of Nano Acid dyes on different fabric like Nylon & Wool fabrics

2nd Year			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Evaluation of Nano Acid dyes on different fabric like Nylon & Wool fabrics	Comparison of Nano Acid dyes results with other textiles	To conclude results and preparation of report	Paper writing

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

Synthesized non-toxic and environment friendly novel component dyes.

Achievements:

- Initially a two intermediates are selected for synthesize the Nano Acid dyes.
3-Amino Acetophenone as diazo component
4-Amino Acetophenone as diazo component
Naphthol-7 sulfonic acid (N-Phenyl-J-acid) as coupler component
2-Amino-5-naphthol 7-sulfonic acid (J-acid) as coupler component.
- 02 Lab Scale batches of Nano Acid dyes (Red & Scarlet) are developed and testing on fabric is in process.



Name of laboratory / Centre/ Unit:

ACRC/ PCSIR Labs. Complex Karachi

Title of Project: Application of Indigenous Based Stones on Denim Fabrics Obtained from Various Areas of Pakistan

Name & Designation of Project Director:

Mr. Mansoor Iqbal, SO

Name & Designation of Project Associate(s):

Dr. Saima Imad, PSO

Dr. Tahir Rafique, PSO
Mr. Muhammad Farhan, SSO
Mr. Kamran Ahmed, SEO

Area(s) of Research:

Textile, Dyeing

Duration:

02 Years (Extended for 01 Year)

Date of Initiation:

July, 2024

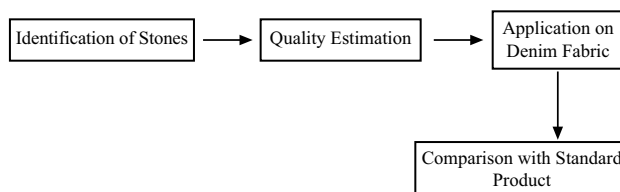
Project Brief:

The process of stone washing began towards the end of the 1970's, putting denim garments together with the pumice stones into the washing machines. As the wash drum rotates, the garments are repeatedly pounded and beaten by the stones, abrading the fibers and the indigo color on the denim fabric. Pumice stone is a natural volcanic stone used for grinding clothes.

Together with stone washing, these stones strip the dye particles on the surface of the fabric yarn, creating a faded, worn and shiny effect on textile products. Stone-washing increases the softness and malleability of rigid fabrics like denim and it produces faded look on denim fabric which is a modern fashion demand of Textile Industries. To achieve this in factories, finished garments are placed into industrial front-load washing machines, along with large stones. Pakistan is very rich in natural resources and possesses many minerals including coal, sulphur, chromite, iron ore, barite, marble, quartzite, pumice and limestone. Objectives are:

- To use indigenously available pumice stone for application on textile as an import substitute.
- To save foreign exchange of the country.

Graphical Abstract:



Quarterly Work Plan:

Quarters	1st Year	2nd Year
1st Quarter	Collection of stones from different location	Technical evaluation of denim Fabric
2nd Quarter	Identification and quality estimation of stones	
3rd & 4th Quarters	Application of various stones on denim fabric	Compilation of results and publication

Funding Source (PSDP/SGI/RD&I etc.):

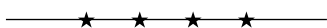
In-House

Tangible Outcomes:

- Using of indigenously available pumice stone will be helpful as an import substitute for textile industries.
- It will save foreign exchange.

Achievements:

- Pumice stones have been collected from different sources.
- Visited two Denim industries in SITE Karachi for industrial trial of stones on denim fabric.
- Characterization of pumice stones is under process.



Name of Laboratory/ Centre/ Unit:

APC&IC/PCSIR Labs. Complex Karachi

Title of Project: Study of Wind-Solar Hybrid Energy using Machine Learning (ML) Techniques

Name & Designation of Project Director:

Mr. Faisal Ghazanfar, SSO

Name & Designation of Project Associate(s):

Mr. Arif Karim, PSO
Dr. Abid Karim, SSO

Mr. Kashif Hussain, TO
Mr. Farhan Aziz Abassi, JEO
Mr. Naseem Ahmed, SEO
Mr. Mansoor Hi, EO
Mr. Mujahid Hussain, RA
Mr. Noman Saeed, TO

Area(s) of Research:

Artificial Intelligence(AI)

Duration:

02 Years

Date of Initiation:

July, 2023

Project Brief:

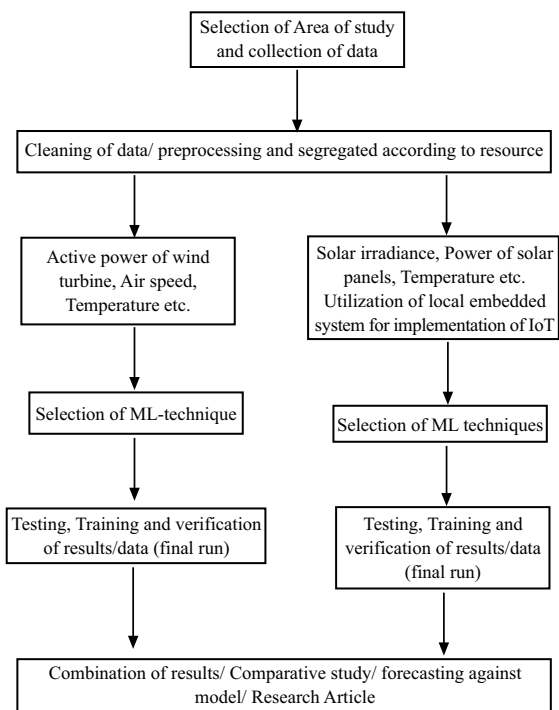
In the field of renewable / alternate energy, especially Solar and Wind based power generation, the prediction of power generation from a plant, throughout the year is a great challenge. The power generation depends on environmental conditions, wind speed, wind direction, solar irradiance, temperature etc. The uncertainty in these parameters leads to uncertainty in power generation. To make the power plant efficient, i.e. getting maximum output and its supply on the national grid with certainty, these parameters need to be calculated or predicted. This energy prediction model helps in utilizing solar and wind based power plants at their optimum level with certainty. This project is aimed at the utilization of Machine Learning (ML) techniques for the prediction of power production form solar and wind farm as a hybrid approach by considering a local wind farm situated at wind corridor of Sindh. In wind and solar based power plants, the certainty in power generation allows them to connect it to the national grid with their committed power. The certainty depends on the environmental parameters like wind speed, wind direction, solar irradiance, temperature etc. The estimation or prediction of these parameters is required for a specific plant throughout the year. The objective are:

- To prepare comprehensive Model for the Optimal Management of Energy / Power production using

ML techniques.

- To study different parameters like wind speed, direction, solar irradiance, temperature etc. for solar panels and wind turbines.
- Comparative study of ensemble and other modern methods of ML for the said application.

Graphical Abstract:



Quarterly Work Plan:

1st Year	<ul style="list-style-type: none"> • Obtained data from different resources such as universities, repositories, Renewable energy explorer, etc. • Implementation of data cleaning techniques to utilize it in ML algorithms. • Training of data and accuracy measurements • Testing of algorithm
2nd Year	<ul style="list-style-type: none"> • Optimization of model accuracy and error. • Using the Trained-Model, prediction of power generation will be carried out monthly, yearly and seasonally.

Funding Source (PSDP/SGI/RD&I, etc.):

In-House

Tangible Outcomes:

- The Trained-Model will help the power sector of renewable / alternate energy. This will eventually lead to clean and green energy production.
- The model is aimed to be applied on the Wind-Corridor of Sind where wind farm is already operative.

Achievements:

- Data Analytics has been carried out on the Data-Set for Wind-Solar Farm.
- Non-recorded and missing values in the data has been filled by different methods such Zero Fill, Interpolation, Median etc.
- “Support Vector Regression” Technique has been evaluated for different data sets to get improved results.
- Both multivariable and univariable tests have been performed to obtain optimum results.



Name of Laboratory/ Centre/ Unit:

APC&IC/ PCSIR Labs. Complex Karachi

Title of Project: Performance Evaluation and Investigation of Various Energy Storage Devices (ESD)

Name & Designation of Project Director:

Mr. Sheikh Kamaluddin, SSO

Name & Designation of Project Associate(s):

- Dr. Abid Karim, SSO
- Mr. Arif Karim, PSO
- Mr. Faisal Ghazanfar, SSO
- Mr. M. Mansoor Hai, EO
- Engr. Muhammad Waleed, JE
- Engr. Teecome-Das, JE
- Ms. Fariha Shabbir, SO

Area(s) of Research:

Efficient Energy Storage, Batteries, Super Capacitors

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

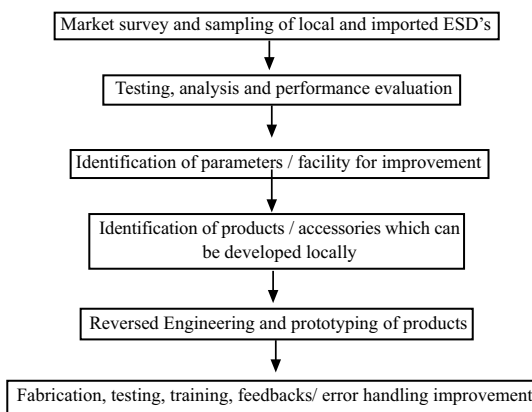
In the present research, investigation of future investments in energy storage devices such as various kind of high-power energy storage devices for the large-scale power conservation in off-peak hours (solar / wind energy in peak hours) which can be utilized in the night time will be carried out. The project includes an extensive research work of the existing manufacturing capacities of the country which mainly depends on lead-acid technology which appear as major drawback due to it lower efficiency, life-span and environment hazard. Several small-scale manufacturers and domestic users started to deploy the imported Lithium-ion batteries due to their lucrative claims regarding their efficiency and life span which results in several under-rated outputs with loss of huge up-front paid-up capital / investments. Several commercial banks offered investment / funding scheme for the solar energy with reverse-metering without the loan-cover for batteries which results in large scale installation of grid-tied solar energy systems which produce excessive power during the sunshine hours and causes large scale grid-congestion. Therefore, it is not viable option to sale out the excessive energy to the regulator (K-Electric / WAPDA) in sunshine hours and re-imports it during night time. Globally, the issues is getting worse due to the congestion of national grids and regulators / government are looking for an alternate option to store the excessive energy and re-used it on-demand with minimal losses and paid-up capital for the infrastructure. The objectives are as follows:

- Demand patterns analysis and projections for the Energy Storage and off-peak hours usage.
- Market surveys, analysis for the on-going current technologies at international and local markets / SMEs.
- Feasibility, analysis and investigation of the existing

manufacturing facility of ESD’s to upgrade the local industries.

- Identification and short-listing of the ESD’s related devices / which can be prototype and fabricated.
- Testing, analysis and error / feedback control for the developed products.

Graphical Abstract:



Quarterly Work Plan:

Quarters	1st Year	2nd Year
1st Quarter	Physical Market inspections at various location for the ESD’s products specification and warranties	Short list and prioritized the product / accessories which can be upgraded / innovated as already manufactured locally.
2nd Quarter	Physical Market inspections and analysis for the customer’s reviews, seller response / services in warranty claims and refund reliability	Prototyping for a selected ESD product / accessory and their stage-wise testing and error compensations.
3rd Quarter	Testing and analysis for the ESD products as compare to the provided / claim specification / quality from the seller / vendor.	Real time testing, analysis and evaluation of outputs / results, feedback controls.
4th Quarter	Performance evaluation / efficiencies for the ESD products as compare to the provided / claim specification / quality from the seller / vendor.	Patents, Publication and policies reviews / recommendations for the indigenous / imported authorities.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Name of Laboratory/Centre/Unit:

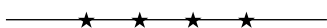
CES/ PCSIR Labs. Complex Karachi

Tangible Outcomes:

- The research will highlight the energy storage devices / accessories which can be manufacturer locally by providing consultancy to the local investor / industrialist in order to help local manufacturing.
- The research will be disseminate / published / disburse with the peer reviews published data and will be used to consult / trained / quality control with the general public in order to optimize their products / accessories related to their energy losses and efficiencies.

Achievements:

- The literature and market survey for the locally manufacture flooded lead-acid batteries for several brands such as OSAKA, EXIDE, PHONICS etc., were technically investigated for amperage, wattage and voltage ranges for their claim of the life cycle / spans and warranties.
- The parameters were investigated for their feasibility to be used in domestic application where the battery is operated under extreme conditions with various load types, charge / discharge cycles unlike their automobile application where these batteries has limited application such as starting and lightening loads which gives added advantage in performance.
- Several claims/ warranties were found catchy but ambiguous due to unavailability of authentic data / study on their used in domestic application which results as frequent failures / damage of these batteries much earlier than claims, which leads to the switching local users towards imported expensive storage options.



Title of the Project: Production of Organic Liquid Fertilizer by Fermentation Method

Name and Designation of Project Director:

Dr. Tooba Naveed, SSO

Area (s) of Research:

Biotechnology and Solid Waste Management

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

The population of Pakistan is growing and this is leading to increasing demand for food. Fertilizers are essential for increasing crop yield, so the demand for fertilizers is expected to grow in line with the demand for food. On the other hand, the increasing cost of mineral fertilizer has posed a barrier for smallholder farmers, resulting in lower application rates, declined soil fertility status and crop yield. Therefore, it is vital to look for cheap, impactful and locally accessible organic fertilizer sources.

Liquid organic fertilizer is expected to be one of the solutions to deal with the problem of organic waste in the environment. The ingredients for making liquid organic fertilizer are also relatively easy and cheap to obtain, the main ingredients for making liquid organic fertilizer usually use kitchen waste, such as vegetable waste, stale rice, fruit and vegetable peel, etc. Liquid organic fertilizer has an important role related to soil structure, namely maintaining soil health in good condition by increasing nitrogen supply and encouraging the growth of microorganisms in the soil The main

objective is:

- Organic Liquid Fertilizer by fermentation method using waste material.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Development of Process for organic liquid fertilizer.

Achievements:

- Lab scale studies on vegetable biomass are currently underway.
- Optimization experiments are being performed at the laboratory scale.



Name of Laboratory/ Centre/ Unit:

CES/PCSIR Labs. Complex Karachi

Title of Project: Development of Three-Way Banknote Checker Pen

Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	<ul style="list-style-type: none"> • Purchasing of raw material • Selection and purchasing of vessel for fermentation studies 	Shelf life studies
2nd Quarter	<ul style="list-style-type: none"> • Trial experiment of liquid fertilizer production by using different formulations on small scale 	<ul style="list-style-type: none"> • Pot/field trial studies to check the affectivity of the product • Shelf life studies
3rd Quarter	Continuation of trial experiments.	<ul style="list-style-type: none"> • Selection of best formulation on the basis of physico-chemical analysis. • Shelf life studies
4th Quarter	Optimization of selected formulations	<ul style="list-style-type: none"> • Shelf life studies • Compilation of data. • Publication

Name & Designation of Project Director:

Mr. Shahid Bhutto, PSO

Name & Designation of Project Associate(s):

Dr. Akhtar Shareef, PSO
 Dr. Nusrat Jalbani, PSO
 Ms. Rubab Fatima, SO
 Syed Arif Hassan Rizvi, JEO

Area(s) of Research:

Security Paper Counterfeit (Inorganic & Physical Chemistry)

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

Counterfeit banknotes are a significant issue in many economies, leading to financial losses for both individuals and businesses. To combat this problem, there is a need for reliable and easy-to-use tools that

can quickly identify counterfeit currency. One such tool is a banknote checker pen, which can help individuals and businesses verify the authenticity of banknotes on the spot. The development of an advanced banknote checker pen has the potential to significantly mitigate the risks associated with counterfeit currency. By leveraging advanced technology and rigorous testing, we aim to create a reliable and user-friendly solution that can be widely adopted by businesses and individuals. This project aligns with our commitment to innovation and addressing real-world challenges in the field of finance and security.

Fake currency note and cheque are one of the alarming problems in our country. The Government recently announce to introduce new currency notes to avoid the dissemination of fake currency note. But due to advancement of printing technology and availability of such technology at cheap cost made the printing of fake security paper easy for criminals. In this situation it is necessary to provide easy to use gadget/tool for masses to check the authenticity of security paper on the spot in real time.

The Banknote checker pen is already available in the market with sensitivity to change its color to yellowish brown on original security paper and to dark purple on fake security paper. But some time the change of color is medium and cause confusion for user. Similarly, the available pen only works on currency paper but is not suitable for cheque paper. Our invention will cover both currency and cheque paper by three-way checking steps. There will be two pen nips to produce two different colors along with UV light to check UV feature of the security paper. The primary objective of this project is to develop an advanced banknote checker pen that offers improved accuracy, reliability and user-friendliness compared to existing solutions by three-ways. The specific goals of the project include:

- Designing a pen-shaped device that is portable and easy to handle.
- Incorporating advanced counterfeit detection technology based on chemical reactions.
- Ensuring compatibility with various currencies, including polymer banknotes.

- Implementing user-friendly features such as visual indicators for authentication results.
- Conducting rigorous testing to verify the accuracy and reliability of the device.

Graphical Abstract:



Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	Conduct initial market research	Identify gaps and opportunities for innovation.
2nd Quarter	Review existing technologies and patents.	Develop initial product PEN proto-type
3rd Quarter	Review scientific literature on counterfeit detection technologies.	Test prototype for basic functionality.
4th Quarter	Study existing banknote authentication methods.	<ul style="list-style-type: none"> • Enhance design for usability and durability • Patent.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

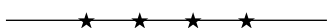
- Development of a highly accurate and reliable three-way banknote checker pen.
- Increased confidence among businesses and individuals in verifying the authenticity of banknotes & security papers (currency and cheque paper).
- Reduction in financial losses due to counterfeit currency.
- Improved convenience and ease of use compared

to existing counterfeit detection methods.

- Patent/Process Development

Achievements:

- 100% of the work has been completed. Three-way security pen prototype is ready to be commercialization.
- Patent application has been filed on 27-06-2025 with Patent Application No. 441/2025.
- Commercialization will occur if a suitable client shows interest in our end product in 2026.



Name of Laboratory/ Centre/ Unit:

CES/ PCSIR Labs. Complex Karachi

Title of Project: Watermark Development on Ordinary Paper Coupled with UV and Chemical Sensitivity

Name & Designation of Project Director:

Mr. Shahid Bhutto, PSO

Name & Designation of Project Associate(s):

Dr. Akhtar Shareef, PSO
 Dr. Nusrat Jalbani, PSO
 Syed Hassan Rizvi Arif, JEO
 Ms. Rubab Fatima, SO

Area(s) of Research:

Security Paper Counterfeit (Inorganic & Physical Chemistry)

Duration:

03 Years

Date of Initiation:

July, 2023

Project Brief:

Watermarking is a long-established paper industry technique for incorporating words, images and patterns into paper in an unobtrusive manner which does not

interfere with the use to which the paper is to be put but which indicates the origin of the paper or guarantees that it is genuine. Thus watermarking is widely employed in the manufacture of banknotes, security papers, Election balloting paper and high-quality branded or bespoke stationery for business or personal use. The uniqueness of watermark always attracts the client and give trustfulness on the process or product. It also guarantees the safety from fraudulent in the documents or forgeries. This project will result in development of unique watermark with two extra features making it almost impossible to be copied by anyone. By adding UV feature and chemical sensitivity the watermark security will increase by tenfold. Because of more than a Million permutation of its components.

Fake and forged documentation is one of key reason for fraudulent in our society. The document authenticity will reduce the easy printing of important documents to get innocent people get lotted or trapped and become victim of such fraud. This technology will improve the authenticity of document with strict security features to make each case unique and easy to detect the fake document.

The ordinary document could be processed to develop watermark and some chemical sensitivity feature along with UV features. This will be done with advanced technology and scientific approach to make the effect permanent. Such carefully developed paper will be utilized by different entities to ensure that their document is secure and no-one else can produce the similar document. This will enhance business trust, security and reliability.

The main objectives of present research work are given below:

- To develop a process for unique watermark on ordinary or thermal paper.
- To improve the security of watermark by adding UV feature to it.
- To make it impossible being copied by adding chemical sensitivity.
- Implementing user-friendly features such as visual indicators for authentication results.
- Conducting rigorous testing to verify the accuracy and reliability of the device.

Graphical Abstract:



Work Plan:

The development of the three-way banknote checker pen will involve the following key steps:

- Research on existing security /ordinary paper used for documentations.
- Identification of chemicals for counterfeit properties.
- Physical structure of the device.
- Identification of reliable entities to print their documents.
- Establish quality control processes.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of a highly accurate and reliable watermark development machine.
- Increased confidence among businesses and individuals in documents that represent financial or asset or any value.
- Reduction in financial losses due to fake documentation in the field of assets, finance and security.

Achievements:

- The 90% mechanical work has been completed. 135 chemical sensitivity experiments, 19 UV ink experiments and 81 watermark experiments were conducted. Among them 12 experiments were successful. Commercialization by mean of

providing services to different entities for printing of their secure paper will expect in 2026.



Name of Laboratory/Centre /Unit:

ESC/PCSIR Labs. Complex, Karachi

Title of Project: Designing and Fabrication of Salt Sprayer Test Chamber

Name & Designation of Project Director:

Engr. Adeel Ahmed Khan, SE

Name & Designation of Project Associate(s):

- Dr. Nighat Sultana, CSO
- Engr. Aman Ullah Lakho, SE
- Syed Kazim Raza, EO
- Mr. Muhammad Kamran, SO
- Mr. Tariq Mughal, Assistant

Areas of Research:

Metallurgical, Manufacturing, Automotive and Materials Engineering

Duration:

02 Years

Date of Initiation:

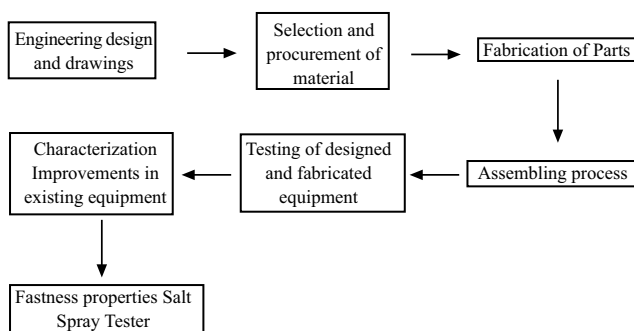
July, 2023

Project Brief:

Salt spray test chamber is equipment designed and developed for performing corrosion resistance tests on metallic parts. The test is performed by keeping the sample in salt sprayer chamber until white or red rust is produced by keeping the metal sample in foggy salt solution within the chamber. This test is used in automotive and manufacturing industry to ensure the quality of painted parts, nuts, bolts and fasteners for sustaining harsh environment and weather conditions. The proposed research proposal covers the need of industry to conduct test for checking resistance of metallic parts. After developing the testing facility

within our Lab, we will commercialize this product to the local market of manufacturing industry of sheet metal. The design of our equipment shall be able to conduct corrosion test according to the following methodology ISO 9227, ISO 9844 and ASTM B117.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

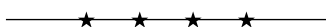
In-House

Tangible Outcome:

- To develop a functional prototype of Salt Sprayer Chamber in order to conduct the corrosion resistance test according to ASTM B117, ISO 9227 and 9844 methods.
- To become capable of manufacturing locally designed and fabricated unit of the salt spray chamber within the country by using the locally available indigenous parts.
- This equipment after fabrication will provide a corrosion testing facility for automotive industry and other industrial MS & SS Products.

Achievements:

- 2D and 3D engineering design and drawing of the equipment has been made.
- Selection and procurement of material preferably from local market has been done.
- Fabrication of outer body of PVC has been made.
- Material for electronic components has been procured.
- Internal rooster pump has been installed with required piping.



Name of Laboratory / Center/ Unit:

ESC/PCSIR Labs. Complex, Karachi

Title of Project: Formulation of Lumbrokinase Extracts through Spray Drying Encapsulation and Emulsification

Name & Designation of Project Director:

Dr. Nighat Sultana, CSO

Name & Designation of Project Associate(s):

Engr. Muhammad Ali Imran, SE
 Mr. Umais Ihsan, EO
 Mr. Tariq Bakshish, EO

Area of Research:

Herbal Drug Development

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

Earthworms have been used as a traditional medicine in China, Japan and other far East countries for thousands of years. Oral administration of dry earthworm’s powder is considered as a potent and active supplement for supporting healthy blood circulation. It has been used as a traditional medicine and food source that having many compounds with potential medicinal properties and have been administrated to treat inflammatory, hematological, oxidative and nerve disease. Earthworms also have antimicrobial, antiviral and anticancer properties. Lumbrokinase is a fibrinolytic enzyme that comes from the earthworm *Lumbricusbimastus*. Fibrinolytic enzyme is made explicitly to break down clotting in the blood and promote healthy heart, blood lung levels and this considered an antithrombotic agent. The preparation method of Lumbrokinase has the characteristics of good quality controllability and stability of the production process.

Encapsulation has been widely used in chemical, pharma and food industries to protect bioactive

compound from environmental conditions such as temperature and light. Encapsulation can be done by spray drying process involved atomizing extract dispersed in polymer solution into droplet by spraying, followed by rapid evaporation. In spray drying encapsulation, almost entirely, aqueous feed dispersion is used. Therefore, water solubility of coating material is of major importance. The extracts were formulated to powder through encapsulation by drying after removal of the solvent. The primary objectives of the present research work are as follows:

- Production of import substitute potential supplements by utilizing indigenous resources.
- To develop remedy for different pharmaceutical condition like inflammatory, hematological, oxidative and nerve disease, antimicrobial, antiviral and anticancer properties.
- To develop easily available and economical remedy by using our indigenous resources.

Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	<ul style="list-style-type: none"> • Source determination of Earth Warm • Taxonomical identification 	Hydrolization process carried out through water bath on temperature 70°C to 80°C under pH control using the enzyme acralas
2nd Quarter	Directly dry the earth warm and powdered by using the Oven and Sun heat.	<ul style="list-style-type: none"> • Filter and concentrate up to required protein (Brix). • Formulation of Lumbrokinase extracts through Spray Drying • Estimation of total protein • Estimation of Amino Acid profile will be carried out.

Quarter	1st Year	2nd Year
3rd Quarter	<ul style="list-style-type: none"> • Grinding, deslagging, salting-out, centrifuging, ultra-filtrating and Minced by using chopper machine or by hand. • Hydrolization process carried out through water bath on temperature 70°C to 80°C under pH control using the enzyme papain 	Microbiological studies and pharmacological studies will be conducted on the final product
4th Quarter	<ul style="list-style-type: none"> • Estimation of total protein • Estimation of fatty acid and Amino Acid profile will be carried out. 	Production of potential supplements

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of product.
- Lease out of Process to industry.
- To save foreign exchange of the country as substitute of import products.
- Utilization of indigenous material within the country thus promoting industrial growth of the country.
- Project will be beneficial for local pharmaceutical industries as the product develop with least side effects, economically bearable & easily approachable for a common man.
- Trainings & consultancies will be provided to clients & academia.
- Publications.

Achievements:

- The sourcing and taxonomic identification of earthworms have been completed.
- Total protein, fatty acid profile and amino acid profile were determined.

- The hydrolysis process using Papain and Alkylase enzymes has been conducted.
- Protein content determination up to 3.5 (without concentration) at different Brix levels using Papain enzyme.
- By studying the amino acids in our sample, we found 11 essential and 6 non-essential amino acids.
- Glutamic acid was the dominant amino acid, constituting 0.58% and Arginine was the second most abundant amino acid with 0.35% in our hydrolysate sample A.
- Sample B, which was the remaining portion from the separated hexane extract, showed that Alanine (0.79%) was the dominant amino acid, followed by Arginine (0.64%) as the second highest. Phenylalanine (0.58%) ranked as the third largest amino acid. In addition to these, Proline (0.49%), Isoleucine (0.44%), Lysine (0.40%) and Valine (0.39%) were also among the higher concentrations found in the Sample B profile.
- The paper is ready for submission for publication.



Name of Laboratory/ Centre/Unit:

CDLE/PC SIR Labs. Complex, Karachi

Title of Project: Design and Development of Micro Bacterial Incinerator (500-900°C)

Name & Designation of Project Director:

Mr. Sohail Akhtar, SSO

Name & Designation of Project Associate(s):

Mr. Aqeel Ahmed Khan, SSO

Engr. Ghulam Mustafa, SE

Mr. Zain ul Abdin, EO

Dr. Abid Karim, SSO

Mr. M. Mazhar, EO

Area(s) of Research:

R&D Organizations Laboratories and Universities

Duration:

02 Years

Date of Initiation:

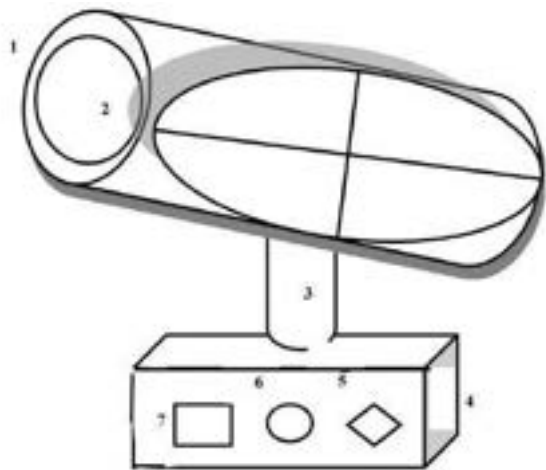
July, 2023

Project Brief:

Microbiological and clinical laboratories regularly strive through with infectious materials that needed sufficient disinfection, sterilization and disposed off utensils against germs. The choice of sterilization method depends on the nature of the object or substance being sterilized, the desired level of sterility and other factors such as material compatibility and cost-effectiveness. Heating under a Bunsen burner is the preferred method of sterilizing the metallic part of the inoculating loop and wire. But an abrupt splatter while heating under the burner can create aerosols with viable organisms, contaminating the experimental and working region. By destroying bacteria, incinerators help to prevent food borne illness. A micro bacterial incinerator is a possible substitute for sterilizing the loops, wire and metals like a needle and lancet. A Micro bacterial incinerator is laboratory equipment that uses heat produced by infrared rays to sterilize inoculating loops and needles from waste materials generated during laboratory procedures. The micro incinerator is based on the incineration principle (destruction by burning), where heating metal objects and organic matter is performed in the absence of oxygen. The main objective of the project is the Development of Micro Bacterial Incinerator (500-900°C). A micro incinerator is designed to safely sterilize metal inoculating loops and needles without using an open flame. The infrared heat inside the ceramic tube protects the laboratory technicians from dangerous gases, flames and splatters. The infrared sterilizer reaches optimum sterilization temperature (900°C + 50°C), the loop or needle is sterilized within 20 seconds. Sample inlet diameter would be is Φ25 mm and the depth of the heated area is 160 mm. The quartz tube (internal part of the barrel) is heated by the infrared rays provided by the electric element in the barrel after connection to the electric source. The temperature inside the loop/barrel is upto 900°C to incinerate the metal loop and needles. Since the loop/barrel is closed from all sides, the aerosols

generated during sterilization stay enclosed and disposed off inside the barrel.

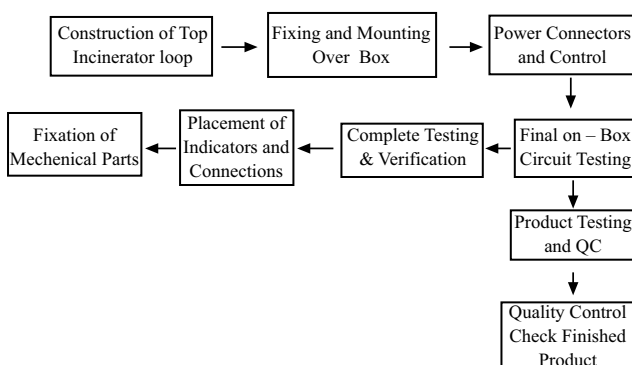
Graphical Abstract:



1. Loop./Barrel
2. Inlet(Φ)
3. Stand
4. Base and Control Box
5. Power Switch
6. Ready/Temperature
7. Set/Display temperature

Work Plan:

- Designing for Nosal and Holding System.
- Procurement of spares and parts.
- Heating Element and glass apparatus assembling and manufacturing
- Mechanical fixture and art work
- Fixation of panel and parts



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- To developed a low cost fully functional prototype model.

Achievements:

- Procurement of spares and parts.
- Designing & Assembly for Control Box.
- Designing of Nosal System.
- Heating Element and apparatus assembling and manufacturing.
- Mechanical fixture and screen printing (art work).
- Mountings of Parts for panel.
- Proto typing & testing.
- Work regarding functional prototype is under process.



Name of Laboratory/ Centre/Unit:

CDLE/PCSIR Labs. Complex, Karachi

Title of Project: Design and Development of Growth Chamber (Digital). (Temp Range: 0 to 50 °C) with Humidity Control and Day/Night Timer)

Name & Designation of Project Director:

Mr. Sohail Akhtar, SSO

Name & Designation of Project Associate(s):

Mr. Aqeel Ahmed Khan, SSO

Mr. Zain ul Abdin, EO

Area(s) of Research:

R&D Organizations, Laboratories, Institutes and universities.

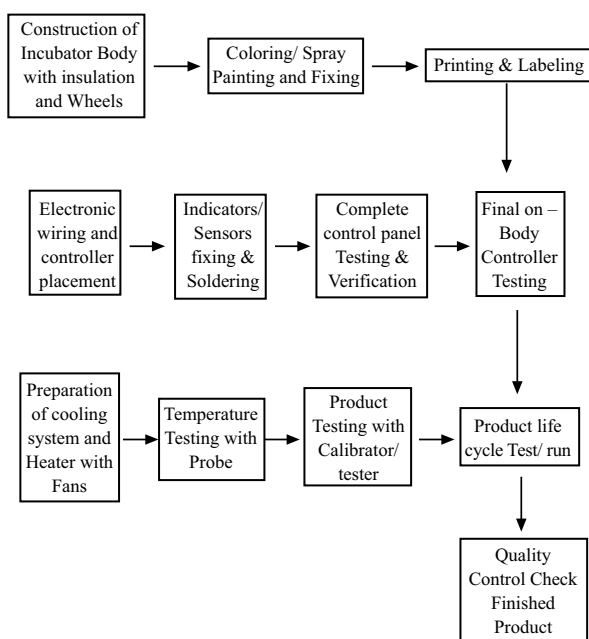
Duration:

02 Years (Extended for 01 Year)

Project Brief:

The objective of this project is to develop commercial products from local indigenous resources for local market and fabricates laboratory equipment on engineering lab scale with price reduction and import substitution. The Plant Growth chambers are designed to produce environmental conditions (humidity and temperature) that maximize plant growth. Growth Chambers are routinely procured by educational institutes, R&D organizations, production Industries etc., from various manufacturers. To fulfil their needs (in buying costly imported equipment), the development of Growth Chamber has initiated. Growth Chambers are used in agriculture and botanical research applications like plant pathology, seed germination studies, plant research (photosynthesis /nutrition studies) and plant tissue culture studies. They provide real time environmental conditions favourable for Plants. The design of equipment works with cooling systems, humidity controller, temperature and timer for proper operation. The instrument will work 24/7 a cycle.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In –House

Achievement:

- Procurement of spares and parts.
- Designing & Assembly of enclosure and Control parts.
- Build up Mechanical Structure and prototype Assembly.
- Cooling and Heating System installation.
- Developed all wiring connections. (With Procurement).
- Functionally ready Mechanical Structure and prototype Assembly.
- Stand by a prototype.
- Improvement in functionality and quality check in process.
- Some work regarding functional prototype is in process.



Name of Laboratory/ Center/ Unit:

CDLE/PCSIR Labs. Complex, Karachi

Title of Project: Exploring the Effectiveness of Generative AI Models for Diabetic Patients

Name & Designation of Project Director:

Engr. Ghulam Mustafa, SE

Name & Designation of Project Associates(s):

- Dr. ShahlaBasit, CSO
- Mr. Sohail Akhtar, SSO
- Mr. Zain-ul-Abedin, EO
- Mr. Muhammad Shahid Ansari, JEO
- Mr. Rehan Allaudin, TA

Area(s) of Research:

Artificial Intelligence, Diabetes Mellitus

Duration:

02 Years

Date of Initiation:

July, 2023

Project Brief:

Diabetes is rapidly spreading, affecting a significant number of adults, with a staggering total of 537 million diabetic individuals. This condition gives rise to various complications that can lead to diabetic retinopathy, foot ulcers, cardiac problems and kidney damage. However, many of these complications can be mitigated by providing patients with accurate information concerning their diet, stress management and weight control.

The recent advancements in Generative Artificial Intelligence-based chatbots have demonstrated their efficacy as intelligent assistants across various aspects of human life. In this study, we aim to assess the effectiveness of these Language Models in assisting patients. Our research plan entails the interaction between patients and chatbots like Chat GPT, both with and without human support, followed by evaluations of these interactions by specialists. Additionally, we will gather feedback from patients regarding their experiences and perceptions of the chatbot interactions. The main objectives of the present study are:

- To evaluate the efficacy of Generative AI-based chatbots in assisting diabetes patients.
- To assess patient-chatbots interaction.
- Gauge the accuracy, appropriateness and effectiveness of information provided by chatbots.
- Collect patient feedback to understand experiences and perceptions of chatbot interactions.
- Determine the potential of AI chatbots to enhance patient education and support in diabetes management.

Graphical Abstract:



Tangible Outcomes:

- Publication of research article based on the evaluation of Patient-Chat GPT interaction.
- Development of mobile phone based application based on tested models.
- Developing knowledge based method to cure Diabetic Patients.

Funding Source (PSDP/SGI/RD&I/ect):

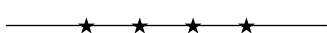
In-House

Achievements:

- Project has been evaluated by National Institute of Health in United States and has got approval for conducting research.
- NIH Reference Number: NCT05883072.
- Website link: <https://clinicaltrials.gov/ct2/show/record/NCT05883072>.
- Evaluated the Large Language Model i.e., Chat GPT in various hospitals and healthcare centers. These hospitals includes:
 - Al-Ibrahim Eye Hospital.
 - Fatimiyah Hospital.
 - OPD Clinic of PCSIR.
 - Diabetic patients’ camp.
- To conduct the study at Aga Khan Hospital, the research team completed multiple courses aimed

at deepening their understanding of ethical considerations when involving human participants. These qualifications were essential for obtaining ethical approval.

- In collaboration with the research team at Aga Khan Hospital, a comprehensive Patient Consent Form and Patient Feedback Form were meticulously designed to ensure ethical compliance and gather valuable insights.
- The study received ethical approval from Aga Khan Hospital and officially commenced at the Diabetic Clinic in the Najar Ali Walji Building. This research is led at Aga Khan by Dr. Qamar Masood, Head of the Diabetes Department.
- As of now, 48 patients have been enrolled, with recruitment actively ongoing to expand the study further.
- Simultaneously, work has begun on the development of a mobile application designed to assist diabetic patients in managing their daily health queries. Powered by AI-driven responses, this app aims to serve as an intelligent diabetes education tool. With potential commercialization through PCSIR, it represents a promising AI-powered solution for diabetic patient support and education.



Name of Laboratory/ Center/ Unit:

FMRRRC/PCSIR Labs. Complex Karachi

Title of Project: Phenotypic and Genotypic Traits of Lactic Acid Bacteria (LAB) in Fermented Foods & their Potential to Use as Probiotic Formulation

Name & Designation of Project Director:

Dr. Zulfiqar Ali Mirani, SSO

Name & Designation of Project Associate(s):

Dr. Abdul Basit Khan, PSO

Dr. Muhammad Naseem Khan, SSO

Mrs. Anila Siddiqui, SSO

Area of Research:

Microbiology

Duration:

1½ Years

Date of Initiation:

July, 2024

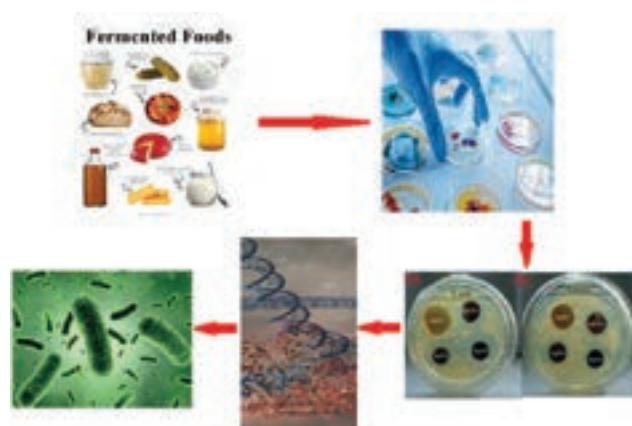
Project Brief:

Fermentation has long been employed as a traditional method for preserving and enhancing various food products. These fermented foods offer numerous health benefits, including improved digestion, fostering a diverse gut microbiota, enhancing nutrient absorption and bolstering the immune system. Across diverse ethnic culinary traditions, including those in Karachi, fermented foods play a significant role. These foods are associated with beneficial microorganisms that contribute to their nutritional value. Inhabitants of the Sindh region, particularly in Karachi, regularly consume a variety of locally fermented foods, such as yogurt, cheese, milk, Lassi and pickles. These fermented items are not only valued for their nutritional content, but also for their functional and probiotic properties. Studies have shown that they can help protect against foodborne illnesses. Probiotics, which are beneficial bacteria consumed in adequate amounts, have been found effective in addressing various health conditions, including diarrhea, Helicobacter pylori infections, inflammatory bowel disease and urinary tract infections. Lactic acid bacteria (LAB) are a prominent group of bacteria widely used in food, dairy, probiotic and beverage production. They are Generally Regarded as Safe (GRAS) and possess characteristics that make them suitable for such applications. LAB play a crucial role in fermentation, dominating the microflora in fermented products and contributing to their preservation

by producing compounds like lactic acid, acetic acid, hydrogen peroxide (H₂O₂), bacteriocin, diacetyl and carbon dioxide (CO₂). Despite the widespread consumption of fermented foods in Karachi, there is a lack of research on the microflora present in these foods and their potential health benefits. Key questions to be addressed include whether the consumption of fermented foods in Karachi results in a diverse array of lactic acid bacteria species, which LAB strains are primary contributors to specific indigenous fermented dishes, whether there's a relationship between isolated LAB strains and their probiotic properties and whether these strains can serve as starting cultures for commercial fermented product manufacturing. The core objectives of the present study are:

- Isolate Lactic Acid Bacteria (LAB) from different fermented food products in Karachi.
- Utilize genotypic and phenotypic traits for the identification and categorization of isolated LAB strains.
- Evaluate the potential probiotic qualities of the isolated LAB strains.
- Assess the antibacterial efficacy of the isolated LAB strains against food borne pathogens.
- Examine the functional characteristics of the isolated LAB strains for potential industrial applications.

Graphical Abstract:



Quarterly Work Plan:

Quarters	1st Year	2nd Year
1st Quarter	Collection of fermented food items and analysis for LAB	Antimicrobial activity against food borne pathogens
2nd Quarter		Antibiotic susceptibility against antibiotics
3rd Quarter	Evaluation of probiotic potential	DNA extraction and PCR amplification of LAB genes
4th Quarter	Antimicrobial activity against food borne pathogens	Report and manuscript writing

Funding Source (PSDP/SGI/RD&I/ect):

In-House

Tangible Outcome:

- Identification of LAB strains with desirable characteristics can lead to the development of novel starter cultures for commercial fermented food production. These cultures could improve product consistency, shelf life, flavor and texture.
- The project may identify LAB strains with specific probiotic properties or bio-functional activities (e.g., antimicrobial properties). These strains could be used as functional food ingredients, enhancing the nutritional value and health benefits of commercially produced foods.
- If isolated LAB strains demonstrate strong probiotic potential (e.g., bile and acid tolerance, antagonistic activity against pathogens), they could be developed into probiotic supplements. These supplements could benefit gut health, immune function and potentially address specific health conditions.
- The project's findings can raise awareness about

the diverse LAB species present in Karachi's fermented foods. This knowledge can encourage the consumption of these traditional foods for their potential health benefits.

- The research findings are likely to be published in scientific journals, contributing to the global knowledge base on LAB diversity and functionality in fermented foods.
- The project can provide training opportunities for researchers and students in food microbiology techniques, potentially leading to a more skilled workforce in the food science sector.

Achievements:

- Conducted an in-depth characterization of the lactic acid bacteria (LAB) isolates that were recovered.
- The focus was on assessing LAB tolerance to various environmental conditions, including acidic pH, NaCl concentration and bile salts.
- A total of 25 samples were collected and lactic acid bacteria were successfully recovered and identified.
- Preliminary results indicate that 70% of the tested isolates exhibited significant growth at pH 3.0 and 4.0, while growth was inhibited at pH 2.0 for most isolates. It was observed that around 60% of isolates demonstrated robust growth at 2%-6% NaCl, while growth significantly declined at 8% and was completely inhibited at 10% NaCl. The bile tolerance test was also performed and it was found that approximately 65% of the isolates showed substantial growth at 0.3% bile salt concentration, while survival rates decreased at 0.5%. The results indicate that a significant proportion of the isolates demonstrate good tolerance to acidic conditions, moderate NaCl concentrations and bile salts. The most promising isolates will be selected for further genomic and functional analyses in the next quarter. Future work will include probiotic potential assessment, antibiotic susceptibility testing and possible strain identification through molecular techniques.



Name of Laboratory/Centre/Unit:

FMRC/PC SIR Labs. Complex Karachi

Title of Project: Production of Microbial Protein as an Alternative Source for Animal Feed

Name & Designation of Project Director:

Dr. Muhammad Asif Asghar, SSO

Name & Designation of Project Associate(s):

Dr. Farman Ahmed, PSO

Area(s) of Research:

Animal / Poultry Feed Industries

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

One of the most prominent aspects of the global population is its rapid expansion, resulting in enormous pressure on global resources and the environment. Furthermore, there have been significant changes in the global animal feed price which will impact the price of animal agriculture. The feed cost accounts for 60–70% of total livestock production costs and there is an increasing reliance on soybean meal and fish meal for protein supply in feeds. To date, the rising costs of protein feed ingredients have largely been experienced by livestock, poultry and aquaculture producers, often with significant financial loss. However, higher costs of production have to be reflected in higher prices for meat and eggs. Consequently, the issues of alternative protein feed sources have generated as public concern.

To address these deficiencies, advancements in agriculture, distribution and food security initiatives are required. Different approaches are available for alternative sources of protein such as plant-based proteins, cultured meat, edible insects and the most demanding microbial proteins (MPs). MPs refer to the type of microbial biomass that can be used as a source of protein for the human and animal consumption. MPs

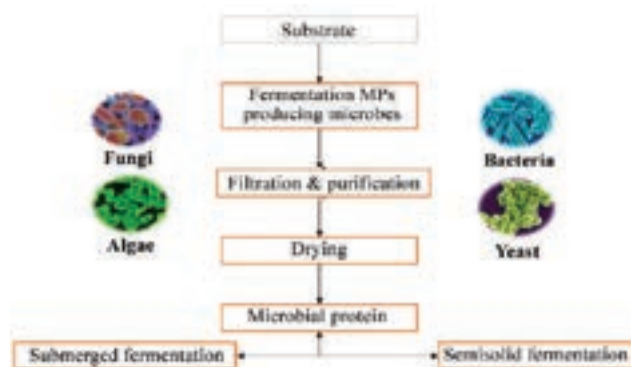
are produced by growing microorganisms, such as bacteria, yeast and algae by fermentation process on various substrates like agro-industrial wastes and industrial by-products. It has several applications regarding high protein content, resource utilization and reducing environmental impact as compared to traditional protein. Aside from the nutritional benefits of MPs, other advantages of microbial protein technology are:

- Throughout the year production.
- It plays a role in waste management as waste materials are used as substrate.
- Small area of land is required and is made in less time.
- Helpful to manage the food and feed crisis.
- Cultivation of MP on the one hand provides alternative substrates and on the other hand helps in solving problems of disposal caused during the process.

In addition, solid waste pollution is a significant environmental concern and its improper disposal and management can cause severe environmental problems. However sustainable MPs production offers a promising solution due to utilizing of waste streams from various sources by converting them into protein. The objectives of present study are:

- To produce the MPs from selected microbial strains.
- To utilize the different fruits and vegetable wastes as a substrate.
- To help solve modern waste disposal problems.
- To optimize the production protocol of MPs.
- To overcome the protein deficiency in animal feed and also help full to improve the protein contents of animal feed.

Graphical Abstract:



Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	Isolation, identification and characterization of suitable microorganisms	Optimization of the substrate
2nd Quarter	Substrate (fruits and vegetable waste) collection and preparation	Collection of microbial protein
3rd Quarter	Fermentation and optimization of the process	Estimation of biomass and protein content
4th Quarter	Harvesting	Application of harvested protein as a supplement in animal diet

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Cost effective technology for MPs production and processing will be developed at national level.
- Bio plants/ Bioreactors can be installed in areas where they are needed most to cope the deficiency of essential nutrients at reasonable cost.
- Entrepreneurs may be attracted to this new business.
- A convenient and excellent Quality Protein may be produced for food and feed purpose of human and livestock, poultry and fish.
- Eye catching and fruitful business for small capital investors.

Achievements:

- Fermentation and optimization process of the microbial protein has been performed.



Name of Laboratory/Center/Unit:

FMRC/PCSIR Labs. Complex Karachi

Title of Project: Bio-control of Banana Wilt Disease Caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) Using Marine Microbial Sources

Name & Designation of Project Director:

Dr. Muhammad Naseem Khan, SSO

Name & Designation of Project Associate(s):

Dr. Abdul Basit Khan, PSO
 Dr. Zulfiqar Ali Mirani, SSO
 Dr. Beena Naqvi, PSO

Area of Research:

Microbiology

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

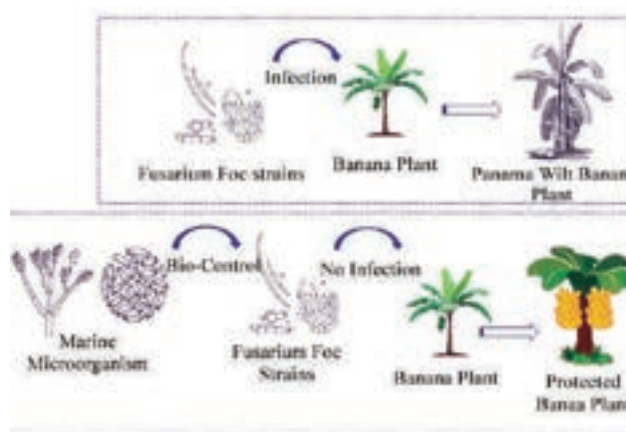
Banana is a vital food crop and a primary source of income for millions of farmers worldwide. However, it faces significant challenges, with disease being a major concern, particularly in subtropical regions where banana cultivation is prevalent. Diseases can directly reduce banana production, quality and shelf life, or indirectly harm plant health, affecting fruit yield. Panama wilt, caused by *Fusarium oxysporum* f.sp. *cubense* (Foc), is highly virulent and destructive, posing a substantial threat to 'Cavendish' banana cultivars and potentially endangering banana production globally. The devastating impact of this disease has been observed in various parts of the world, as evidenced by its eradication of banana crops. In Pakistan, where the Panama disease was first reported in 2015, the lack of effective management strategies has allowed this lethal disease to continuously devastate banana production, particularly in Sindh. Recent surveys have revealed varying disease incidences across eleven districts, indicating a pressing need for intervention.

Fusarium wilt in bananas is among the most destructive diseases, presenting a significant threat to

the global banana industry, with no effective control measures currently available. Marine microbes represent a rich source of metabolites, with globally recognized antimicrobial properties. Utilizing these microorganisms in banana plants holds promise for controlling banana wilt disease. The core objectives are:

- To isolate *Fusarium oxysporum* f. sp. *cubense* (Foc) from infected banana samples.
- To identify the fungi through microscopic, morphological and molecular methods.
- To assess the antagonistic activity of marine microbes against *Fusarium oxysporum* f. sp. *cubense* (Foc) strains.

Graphical Abstract:



Quarterly Work Plan:

Quarters	1st Year	2nd Year
1st Quarter	Isolating <i>Fusarium</i> strains from infected plants	Screening anti-fungal activity of marine isolates
2nd Quarter	Molecular Identification of <i>Fusarium</i> strains	Conducting morphological and microscopic identification of potential anti-Foc marine isolates
3rd Quarter	Gene specific confirmation	Performing molecular identification of potential anti-Foc marine isolates

Quarters	1st Year	2ns Year
4th Quarter	Screening antifungal activity of marine isolates	Report and manuscript writing

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Method development for the identification of *Fusarium oxysporum* f. sp. cubense tropical race 04.
- Selection of potential anti-Foc biocontrol agents to mitigate the spread of the disease in Pakistan.

Achievements:

- With the collaboration of Sindh Agriculture University Tandojam, multiple infected banana plant samples have been successfully collected from banana fields across various districts of Sindh. These districts include Hyderabad, Badin, Thatta, Tando Allahyar, Tando Muhammad Khan, Khairpur, Matiari, Sanghar, Naushero Feroz and Badin. A total of 31 *Fusarium* samples have been collected from diverse locations, ensuring representation of the affected banana crop areas.
- *Fusarium* strains were successfully isolated from infected banana plants collected from different districts of Sindh. Preservation and maintenance of isolates are ongoing for further analysis.
- DNA extraction from *Fusarium* strains has been completed. PCR protocols have been optimized for molecular identification. Gene-specific amplification is in progress, focusing on key *Fusarium*-associated genes for precise classification.
- Reviving marine microbial sources for potential antifungal activity is underway. Initial culture preparation of marine isolates has been performed for further screening.

Bottleneck:

- Some *Fusarium* isolates required multiple DNA extraction attempts due to low DNA yield.
- Reviving marine microbial sources for antifungal

screening is time-intensive, requiring additional refinement of culturing conditions.



Name of Laboratory/ Centre/Unit:

Food and Marine Resources Research Centre/
PC SIR Laboratories Complex, Karachi

Title of Project: Development of Dietary Protein Hydrolysates and their Application in Nutraceutical Drinks/Functional Food

Name & Designation of Project Director:

Dr. Asad Ullah, SO

Name & Designation of Project Associate(s):

Dr. Muhammad Samee Haider, PSO
Mrs. Nida Saleem, SSO
Mr. Umeed Ali Soomro, SSO
Mr. Waqas Afzal, SO

Areas of Research:

Protein Hydrolysates, Bioactive Peptides and Amino Acids, Food Application of Hydrolysates

Duration:

02 Years

Date of Initiation:

2024

Project Brief:

Protein hydrolysates (PHs) have vast application in food and agriculture. Hydrolysates of proteins have advantage to easily be absorbed and utilized for various metabolic activities rather than their respective whole proteins. Numerous researches in the last few decades have described that protein hydrolysates from several food sources, in addition to their nutritional properties, showed many biological functional effects including antioxidant, antimicrobial, hypotensive, anticoagulant, cholesterol-lowering ability, hypoglycemic effect, antitumor activity, etc. Such functional properties are related with their biopeptides, of 3–50 amino acid residues in length, present in the protein hydrolysates.

Hydrolysis of proteins by various method can increase solubility and lead to the formation of bioactive peptides, as well as other physicochemical properties.

Fish protein hydrolysate (FPH) is well-known good nutritional supplements as their bioactive ingredients can simply be absorbed. Similarly, the enzymatic hydrolysates of whey proteins (WPHs) have more functional characteristics in food applications compared to intact whey proteins. Soy protein hydrolysates (SPHs) are produced from soy proteins by various methods and such methods have different effects on the property of educed hydrolysates. SPHs are important in the food industry due to their functional properties including gelling, emulsifying and water-holding properties. Protein hydrolysates offer high potential in different diets and nutritional effects. They are tremendous digested protein sources for human nutrition and physiological functions, as they are simply absorbed in the gastrointestinal tract more effectively than their native protein. Therefore, they are suitable for the production and fortification of elderly, infants and patients (allergic, digestive issues, liver disease, etc.) foods.

There are no reliable industries for the production of protein hydrolysate in Pakistan. According to the import data of “Volza’s Pakistan” Pakistan imports most of the protein hydrolysate powder from India, Hungary and United States. Top three protein hydrolysate powder product categories of imports in Pakistan are under the HSN Code of 35040099, 35040000 and 35040010. Therefore, the developed protein hydrolysates and their products would be good import substitutes.

The technical informations are as follows:

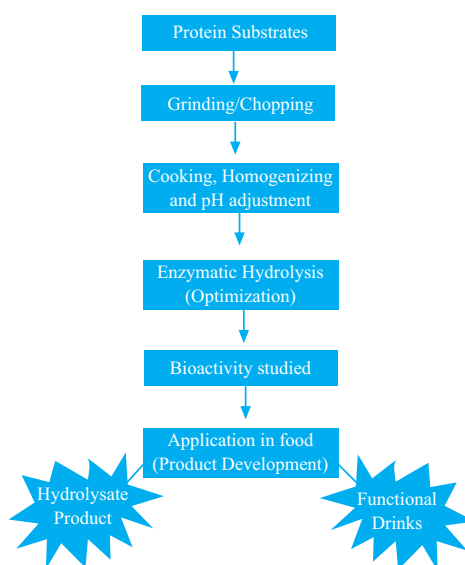
- Protein hydrolysates and peptides with notable biological properties are produced widely through the use of proteolytic enzymes.
- Paralleled to chemical treatments, an enzymatic proteolysis method is an appreciated method to prepare protein hydrolysates, due to the milder conditions the process requires and does not produce unwanted chemical impurities.
- Spray drying and freeze drying technologies will be under study for the hydrolysate powder formation.

- Quality evaluation of protein hydrolysate will be conducted through amino acid analyzer.
- Accelerated shelf-life study will be under taken for product stability.

Objectives:

- To utilize the trash fish, dairy waste (whey) and Agri-waste (soy meal) for the production of protein hydrolysate powder.
- To produce hydrolysates with characterized biological properties.
- As product, protein hydrolysate powder will be made from selected biologically active hydrolysate (having essential and branched-chain amino acid and bioactive peptide).
- To prepare ready-to- use hydrolyzed protein based nutraceutical drinks/functional food.

Graphical Abstract:



Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	Optimize protein hydrolysis condition	Functional drinks will be developed from Protein hydrolysate
2nd Quarter	Determine the amino acid and bioactive peptide profile.	Continues as 1st quarter

Quarter	1st Year	2nd Year
3rd Quarter	Study the bioactivities of hydrolysate and bioactive peptide	Composition of developed drinks will be determined.
4th Quarter	Food grade protein hydrolysate powder will be produced	Shelf life study of developed products

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

- Process/technology development of Protein hydrolysate powder.
- Product development of Nutraceutical food/ beverage drinks using protein hydrolysate powder.
- Publications and patents.
- Beverage, Confectionery and Nutraceutical food industries will be the main beneficiary.

Achievement:

- During the first quarter, hydrolysis conditions for whey protein substrate were optimized using commercially available alcalase enzyme.
- A univariate approach was employed to assess the effects of substrate-to-enzyme ratio, pH, enzyme concentration, temperature and digestion time.
- Protein hydrolysis was evaluated by measuring initial and final Brix levels hydrolyzed solution.
- In the current quarter, the hydrolysis of soy protein was systematically optimized using response surface methodology (RSM). In the RSM optimization approach, two enzyme sources alcalase and papain juice were compared based on key hydrolysis factors, including substrate-to-enzyme liquid ratio, enzyme concentration, temperature and incubation time.
- The systematic optimization process for soy protein is completed and the amino acid profile at the final optimized conditions was analyzed to identify the most effective hydrolyzing enzyme source for further studies.

Name of Laboratory / Centre/ Unit:

FMRC/PCSIR Labs. Complex Karachi

Title of Project: Establishment of *Ganoderma lucidum* (Reishi) Farming Technology and Production of Pure Seeds as Product

Name & Designation of Project Director:

Dr. Sofia Qaisar, SSO

Name & Designation of Project Associates:

Ms. Anila Siddiqui, SSO

Area(s) of Research:

Mycology, Biotechnology

Duration:

02 Years

Date of Initiation:

July, 2023

Project Brief:

Ganoderma lucidum (Reishi) is a medicinal mushroom and Ancient Chinese physicians discovered the multiple properties of Reishi and it has been used for centuries to promote health, combat cancer and reduce causes of cardiovascular disease and longevity, which earned Reishi the title, “Mushroom of Immortality”. Indoor culture/farming of Reishi is an opportunity for cottage industry especially for youth and woman to earn their livelihood so agricultural land would not be burdened.

Pakistan has also a big demand for mushrooms but continuous supply is still absent and this demand has been fulfilled through import from different countries. Reishi based imported products are also being marketed and sold in the country. Mushroom production is very limited due to unavailability of quality spawn material and unskilled labor. Mushrooms-expected to have fastest growth in global market. Asia Pacific is expected to hold highest market share in future. Pakistan also has plans for CPEC to increase business and Industry in the country, wherein, the mushrooms and medicinal



mushrooms farming could contribute its part in current scenario. Herein the cultivation of this medicinal miracle is the basis of this project. Objectives are:

- Establishment of Reishi mushroom cultivation/ farming module.
- Production of pure seed.

- Pure seeds of mushroom.
- Biomass of said mushroom.

Achievements:

Pure seed of Mushroom has been developed.



Quarterly Work Plan:

Quarter	1st Year	2nd Year
1st Quarter	Literature review, isolation	Optimization of physical conditions needed for mushroom growth
2nd Quarter	Purification	Growth trials for selected species
3rd Quarter	Optimization for spawn development	Augmentation of substrates to increase harvest (mushroom edible body)
4th Quarter	growth room preparation	Write up for process/technology, paper.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcomes:

- *Ganoderma lucidum* (Reishi) farming technology.

Completed Project

Title of Project	Achievements
Development of Embedded Software for Blood Collection Monitor	<ul style="list-style-type: none"> • Embedded Software in C-Language has been successfully developed and deployed in the Microcontroller-Chip. The software performs following operations: • Diagnostic of Product (Blood Collection Monitor) on every startup, which include checking of shaking tray (motorize), blood-tubing clamp (motorize), Calibration parameters. • Monitoring and control of Blood Volume to be collected with accuracy of +/-5mL. • Shaking of Blood bag during collection to avoid clotting in blood. • Monitoring of Needle (Blood Collection) and tubing for any leakage or blockage, in such case the software generates alarm and halt collection. • A patent has been filed entitled: “Fault-Tolerant Controller for Blood Collection Machine (FTCBCM)”in June, 2024.
IoT Based Lab Monitoring and Control System	<ul style="list-style-type: none"> • Device for Monitoring and Data logging of Temperature, Humidity, Light-intensity and Smoke has been completed (Prototype). It is based on ESP-32 Embedded System. Software in C++, Ting Speak and Blink IoT plate form has been completed and tested. • Device for Instrument (Furnace) control, status and power consumption has been completed (Prototype).
Development of Digital Fundus Images Dataset for Artificial Intelligence Based Model Development and Performance Testing	<ul style="list-style-type: none"> • Ethical approval of study from Al-Ibrahim Eye Hospital. • Printing of Patient consent forms for participation in research. • Enrolled 1100 patients in the study. • Collected data of digital fundus images from hospital. • Developed five FCPS doctors' team specialized in diagnosing diseases via Retinal Photograph. • Received 5,000\$ credit from Amazon Web Services to perform computational work. These credits were utilized in various tasks related to Computational powers including; <ol style="list-style-type: none"> i. Sharing Retinal images on Cloud. ii. Labeling of Fundus Images. iii. Utilizing latest Preprocessing techniques to improve the image quality of Digital Fundus Photograph. • Labeled 300 images by four doctors. • Clinical Study Approval and Grant Acquisition: The clinical study received approval from the National Institute of Health (NIH) in the USA. (https://clinicaltrials.gov/study/NCT06287645) and was awarded a \$6,200 grant from Amazon Web Services. The grant supported the development of advanced techniques to remove noise from digital fundus images, significantly enhancing image quality.

Title of Project	Achievements
	<ul style="list-style-type: none"> • International Collaboration and Dataset Completion: An MoU with Tongji University of Shanghai, China, was finalized and submitted to the Ministry of Science and Technology for approval, fostering international collaboration. Additionally, the labeling of all 1,100 fundus images was completed, marking a significant milestone in dataset preparation. • A research article co-authored with Chinese counterparts, focusing on innovative noise removal techniques from fundus images, has been drafted and is being prepared for submission to a prestigious journal.
Method Development of Highly Potential Herbal Extract for Various Herbal Formulations and Screening of Herbs Extract for Pharmacological Activities	<ul style="list-style-type: none"> • Product developed of specific Herbal Tea for medicinal purpose, Nausea, headache, dizziness. • Formulation of Anti- Anxiety Herbal Tea for Anxiety Patient was developed. • Production of potential herbal extracts/ powder was provided to client M/s. Hamdard Lab, Karachi. • A process has been developed for the preparation of HISBISCUS/ FENNEL Tea in the form of infusion, can be used for flu. • A process developed for the preparation of lemon grass/cinnamon Tea in the form of infusion, can be used for flu. • A process developed for the preparation of moringa powder. • A process developed for the preparation of aloe vera gel from aloe vera plant. • The Patent Title “Preparation of Anti-Anxiety Herbal Tea” has been submitted to Patent Office.
Improving the Performance of Edible Food Packaging Films using Nanocellulose as an Additive	<ul style="list-style-type: none"> • Cellulose has been extracted from the agricultural bio-waste material. • The extracted cellulose has been converted into nano-cellulose (CNC). • The characterization of the extracted CNC has been performed using FTIR, SEM, EDX and XRD techniques. • The food packaging film has been produced using the synthesized CNC incorporation in polymer-based material. • The physical properties such as color, thickness, moisture-retaining capability, swelling index, solubility and biodegradability of the produced film have been tested. • The mechanical properties such as tensile strength, elongation at break and Young’s modulus of the produced film have been tested. • It is expected that such derived CNC-based film can be a good addition to the packaging industry for the development of multi-functional biodegradable packaging materials.

Title of Project	Achievements
Designing & Fabrication of Portable Ultrasonic Humidifier for the Cultivation of Mushroom in Agri-Lab	<ul style="list-style-type: none"> • Body controller testing completed. • Achieved the efficiency of ultrasonic transducer pad at 1L humidity/hour. • Prototype Humidifier Developed.
Exploration of <i>Rumex dentatus</i> for Potential Anti-inflammatory and Analgesic Skin Application	<ul style="list-style-type: none"> • 6 Kg of aerial parts of <i>Rumex dentatus</i> were collected from Swat region. The aerial parts of the plant were shade dried to yield 3.4 Kg plant material. The plant was grounded to powder form for extraction. • The hexane and ethanolic extracts were tested for analgesic and anti-inflammatory activity in experimental laboratory animals (Albino rats and mice). Both extracts showed significant results (>70 %). • The ethanolic extract was incorporated to develop analgesic gel-like ointment. • The developed formulation was tested for analgesic and anti-inflammatory activity in experimental laboratory animals (Albino rats and mice) and showed comparable results with commercially available ointments. • QC parameters have been developed for the ointment. • The patent is under drafting • Process will be available for commercialization after patenting.
Soluble Fertilizer Formulations of Organo metallic Complexes for Foliar Feeding	<ul style="list-style-type: none"> • Process developed for Chelated Liquid Potash. • Supplied 2200 liter of Chelated Potash to M/s. STEDEC. • Process leased out. • ILD/Process Imp./2024-34478, Chelated Liquid Potash Fertilizer is leased out to Al-Haider Agro Industries (Pvt.) Ltd. at the charges of Rs. 60,000/=.
Fungal Biosynthesis of Skin Lightening Agent: Kojic Acid and Evaluation of its Non-cytotoxic Character Using Animal Tissue Culture Technique	<ul style="list-style-type: none"> • Kojic acid has been extracted successfully from <i>A. Flavus</i>. • Kojic acid was precipitated. • Non cytotoxic kojic Acid with Anti-bacterial, Anti-Oxidant and Anti-tyrosinase activity has been synthesized’. • Process of kojic acid production was developed.
Production of Polyphenol Oxidase from Bluemold Specie for Potential Application in Bioremediation of Phenolic Compounds	<ul style="list-style-type: none"> • Partially purified Phenol oxidase enzyme was produced from blue mold. • Immobilization of polyphenol oxidase. • Patent Submitted. • Bioremediation of textile dyes by immobilized poly phenol oxidase.
Investigation of Corrosion in an Implant Medical Devices using Modern Techniques	<ul style="list-style-type: none"> • Identification kit has been developed that support the manufacturer for selection of quality stainless steel of SUS 304 and SUS 316. • Shelf life or stability studies are under progress utilizing various steel plate surfaces to evaluate the product efficacy.

Title of Project	Achievements
	<ul style="list-style-type: none"> • Developing of test method as per ASTM F2129-01 under process. • Patent will be filed after successful stability studies.
Evaluation of Hepatoprotective Effect of Medicinal Plants (<i>Moringa Olifera</i> & <i>Glycyrrhiza Glabra</i>) in Animal Model	<ul style="list-style-type: none"> • Hepatoprotective formulation has been developed. • The polyherbal formulation demonstrated significant hepatoprotective effects (70%), which is comparable to the standard market drug silymarin's hepatoprotective effects (77%) in an animal model (albino rats) at a dose of 400 mg/kg. • Paper is under compilation. • Product is ready for commercialization.

PCSIR Laboratories Complex, Peshawar

Name of Laboratory/Centre/ Unit:

FTC /PCSIR Labs. Complex, Peshawar

Title of Project: Development and Nutritional Assessment of Herbal-Based Energy Drink as Import-Substitute

Name & Designation of Project Director:

Dr. Abdul Wajid Khalil, SSO

Name & Designation of Project Associate(s):

Dr. Arshad Hussain, PSO
 Dr. Humaira Inayat, SSO
 Dr. Rehman ullah, SO
 Mr. Muhammad Saddique, Jr. Engr.

Area(s) of Research:

Food Science Industry and Nutrition

Duration:

01 Year

Date of Initiation:

2025

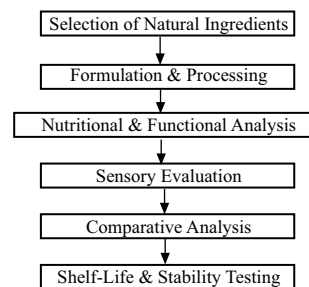
Project Brief:

Energy drinks are widely consumed for their perceived ability to enhance alertness, stamina and physical performance. In Pakistan, the majority of these beverages are imported, leading to high market prices and reliance on foreign suppliers. The energy drinks market in Pakistan is expected to grow quickly, increasing by about USD 209.4 Million, with an annual growth rate of around 11.8%. The main reason for this growth is the rising demand among young people. According to the World Health Organization (WHO), global consumption of energy beverages in 2013 surpassed 5.8 Billion liters across around 170 countries. This project focuses on the formulation and development of a locally manufactured substitute for imported energy drinks, aiming to reduce costs, promote self-reliance and utilize locally available Plant based herbs while ensuring quality, safety and consumer acceptance in line with international standards.

Pakistan’s energy drink market is dominated by expensive imported brands. Demand is growing,

especially among youth, athletes and those seeking quick energy. However, there is a shortage of locally made products that are equivalent to imported products in terms of sensory attributes, physicochemical quality and functional efficacy. This study aims to develop and evaluate a locally produced energy drink as a functional alternative to imported products. Locally available natural ingredients like Guarana (*Paullinia cupana*), Ashwagandha (*Withania somnifera*) and Rhodiola (*Rhodiola rosea*)—will be used to replace synthetic stimulants such as caffeine, taurine and ginseng. The formulation will be optimized for desirable sensory characteristics (taste, aroma, color) and physicochemical parameters, including pH, °Brix, titratable acidity, caffeine content and carbonation level. Laboratory analyses will assess physicochemical properties, quantify active compounds, evaluate shelf-life stability and conduct microbiological testing in accordance with Codex Alimentarius, WHO and PSQCA standards. The primary objective of this study is to develop and evaluate a locally manufactured energy drink as an import substitute, utilizing natural herbs (*Guarana, Ashwagandha, Rhodiola*).

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Market survey of the available energy drink & detailed nutritional evaluation of the product 	Development and Optimization based sensory and nutritional evaluation	Stability and Shelf-Life Study	<ul style="list-style-type: none"> Develop packaging and labeling Pilot production Commercialization/ marketing/ Process lease out

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> Procurement and preliminary evaluation of locally available natural ingredients (Plant based herbs like <i>Guarana</i>, <i>Ashwagandha</i>, <i>Rhodiola</i>). 			

Year of Initiation:

2025

Project Brief:

Diet drinks are calorie-free and low-calorie drinks, which do not include 100% fruit juices and other unsweetened beverages. Diet beverages, often known as health drinks and marketed as diet refreshments since 1952, are quickly becoming an important part of partying subculture among all age groups with the help of appealing advertisements. There is an increased hike in the demand for diet (health) drinks in recent years, owing to increased awareness, socioeconomic status and nutritional lifestyle changes, among other factors. Because of changing trends toward a healthier lifestyle and the availability of disease-specific products, numerous new brands of low sugar or sugar-free diet beverages have been introduced for persons with diabetes and other health-conscious people. Fruit-based diet drinks are currently lacking in the market and they should be researched in the coming future with the goal of providing end users with the health benefits of fruits as well as normal ingredients (chemical-based ingredients replaced with natural ingredients) of diet drinks. However, to date, no attempt has been made by the researchers in the development of fruit-based diet drinks. This sector requires the attention of researchers and industrialists to provide complete healthy diet beverages to consumers. To fulfill their research gap, the present study aimed to develop a fruit-based diet drink using all the natural ingredients. Most conventional functional beverages, such as energy drinks, sports drinks and fruit beverages, are sweetened and contain significant amounts of sugar and hence, consuming them can potentially increase the risk of diabetes, obesity and heart disease. The low-calorie diet drinks are entering into a new era as preferred by different age groups. Using non-nutritive-high intensity sweeteners such as sucralose can meet consumer demand for no/low-sugar content products aimed at obesity prevention, weight control and diabetes management. The development of fruit-based diet drinks will open a new door to the researchers and the diet drink industry with the synergetic health effects of fruits and other ingredients like herb extract owing to the nutraceutical potential health benefits. Pakistan imports different types of ready-to-drink fruit juices. Fruit juice products represent an important category of international trade. According to Pakistan

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

- Process.
- Product development.

Achievements:

New Project



Name of Laboratory/Center Unit:

FP&QCRC/PCSIR. Labs. Complex, Peshawar

Title of Project: Development of Import Substitute Diet Peach Drink

Name and Designation of Project Director:

Dr. Rehman Ullah Khan, SSO

Name and Designation of Project Associate(s):

- Dr. Arshad Hussain, PSO
- Ms. Salma Iman, SSO
- Dr. Abdul Wajid Khalil, SSO
- Engr. Muhammad Saddique Arbab, SE

Area(s) of Research:

Food Science

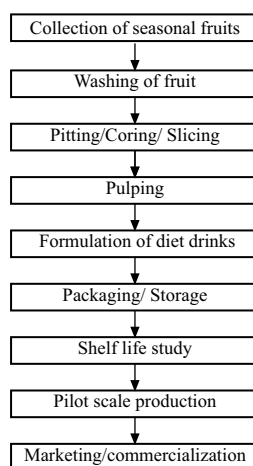
Duration:

01 Year

bureau of statistics, in 2024 Pakistan imported different kinds of fruits beverages from China, France, Thailand, USA, Turkey, Germany, United Arab Emirates and European Union. In 2024, total global trade of fruits and vegetable juice was 13.8 million tons; worth USD 14.6 billion. While Pakistan imported different kind of fruits beverages having worth of USD 128.21 million in 2024.

The prepared peach diet drink product will be preserved using food grade preservative at permitted level. The quality of the product will be evaluated during its shelf life studies. The primary objective of the present project is the formulation of import substitute low caloric fruit based peach drink.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Purchase of raw materials from local market. • Preparation/processing of raw materials. • Physico-chemical analysis of the raw materials. 	<ul style="list-style-type: none"> • Optimization and standardization of the processes. • Shelf life studies of the product. 	<ul style="list-style-type: none"> • Shelf life studies of the product. • Design of packaging material/ label/ brusher of the product. 	<ul style="list-style-type: none"> • Pilot production of developed product. • Commercialization/ Marketing. • Compilation of results in the form of Technical report/Research article.

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Formulation of product and customer feedback. • Optimization and standardization of formulation. 			

Funding Sources (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

Processes and products development

Achievements:

New Project



Name of Laboratory/Centre/ Unit:

FTC/PCSIR Labs. Complex, Peshawar

Title of Project: Development of Different Food Products from Cactus Pear Fruit

Name & Designation of Project Director:

Mrs. Salma Iman, SSO

Name & Designation of Associate (s):

Dr. Arshad Hussain, PSO

Dr. Rehman Ullah Khan, SSO

Area(s) of Research:

Food Science

Duration:

01 Year

Date of Initiation:

2025

Project Brief:

Global trends in food and nutrition indicate a growing interest in the consumption of fruits and vegetables, given their nutritional value and benefits for the functions of the human body. *Opuntia* (*Opuntia ficus-indica*) is a tropical to subtropical plant belonging to the Cactaceae family. It is known that prickly pear (*Opuntia* species) cultivation is present in Pakistan, particularly in the Khyber Pakhtunkhwa province. The crop is grown in areas like Peshawar, Hazara and Mardan. *Opuntia* is succulent fruit characterized by its high content in water (almost 92% wt), followed by carbohydrates (4–6% wt), proteins (1–2% wt) and minerals (around 1% wt). It is known for its high fibre and phytochemical (antioxidant and bioactive) content, vitamins mainly ascorbic acid and minerals, such as magnesium (Mg), calcium (Ca) and potassium (K), as well as being rich in antioxidants like phenolic compounds and flavonoids. Therefore, the fruit is appreciated for its nutritional value and health benefits. Especially, it is recommended for its good effects on diseases such as cancer, cardiovascular diseases, diabetes obesity, hypertension, anti-diarrheal, protects the colon and effectively fights against digestive disorders and gastrointestinal pain, even preventing ulcers, kidney diseases and wounds. It improves urinary flow and also prevents the accumulation of cholesterol in the veins and arteries. It delays the premature aging by protecting the body from oxidative stress. In Pakistan, it is used as a digestion enhancer.

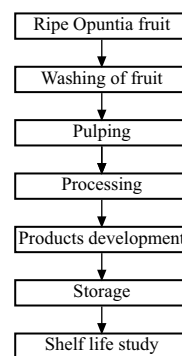
Many processed foods contain artificial colors, flavors and sweeteners that may cause allergic reactions or different health diseases in the long run. Excessive use of salts, sugar and unhealthy fats in processed foods also increases the risk of diabetes, high blood pressure, obesity and heart diseases. The natural ingredients in the food during processing become lost and hence less nutritional products are developed. So keeping in view these facts, the present research work is initiated to utilize the *opuntia* fruit which is an underutilized fruit in Pakistan into different food products for gaining its nutrients and health benefits. It grows well on its own in most barren lands at no cost.

The cactus is known for its uses as; a source of food, traditional medicine and as a hedge or ornamental plant. It is a supplementary feed for livestock. Mucilage from different species of cactus such as *Opuntia Ficus*

indica is now being used in the food packaging industrial raw materials for films and coating and more recently, it has been developed as a food preservative. Based on the above-mentioned health benefits of *opuntia* fruit, it can be utilized in different food products. The objectives of this study are to describe the physical, chemical, nutritional and antioxidant properties of prickly pear and to assess the effects of the addition of prickly pear fruit juice at various doses on the physicochemical properties of prepared products like jam, squash and nectar. The objectives of the present research work are as follows:

- Development of food products from cactus pear fruit.
- Development of seed bank for cultivation of cactus pear fruit plant.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Purchase of raw materials from local market	Processing of fruit into different products	Shelf life studies	Pilot production
Preparation/ processing of raw materials	Optimization and standardization of the processes	Compilation of results in the form of Technical report/ Research article	Commercialization/ marketing
Physicochemical analysis of the raw materials			

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

Processes & Products development.

Achievements:

New Project



Name of Laboratory/Centre Unit:

FTC/PC SIR Labs. Complex, Peshawar

Title of the Project: Smart IoT-Based Solar-Assisted Dehydration System to Optimize the Drying Process for Seasonal Fruits/Vegetables

Name & Designation of the Project Director:

Engr. Muhammad Saddique Arbab, Sr. Engr.

Name & Designation of the Project Associate:

Dr. Arshad Hussain, PSO
 Engr. M. Younas, PE
 Dr. Rahman Ullah, SSO
 Engr. Syed Messam Raza, JE

Area(s) of Research:

Renewable Energy, Food Preservation and Security

Duration:

01 Year

Date of Initiation:

2025

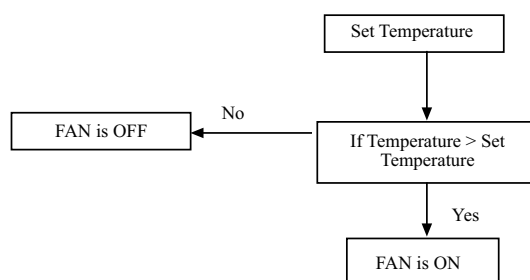
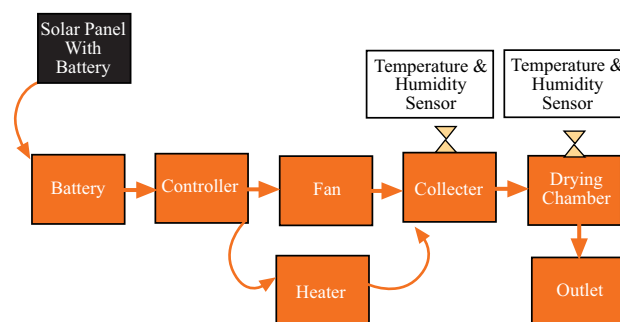
Project Brief:

Fruit dehydration is an essential method for preserving perishable fruits, extending their shelf life and reducing post-harvest losses. Traditional drying methods, such as sun drying and hot air drying, often suffer from inefficiencies, contamination risks and energy-intensive processes. To address these challenges, Smart IoT-Based Solar-Assisted Dehydration System to Optimize the Drying Process for Seasonal Fruits/

Vegetables is proposed, specifically designed for drying of fruits and vegetables in a controlled and efficient manner.

This system integrates solar energy, Internet of Things (IoT) technology and advanced process control mechanisms to optimize the drying process. Solar-assisted drying provides an eco-friendly and cost-effective solution by utilizing renewable energy, while IoT-based automation ensures precise monitoring and control of key drying parameters such as temperature, humidity, airflow and moisture content. The objective of the present project is the development of Smart IoT based Solar-Assisted Dehydration System for drying of fruits including (strawberry, watermelon and persimmon) and vegetables (Onion, Tomatoes and Ginger).

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

- Functional Smart Solar Dehydration System.
- High-Quality Dehydrated Fruits.
- IoT-Based Remote Monitoring and Control System.
- Market-Ready Technology for Farmers and Food

Industries.

- Environmental and Social Impact.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Non-addictive and Non-sedative Herbal Supplement Focusing Cognitive Enhancement

Name & Designation of Project Director:

Dr. Humaira Inayat, SSO

Name & Designation of Project Associate(s):

Ms. Farina Kanwal, PSO
 Dr Mushtaq Ahmad, SSO
 Dr. Hina Fazal, SSO
 Dr. Farah Gul, SSO

Area(s) of Research:

Nutraceuticals

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

People vary in their mental abilities allowing them to acquire certain skills more quickly or slower. Strategies to improve the acquisition and maintenance of cognitive skills are thus gaining importance. To enhance the cognitive skills, various strategies are in use including biochemical enhancers (glucose, caffeine, L-theanine, amphetamine, methylphenidate or modafinil), behavioral (sleep or physical exercise, mnemonic techniques) and physical (transcranial direct current stimulation (tDCS55), electrical stimulation methods, etc).

Strategies to make use of certain nutritional

components, having no or less risks are in practice. Several herbal nootropics used for promoting relaxed state of mind with alertness and elevating happy mood. For example, *Camellia sinensis* is rich in l-theanine which effects secretions of calming neurotransmitters (decreases stress disorders and quality sleep) and activating neurotransmitters enhancing relaxed state of mind, without drowsiness. *Melissa officinalis* extracts by increasing cell proliferation and decreasing serum corticosterone levels, increases GABA brain chemical. *Hedera helix* with its anti-anxiety effects improves sleep quality. Similarly, *Mucuna pruriens*, consisting of a biochemical L-dopa, is involved in elevating mood and memory. Withanolides from *Withania somnifera* are neuroprotective in nature, hence play role in stress management. Herbal supplements are the best choice. The active ingredient in them may elevate or decrease chemicals (serotonin, GABA levels, dopamine, epinephrine and norepinephrine) produced by brain which in turns effects stress disorders, alertness and focus.

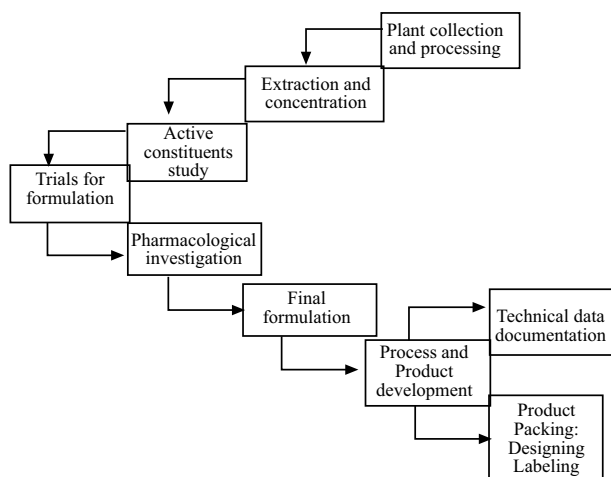
To support the pharmacological claims, computational molecular docking will be performed to assess binding interactions of major active compounds with neural receptors involved in cognitive functions. The docking studies will help:

- Identify high-affinity ligand-receptor interactions.
- Predict the binding strength and potential bioavailability of active compounds.
- Guide formulation strategies by selecting the most promising bioactive compounds.

Purpose of the project is formulating an herbal supplement to improve the acquisition and maintenance of cognitive skills. Also, the product will have minimal unwanted effects like addiction, sedation, drowsiness etc., allowing optimal concentration even in stressful situations such as exams and stressful work days. Variety of products are available in the market as herbal supplements for recreational purpose and improving mental activity. Relaxen day (Adrien Gagnon), Nurilax (Nutrifactor), Ginkwell (Herbiotics), Mintat (Himalaya) etc. Along with benefits, natural products are also associated with unwanted effects such as sedation, drowsiness, tiredness, euphoric, stimulant and hallucinogenic experiences. Sometimes these are addictive, causing serious problems on physical and mental health.

Chances are there for abuse of these recreational drugs/supplements. Alongside, most of these are imported, utilizing huge foreign exchange. On the basis of this, the project is designed to prepare a healthy, safe and cost-effective formulation for maintenance of cognitive skills.

Graphical Abstract:



Quarterly Work Plan:

<p>1st Quarter</p>	<p>Indigenous available plants will be collected Herbal raw material will be shade dried or treated as required. Available quality checks will be conducted to for the quality assurance of the raw material including Ash, acid insoluble ash, heavy metal analysis, essential metal analysis. Extraction will be done in specified solvents and under required conditions. Crude extracts will be concentrated and dried.</p>
<p>2nd Quarter</p>	<p>Experiments will be performed to determine the active compounds before processing for the product formulation. Testing will be performed on GC/MS, HPLC and UV-Visible as per requirements. Computational Studies will be performed to Predict the binding strength and potential bioavailability of active compounds</p>

<p>3rd Quarter</p>	<p>Formulation development: Pharmacological studies will be conducted on animal models to check anxiety and stress management.</p>
<p>4th Quarter</p>	<p>Product Development in the form of Tablets/Capsules. Packaging and Shelf-Life Testing</p>

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Process, product development.
- Paper, patent, technical report and feasibility report.

Achievements:

New Project



Name of Laboratory/Centre Unit:

MBC/PCSIR Labs. Complex, Peshawar

Title of Project: Herbal Synergized Supplement for Muscle Relaxation and Modulation of Motor Coordination

Name & Designation of Project Director:

Dr. Farah Gul, SSO

Name & Designation of Project Associate(s):

- Mrs. Farina Kanwal, PSO
- Mr. Siddiq Afridi, PSO
- Dr. Mushtaq Ahmad, SSO
- Dr. Shuja Uddin Badar, SSO
- Dr. Yaqoob ur Rehman, SO
- Mr. Ziaf ur Rahman, SO

Area(s) of Research:

Pharmacology

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

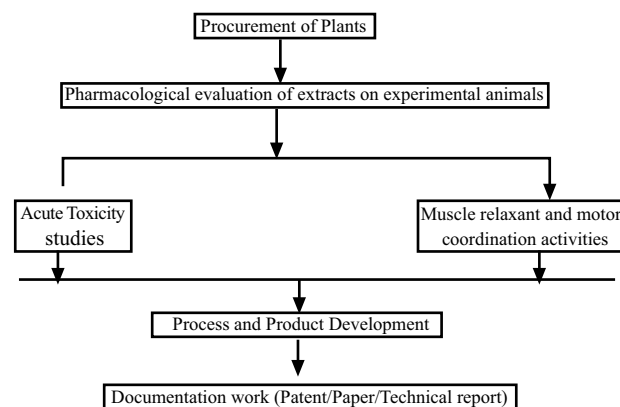
Medicinal plants and their products contribute more than half of all clinically administered drugs of modern day. Herbal medicines have gained significant recognition as a viable substitute for contemporary allopathic medicine on a global scale. Despite being prevalent in society, only a small number of medicinal herbs have undergone scientific evaluation for their efficacy in medical treatment. Pakistan is gifted with a rich flora of almost 5700 species of which around 2000 are reportedly medicinal plants, most of which have been found to be of significant and paramount importance in folkloric medicine. There is a need of scientific and pharmacological authentication of the traditional claims of the plants for their better therapeutic efficacy. In view of this and the growing interest in herbal remedies, it is considered worthwhile to study the activities attributed to herbal extracts/medicines on laboratory animals to give them a scientific proof. Hence, they should be utilized in a better way through their proper screening via Pharmacological activities. This project focuses on harnessing the best of natural ingredients to create a product designed to enhance muscle relaxation and motor coordination modulation, promising a holistic approach to physical well-being, paving the way for superior physical performance. The plants selected are *Nardostachys jatamansi*, *Matricaria chamomile*, *Withania somnifera*, *Ziziphus jujuba*, *Mentha piperita*, *Valeriana wallichii/officinalis*, *Ocimum basilicum*.

Allopathic medications used for motor coordination and muscle relaxation often work by targeting the central nervous system (CNS) to alleviate spasms, pain, or tension. However, because they influence the nervous system, they can come with several side effects like respiratory depression, impaired judgment, memory disorders, decrease motor skills, blurred vision, drowsiness/ sedation, addiction or dependence, Gastrointestinal discomfort etc. As a result, many people seek herbal formulas or natural alternatives. The scope of this project is designed to explore a novel approach to muscle relaxation and motor coordination through a synergized herbal formulation. By combining scientific research and herbal knowledge, this project

will contribute valuable insights into non-pharmaceutical interventions for improving neuromuscular health, with potential applications in various therapeutic and wellness industries. The objectives are as follows:

- To evaluate the indigenous medicinal plants for modulation of motor coordination and muscle relaxation.
- To observe side effects through acute toxicity studies of plants.
- To assess muscle relaxant and motor coordination effects in experimental lab. animals.
- Synergized product formulation for muscle relaxation and modulation of motor coordination.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	Procurement of plant material. Drying, grinding, extraction (maceration/ Soxhlet), concentration.
2nd Quarter	Toxicological studies of individual plant extracts at different dose levels.
3rd Quarter	Muscle relaxant and motor coordination effects of individual plant extracts in animal models.
4th Quarter	Preparation of synergized product oral formulation. Identification and Quantification of active classes of compounds through different lab techniques, in the synergized product and its constituent extracts.

5th Quarter	Toxicological, muscle relaxant activities and modulation of motor coordination in synergized product. Stability/Shelf-life studies.
6th Quarter	Formulation of Supplement

Funding Source (PSDP/SGI/RDI)etc.:

In-House

Tangible Outcome:

- Process and Product development.
- To support the pharma industry.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Production of Single Cell Protein from the Biomass of *Cannabis sativa* as an Efficient and Sustainable Bio-food Supplement in Pakistan

Name & Designation of Project Director:

Dr. Muhammad Akram, PSO

Name & Designation of Project Associate(s):

- Mrs. Farina Kanwal, PSO
- Dr. Hina Fazal, SSO
- Dr. Kishwar Sultana, SSO
- Ms. Uzma Ameer Marwat, SSO
- Dr. Noman Salehzada, SSO
- Engr. Syed Messam Raza, JE
- Mr. Ziaf-ur-Rahman, SO
- Mr. Danish Iqbal, SO

Area(s) of Research:

Industrial Microbiology and Biotechnology Research

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

The increasing demand for sustainable and high-quality protein sources in the poultry industry has intensified research into alternative protein solutions. Single Cell Protein (SCP) offers a promising avenue due to its high protein content, rapid production and resource efficiency. This project aims to utilize the seed cake of *Cannabis sativa*, a nutrient-rich agricultural byproduct, as a substrate for SCP production using *Aspergillus flavus*. The study will explore the feasibility, optimization and nutritional profiling of SCP derived from *C. sativa* seed cake to support sustainable poultry farming in Pakistan.

The proposed project aims to establish an innovative and sustainable approach to SCP production using *C. sativa* seed cake. The findings will contribute to reducing the environmental footprint of poultry farming while enhancing feed quality and affordability. This endeavor holds the potential to revolutionize the poultry feed industry in Pakistan, paving the way for sustainable agricultural practices. The process involves pre-treating *C. sativa* seed biomass, fermenting it with a non-toxicogenic fungal strain under optimized conditions, harvesting and drying the microbial biomass and analyzing it for protein content, amino acid profile and safety to obtain a high-quality, mycotoxin-free Single Cell Protein supplement. This project aligns with global and national priorities for sustainable agriculture and resource utilization. By valorizing *C. sativa* seed cake, a low-cost and abundant byproduct, this study contributes to reducing feed costs, minimizing waste and enhancing poultry productivity in Pakistan. Furthermore, it provides an environmentally friendly alternative to conventional protein sources, supporting the transition toward sustainable food systems.

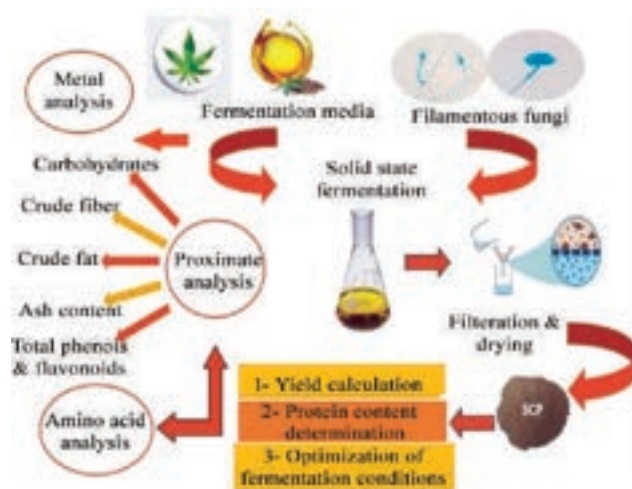
Pakistan imports a significant amount of soybean meal and fish meal to meet the protein demands of the poultry and livestock industries. According to trade data, Pakistan spends Millions of dollars annually on importing protein-rich feed ingredients, mainly from the USA, Brazil and Argentina. High dependency on imports exposes the feed industry to price fluctuations and supply chain disruptions. Locally produced SCP from *Cannabis sativa* seed residue can replace a portion of imported soybean and fish meal in animal feed

formulations. SCP has a high protein content (50–80%), essential amino acids and better digestibility compared to traditional feed ingredients. The utilization of agricultural residues (*C. sativa* seed cake) for SCP production reduces waste and promotes sustainable bioconversion.

The poultry industry in Pakistan plays a critical role in providing affordable protein sources for human consumption. However, the sector faces challenges in meeting the growing demand for feed protein sustainably. *C. sativa* seed cake, a byproduct of oil extraction, is abundant in nutrients, including proteins, carbohydrates and minerals, making it an ideal substrate for microbial fermentation. *A. flavus*, a well-characterized filamentous fungus, has demonstrated efficiency in converting agricultural residues into high-quality SCP. This project aims to harness the potential of *C. sativa* seed cake to produce SCP for use as a sustainable poultry supplement. The main objectives of the project are as follows:

- To produce SCP from *C. sativa* seed cake using *Aspergillus* species.
- To optimize fermentation conditions for maximum SCP yield.
- To conduct nutritional profiling of the produced SCP.
- To assess the SCP as a dietary supplement for poultry.
- To evaluate the economic feasibility and scalability of the production process.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection and pre-treatment of <i>C. sativa</i> seed cake; culture maintenance of <i>Aspergillus</i> species. Experimental setup for parameter optimization; data collection and analysis.	SCP Production and Analysis (nutritional and safety analysis).	Formulation of SCP-based poultry feed; performance evaluation in poultry.	Data analysis, preparation of final report and publication.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Successful production of SCP from *C. sativa* seed cake with high nutritional value.
- Technical Report.
- Patent/Publication.

Achievements:

New Project



Name of Laboratory/Centre Unit:

MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Process Development for Industrial Production of Xanthan Gum through Microbial Fermentation

Name & Designation of Project Director:

Dr. Numan Saleh Zada, TM
Engr. Syed Messam Raza, JE

Name & Designation of Project Associate(s):

Dr. Muhammad Akram, PSO
 Mrs. Farina Kanwal, PSO
 Dr. Muhammad Qaisar, PSO
 Ms. Uzma Ameer Marwat, SSO
 Dr. Kishwar Sultana, SSO
 Engr. Umar Arif, Tech.

Area(s) of Research:

Industrial Microbiology and Biotechnology

Duration:

02 Years

Date of Initiation:

August, 2025

Project Brief:

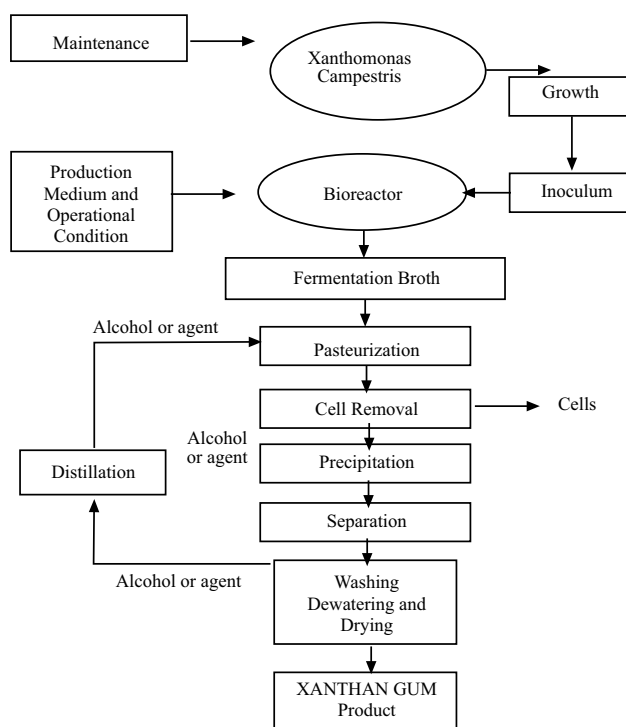
Xanthan gum is an extracellular heteropolysaccharide and an important industrial biopolymer, produced by *Xanthomonas campestris* in controlled conditions. It was discovered in the 1950s at the Northern Regional Research Laboratories (NRRL) of the United States Department of Agriculture. Xanthan gum primary structure consisting of repeated pentasaccharide units formed by two glucose units, two mannose units and one glucuronic acid unit, in the molar ratio 2.8:2.0:2. Its main chain consists of β-D-glucose units linked at the 1 and 4 positions. The chemical structure of the main chain is identical to that of cellulose. Trisaccharide side chains contain a D-glucuronic acid unit between two D-mannose units linked at the O-3 position of every other glucose residue in the main chain. Xanthan gum solutions show pseudoplastic and shear thinning behavior with changes in time or shear rate. Due to non-toxicity, biocompatibility, biodegradability and cost-effectiveness, xanthan gum is widely used as a viscosity enhancer in cosmetics, drug delivery, water-based paints, tissue engineering and regenerative medicine applications. The Xanthan Gum Market size is estimated at USD 0.80 Billion in 2025 and is expected to reach USD 1.05 Billion by 2030, at a CAGR of 5.71% during the forecast period (2025-2030). Pakistan has imported

532440 kg of Xanthan Gum at the price of \$3,085,938 in Sep 2023 to Feb 2024 (≈ kg 1.06 Million at the price of \$6.2 Million per year). Pakistan market size of Xanthan Gum is approximately.

Xanthan gum production will be carried out through aerobic fermentation under optimal temperature conditions, where organic acids will significantly enhance the synthesis process. In commercial production, the microorganism *Xanthomonas campestris* can convert approximately 70% of the substrate into xanthan gum. To achieve high product quality and maximum efficiency, process parameters will be meticulously evaluated. The main objectives are:

- Isolation of *Xanthomonas Campestris*.
- Optimization of fermentation parameters to maximize xanthan gum yield.
- Investigate the influence of different carbon and nitrogen sources on production efficiency.
- Establish a robust purification and recovery process for the final product.
- Evaluate the physical and chemical properties of the produced xanthan gum for compliance with industrial standards.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2rd Quarter	3th Quarter	4th Quarter:
Isolation of Xanthomonas Campestris (X.C) Identification and characterization of Bacteria	Optimization of the parameters for Lab Scale Production by chemicals Selection of different agricultural waste which have suitable composition	Investigate the influence of different carbon and nitrogen sources on production efficiency Optimization of fermentation parameters to maximize xanthan gum yield.	Lab Scale Production of Xanthan Gum Identification and characterization of Xanthan Gum
5th Quarter	6th Quarter	7th Quarter	8th Quarter:
Establish a robust purification and recovery process for the final product.	Optimize and establish Drying process, labeling and packing of the product	Comparative study and testing of produced Xanthan gum and Market available product.	Evaluate the physical and chemical properties of the produced xanthan gum for compliance with industrial standards

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcomes:

Contribution to the existing body of knowledge on xanthan gum production processes, potentially

paving the way for further advancements and innovations.

- Import Substitute.
- The acceleration of industrial xanthan discovery will help facilitate the development of new sustainable industrial processes as well as the burden on country's weak economy.
- Generation of trained manpower in the cutting-edge areas of Industrial Microbiology and Biotechnology.
- Application of a biotechnological process in industry for the production of value-added products.
- The proposed research also involved the use of the in-depth information on the advanced molecular biology techniques.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

MBC/PCSIR Labs. Complex, Peshawar

Title of Project: Optimization and Culturing of Spirulina, An Edible Cyanobacterium with Potential Therapeutic Health Benefits, Leading Towards Product Development

Name & Designation of Project Director:

Dr. Hina Fazal, SSO

Name & Designation of Project Associate(s):

Mrs. Farina Kanwal, PSO
 Mr. Muhammad Siddique Afridi, PSO
 Dr. Kishwar Sultana, SSO
 Dr. Numan Salehzada, TM

Area(s) of Research:

Phycology/Nutraceutical/Pharmaceutics

Duration:

02 Years

Date of Initiation:

2025

Project Brief:

Spirulina, a filamentous cyanobacterium, possesses diverse biological activities and nutritional significance. It is cultivated for maximum protein content and presence of essential nutrients such as carbohydrates and vitamins. It is a storehouse of minerals including iron, calcium, chromium, copper, magnesium, manganese, phosphorus, potassium, sodium and zinc. Simultaneously, γ -linolenic acid, as well as pigments such as chlorophyll A and phycobiliproteins are major components of its rich nutritional profile. *Spirulina* is known to have various promising effects on the prevention of cancer, oxidative stress, obesity, diabetes, cardiovascular diseases and anemia. It also plays a positive role in treating muscular cramps. Different *Spirulina* preparations influence immune system and are active against several enveloped viruses. They are capable to inhibit carcinogenesis due to anti-oxidant properties that protect tissues and also reduce toxicity of liver, kidney and testes.

Spirulina is one of the most widely consumed microalgae, particularly known for its rich content of proteins (60–70% dry weight). However, large-scale production of high-quality *Spirulina* remains a challenge due to the high costs associated with cultivation, media formulation, harvesting and processing.

The global demand for plant-based protein alternatives, dietary supplements and functional foods has led to an increased market for algae-based products, particularly *Spirulina*. *Spirulina* has gained significant attention in recent years due to its high nutritional value. This project aims to develop and scale up a feasible protocol for *Spirulina* production through optimized cultivation techniques, media formulation and pilot-scale production methods. This will focus on overcoming the current limitations in *Spirulina* production and processing, which will enable better cost-efficiency and scalability, making it a viable source of nutrition and health products for the growing global population. Development of various products derived from *Spirulina*, such as supplements, powders and nutraceutical will help to substitute the import and to meet the increasing global demand for algae-based health solutions. The objectives are as follows:

- Optimization of growth conditions for a scalable and sustainable process for large scale production.
- To develop cost-effective strategies for harvesting,

drying and processing *Spirulina*.

- To design and implement a pilot-scale facility for the cultivation of *Spirulina*.
- Standardization of post-harvest processing to develop value-added medicinal and nutraceutical product.

Graphical Abstract:



Quarterly Work Plan:

1st Year	1st Quarter	<ul style="list-style-type: none"> • Procurement of algal culture • Media Optimization • Optimizing Growth Parameters
	2nd Quarter	<ul style="list-style-type: none"> • Selection of Cultivation System • Lab scale production • Photo bioreactors • Open Pond System
	3rd Quarter	<ul style="list-style-type: none"> • Pilot-Scale Production • Scaling-Up Tracking growth rate
	4th Quarter	<ul style="list-style-type: none"> • Harvesting • Processing and Product Development • Packaging and Shelf-Life Testing
2nd Year		<ul style="list-style-type: none"> • Large Scale production of Spirulina • Market Analysis & Commercialization • Technical report, Research articles, Patent

Funding Source (PSDP/SGI/RD&I/etc)

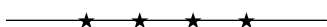
In-House

Tangible Outcome:

- Optimized Cultivation Protocols for high-yield production
- Cost-effective, locally-sourced media formulations
- Designing of Pilot-Scale Facility
- Commercialized Products: *Spirulina* powder, tablets, capsules and functional foods

Achievements:

New Project.



Name of Laboratory/Centre/Unit:

PCSIR Labs Complex, Peshawar

Title Project: Development of Potassium-Based Chemicals from Indigenous Feldspar Ore

Name & Designation of Project Director:

Dr. Waheed-Ur-Rehman, SE

Name & Designation of Project Associate(s):

Mr. Amin-Ur-Rehman, PSO

Ms. Asma Yamin,SSO

Dr. Sohail Noor, JTO

Area(s) of Research:

Materials Science, Chemical Engineering, Fertilizer

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Feldspars are complex silicates of sodium, potassium and calcium, naturally occurring as an important group of rock forming minerals. The Khyber Pakhtunkhwa province has vast reserves of Feldspar.

According to a report of the Sarhad Chamber of Commerce and Industry, 1,093,441 Tons of Feldspar was mined in KP during 2018-2021. Large deposits of potash feldspar occur in Swat and Bunair Districts. The potash feldspar of Swat contains around 14% of K_2O , which is an excellent source for utilization in the production of potassium-based chemicals like potassium chloride and potassium sulfate.

It will be a matter of great concern, if the huge potash feldspar resources are not utilized in the form of value-added products. Pakistan is spending a huge amount of foreign exchange on the import of products that can be produced or developed from the indigenous industrial minerals. Around 90–95% of the total potassium production in the world is consumed for fertilizer making, whereas the pharmaceuticals, food, detergent, glass and chemical industries absorb the rest. In fertilizer, about 96% of potassium is used in the form of potassium chloride (muriate of potash) whereas, potassium sulphates, potassium nitrates and other forms of potassium account for the rest 4%.

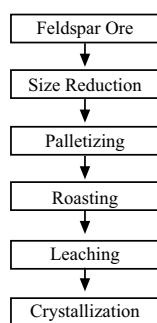
According to the World Bank statistics, a total of 34,672 tons of Potassium Chloride was imported in Pakistan against a value of US \$16.573 Million in the year 2023. Likewise, 42,457 tons of Potassium Sulfate was imported against a total sum of US \$26.488 Million. These figures show that there is a huge potential for the development of process and technology to produce these chemicals within Pakistan, because of the abundant reserves of potash feldspar.

In the proposed project, the indigenous potash feldspar ore will be used as a raw material to synthesize potassium salts through roasting-leaching process. The ore will be crushed, ground and then palletized with inorganic salts. The pallets will be roasted and then leached to release potassium salt. Operating parameters like temperature and time will be optimized to obtain the best yield. It is worth mentioning that the process parameters will be optimized on bench scale and then upscaled to pilot plant level to test the process. The objectives are:

- Value-addition of the of indigenous feldspar resources of Khyber Pakhtunkhwa.
- Reducing the import dependency, that is currently posing a huge challenge towards Pakistan.

- Demonstration of the developed process on pilot plant level to the industrial entrepreneurs, encouraging investment in the profitable utilization of the vast feldspar resources of Khyber Pakhtunkhwa.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Raw material procurement, evaluation and initial experiments	Optimization of parameters for synthesis of potassium salts on bench-scale	Optimization of parameters for synthesis of potassium salts on pilot plant level	Products characterization, evaluation and report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Process/technology for the synthesis of potassium chloride and potassium sulfate from indigenous feldspar ore.
- Feasibility study on the production of potassium chloride and potassium sulfate from indigenous feldspar ore.
- The beneficiary industries for the process of potash chemicals will be Fertilizer industry, Chemical industry, Agriculture.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

MRC/ PCSIR Labs. Complex, Peshawar

Title Project: Purification of Indigenous Quartz for Industrial Application

Name & Designation of Project Director:

Dr. Sohail Noor, JTO

Name & Designation of Project Associate(s):

Mr. Amin Ur Rehman, PSO
 Dr. Mahmood Iqbal, PSO
 Dr. Waheed Ur Rehman, SE

Area(s) of Research:

Minerals and Materials Science

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Quartz is a widely used mineral in various industries, including glass manufacturing, electronics and construction. However, the presence of iron impurities in quartz can significantly affect its quality and usability. Iron impurities can cause discoloration and reduce the transparency of quartz, making it less desirable for high-purity applications. Therefore, the removal of iron from quartz is a critical process in mineral processing. Organic methods involve the use of biodegradable and environmentally friendly agents. Traditional methods for iron removal include physical separation (e.g., magnetic separation) and chemical leaching using mineral acids (e.g. hydrochloric acid, sulfuric acid). However, these methods have limitations, including high energy consumption, environmental concerns and potential damage to the quartz structure. As of the latest available data up to 2020-21, Khyber Pakhtunkhwa (KP), Pakistan, is known to have signifi-

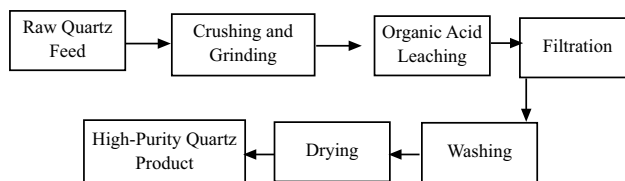
cant quartz deposits 20,203 Tons, particularly in regions like Mansehra (1705 Tons) and Malakand (7043 Tons).

This project aims to develop a sustainable and efficient method for removing iron impurities from quartz using weak organic acids. Iron can exist in quartz as inclusions, surface coatings, or lattice substitutions. The most common forms are hematite (Fe₂O₃) and goethite (FeO (OH)). Organic acids such as oxalic acid, citric acid and acetic acid have shown promise in leaching iron from minerals. These acids can form stable complexes with iron ions, facilitating their removal from the quartz matrix.

The use of mineral acids for iron removal from quartz is not sustainable in the long term due to its adverse environmental impact, high cost of waste management and potential health risks to workers. There is a growing need for alternative methods that are environmentally friendly, cost-effective and safe. Organic methods, which utilize biodegradable and less toxic reagents such as citric acid, oxalic acid, or acetic acid, offer a promising solution. However, the efficiency of these organic methods in removing iron from quartz has not been thoroughly investigated or optimized. The successful completion of this project will contribute to the production of high-purity quartz, which is essential for advanced technological applications. Additionally, the use of organic acids will reduce the environmental impact compared to traditional methods, aligning with global efforts towards greener industrial processes. The primary objectives of this project are:

- To develop an efficient and environmentally friendly method for removing iron impurities from quartz using organic acids. Organic acids are preferred over mineral acids due to their minimum effect on crystal structure, lower environmental impact and milder reaction conditions.
- To evaluate the effectiveness of different weak organic acids (e.g., oxalic acid, citric acid, acetic acid) in removing iron impurities from quartz.
- To optimize the leaching conditions, including acid concentration, temperature, leaching time and solid-to-liquid ratio.
- To characterize the treated quartz to determine the extent of iron removal and the impact on quartz quality.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Literature review, raw material purchasing and sample preparation.	Conduct leaching experiments with different organic acids with different conditions.	Analyze the results with different organic acids separately and in combination and optimize the leaching process.	Characterize the treated quartz, optimize best treating composition and finalize the findings in technical report.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

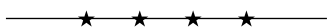
Tangible Outcome:

- Identification of the most effective organic acid for iron removal from quartz.
- Determination of optimal leaching conditions (acid concentration, temperature, time, solid-to-liquid ratio).
- A significant reduction in iron content in the treated quartz, meeting industry standards for high-purity quartz.
- A cost-effective and environmentally friendly method for iron removal that can be scaled up for industrial applications.

- The beneficiary industry for the process of iron removal from quartz, particularly through organic acid leaching or organic removal methods, is primarily the high-purity quartz industry i.e.
 - Semiconductor industry,
 - Solar industry, optical industry,
 - LED and lighting Industry,
 - Telecommunications industry,
 - Laboratory and scientific equipment,
 - glass industry,
 - Cosmetics and pharmaceuticals,
 - Advanced ceramics and water filtration.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

MRC/PCSIR Labs Complex, Peshawar

Title Project: Development of Sulfur Based Pesticide from Indigenous Sulfur Resources

Name & Designation of Project Director:

Mrs. Asma Yamin, SSO

Name & Designation of Project Associate(s):

- Mr. Qazi Muhammad Sharif, PSO
- Mr. Amin Ur Rahman, PSO
- Dr. Waheed Ur Rehman, SE
- Dr. Hina Fazal, SSO

Area(s) of Research:

Minerals

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Sulfur is a vital agricultural input widely used as a fungicide and miticide to control pests and diseases in crops. Pakistan's domestic sulfur sources include

natural deposits and industrial byproducts. The country's largest sulfur deposit is in the Koh-i-Sultan volcano in Quetta Division, with estimated reserves of 85,000 tons of sulfur ore with a purity of less than 50%. Additionally, oil refineries, such as Pak-Arab Refinery Limited (PARCO) and National Refinery Limited (NRL), produce sulfur as a byproduct with a purity of 90-95%. Natural gas processing plants, like the Sui Gas Field in Baluchistan and the Dhodak Gas Field in Khyber Pakhtunkhwa, also produce sulfur with a purity of 95-99.5%. These sources provide a significant supply of sulfur for various applications, including fertilizer, pesticide and pharmaceutical production.

Sulfur 80 WG (Wettable Granule) is a highly effective formulation containing 80% elemental sulfur, designed for easy application and broad-spectrum pest control. It can be used for strawberries, grapes, tomatoes, apples, citrus fruits, cucumbers, peppers and beans. It is worth to be mentioned that the developed product will have a relatively low toxicity to humans and animals compared to many of the synthetic pesticides. This project proposes the development of Sulfur 80 WG using sulfur ore as the primary raw material. The project aims to create a cost-effective, environmentally friendly and scalable production process to meet the growing demand for sulfur-based agricultural products.

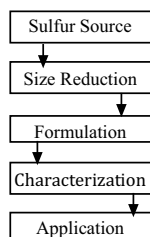
With the growing demand for organic farming inputs in Pakistan, there is an increasing need for high-quality sulfur-based products. This project aims to develop a sustainable and cost-effective process for producing Sulfur 80 WG from locally available sulfur ore and industrial byproduct sulfur, providing an eco-friendly alternative while supporting agricultural growth and reducing reliance on imports.

Sulfur 80 WG is typically applied as a foliar spray or dust to control fungal diseases, mites and other pests in various crops. It is a widely used fungicide and miticide that contains 80% sulfur in the form of water-dispersible granules (WDG). It is effective against a variety of fungal diseases and pests, particularly powdery mildew, rusts and mites. Sulfur 80WG is effective on a wide range of crops, including fruits, vegetables and legumes.

- To develop a scalable and cost-effective process for producing Sulfur 80 WG from sulfur ore
- To formulate sulfur into a stable, easy-to-apply wettable granules

- To ensure that the product meets quality standards for agricultural use
- To minimize environmental impacts during production and application

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Raw material procurement, evaluation and initial experiments	Optimization of parameters for formulation of Sulfur 80 WG	Optimization of parameters for formulation of Sulfur 80 WG (continued)	Products characterization, evaluation and report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Preparation of Techno economic feasibility report.
- Commercialization of the pilot plant process.
- Beneficiary industry
 - Agriculture
 - Fertilizer
 - Plant protection

Achievements:

New Project



Name of Laboratory/Centre/Unit:

RC/PCSIR Labs. Complex, Peshawar

Title of Project: Design and Development of Solar Hybrid Inverter(3 KW, 5 KW) as a Substitute to Imported Inverters

Name and Designation of Project Director:

Mr. Bakhtiar Nawaz, SSO

Name and Designation of Project Associate(s):

Mr. M. Farukh Zeeshan, SE

Mr. Shah Faisal, Sr.Tech

Mr. M.Anwar Khan, Sr.Tech

Area(s) of Research:

Energy/Electrical/Electronics

Duration:

01 Year

Date of Initiation:

2025

Project Brief:

The increasing demand for renewable energy sources has prompted extensive research into technologies that can efficiently integrate renewable energy into existing power systems. Solar energy generation systems are primarily connected to the grid via inverters, which play a critical role in converting the DC (direct current) produced by solar panels into AC (alternating current) suitable for grid integration. Solar hybrid inverters provide higher efficiency and better energy management by dynamically switching between solar power, energy storage and grid power. These systems are particularly suitable for off-grid and hybrid systems, ensuring continuous power availability while reducing dependency on the grid.

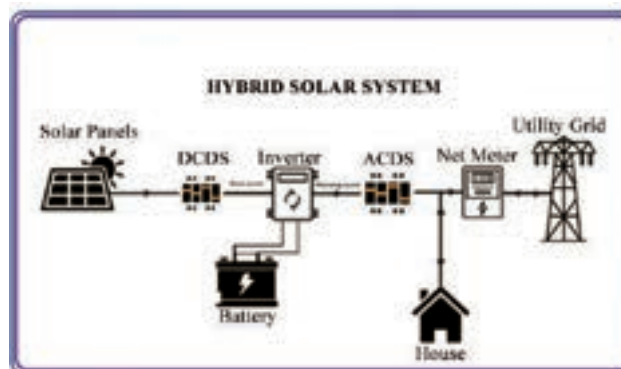
This project aims to develop a state-of-the-art solar hybrid inverter (initially 3kw and 5kw) that seamlessly integrates solar power generation, energy storage and grid connectivity, providing a reliable and sustainable energy solution for residential, commercial and industrial applications. The proposed solar hybrid inverter will feature intelligent power management systems to optimize energy distribution, increase system

flexibility and reduce energy costs, making it an essential component for advancing sustainable energy solutions. In Pakistan, the locally manufactured (by reverse engineering process) on-grid solar inverters are already available in market, but the hybrid inverters is still not manufactured on local basis. The imported hybrid inverters available in the Pakistan market are not cost effective as it is too costly, so the need to develop (by reverse engineering) this inverter on local basis is highly required to make it cost effective.

Solar inverters, which convert the DC power generated by solar panels into usable AC power, are crucial for optimizing the performance of solar energy systems. Traditional solar inverters operate solely on solar energy, limiting their effectiveness during cloudy weather, night time, or when the solar power generated is insufficient to meet energy demand. Hybrid inverters, which combine solar power with backup energy sources such as batteries or the grid, offer a promising solution to address these limitations. However, current hybrid inverters often face challenges related to system complexity, cost, efficiency and integration with various energy storage solutions. Also, in Pakistan hybrid inverters are still not being manufactured on local basis which is the main reason behind its high cost. The problem at hand is the need for an efficient, reliable and cost-effective solar hybrid inverter that can seamlessly integrate solar power with additional energy sources. The main objectives of the present research work are:

- Design an efficient and reliable solar hybrid inverter that can seamlessly integrate solar, grid and battery storage, enabling better management of energy resources.
- Optimize power conversion efficiency across all modes of operation, ensuring minimal energy loss during the DC to AC conversion.
- Implement smart energy management algorithms to dynamically prioritize power sources (solar, grid, battery) based on availability, demand and storage status.
- Ensure safe and effective battery management to enhance the lifespan and performance of the energy storage systems.
- Develop a user-friendly interface and monitoring system for real-time tracking and control of energy generation, consumption and storage.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter
Local training of concerned personal on hybrid inverter technology. Study the current state-of-the-art in hybrid inverter technologies. Identify key components, circuit topologies and design strategies employed in hybrid inverter systems.	Design the architecture of the hybrid inverter using simulation software. Design the power conversion circuits, control systems and protection mechanisms. Design a battery management system (BMS) to ensure efficient charging and discharging of the battery, with temperature and voltage regulation. Procurement of required accessories for the project. Construct a prototype of the solar hybrid inverter based on the designed model.
3rd Quarter	4th Quarter
Conduct laboratory tests to measure the efficiency and reliability of the inverter under various operational conditions. Evaluate the performance of the hybrid inverter in grid-tied and off-grid configurations. Analyze the data collected from testing and make necessary improvements in system design.	Start production and install pilot systems in various recommence and gather feedback for future updates.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Date of Initiation:

July, 2025

Tangible Outcome:

- Energy Storage Integration.
- Grid Stability.
- Reduced Electricity Bills.
- Backup Power.
- Hybrid inverters offer advanced energy management features, allowing users to monitor and control their energy production, storage and consumption through apps or smart meters. This helps optimize energy use for maximum efficiency.
- Hybrid inverters tend to be more efficient than traditional solar-only systems, reducing losses and ensuring that energy is used in the most efficient way possible.
- By utilizing renewable solar energy, these inverters reduce the reliance on fossil fuels, lower greenhouse gas emissions and contribute to sustainability efforts in the long term.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

MRC/PCSIR Labs Complex, Peshawar

Title Project: Extraction of Copper from Chalcopyrite Concentrate of North Waziristan, Khyber Pakhtunkhwa

Name & Designation of Project Director:

Dr. Waheed-Ur-Rehman, SE

Name & Designation of Project Associate(s):

Mr. Amin-Ur-Rehman, PSO
Dr. Sohail Noor, JTO

Area(s) of Research:

Materials Science, Pyrometallurgy

Duration:

01 Year

Project Brief:

Pakistan possesses rich and largely untapped mineral resources, particularly in the tribal and mountainous regions. Among these, North Waziristan in Khyber Pakhtunkhwa holds substantial reserves of copper in the form of chalcopyrite (CuFeS₂). The Frontier Works Organization (FWO) has played a significant role in the exploration and beneficiation of these ores, resulting in the availability of chalcopyrite concentrate containing approximately 21% copper.

Despite this promising resource, Pakistan currently lacks localized and industrial-scale processing capabilities for copper extraction. With global demand for copper rising in sectors such as renewable energy, electronics and infrastructure, this project aims to develop a pyrometallurgical route to extract copper from FWO's chalcopyrite concentrate. The initiative will help shift from raw material export to value-added metal production, enhancing national industrial capability and regional development.

Although FWO has successfully produced high-grade chalcopyrite concentrate from North Waziristan, no downstream extraction infrastructure exists to process this material within the country. As a result, the concentrate remains underutilized, with limited economic value realization. Pakistan continues to import refined copper, despite having local resources. The absence of a technically viable and economically scalable extraction process limits industrial uptake and deters private sector investment. Thus, there is a critical need to design and demonstrate a pilot-scale pyrometallurgical process to convert this concentrate into refined copper locally. The project will use chalcopyrite concentrate (~21% Cu) supplied by FWO as the raw material. The proposed work is divided into the following technical areas:

- Determination of copper, iron, sulfur and gangue elements through AAS.
- XRD and SEM for mineral phase identification.
- Conversion of chalcopyrite to copper oxides and sulfates.

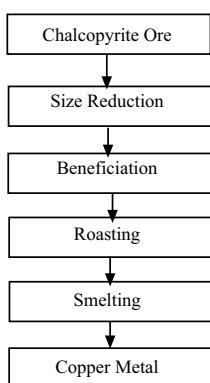
- Reduction in a furnace to form copper matte ($\text{Cu}_2\text{S} + \text{FeS}$) and slag separation.
- Oxidation of matte to produce copper metal.
- Bench-scale setup: 0.5–1 kg/batch.
- Pilot-scale batch: 5–10 kg/batch.
- Designing, testing and optimization of a pyrometallurgical process for copper extraction from FWO's concentrate.
- Determination of copper recovery rates, process efficiency and material balances.
- Evaluation of the economic feasibility and potential for industrial-scale upscale.
- Feasibility study on the roasting and smelting of chalcopyrite concentrate.
- The beneficiary industry for the process of copper extraction will be Metallurgy industry, Beneficiation plants, Copper smelters.

Achievements:

New Project



Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Raw material procurement, evaluation and initial bench-scale experiments	Optimization of parameters for roasting	Optimization of parameters for smelting	Products characterization, evaluation and report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Process/technology for the roasting and smelting of chalcopyrite concentrate.

On-Going Projects

Name of Laboratory/Centre/Unit:

MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Preparation of Chromate Salts from Indigenous Chromite Ore

Name & Designation of Project Director:

Mrs. Asma Yamin, SSO

Name & Designation of Project Associate(s):

Dr. Waheed Ur Rehman, SE

Mr. Amin Ur Rahman, PSO

Area(s) of Research:

Minerals

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

Chromite is widely used in metallurgical, chemical and refractory industries. Huge deposits of this ore occur in Pakistan, which can be exploited as basic raw material for chromite chemical industries. In Khyber Pakhtunkhwa (KPK) chromite deposits occur in Dargai, Malakand agency (0.7 Million tons), Heroshah, Malakand agency (0.1 Million ton), Jijal, Kohistan (0.2 Million tons) and small deposits are also occur in areas of Waziristan agency with chromite (Cr₂O₃) contents varying from 27-48%.

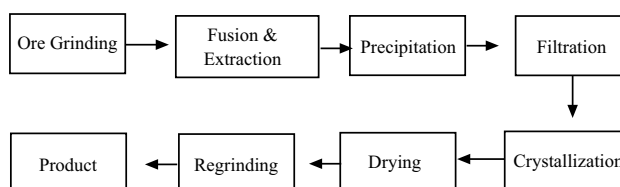
Chrome chemicals are extensively used in paints, pigments, tanning and dyeing of leather, corrosion inhibitor, drilling muds, catalysts, wood and wood treatment. The country requirements of chromite chemicals are met through import. A sizeable amount of foreign exchange is being spent on the import of sodium chromate, sodium dichromate, potassium dichromate, potassium chromate, chromium oxide and chromium based pigments. The objectives are:

- To utilize indigenous chromite ore for the

preparation of value added product.

- To save the foreign exchange being spent on the import of chrome chemicals.
- Development of technology for semi large scale production for commercialization.
- To encourage the public and private sector investment in utilization of mineral resources of the country.

Graphical Abstract:



Quarterly Work Plan:

The project will be executed in the following phases:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter:
<ul style="list-style-type: none"> • Procurement of raw materials. • Analysis and characterization of Chromite ore. 	<ul style="list-style-type: none"> • Optimization of parameters for bench scale preparation of products from Chromite ore 	<ul style="list-style-type: none"> • Characterization of product samples by the physical and chemical methods 	<ul style="list-style-type: none"> • Upgradation of bench scale developed technology to semi pilot plant scale. • Performance evaluation of various properties of bone char filter.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

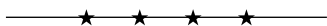
Tangible Outcome:

- Preparation of Technoeconomic feasibility reports

- Commercialization of the pilot plant process.

Achievements:

- The laboratory trials have been completed.
- Pilot scale products has been successfully made.
- Practical Report is under process.



Name of Laboratory/Centre/Unit:

MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Development of Grafted Styrene Butadiene Rubber Adhesive

Name & Designation of Project Director:

Dr. Mahmood Iqbal, PSO

Name & Designation of Project Associate(s):

Dr. Waheed Ur Rehman, SE
Mr. Sohail Noor, JTO

Area(s) of Research:

Polymer

Duration:

02 Years

Date of Initiation:

July, 2024

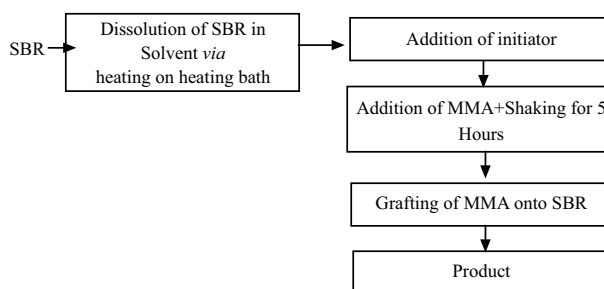
Project Brief:

Styrene Butadiene Rubber (SBR) adhesive is the most widely used synthetic rubber adhesive/sealant, which is produced from copolymer of styrene and butadiene rubber. SBR adhesive shows excellent abrasion, crack & heat resistance and aging stability. They have various applications such as in tapes and flooring. SBR adhesive resistance to water, chemical and general abrasion. It is actively tough for the flooring installation, whether it is indoor and outdoor. Grafting of MMA onto SBR increases heat resistance and also reduce drying time. This property of SBR increase the

demand in flooring application which provides lucrative growth in SBR based adhesive in the market. These adhesive are used for bonding high –pressure laminates, automotive train, roofing-membrane attachment, furniture, kitchen cabinets, custom display cabinets, interior and exterior panels, wall partition, shoe soles and many other applications where quick, high-strength, permanent bonds are needed. The degree of grafting will be further increased in order to improve the adhesion. The objectives include:

- To prepare Methyl methacryalte-graft Styrene Butadiene Rubber adhesive with enhanced physical properties at low cost.
- To utilize indigenous facilities and resources for the preparation of methyl methacryalte-graft Styrene Butadiene Rubber adhesive.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	<ul style="list-style-type: none"> Procurement of raw materials. Characterization of raw materials.
2nd Quarter	<ul style="list-style-type: none"> Synthesis and grafting
3rd Quarter	<ul style="list-style-type: none"> Characterization of product developed on bench scale.
4th Quarter	<ul style="list-style-type: none"> Up gradation of bench scale product to pilot plant. Compilation of results in the form of technical report.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Indigenous technology will be development for the production of value added products. The program will be helpful in uplifting the industrial as well as social sector in the countries.
- Proposed Technology will save foreign exchange regarding its imports.

Achievements:

- Process for the preparation SBR of rubber adhesive were developed.
- The product is under evaluation



Name of Laboratory/Centre/ Unit:

MBC/ PCSIR Labs. Complex Peshawar

Title of Project: Product Development from Carbon Dioxide (CO₂) Supercritical Extracts of Some Important Selected Plants

Name and Designation of the Project Director:

Mr. Muhammad Siddique, PSO

Name and Designation of the Project Associate (s):

Dr. Muhammad Akram, PSO

Ms. Farina Kanwal, PSO

Dr. Hina Fazal, SSO

Area(s) Research:

Cosmetics, Medicine, Food

Duration:

02 Years

Date of Initiation:

2023-24

Project Brief:

Carbon dioxide extraction (CO₂) is a cutting-edge

method of obtaining high-quality ingredients from natural sources. During supercritical fluid extraction with CO₂ components are separated from a solid or liquid carrier material by using supercritical CO₂ as solvent.

Carbon dioxide (CO₂) is the most frequent solvent used that fairly nontoxic and can be easily removed from the extract.

The elimination of CO₂ is easily achieved since CO₂ is in a gas state at room temperature. CO₂ in the supercritical state is in a moderate critical temperature (31.3 °C) and pressure (7.38 MPa). Supercritical state is when gas and liquid are indistinguishable where at this state it is compressible but possessing a density of a liquid. In a word, supercritical CO₂ makes a good solvent because of the gas-like state that attributed the low viscosity and high diffusion coefficient and the liquid-like state that gave the solvating power.

For many applications CO₂ has well-suited solvent properties which can be easily controlled by varying the pressure and temperature. In addition carbon dioxide in the supercritical state has a very low viscosity and no interfacial tension. Therefore it can penetrate well into complex structures and materials. These properties make it suitable for many different processes.

CO₂ extract is a new technology based raw product. Its use in herbal products is opening a new door in the world of herbal industries.

Keeping in mind all these properties, CO₂ will be used for extraction process of different useful plants available in the local areas. For this purpose some commercially important plants were selected. By using CO₂ extracts new medicinal and cosmetics products will be developed. These selected plants are:

1. Curcuma longa
2. Licorice
3. Cannabis
4. Red chellies
5. Berberis
6. Levistonia
7. Carrot

8. Papaya
9. Rose
10. Eucalyptus

Utilizing carbon dioxide extraction (CO₂) for obtaining high-quality ingredients from selected plants has significant potential in the fields of herbal products i.e, cosmetics and pharmaceuticals.

Supercritical CO₂ (carbon dioxide) extraction is a popular and efficient method for extracting essential oils, flavors, fragrances and other compounds from various materials, such as plants, herbs and spices. It is considered a safe and environmentally friendly technique.

Extraction process consists of three stages:

1. Compression
2. Separation
3. Collection

We have well equipped Labs in MBC. CO₂ supercritical extraction machine, GC/MS, AAS and HPLC such as highly sophisticated machines are available. We also have our Microbiology section, where antimicrobial and antifungal activities will be carried out. Selected plants having good potential value will be collected and processed for CO₂ supercritical extraction. The CO₂ supercritical extract obtained will be subjected for instrumental analysis to know the different chemical constituents of the CO₂.

CO₂ extract has a wide range of applications in various industries, including skincare and pharmaceuticals. In the skincare industry, CO₂ extract is commonly used for its anti-inflammatory and antioxidant properties. In the pharmaceutical industry, CO₂ extract is used for its medicinal properties.

Extracts obtained by supercritical CO₂ will be utilized in the preparation of cosmetic and pharmaceutical products. These will be CO₂ extract new technology based products. It will be a good innovation in these products and will open a new door for further work on cosmetic, medicinal and food products developments.

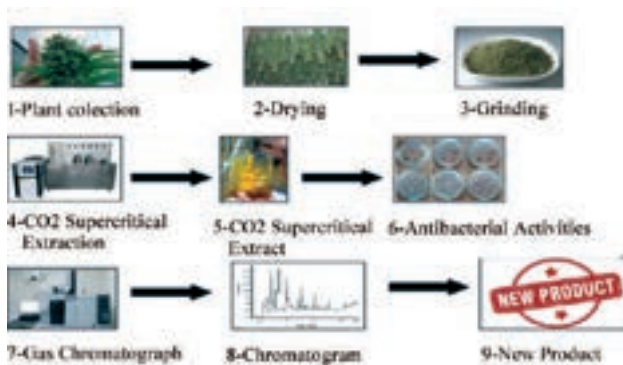
Two types product will be developed i.e,

- Pharmaceuticals/Food
- Cosmetics

Objectives:

- To utilize indigenous plant raw material.
- To prepare CO₂ supercritical extracts of some commercially important selected plants.
- Analysis of the extracts through different sophisticated instruments
- Development of herbal cosmetic and medicinal processes/products
- To find out different relevant bio-activities of the extracts and the products thereof.
- To publish the data obtained in form of report/paper/patent

Graphical Abstract:



Funding Source (PSDO/ SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Product and process development.
- Report
- Patent
- Paper

Achievements:

Project has been completed in 2024. Its main achievements are given below

- Processes developed: Three processes were developed for the preparation of Skin care oil, Pain

Kill Oil and Stevia Drops.

- Products developed: Three products were developed under this project.
 - Skin Care oil (Cosmetic product)
 - Pain Kill Oil (Herbal analgesic medicine)
 - Stevia Drops (Natural Sweetener)
- Publication: Technical report and a research paper is in process.



Completed Projects

Title	Achievements
Development of Bone Char Filter for Industrial Waste Water Treatment	<ul style="list-style-type: none"> • Process was developed for the conversion of waste bones into bone char. • Almost 300 samples of lead, cadmium and chromium solutions were adsorbed over various adsorbents including bone char. • Lead and cadmium were found to be completely removed, while more than 40% of chromium was also removed through bone char adsorbent. • Technical report is under compilation.
Preparation of Chromate Salts from Indigenous Chromite Ore	<ul style="list-style-type: none"> • Roasting of Chromite was carried out varying temperature and raw materials ratio. • 70 % purity of sodium chromate was achieved. • Lab scale process for the preparation of sodium chromate from indigenous chromite ore has been developed.
Synthesis of Graphene for Industrial Applications	<ul style="list-style-type: none"> • Process has been developed for the synthesis of Graphene. • Graphene/MMA nanocomposites were also prepared. • The paper has been accepted in international journal.
Preparation of Water Proofing System for Durable Concrete	<ul style="list-style-type: none"> • Lab scale process has been developed for the preparation of concrete admixture and air entraining agents. • Technical report is under compilation.
Identification and Phylogenetic Analysis of Medicinal Plant Species from Pakistan by DNA Barcoding Approach	<ul style="list-style-type: none"> • Successfully collected, identified and preserved a significant number of medicinal plant specimens from various regions of Pakistan. • Optimized protocols for high-quality DNA extraction from diverse and often challenging plant materials (e.g., dried leaves, roots, herbal products). • Amplified and sequenced standard DNA barcode regions (e.g., rbcL, matK, ITS) for the collected specimens. • Conducted phylogenetic analyses to accurately identify species and resolve taxonomic ambiguities, uncovering instances of mislabeling and adulteration in local market samples. • Established a foundational DNA barcoding workflow that can be used for quality control and assurance of herbal medicinal products (HMPs) in Pakistan.
Characterization and Production of Wood Vinegar from local Biomass	<ul style="list-style-type: none"> • Designed and fabricated the production unit for wood vinegar production. • Developed a processed to produce wood vinegar and its by product. • Utilized the local biomass and wood waste to help in proper management and utilization/recycling of local waste biomass.

Title	Achievements
Design, Development and Performance Evaluation of ECO Solar Dehydrator with Thermal Energy Storage System	<ul style="list-style-type: none"> • Industrial Design filed with IPO. • Technical Report officially signed and submitted. • Commercialized Unit to other units.
Value Addition of Seasonal Fruits with Aloe Vera Gel as Natural Preservative	<ul style="list-style-type: none"> • Apple aloe vera blended fruit spread product is developed. • Shelf life studies of the prepared fruit spread is completed. • Shelf life studies showed that fruit spread can be preserved with aloe vera gel along with minimum concentration of other preservative. • A more nutritional and medicinal fruit spread with aloe vera health benefits minimize risks associated with consuming synthetic preservatives. • Technical report and process developed is submitted on the compiled research data. • The apple aloe vera blended spread product is commercialized.
Design and Fabrication of Fused Deposition Modeling (FDM) 3D Printer	<ul style="list-style-type: none"> • Literature Reviewed. • Engineering Design completed. • 3D Printer Developed and Fully Operational. • Trained NAVTTC Students.
Development of Skincare Product from Brassica Juncea Seeds for the Treatment of Skin Disorders	<ul style="list-style-type: none"> • Raw material (Brassica juncea seeds) has been procured from Lakki Marwat. • Identification/Authentication of seeds has done and the specimen voucher number (10727) was received from Botany Section Herbarium, MBC, PCSIR. • The obtained seed crude extract was analyzed by GC-MS at Analytical section and the main contents detected were Allyl isothiocyanate (89%), 3-Butenyl isothiocyanate (0.36%), 5-(Methylsulfanyl) pentanenitrile (5.74%), Eugenyl methyl ether (4.35%). • Whereas the fatty acid profile of the B. juncea oil on GCMS showed the presence of Linoleic acid (35.33%), Palmitic acid (32.08%), Oleic acid (18.03%), Stearic acid (10.49%). • Skin Irritancy studies of Oil and extract has been completed and caused no irritancy. So, both the oil and extract are found safe for topical use. • Leaves of Neem, Tea Tree and Aloe vera for formulation of Medicated herbal Shampoo were collected from MBG and extract were prepared. • Extractive values were calculated of <i>B. juncea</i> (10%), Neem (25%) and Tea Tree (16%).

Title	Achievements
	<ul style="list-style-type: none"> • Formulation of Anti-dandruff and Anti-lice shampoo has been completed and its skin irritancy studies were performed. • Antioxidant, Antimicrobial, Anti-inflammatory and Analgesic activities of <i>B. juncea</i> (B.J) have been completed and showed good activity. • All parameters (Moisture, Free fatty acids, Peroxide value, Refractive Index, Rancidity, Vitamin A & Saponification value checked for qualitative assessment of Pure Cold pressed Oil. • <i>B. juncea</i> seeds sample were analyzed on AAS for essential and heavy metal analysis. Ca, Zn, Co, Mn & K were detected while Al, Pb & Cd were not detected. • Raw material for the formulation of cream/lotion for the treatment of scabies were procured and the extraction of neem oil, tea tree oil, clove oil, rose oil, brassica juncea oil and aloe vera gel has been completed. • Process developed, pH, viscosity and skin irritancy tests have been performed. • Herbal Haircare Shampoo for dandruff and lice control have been formulated from <i>B. juncea</i> seeds, neem and tea tree extract with aloe vera gel. • 50 bottles of Herbal Shampoo have been submitted to Welfare Shop for sale. Feedback of the products through volunteers, shelf-life studies and technical report writing is underway.
Bio-detoxification and Biodegradation of Aflatoxins in Poultry and Fish Feed Using <i>Bacillus Subtilis</i>	<ul style="list-style-type: none"> • <i>Bacillus subtilis</i> activation, slant, Petri dish growth and mother culture preparation were carried out. • Mass production of <i>Bacillus subtilis</i>, its ability to check antifungal, Aflatoxin production inhibition and Aflatoxin degradation or either cell wall adsorption in liquid medium were archived. • Large scale production of <i>Bacillus subtilis</i> cell mass, quality checking and product development were carried out in 100L capacity fermentor. • The extracts were checked to inhibit/reduce the spores of various <i>Aspergillus</i> species. • The cultures were blended and formulated with different ingredients and tested against poultry and fish feed aflatoxins. • The product is developed in solid powder form as well as in liquid form at laboratory and pilot plant scale.
Development and Physico-Chemical Evaluation of Functional Detox Beverages	<ul style="list-style-type: none"> • Fruits and vegetables were selected based on their detoxification properties. Multiple formulation trials were conducted using different ingredient combinations, such as apple-ginger, beetroot-carrot and beetroot-pomegranate-ginger. The most acceptable and stable formulation was finalized through sensory and nutritional evaluation.

Title	Achievements
	<ul style="list-style-type: none"> • The finalized product was subjected to nutritional evaluation, including physicochemical analysis, mineral composition and microbiological assessment. • Storage studies were carried out under two conditions: refrigeration and room temperature. The product was analyzed at 15-day intervals for microbial analyses, pH, titratable acidity, vitamin C content, taste and color. Results indicated that the detox drink maintained its quality attributes for up to three months at room temperature and six months under refrigeration. • The Chief Executive of <i>M/s M.K. Marwat Red Rose Food Corporation</i> has expressed interest in leasing the developed detox drink formulation and process for potential commercialization.
Cloning, Functional Expression and Purification of Recombinant <i>TAQ</i> DNA Polymerase from <i>Thermus Aquaticus</i>	<ul style="list-style-type: none"> • Successfully cloned the gene encoding Taq DNA polymerase into the pET28a(+) expression vector. • Achieved high-level functional expression of the recombinant Taq DNA polymerase in <i>E. coli</i> host cells. • Established and optimized a novel, efficient and cost-effective purification protocol using Histag affinity chromatography, resulting in a high yield of the enzyme. • Purified the recombinant enzyme to homogeneity, confirming its size and purity through SDS-PAGE analysis. • Functionally characterized the purified enzyme, confirming its thermostability and specific polymerase activity, making it suitable for PCR applications. • Demonstrated a successful proof-of-concept for the local production of a high-value enzyme, reducing reliance on expensive imported alternatives and building in-house capacity for enzyme technology.
Strengthening of Lab. for the Quantification of Pesticides and Antibiotic Residues in Different Varieties of Honey Leading to ISO Certification	<p>The project was initiated to develop a testing facility for the quantification of pesticides and antibiotic residues in different varieties of honey in KPK.</p> <ul style="list-style-type: none"> • Method has been developed for the screening of Honey samples against 24 general pesticides on GCMS. Moreover, facility has been developed for the screening of honey samples on GCMS for Organochlorine pesticides (20 components). • Similarly, lab has developed facility for the quantification of Chloramphenicol and Oxytetracycline residues on HPLC using PDA detector. • More than fifty customers from honey business have been served for the analysis of 120 samples of export quality Honey against a payment of Rs.720000/-.

Title	Achievements
	<ul style="list-style-type: none">• CRMs have been procured. Lab is ready to participate in the upcoming round of PT being offered by FAPAS, UK through SWISS consultants, Lahore.• Necessary documentation has been completed regarding accreditation with PNAC for ISO-17025 certification.

PCSIR Laboratories, Islamabad

Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad

Title of Project: Design and Fabrication of Water Purification Pot for Drinking by Using Indigenous Low-Cost Materials

Name & Designation of Project Director:

Ms. Fouzia Hussain, SSO

Name & Designation of Project Associate(s):

Ms. Razia Kalsoom, SSO

Dr. Fouzia Noreen, SSO

Dr. Uzma Rashid, SSO

Dr. Abdullah, JTO

Dr. Anila Sajjad. Consultant

Area(s) of Research:

Water Industry

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

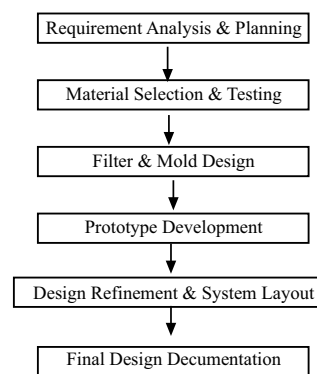
Water is an essential resource vital for human health, agriculture and industry. Despite its importance, access to clean drinking water remains a challenge in Pakistan, particularly in rural and brackish water regions. Many conventional water purification methods, such as Reverse Osmosis and Distillation, are costly as well as inaccessible for low-income communities and often fail to address microbial contamination effectively. There is a need for an affordable and sustainable solution that utilizes indigenous materials for water filtration.

Moreover, brackish water in many regions of Pakistan is unfit for drinking and irrigation, leading to health risks and agricultural limitations. The project focuses on designing, fabricating and testing a low-

cost water purification pot using locally available materials such as clay, sand, silt, pebbles, grog and wood sawdust. The project also aims to refine the pot’s filtration efficiency, optimize material composition and establish a framework for mass production and distribution. This initiative supports environmental sustainability by using natural resources and reducing reliance on plastic filtration systems. The objectives are given below:

- Design and fabricate a ceramic-based water purification pot.
- Identify the most effective local materials for water treatment.
- Determine the optimal material composition for efficient brackish water purification.
- Develop a sustainable production model for large-scale implementation.
- Improve water quality by removing physical, chemical and biological contaminants.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2025-26	Study feasibility plan, & technical requirements for developing preliminary design	Identification, fabrication of indigenous materials & conduct performance testing on the initial prototype	Field testing & compliance with water quality standard	Finalize the design & prepare for mass production

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Product: A cost-effective, environmentally friendly water purification pot made from local materials.
- Technology: A sustainable and affordable water filtration solution.
- Process: A scalable manufacturing and design framework.
- Beneficiaries: Rural communities, regional artisans and the environment.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad

Title of Project: Design & Fabrication of a High-Speed Indigenous Homogenizer: An Import Substitute for Efficient Solvent Mixing

Name & Designation of Project Director:

Engr. Muhammad Azam, Jr. Engr.

Name & Designation of Project Associate(s):

Mrs. Razia Kulsoom, SSO
Engr. Muhammad Yousuf, Jr. Engr.

Mr. Muhammad Afzal, EO
Dr. Anila Sajjad, Consultant

Area(s) of Research:

Engineering

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Homogenization is a critical process in various industries, including pharmaceuticals, chemical engineering and food processing. A high-RPM homogenizer ensures uniform mixing of solvents, improving consistency and efficiency in production. However, many available homogenizers are expensive and imported. This project aims to design and fabricate an indigenous high-RPM homogenizer that is cost-effective, efficient and adaptable for industrial and laboratory applications.

Homogenization is essential in industries like pharmaceuticals, chemicals and food processing for uniform solvent mixing. However, most high-speed homogenizers are imported, expensive and not tailored to local needs, leading to higher costs and procurement delays. Existing models also lack customization, energy efficiency and ease of maintenance, limiting their adoption on lab scale and in small- and medium-scale industries.

This project aims to develop a cost-effective, high-RPM indigenous homogenizer as an import substitute, ensuring efficiency, durability and affordability while promoting self-reliance in industrial machinery production.

The technical Scope of homogenizer is:

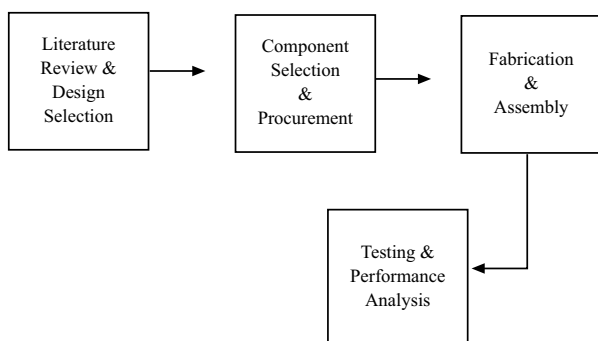
- Capacity 5 to 30
- Rotatory Speed 500–11,000 RPM
- Motor power: 400–800 W
- Power Supply: 220 V AC input, converted to 48 V DC
- Stainless-steel shaft with precision bearings,

vibration-free coupling

The main objectives of the project are as follows:

- To develop an indigenous, cost-effective alternative to imported homogenizers.
- To fabricate and test a prototype that meets industry standards.
- To evaluate the performance of the homogenizer in terms of speed, efficiency and durability.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2025-26	Design and Component Selection and Procurement	Fabrication and Assembly	Testing and Performance Analysis	Optimization and Final Implementation

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- A fully functional high-RPM homogenizer prototype.
- Cost reduction in solvent homogenization compared to imported models.
- Improved mixing efficiency for industrial and laboratory applications.
- Potential for commercialization and scalability in various industries.
- Cater to the needs of the local industry by introducing an indigenous homogenizer as an import substitute.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad

Title of Project: Design & Fabrication of a Solar-Powered Selective Filtration Plant for Production of Premium Quality Natural Mineral Spring Water in Baltistan Division — Exploring Export Potential and Import-Substitute

Name & Designation of Project Director:

Engr. Muhammad Azam, Jr. Engr.

Name & Designation of Project Associate(s):

Mrs. Razia Kulsoom, SSO
 Engr. Muhammad Yousuf, Jr. Engr.
 Dr. Anila Sajjad, Consultant

Area(s) of Research:

Engineering

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Gilgit-Baltistan (GB) is endowed with abundant natural water resources from glaciers, rivers and springs. These glacial and spring waters are renowned for their natural mineral content, making them highly suitable for human consumption and potential commercial use.

The global bottled water market was valued at USD 333.2 Billion in 2023 and is projected to reach USD 538.9 Billion by 2032. The spring water segment alone is expected to grow from USD 214.9 Billion to USD 474.5 Billion. Countries like France and Turkey have capitalized on this demand, with France leading global exports at USD 921 Million in 2022 and Turkey earning USD 66.8 Million from 429,619 tons of exports

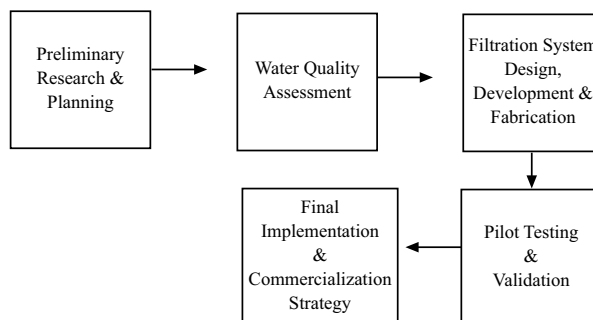
in 2017 to markets such as the UK, Germany and UAE.

The increasing demand for natural and safe drinking water presents a lucrative opportunity for Pakistan. With its rich natural water resources, Pakistan has the potential to become a key exporter of premium bottled spring water, leveraging its access to pristine water sources. However, to meet international export standards, spring water must undergo purification to remove microbial contaminants, sediments, turbidity and organic impurities without disturbing its natural mineral composition.

This project aims to develop a customized filtration plant designed specifically for the purification of spring water. The system will ensure the removal of contaminants while preserving essential minerals, making the water compliant with global quality standards for Natural Mineral Spring Water. This initiative will not only enable Pakistan to enter the global premium bottled water market but also reduce reliance on imported bottled water. Baltistan Division possesses abundant natural spring water, yet Pakistan remains a net importer of bottled water and lacks infrastructure to meet global standards for premium exports. Existing purification systems are costly, energy-intensive and unsuitable for preserving natural mineral content. There is a need for a solar-powered selective filtration plant to produce high-quality spring water, reduce imports and tap into the growing global bottled water market. The main objectives of project are as follows:

- In-depth evaluation of various spring water sources in Baltistan Division Gilgit-Baltistan.
- Design and development of a cost-effective, solar-powered filtration plant that effectively removes contaminants, including microbial impurities, sediments, turbidity and organic pollutants, while preserving the natural mineral composition of the water.
- Utilize solar energy to power the filtration system, making it an environmentally friendly and sustainable solution for remote regions.
- Promote Pakistan’s economic growth by boosting premium spring water exports and reducing dependence on imported bottled water.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Preliminary Research & Planning		Water Quality Assessment	
2nd Year	Filtration System Design, Development & Fabrication		Pilot Testing & Validation	Final Implementation & Commercialization Strategy

Funding Source (PSDP/SGI/RD&I):

In-House

Tangible Outcome:

- Design: Design and fabrication of a customized, cost-effective solar filtration plant specifically for the removal of contaminants from spring water without disturbing its natural mineral content.
- Beneficiary: A detailed assessment of the various spring waters quality in Gilgit-Baltistan will help attract investors to the region for the production of natural mineral spring water, aimed at both export purposes and as an import substitute.
- Quality Report: A detailed scientific report on the quality parameter of various springs in Gilgit-Baltistan.
- Public Health Benefits: The availability of clean, naturally mineral-rich spring water will benefit local consumers, improving public health.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad

Title of Project: Advanced Ceramic Nanofiltration: A Sustainable Alternative to Reverse Osmosis for Water Purification

Name & Designation of Project Director:

Engr. Muhammad Yousif, Jr.Engr.

Name & Designation of Project Associate(s):

Ms. Razia Kalsoom, SSO
 Dr. Fouzia Noreen, SSO
 Ms. Fouzia Hussain, SSO
 Engr. Muhammad Azam , Jr.Engr.
 Mr. Muhammad Afzal , EO
 Dr. Anila Sajjad, Consultant

Area(s) of Research:

- Advanced Filtration Materials (Ceramic & Nanotechnology).
- Water Treatment and Purification Technologies.

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

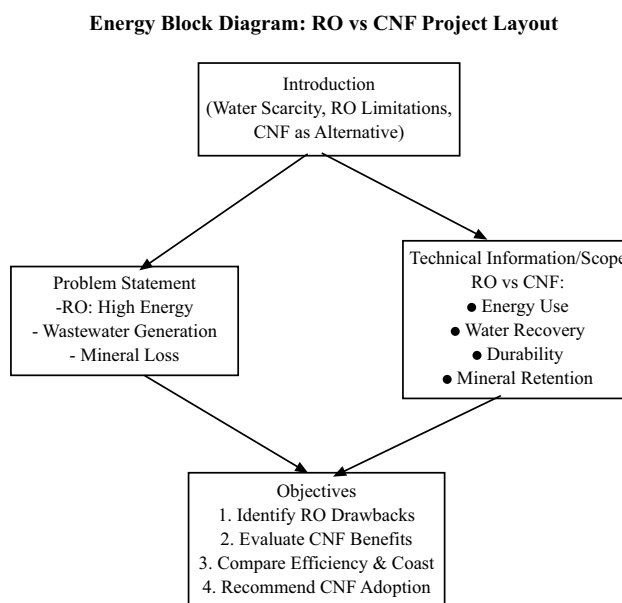
Water scarcity and contamination are pressing global challenges. Reverse Osmosis (RO) has been widely adopted for water purification, but it comes with limitations such as high- energy demand, excessive wastewater and mineral loss. Advanced Ceramic Nanofiltration (CNF) offers an emerging alternative with improved sustainability, durability and efficiency. Despite its wide adoption, RO technology is not sustainable in the long term due to high operational energy, production of large amounts of reject water and removal of beneficial minerals. These drawbacks increase costs, affect water quality and limit its practicality in regions facing water scarcity.

This project compares RO and CNF technologies in terms of efficiency, durability, sustainability and cost-effectiveness for water purification applications.

Key objectives are as follows:

- To identify the limitations of RO technology in water purification.
- To develop and evaluate the advantages of Advanced Ceramic Nanofiltration (CNF).
- To compare both technologies with respect to energy, cost and sustainability.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Literature Review on RO & CNF	Identify RO Drawbacks	Compare RO vs CNF	Design & Experimentation
2nd Year	Design & Experimentation	Analysis Results & Cost-Benefits	Analysis Results & Cost-Benefits	Report writing & present findings with recommendations

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Technology: Development of advanced CNF-based nanofiltration system.

- Product: Prototype CNF membrane for efficient water purification.
- Process: Low-energy, high-recovery water treatment method.
- Beneficiary: Communities facing water scarcity, industries requiring sustainable water solutions.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad

Title of Project: Harnessing the Power of Plants & Bioactive Ingredients in Skin & Hair Care Products

Name & Designation of Project Director:

Dr. Anila Sajjad, Consultant

Name & Designation of Project Associate(s):

- Ms. Razia Kulsoom, SSO
- Dr. Fouzia Noreen, SSO
- Ms. Fouzia Hussain, SSO
- Dr. Iram Fatima, SO
- Syed Arif Hussain, SO
- Mr. Muhammad Afzal, EO

Area(s) of Research:

Cosmetics /Skincare Product Development

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Global demand for natural personal care products is rising as consumers shift toward plant-based, sustainable alternatives to chemical-laden imports. This shifted trend is driven by concerns over the health and environmental impacts of synthetic ingredients. Herbal extracts, essential oils and vitamins rich in bioactive compounds offer proven benefits for skin (antiseptic, anti-inflammatory, anti-aging) and hair care (growth,

shine, softness and repair). The project is designed to harness these plant-based bioactive ingredients to develop a range of skin & hair care products, including different face serums, hair growth toners and sulfate & paraben-free shampoos and conditioners. By focusing on local production of these products, the project seeks to substitute imported products, reduce dependency on foreign imports and create an economic value chain for the local community, while generating revenue and promoting sustainability.

Pakistan's cosmetics import is expected to reach \$275 Million by 2026, up from \$233 Million in 2021. This represents an average growth rate of 2.8% year on year. The personal care industry in Pakistan relies heavily on costly imported products, many of which contain harmful synthetic chemicals and artificial fragrances that can be harmful to skin and hair health. These products are often unaffordable for low and middle-income consumers, while local markets lack effective natural alternatives. Despite the availability of beneficial local resources such as herbal extracts/gels and essential oils, they remain underutilized. The key challenge is to develop high-quality, plant-based skin and hair care products that reduce import dependency while meeting consumer expectations for safety, efficacy and convenience.

With growing preference for organic skincare, this project focuses on formulating herbal-based products using herbal extracts/gels, essential oils (Lavender, Tea Tree, Rosemary) and vitamins. These ingredients offer natural antiseptic, anti-inflammatory and nourishing properties, suitable for treating acne, promoting hair growth and soothing sensitive skin with anti-aging properties. The aim is to develop safe, stable and effective formulations that meet consumer demand for natural and therapeutic personal care solutions. The specific objectives of project are as:

- To utilize locally sourced plant-based bioactive ingredients like herbal gels and various herbal extracts, oils and vitamins for skin & hair care products.
- To replace synthetic, chemical-laden products with natural bioactive alternatives that promote skin hydration, nourishment and hair health and growth.
- To establish a local production system for these

products, reducing dependency on imported products and boosting the local economy.

- To generate significant revenue through local and international sales.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Selection & processing of plants extracts, herbal gels & herbal oil	Develop prototypes for various products	Formulation of skin & hair care products Conduct consumer trials	Formulation of skin & hair care products Shelf-life & stability test
2nd Year	Formulation of skin & hair care products	Conduction of <i>in-vitro</i> & <i>in-vivo</i> tests	shelf-life & stability test	Commercial-ization of end-products

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Development of locally produced, plant-based skin & hair care products.
- Reduced dependency on imported cosmeceuticals products.
- Local Industry Growth.
- Process development for locally manufactured cosmeceuticals products.

Beneficiary:

- Common consumers.
- Cosmeceutical industry.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

PCSIR Laboratories, Islamabad

Title of Project: Bio-Nano-Fertilizers Production using Plants to Mitigate the Environmental Stress Conditions and Enhance Crop Growth, Flowering and Fruiting

Name and Designation of the Project Director:

Dr. Anila Sajjad, Consultant

Name and Designation of the Project Associate(s):

- Ms. Razia Kalsoom, SSO
- Dr. Fouzia Noreen, SSO
- Ms. Fouzia Hussain, SSO
- Dr. Uzma Rashid, SSO
- Dr. Iram Fatima, SO
- Mr. Muhammad Afzal, EO

Area(s) of Research:

Agriculture Biotechnology

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

In agriculture, nanotechnology can help to improve growth and crop productivity by the use of various nanoscale products such as nano-fertilizers, nano-herbicides, nano-fungicides, nano-pesticides etc. An optimized concentration of NPs can be administered by foliar spraying, irrigation with NPs, direct injection, hydroponic treatment and delivery by biolistics. NPs can improve nitrogen metabolism, enhance chlorophyll as well as protein content and upregulate the expression

of abiotic- and biotic stress-related genes. Based on this observation, copper and zinc oxide NPs mediated fertilizer can be formulated to enhance crop growth and withstand stress conditions.

The overuse of synthetic fertilizers leads to soil degradation, water pollution and reduced microbial diversity. Nanoparticle-based fertilizers offer a sustainable alternative by enhancing nutrient efficiency, reducing input needs and promoting plant growth. In Pakistan, a large portion of edible vegetables including leguminous (US\$ 870 Million) and alliaceous (US\$ 109 Million) are imported annually, contributing to an estimated US\$ 70 Billion in vegetable imports (Trend Economy). The development of eco-friendly bionanofertilizers using local plant resources (plant extracts containing N, P, K) can reduce import dependency and improve crop productivity. These nanofertilizers will be applied to some ornamental and medicinal plants to enhance growth and yield under local conditions.

The development of novel and improved agricultural strategies can meet the global demand for food productivity. The scope of this study focuses on the development of environmentally friendly, nanoparticle-based biofertilizers synthesized using leaf extracts of *Albizia julibrissin* and *Sophora mollis*, which are naturally rich in essential nutrients such as nitrogen, phosphorus, potassium and calcium. These NPs enhance plant growth by improving photosynthetic efficiency, antioxidant activity and hormone regulation, thereby increasing stress tolerance. Collectively, these benefits contribute to improved flowering, fruiting and overall plant yield. This approach also supports sustainable agriculture by offering a viable, eco-friendly alternative to conventional chemical fertilizers, with potential for industrial-scale application. This project was developed to meet the following objectives:

- Collection and identification of *Albizia julibrissin* and *Sophora mollis*.
- Green synthesis of CuO and ZnO nanoparticles using plant extracts.
- Formulation and application of BioNano-fertilizers to evaluate effects on plant growth, flowering and fruiting.
- Biological characterization of synthesized nanoparticles and treated plants using standard protocols.

- Development of a commercialization strategy as a sustainable alternative to chemical fertilizers.
- To publish the data as a report, paper and/or patent.

Graphical Abstract:



Quarterly Work Plan:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Plant identification, collection, & drying	ZnO & CuO Nanoparticles synthesis & Physio-chemical characterization	BioNano-fertilizer formulation & Application to pots plants	Harvesting of plants, Morphological analysis & Biological characterization
2nd Year-	BioNano-fertilizer application to soil plants	Harvesting, Morphological, Biological characterization of plants, & Comparative Data analysis	Commercialization strategy & Product commercialization	Report & Paper write up

Funding Source (PSDP/SGI/RD&I/etc.):

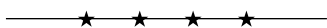
In-House

Tangible Outcome:

- Establishment of an eco-friendly approach for promoting plant growth.
- Development of a novel, plant-based BioNano-fertilizer for potential use in sustainable agriculture.
- Report writing and publication.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

PCSIR Laboratories, Islamabad

Title of Project: Development of Hygienic Travel Paper Soap Using Fruit Peels

Name and Designation of the Project Director:

Ms. Razia Kalsoom, SSO

Name and Designation of the Project Associate(s):

- Dr. Fouzia Noreen, SSO
- Ms. Fouzia Hussain, SSO
- Engr. Muhammad Yousu, Jr. Engr.
- Engr. Muhammad Azam, Jr. Engr.
- Dr. Anila Sajjad, Consultant
- Dr. Iram Fatima, SO
- Dr. Abdullah, JTO

Area(s) of Research:

Skincare Product Development

Duration:

01 Year

Date of Initiation:

July, 2025

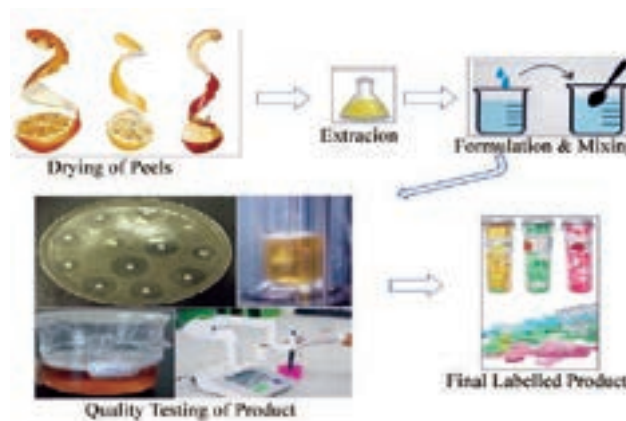
Project Brief:

Personal hygiene is an essential aspect of health and well-being and maintaining cleanliness while travelling can be a challenge due to the lack of access to water or proper sanitation facilities. Paper soap is a thin, lightweight and compact form of soap ideal for travel and outdoor activities. Studies have shown that fruit peels are effective against multifarious bacteria, fungus and parasites that can cause health problems. Considering the antimicrobial potential of fruit peels, their utilization as handwashing soap production becomes an interesting prospect.

Currently, soap products in the market are presented in various forms like solid or liquid, to meet consumer needs. However, travelling with a bar of soap requires more space in the bag. Similarly, travelling with a small bottle of hand wash may cause spillage and leakage in backpack. In such circumstances, travel soaps resembling thin sheets of paper are effective and help in maintaining hygienic conditions. Soaps made up of fruit peels can help with pigmentation, dark spots and detoxify and brighten the skin as fruit peels contain plant chemicals having protective or disease-preventive properties. The main objectives of this project are:

- To utilize indigenous raw materials.
- Preparation of a travel paper soap using fruit peels.
- To determine the antibacterial properties of soap.
- Revenue generation by commercializing the herbal product.
- To publish the data as a report, paper and/or patent.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2025-26	Fruit peel collection, drying and extraction	Preparation of paper soap and its antibacterial testing	Trials and gather feedback from people	Commercialization activities of the end product

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Development of herb-based paper soaps with antimicrobial properties.
- Chemicals free product, reducing concerns associated with skin irritation, allergies and potential long-term health risks.
- Optimized process development and validated herbal product for common use by individuals.
- Travelers and outdoor enthusiasts will be the main beneficiaries benefiting from this product.
- Health-conscious individuals and people achieving a modern living style will prefer using paper soap.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

PCSIR Laboratories, Islamabad.

Title of Project: Formulation of Herbal Mediated Antiperspirant Deodorant with Antiseptic Behavior

Name and Designation of the Project Director:

Ms. Razia Kalsoom, SSO

Name and Designation of the Project Associate (s):

- Dr. Fouzia Noreen, SSO
- Ms. Fouzia Hussain, SSO
- Dr. Anila Sajjad, Consultant
- Dr. Iram Fatima, SO
- Engr. Muhammad Azam, Jr.Engr.

Area(s) of Research:

Cosmetics/Personal Care Product Development

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

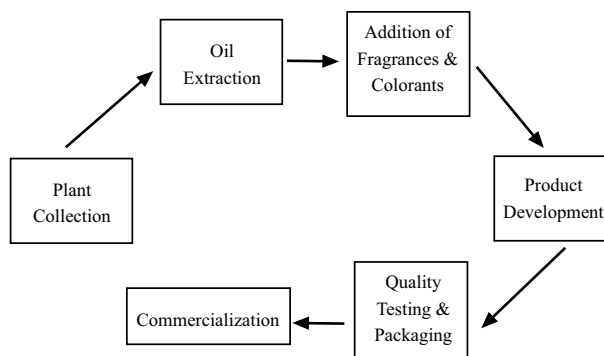
Body odor is a natural consequence of perspiration, a process controlled by sweat glands that regulate body temperature. Underarm perspiring deodorant products make up one of the largest segments in the health and beauty aids industry today. Natural plant-based

antiseptic, antiperspirant deodorant could be created and recommended to people suffering from odour problems.

Currently, various deodorant products are available in the market to meet consumer needs. However, they are associated with side effects like skin irritation, sneezing and nasal congestion. In such cases, plant-based deodorant will be effective for people with sensitive skin as these are safe, convenient and effective options to stop sweating. The deodorant acts by inhibiting the growth of malodour bacteria using bacteriostatic agents such as Triclosan. Traditional deodorants exhibit potential long-term health risks, so herb-based deodorants with antiseptic properties are gaining interest. These are essentially required during exercise and in a warm climate. The main objectives of this project are:

- To formulate tea tree oil and frankincense-based deodorant that provides antiperspirant and antiseptic properties.
- To assess the efficacy and safety of the developed formulation through *in-vitro* and *in-vivo* testing.
- To compare the formulated herbal deodorant's performance to conventional commercial deodorants and antiperspirants.
- Revenue generation and publication.

Graphical Abstract:



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2025-26	Plant collection & extraction	Develop formulation of deodorant	Evaluation and validation of herbal product	Commercialization activities of the finished product

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Date of Initiation:

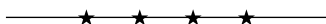
July, 2025

Tangible Outcome:

- Development of eco-friendly, inexpensive products using indigenous resources.
- Optimized process development for the formulation of a deodorant from plant source.
- People with sensitive skin to avoid irritation, allergic reactions or rashes.
- Individuals interested in natural scents and to avoid yellow stains on clothes will prefer herbal deodorant.
- Commercialization of the product in the market as an alternative to the conventional deodorants.

Achievements:

New Project



Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Islamabad.

Title of Project: Design and Development of Analgesic Transdermal Patch from Turmeric and Frankincense

Name & Designation of Project Director:

Ms. Razia Kulsoom, SSO

Name & Designation of Project Associate(s):

Dr. Anila Sajjad, Consultant
 Dr. Nafeesa Qudsia Hanif, PSO
 Dr. Anila Fariq, SSO
 Dr. Bushra Arshad, SSO
 Syed Arif Hussain, SO
 Ms. Anum Goraya, SO

Area(s) of Research:

Pharmaceutical Plant Biotechnology

Duration:

02 Years

Project Brief:

The pharmaceutical industry in Pakistan faces high dependency on imported Active Pharmaceutical Ingredients (APIs), raising costs and exposing supply chains to disruption. Conventional analgesics and NSAIDs, though widely used, are associated with significant side effects. This project explores *Curcuma longa* (Turmeric) and *Boswellia* species (Frankincense) medicinal plants with proven anti-inflammatory and analgesic properties as natural alternatives to synthetic APIs. Due to poor oral bioavailability of their bioactive compounds, a transdermal drug delivery system (TDDS) will be developed to ensure controlled release, improved absorption and reduced systemic side effects. The study involves phytochemical analysis, patch formulation, in-vitro skin permeation and comparative evaluation with commercial analgesics. This research supports sustainable, plant-based pharmaceutical development and contributes to import substitution and healthcare innovation. The technical aspect for developing transdermal patch are:

- Conventional NSAIDs pose safety concerns such as gastrointestinal toxicity and cardiovascular risks. Further existing pain management strategies require frequent dosing, leading to patient non-compliance.
- There is a sheer need of suitable, sustainable solution for optimal analgesic API bioavailability.
- Transdermal delivery offers a promising alternative, offering controlled and targeted release, enhanced bioavailability and non-invasive administration but requires optimized formulation and validation.

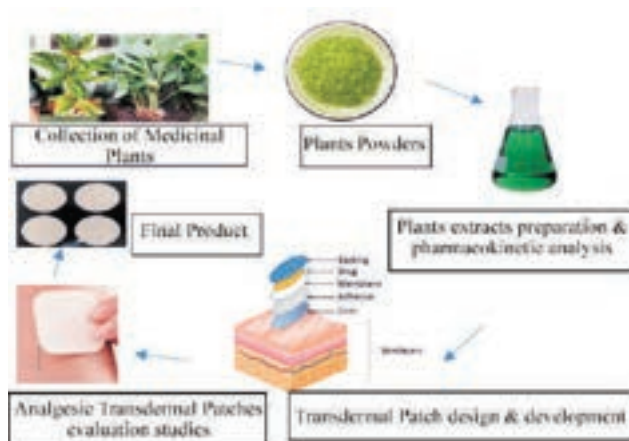
This study aims to overcome these challenges by designing and developing effective and sustainable validated analgesic transdermal patch with controlled delivery of Turmeric and Frankincense. The main objectives are as:

- Utilization of indigenous of plant-based APIs as a step towards import substitution and sustainable pharmaceutical development.
- Preparation, analysis and quantification of the plants extracts active pharmaceutical ingredients (APIs)

- Design, Development and optimization of transdermal patch formulation processes\ products for enhanced drug delivery.
- Assessment of physicochemical properties.
- Evaluation of prepared of transdermal patch via in-vitro studies.
- Compare efficacy with standard NSAIDs through in-vitro analgesic assays.

- plant sources (Turmeric and Frankincense).
- Process leased out or commercialization to pharmaceutical industry as an alternative to NSAIDs.
- Product will save foreign exchange of the country as substitute of import analgesic APIs products.
- Trainings & consultancies will be provided to clients.
- Generation of Significant and impactful Publications.

Graphical Abstract:



Achievements:

New Project



Quarterly Work Plan:

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	Plants collection & Extraction, & Phytochemical Analysis	Quantification of the extracts APIs Pharmacokinetic & Bioavailability Studies	Design, Development & optimization of transdermal patch formulation	Optimization of patch formulation
2nd Year	Assessment of physicochemical properties	In-vitro skin permeation & Comparative Efficacy Testing studies vs NSAIDs-	Documentation & Commercialization Strategy-	Report & Paper write up

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Development of novel Analgesic Product from

Completed Projects

Title of Projects	Achievements
Effects of Chemical /Dehydration /Coating Techniques on Nutritional Quality, Functional Property and Sensory Acceptability of Fruits & Vegetables	<ul style="list-style-type: none"> • A Process Developed for the dehydration of fruits and vegetables by solar dehydrator. • Paper Publications in progress. • Commercialization Status In- Process.
Extraction of Orange Peels Oil using Microwave Assisted Solvent Extraction Technique.	<ul style="list-style-type: none"> • A Process developed to extract oil from orange peels. • Paper Publications in progress. • Commercialization Status In- Process.
Studies on Nano Composite Films for Water Purification and Development of Flavored Alkaline Water	<ul style="list-style-type: none"> • Technical report has been prepared for onward submission to the Head of Unit comprising all the lab data, findings and conclusions. • So far, the purification process is not found much effective in terms of technology development but the data is quite thought-provoking to be published in an international/national Journal of relevant discipline.
Formulation of Chocolate Coated Fruit Delights as Natural & Nutritious Substitute of Synthetic Sweets	<ul style="list-style-type: none"> • Chocolate Coated Fruit Delights product has been successfully developed. • Shelf-life studies are completed.

PCSIR Laboratories, Quetta

Name of Laboratory/Centre/Unit:

MTC/PCRIR Labs. Quetta

Title of Project: Beneficiation/Up Gradation of Sulfur Ore of Balochistan

Name & Designation of Project Director:

Mr. Muhammad Aamir Raza, EO

Name & Designation of Project Associates:

Mr. Khurram Shahzad Buzdar, SSO

Ms. Bibi Seema, SO

Ms. Nadia, SO

Area(s) of Research:

Mineral

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

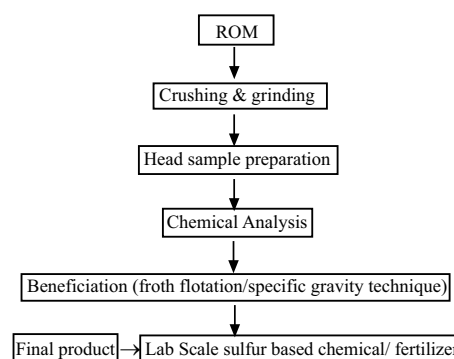
Balochistan is rich in natural resources including sulfur which is primarily mined in areas like districts Chagai and Kalat. Elemental sulfur deposits at Koh-i-Sultan volcano in the District Chagai of Balochistan is Pakistan's only assured source of elemental sulfur. The Koh-i-Sultan (Loc. S-1) sulfur deposits (lat 29°07'N., long 62°47'E.) are in the dist Chagai. Koh-i-Sultan sulfur is the most important Reserves were estimated in 1976 at 85,000 Tonnes but in recent study these are about 0.8 Million Tonnes. These deposits are grouped into four areas named the Batal, Miri, Nawar, and Zonk and all lie within an area of about 7 square miles.

According to available data Pakistan has imported approximately 95,000 Tonnes of Crude/Unrefined Sulfur from Iran, Uzbekistan and Saudi Arabia. By the execution of this project, import of sulfur will be reduced. Moreover, sulphur has a wide range of applications across various industries. One of its primary uses is in the production of sulfuric acid, a key chemical in fertilizers, batteries, paper, textile industries. In the

agriculture sector, sulfur is used as a soil conditioner and a pesticide to control fungal diseases in crops. The objectives include:

- Sulfur mining contributes to the local and national economy by generating revenue.
- Employment opportunities to local community.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd, 4th, 5th Quarter	6th , 7th, 8th Quarter
<ul style="list-style-type: none"> • Literature survey. • Sulfur ore procurement. 	Crashing and grinding, Sample preparation, Screening	<ul style="list-style-type: none"> • Different trails for beneficiations/ up-gradation Chemical analysis. • Trails for sulfur-based chemical & fertilizer. • Product evaluation. 	<ul style="list-style-type: none"> • Data compilation. • Report writing.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

- Import Substitute / Reduce Import of crude & refined sulfur.
- Indigenous low grade sulfur ore would be upgraded to value added product.
- Process development.
- Enhance local mining sector

On-Going

Name of Laboratory/Centre/ Unit:

FTD/PC SIR Labs. Quetta

Title of Project: Process Development and Formulation of Whey-based Vegetable Soups and Evaluation of their Properties

Name & Designation of Project Director:

Mr. Junaid Ahmed, SO

Name & Designation of Project Associate(s):

Ms. Hiba Amanat Ali, SO

Area(s) of Research:

Food Technology

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

The surge in protein-rich diet consumption in recent years reflects a growing global awareness of health benefits. With increasingly busy lifestyles, many find it challenging to maintain a consistently diet. Consequently, there's a heightened demand for convenient sources. This has led to a rise in protein supplements and fortified foods, offering quick, efficient alternatives to traditional meals. As such, the market for protein-rich options continues to expand, meeting the dual needs for health-conscious choices and convenience in today's fast-paced world.

Whey a protein complex derived from milk is being acknowledged as a functional food with a number of health benefits. The biological components of whey, including lactoferrin, beta-lactoglobulin, alpha lactalbumin, glycolmacropeptide and immunoglobulin demonstrate a range of immune enhancing properties.

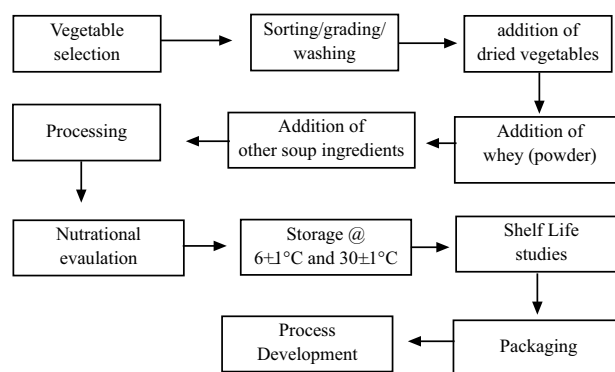
Whey has the ability to act as an antioxidant,

antihypertensive, antitumor, hypolipidemic, antiviral, antibacterial and chelating agent. Today, whey is a popular dietary protein supplement purported to provide antimicrobial activity, immune modulation, improved muscle strength and body composition and to prevent cardiovascular disease and osteoporosis. Several important constituents in whey having excellent functional characteristics enhance opportunities for a wide-range application of whey and whey constituents in the food industry.

Dried soup powders have an advantage of protection from enzymatic and oxidative spoilage and flavor stability at room temperature over long periods of time (6–12 months). In addition, they are ready for reconstitution in a short time for working families, hotels, hospitals and restaurants. The primary objectives of the present study are as follows:

- Development of whey-based-vegetable-soup can help solve the problem of its disposal and can supply better to the health-conscious consumers as vegetable soups are liked for its taste, color and aroma.
- Exploring different ratios and combinations to achieve desired taste, texture, profile and formulation development meets the dietary guidelines.
- Investigating various processing techniques for integrating whey and vegetable ingredients in to soup formulations.
- Conducting comprehensive analysis for whey-based soups to determine macronutrient and micronutrient profiles.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of cost effective and rich whey-based vegetable soups.
- Current research aims to impact the economy positively through profitable product development with minimal investment.
- Development of instant soup mixes providing quick and easy meal options.

Achievements:

- Ingredients selection and Preliminary formulation has been carried out.
- Experimental Design and optimization of soup formulations are in progress.
- Small scale trails are in progress.



Name of Laboratory/Centre/ Unit:

MTD/PCSIR Labs. Quetta

Title of Project: Study of Precious Metals and Upgradation of Copper Ore of Balochistan

Name & Designation of Project Director:

Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate:

Mr. Muhammad Aamir Raza, EO

Area(s) of Research:

Mineral Up-gradation

Duration:

2 ½ Years

Date of Initiation:

July, 2023

Project Brief:

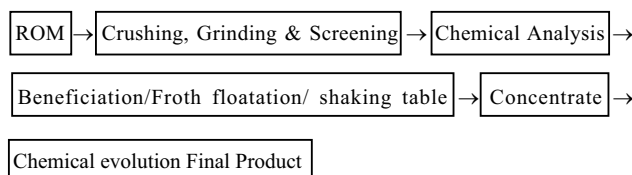
Huge reserves of copper ore are presents/reported in chagai District of Balochistan. Reko Diq, saindak, amuri represents one of the largest copper and gold reserves in the Pakistan having estimated reserves of

5.9 Billion tons of ore grading 0.41% copper and gold reserves amounting to 41.5 Million.

The area has been a subject of research and exploration by mining companies due to its potential for large scale mining operations. typically focus on such as evolution precious metals as well as up gradation of copper in reko diq copper ore. The global market has announced copper as a modern energy metal and finds its extensive utilization in the electrical wiring, power transmission lines, alloying, anticorrosive, coating, heat exchangers, refrigeration tubing, etc. Copper ore is primarily beneficiated from sulphide mineral deposits. Due to high-grade copper sulphide deposit exhaustion, the focus has now shifted towards recovery from different lean-grade oxide and mixed ore deposits. Extensive research has been carried out on the flotation of copper sulphide ore as compared to copper oxide and mixed type ores. The objectives are as follows:

- This project will be helpful to provide data of precious metals and up gradation of copper ore.
- To exploit the natural resources of the province.
- To develop cost effective process.

Graphical Abstract:



Work Plan:

- Sample collection.
- Crushing grinding and screening.
- XRF and XRD analysis of samples.
- Beneficiation by using shaking table and froth floatation techniques.

Funding Source (PSDP/SGI/RD&I/etc):

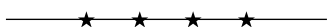
In-House

Tangible Outcome:

- Up gradation of copper ore for commercial use.
- Identification of precious metals.

Achievements:

- Collection of samples has been done.
- Crushing and grinding completed.
- Screening/mesh size completed.
- Chemical analysis of head sample and different mesh sizes is under way.
- Available ore has low percentage of Copper content as well as precious metals.
- New samples will be arranged.



Name of Laboratory/Centre/ Unit:

MTD/PCSIR Labs. Quetta

Title of Project: The Development of Hydro-metallurgical Process for Separation of Associated Silica from Ferromagnetic sand of Baluchistan

Name & Designation of Project Director:

Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate:

Mr. Muhammad Aamir Raza, EO

Area(s) of Research:

Mineral Up-gradation

Duration:

2 ½ Years

Date of Initiation:

July, 2023

Project Brief:

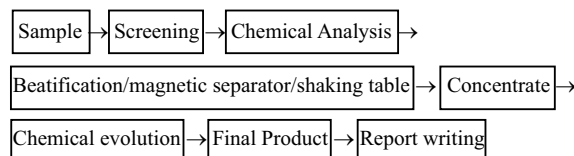
Magnetite is a ferrimagnetic mineral with chemical formula Fe_3O_4 , one of several iron oxides and a member of the spinel group. The chemical name is iron oxide and the common chemical name is ferrous-ferric oxide. The formula for magnetite may also be written as $FeO \cdot Fe_2O_3$. Magnetite is the most magnetic of all the naturally occurring minerals on earth. Naturally magnetized pieces of magnetite, called lodestone, will attract small pieces of iron. Magnetite has been very important in understanding the conditions under which rocks form. Magnetite reacts with oxygen to produce hematite, small grains of magnetite occur in almost all

igneous and metamorphic rocks. Magnetite also occurs in many sedimentary rocks, including banded iron formations. In many igneous rocks, magnetite-rich and ilmenite-rich grains occur that precipitated together from magma. Magnetite also is produced from peridotites and dunites by serpentinization. These sedimentary rocks have been used to infer changes in the oxygen content of the atmosphere of the Earth.

Magnetic iron oxides are often used in magnetic storage, for example in the magnetic layer of hard disks, floppy disks and cassette tapes. Magnetite powder efficiently removes arsenic from water, the efficiency of which increases ~200 times when the magnetite particle size decreases from 300 to 12 nm. Arsenic contaminated drinking water is a major problem around the world, which can be solved using magnetite as a sorbent.

In Balochistan magnetite minerals are found in Chagai district. Pachinkoh - 45 Million tons with average iron content 49%, predominantly magnetite, Chigendik - 05 Million tons with average iron content 45% predominantly magnetite, Chighazi - 20 Million tons. The main objective of the present study is to explore the mineral of Baluchistan for value added products.

Graphical Abstract:



Work Plan:

- Sample collection
- Screening
- Chemical analysis of different mesh sizes
- Beneficiation by using magnetic separator and shaking table

Funding Source (PSDP/SGI/RD&I/etc):

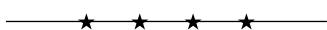
In-House

Tangible Outcome:

To develop cost effective processes for synthesis of iron on industrial scale.

Achievements:

- Chemical analysis of head sample is completed.
- Sieving analysis of head sample {06 mesh sizes}.
- Chemical analysis of iron and silica of 06 different fractions obtained from sieve analysis is completed.
- Four mesh sizes (-50 + 80, -80 + 100, -100 +150 and -150) introduced on magnetic separator.
- 500g of combined mesh sizes results.
- Concentrate of iron obtain 259.10 g; Slime weight 240.60 g; Head sample upgrade 51.82 % with 12.20% silica.
- To minimize percentage of silica and to increase percentage of iron content trails are under way by using shaking table technique to get maximum iron percentage.
- Different trail was conducted to achieve maximum purity & weight recovery.
- Technical report will be submitted.



Name of Laboratory/Centre/ Unit:

MTD/PCSIR Labs. Quetta

Title of Project: Study and Classification of Coals by Rank of Different Coal Fields in Baluchistan

Name & Designation of Project Director:

Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate:

Mr. Muhammad Aamir Raza, EO

Area(s) of Research:

Mineral Up-gradation

Duration:

2 ½ Years

Date of Initiation:

July, 2023

Project Brief:

There are six main coal producing areas in Balochistan where coal-mining activities are in progress. These are - Khost–Shahrig–Harnai 76 Million Tonnes; Duki 50 Million Tonnes; Sor Rang–Daghari 50 Million Tonnes; Pir Ismail Ziarat 2 Million Tonnes; Mach 23

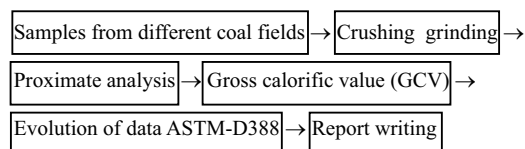
Million Tonnes and recently mining was started in Chamalang area. The heating value of coal produced from Balochistan varies from 9637 to 14357 Btu/lb.

The current estimated coal import in Pakistan is around 3-5 Million tons per year in the year 2013 and the coal consumption is expected to be more than double in the next few years as the government has planned to convert some existing oil based thermal power plants to coal and also to establish new power plants based on coal consumption. The international market price of coal is 70 to 120 USD which equals to 7000 to 12,000 Rs. per metric ton. In this regard the coal importers are spending an amount of 300 to 500 Million Pakistani rupees for the import of coal, this amount can be reduced 50% if we develop and utilize our local coal resources.

Coals classification will establish categories of coal based on gradational properties that depends principally on degree of metamorphism to which the coal was subjected while buried. These categories indicate ranges of physical and chemical characteristics that useful in making broad estimate of the behavior of coal in mining, preparation and use. Classification of coal is based on fix carbon and gross caloric values (GCV). The higher rank coal is classified according to fixed carbon on dry basis; on other handed of lower ranks coals are classified according to gross caloric valued (GCV) on the moist basics. The objective are:

- To utilize the indigenous coal resources for economic growth of the province and the country.
- It will be useful/ helpful for researchers and local mining industry.

Graphical Abstract:



Work Plan:

- Sample collection from different coal fields of Balochistan.
- sample preparation.
- proximate analysis.
- GCV.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Classification of coal will be useful in making broad estimate of the behavior of coal in mining sector and use.
- Tabulated data of classification of coals rank will be helpful for local mining sector, mine owners and for further research in field of coal.

Achievements:

- Coal samples from different coal fields (sharag, mach, musa khel and duki) in Balochistan has been collected.
- Crushing and grinding of collected samples has been completed.
- Gross calorific values of 12 samples which collected from different coal fields in balochistan have been completed.
- Proximate analysis of collected samples has been completed.
- All data in compilation phase and technical report will be submitted.



PCSIR Fuel Research Center, (FRC)

Name of Laboratory / Centre / Unit:

Fuel Research Centre – PCSIR Karachi

Title of the Project: Development of Sustainable Soil Amendment Conditioner from Coal Ash

Name & Designation of Project Director:

Mr. Santosh Kumar, PSO

Name and Designation of Project Associate(s):

Mr. Amanat Ali, SSO

Mr. Nadir Buksh, SSO

Engr. Ali Gohar, SE

Syed Najam Ul Islam, TO

Area of Research:

Agriculture, Environment, Energy, Industry etc.

Duration:

02 Years

Date of Initiation:

July, 2025

Project Brief:

Low rank or grade coals (LGC) are widely distributed over the world. Coal plays a vital role in the global energy demand especially through power generation and it mitigates the energy poverty. Pakistan is having large reserves of low grade coals. The use of low-grade coal in various industries like power plants, metallurgical plants, cement units etc. leads to environmental pollution because of generation of large amount of solid (Coal Ash) and gaseous pollutants.

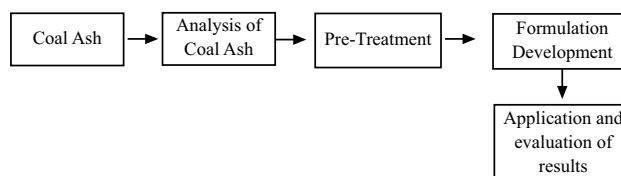
Coal ash, a byproduct of coal combustion, can be a source of micronutrients for the agricultural sector. When applied to soil, certain types of coal ash, particularly fly ash, can increase the availability of micronutrients like boron, copper, iron, manganese and zinc, potentially improving plant growth and yield. However, the effectiveness and safety of using coal ash as a fertilizer depend on factors like ash type, soil type and plant species.

The low grade coal and coal briquettes when used in industries they produces tons of ash. Conversely, as

the result of this industrial application, several tons of solid waste (ash) will be generated per day resulting in significant environmental issues. Therefore, disposal of generated solid waste will become one of the major issues of the country needed to be resolve on prior basis in near future with utilization of coal ash in different industries like agriculture sectors. Some coal ashes may contain heavy metals, which could pose risks if they accumulate in the soil or plants at high levels. In current research the ash of low-grade coal and coal briquettes will be utilized to obtain micronutrient for agricultural sector. The objectives are:

- To evaluate coal ash to increase the availability of micronutrients in the soil, potentially addressing deficiencies and enhancing plant uptake
- To evaluate coal ash to improve soil texture and water retention capacity, particularly in sandy soils
- The outcome of the project may result in providing a source of micronutrients and can eventually reduce the use of synthetic fertilizers

Graphical Abstract:



Work Plan:

- Literature survey.
- Investigation and identification of coal ash to be used for evaluation purpose.
- Identification of efficient methods for the pre and post treatments of coal ash.
- Application of the methods on lab and pilot scale and selection of suitable method.
- Data compilation and publication of R&D outcome (Papers, Patent, Research Report, Conference, Seminar etc).

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

Utilizing coal ash in agriculture can be a sustainable way to manage a byproduct that would otherwise require disposal.

Achievements:

New Project



Name of Laboratory / Centre / Unit:

Fuel Research Centre – PCSIR Karachi

Title of the Project: Boiler-Specific Clean Fuels for Sustainable Industrial Energy: Addressing Pakistan’s Energy Crisis

Name & Designation of Project Director:

Dr. Anila Sarwar, SSO

Name and Designation of Project Associate:

Syed Kabir Shah, SSO

Area of Research:

Fuel & Energy

Duration:

01 Year

Date of Initiation:

July, 2025

Project Brief:

Boilers play a fundamental role in industrial energy systems by generating steam for various manufacturing processes. Their fuel selection significantly influences efficiency, cost and environmental sustainability. Globally, natural gas is preferred due to its high efficiency and low emissions, while coal remains a key energy source despite environmental concerns. Furnace oil serves as an alternative where gas infrastructure is lacking, but economic and regulatory challenges are limiting its use. Biomass fuels are emerging as viable substitutes in some regions, supporting cleaner energy transitions. Countries like China and India have successfully integrated coal briquetting technologies

to improve combustion efficiency and reduce emissions. Pakistan’s industrial sector relies heavily on natural gas, imported coal and furnace oil for steam generation. However, rising energy costs, supply constraints and environmental concerns are driving industries to explore alternative energy sources such as biomass, solar energy and indigenous coal. For instance, the cement industry is considering Thar coal to reduce reliance on imported fuels. Despite possessing significant coal reserves, inefficient combustion and high emissions hinder effective utilization. Most industries in Pakistan operate fixed-bed and chain grate boilers, which require optimized fuel solutions for better efficiency and sustainability.

Fuel briquetting presents a promising approach to improving combustion efficiency, reducing environmental impact and ensuring a more sustainable industrial energy supply. Coal briquettes provide high energy output, biomass briquettes offer a low-emission alternative and mixed briquettes optimize both efficiency and environmental impact. Developing boiler-specific fuel briquettes will support key industries like textiles, cement and food processing by lowering costs and promoting cleaner fuel solutions. The fabrication of coal, biomass and mixed briquettes enhances combustion, lowers emissions and improves adaptability, providing industry-specific energy solutions.

This research aligns with Pakistan’s national energy policy by reducing dependence on costly imported fuels and promoting the utilization of locally available energy resources in fixed bed and chain grate boilers. Enhancing fuel efficiency and sustainability contributes to industrial self-sufficiency while supporting environmental goals. Additionally, the development of a fuel briquette industry has the potential to replace imported coal and furnace oil, reducing the country’s trade deficit. Strengthening local production capabilities can also create export opportunities, increasing Pakistan’s presence in the global energy market and supporting long-term economic growth.

Pakistan's industries face multiple challenges related to boiler fuel:

- **Natural Gas Shortage:** Industries struggle with inconsistent gas supply, leading to operational disruptions.

- High Cost of Imported Fuel: Dependence on imported coal and furnace oil increases production costs and strains foreign exchange reserves.
- Inefficient Combustion of Raw Coal: High unburnt carbon residues, reduced energy output and increased slagging affect efficiency.
- Environmental Concerns: High emissions from existing fuel sources pose compliance challenges with environmental regulations.
- Limited Adoption of Alternative Fuels: Despite the potential of biomass and hybrid fuel briquettes, industries lack the necessary technical support for implementation.

Recognizing these challenges, Pakistan has introduced policies such as the Alternative & Renewable Energy Policy 2019, Coal Gasification Initiatives and the Thar Coal Development Plan to encourage the utilization of indigenous coal and alternative energy sources. However, effective implementation remains a challenge due to combustion inefficiencies and lack of suitable fuel technologies. This research aims to bridge that gap by optimizing combustion efficiency, minimizing operational costs and reducing emissions through the development of high-quality, boiler-specific fuel briquettes tailored for industries. This project will focus on a comprehensive industrial-scale R&D proposal covering the following areas:

i. Fuel Briquette Formulation & Manufacturing:

- Selection of optimal coal and biomass fuel sources for industrial fuel composition.
- Development of standardized production techniques for large-scale manufacturing.

ii. Pilot Scale Combustion Performance Analysis in Various Boiler Systems:

- Evaluation of combustion efficiency, energy output and fuel consumption in different boiler types (e.g., fixed-bed, chain grate).
- Assessment of unburnt carbon residues, slagging tendencies and emissions.

iii. Optimization of Boiler Operations:

- Identification of optimal air-to-fuel ratios, grate speeds and fuel feeding rates.
- Implementation of modifications to improve heat

transfer efficiency and reduce operational costs.

Environmental Impact Assessment:

- Measurement and comparison of emissions from briquettes versus raw fuels (coal, furnace oil, natural gas).
- Recommendations for achieving compliance with environmental standards.

The objectives of the present study are given below:

- To enhance combustion efficiency and energy output of existing industrial fuel.
- To minimize unburnt carbon residues and slag formation, improving industrial boiler performance.
- To reduce emissions and promote sustainable industrial practices.
- To assess the economic and commercial viability of fuel briquettes as an alternative to imported fuels.
- To develop industry guidelines for optimal utilization of fuel briquettes in different boiler types.
- To foster the adoption of locally manufactured fuel briquettes and expand export potential.

Graphical Abstract:



Process Flow Diagram: Combustion of Proposed Industrial Fuel in Boiler

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

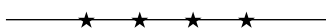
Tangible Outcome:

- Technology / Product: Fuel briquettes design for use in industrial chain grate and fixed bed boilers.
- Process: Briquetting and Combustion Optimization Process.
- Beneficiary:
 - Industrial Sectors (Textile, Cement, Food

- Processing *etc.*).
- Local Coal Producers and Coal Briquetting Industry.
- Environment and National Economy.

Achievements:

New Project



On-Going

Name of Laboratory / Centre / Unit:

Fuel Research Centre – PCSIR Karachi

Title of the Project: Conversion of By-product of Humic Acid Pilot Plant to Clean Fuel

Name & Designation of Project Director:

Mr. Amanat Ali, SSO

Name and Designation of Project Associate(s):

Syed Kabir Shah, SSO
Mr. Nadir Buksh, SSO

Area(s) of Research:

Environment, Energy, Industry *etc.*

Duration:

02 Years

Date of Initiation:

July, 2024

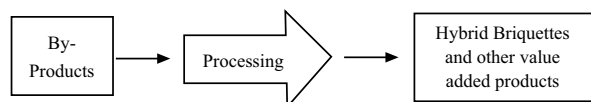
Project Brief:

Low grade coal is utilized for various purposes; one of them to extract organic matter for industrial purpose, after the extraction of organic matter the major part of by-products is consist of carbon that may convert to value added products such as activated carbon and solid fuel *etc.* Humic acid Pilot Plant is in activated condition at PCSIR FRC, Karachi to promote FRC developed technologies. During the production of liquid humic acid the solid contents of coal are produced as

by products that contain carbon and cationic mass that leads environmental pollution if discarded to the environment as land filler. The aim of this study is to utilize the by-products for the production of value-added product and reduce the environmental pollution. The objectives are:

- Value addition to industrial & agriculture waste material.
- Development of new low cost clean fuel.
- Development of new processing methods for different formulations of humic acids and allied fertilizers.

Graphical Abstract:



Quarterly Work Plan:

1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Lab scale process development	Developed Process will be applied on pilot scale	Data compilation and evaluation of processes	Report writing & Promotion of developed Technologies

Work Plan:

- Process the by-product to separate the metallic oxides.
- Blend the carbon contents with agriculture or bio-waste material and other additives to produce hybrid briquettes and evaluate its characteristic properties to utilize as clean fuel.
- Data compilation to promote the developed technology.

Funding Source (PSDP/SGI/RD&I/*etc.*):

In-House

Tangible Outcome:

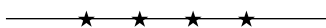
- To convert by-product to value added products.
- To utilize the by-product of Humic Acid Pilot Plant

in a fruitful manner.

- To promote the developed technologies.

Achievements:

- Three novel coal samples of different calorific value have been selected and tested for GCV, proximate and other parameters as well.
- Lab. Scale processes have been developed to obtain as clean fuel; fractions have been separated and collected for lab testing for comparison purpose and optimization of parameters.
- One of three samples with good reported composition of Humic Acid is processed at pilot scale for the separation of fraction and process developed protocols.
- Lab-scale work is started to separate the humic acid, ash and higher GCV fractions to optimize the clean fuel characteristics.
- Briquettes of the raw coal samples have been prepared for comparative study purpose and to establish the correlation between processing methods and combustion characteristics of the coal.
- Protocols for the marketing of two products namely FR-Humibase-50% (w/w) and FR-Humibase-70% (w/w) have been established to market the products for agricultural sector (the products are made of natural leonordite / lignite coal with minimum 50% and 70% humic acid composition. It has excellent soil conditioner effects and can be applied in all agricultural and horticultural plants).
- For the purpose of ash and emission gases reduction basic (NaOH) washing protocols on pilot scale of low grade fuels to convert into high grade solid fuel are under optimization.



Completed Projects

Project Title	Achievements
Waste-to-Energy Conversion: Potential and Development of Renewable Fuel from Indigenous Biomass Waste	<ul style="list-style-type: none"> • Process Developed: 01. • Paper publication: in progress.
Extraction of Metal Oxides from Coal Bottom Ash	<ul style="list-style-type: none"> • Process Developed: 01. • Paper publication: in progress.

Leather Research Center (LRC)

Name of Laboratory/Centre/Unit:

Leather Research Centre, PCSIR Karachi.

Title of Project: Preparation of Intumescent Coatings for Leather Using Indigenous Materials

Name & Designation of Project Director:

Dr. Beena Zehra, SSO

Name & Designation of Project Associate(s):

Mrs. Tahira Ayaz, SSO

Mr. Muhammad Noushad, RTA

Area(s) of Research:

Leather

Duration:

02 Years

Date of Initiation:

2025

Project Brief:

Intumescent coatings are used to provide protection against thermal degradation. These protective items are needed in the commercial places where protections are required. Leather is used in majority of protective items i.e. gloves, high heat clothing, shoes cover etc.

The conventional type protective coatings are made from silicone, acrylics, styrene acrylics, epoxides, urethanes, chlorinated rubber etc. as per industry requirement. The complete conventional finish decreases the flame resistance of leather.

The tanned leather is resistant up to 200°C for a short duration after that pyrolysis will occur. To increase the high temperature resistance an additional coating process/formulation is required. The leather itself has much flame resistance as compared to other synthetic type materials such as plastic and textile fabrics. Due to this characteristic, the leather is used in the protective items, the stability of leather to increase to make it useful for protection is an industrial demand. The leather finishing systems are designed according to the end-leather desired with improved feel and appearance. However, due to the fibrous structure, each type of leather shows a different flame resistance. An intumescent coating for leather that can resist

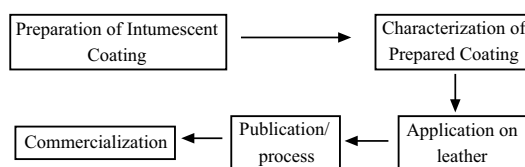
temperature range 200°C to 600°C. The intumescent coating will be efficient toward these two parameters:

- Reduce the efficiency of flame spread.
- Resistance against ignition at high temperature.

The ability of leather coating to resist deterioration when kept at high temperature use. This heat resistance of leather depends on the finishing binder's system and tanning. Therefore, this project will enhance the main feature of the leather utilization in an efficient and modern finishing high thermal stable product. Other objectives include:

- Preparation of Intumescent coating for leather.
- Characterization & application on leather.

Graphical Abstract:



Quarterly Work Plan:

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<ul style="list-style-type: none"> • Literature Survey • Selection of Raw materials 	<ul style="list-style-type: none"> • Purchasing and Characterization of selected Raw Materials • Preliminary Experimentations 	<ul style="list-style-type: none"> • Preparation of Intumescent Coatings • Optimization of Reaction Conditions for best Technique 	Characterization of prepared Intumescent Coatings
5th Quarter	6th Quarter	7th Quarter	8th Quarter
Application on Different leathers samples in tannery area Finishing Room	Thermal and physical testing of Applied Leathers i.e. flame impact testing, tensile and tear strength etc.	Compilation of data	<ul style="list-style-type: none"> • Patent /Publications • Marketing /Commercialization

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Tangible Outcome:

Technology for Intumescent Coating

Achievements:

New Project



Name of Laboratory / Centre / Unit:

Leather Research Centre, PCSIR Karachi

Title of Project: Reduction of Heavy Metals in Tannery Effluent through Phycoremediation using Microalgae

Name & Designation of Project Director:

Dr. Rajkumar Dewani, SSO

Name & Designation of Project Associate(s):

Dr. Farman Ahmed, PSO

Mrs. Tahira Ayaz, SSO

Mr. Sikandar Ali Soomro, JTO

Area(s) of Research:

Leather and Textile

Duration:

02 Years

Date of Initiation:

July, 2024

Project Brief:

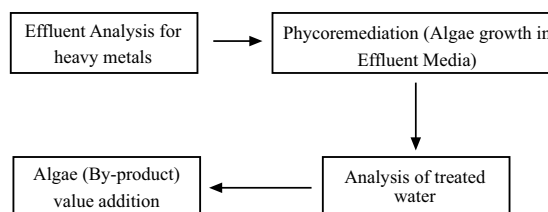
Pakistan is passing through a phase of severe economic crisis which is drastically affecting its industrial sector. To overcome these challenges the industrial sector must be facilitated in all possible ways. Unfortunately, after production the export oriented products have to go through stringent quality testing as per international standards that aids to difficulties of the industrialists. The test costs are heavily charged in foreign currency which is an additional load. The

current project is designed to mitigate some of these difficulties by developing test methods that are low cost, optimized and validated to be comparatively efficient as the standard methods if not better.

The traditional methods for analysis of heavy metal pollutants require State-of-the-art equipment for quantification that aid to the total production costs of our export-oriented industry. Modified methods with medium cost and lost cost analysis techniques could be further explored to address some of these issues. Metal complexation and consequent screening through visible spectrophotometry is the conventional technique for analysis of vast number of metallic species. A metal-ligand pair provides a specific peak wavelength (λ_{max}) for quantitative application. By replacing the ligand, the sensitivity of the technique, the linear range and resistance to interference may be enhanced. Similarly, advanced sample preparation and pre-concentration techniques can offer better detection limits as compared to those already reported. These potential dimensions will be explored to produce analytical results that are near (if not comparable) to advanced analytical techniques like Flame atomic absorption spectroscopy etc. The objectives are as follows:

- The project aims to optimize the existing testing methods for analytes like chromium (both tri and hexavalent), iron, arsenic, cadmium, mercury, lead, ammonia nitrogen etc. through colorimetric methods utilizing newer ligands for metal complexation.
- Focus would be to introduce and apply modern sample preparation methods to improve analysis results and / or their credibility and ranges.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.)

In-House

Tangible Outcome:

- The expected outcome of project is a process that may be updated to a technology depending on the performance. The novelty may lead to good quality research article.
- The immediate beneficiary would be leather and textile industries of Pakistan. The success of the project may benefit and involve a wider range of industrial sectors, Environmental Protection Agency (Sindh) or private investors interested in commercializing the process.

Achievements:

- The project currently in progress. Initial effluent trials for determination of heavy metals like; mercury, cadmium, lead, chromium etc. have been carried out successfully through standard methods.
- Two species of microalgae were grown successfully in artificial medium with 50% effluent water. The algal species reduced the concentration of chromium, lead and mercury to significant levels.
- Further trials will be carried out with other metals and with textile effluent.



Name of Laboratory/ Centre/ Unit:

Leather Research Center, PCSIR Karachi

Title of Project: Develop a Bio-polymer for Safe Leather Re-tanning Process & Study the Environmental Impact

Name & Designation of Project Director:

Dr. Beena Zehra, SSO

Name & Designation of Project Associate(s):

Raja Asad Ali, Sr. Tech.

Area(s) of Research:

Leather Processing Chemicals

Duration:

02 Years

Date of Initiation:

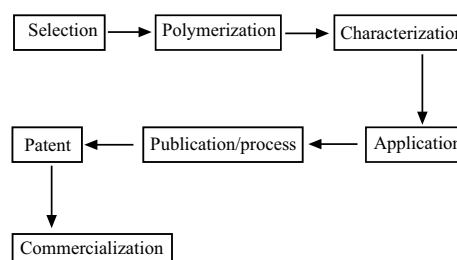
July, 2024

Project Brief:

Raw skin/Hide is converted into a useful durable form called leather after various tanning stages. Re-tanning of leather fills the looser areas of hides and skins and improves the leather physical properties. Re-tanning process of leather requires various types of polymers to provide leather full softness, fullness, filling efficiency, increase in shrinkage temperature, etc. Mostly re-tanning is being carried out is costly with the usage of acrylic based polymers which are mostly un-available. The sustainable products for leather processing are gaining more interest for better consumption of product recycling and biodegradation. Most commonly monomers are Acrylonitrile, Acrylic Acid, Ethyl Acrylate, Butyl Acrylate Methacrylate, Acroleic Acid, etc. For the reduction of environmental impacts of acrylic re-tanning alternate products are highly demanded by tanners. Therefore, this project is emphasized to prepare new bio-based polymers from natural resources. The bio monomers are being develop from natural polysaccharides, starch, proteins, natural oil and fats, etc. The polymerization of bio-based products will increase the efficiency of products beside the clear elimination of hazardous re-tanning chemicals with a positive economic impact. The present project was initiated the following objectives:

- Preparation of Bio-polymers for re-tanning process.
- Environmental Assessment for application in leather Processing.
- Develop a biopolymer not originating from petrochemicals to reduce environmental impact.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of new process / methods.
- Bio-Polymer product development for Leather.
- Cost savings in application.
- Commercialization & Publications.

Achievements:

- A Process develop for Soft retanning of Garment Leather using Glycolics as alternate of powder form commercial re-tanning agents.
- A process developed for Glycolics-Metal Sulphate systems for Leather Retanning.
- Research paper has been published.



Completed Projects

Title of Projects	Achievements
<p>Effects of Chemical /Dehydration /Coating Techniques on Nutritional Optimization of Traditional Analysis of Important Analytes in Water and Wastewater Through Modern Techniques</p>	<ul style="list-style-type: none"> • A Process Developed for the dehydration of fruits and vegetables by solar dehydrator. • Various experiments were conducted with different metal ions and organic moieties functioning as ligands. Success was achieved with iron and gallic acid forming a stable complex in controlled pH environment. • Process Developed. • Complex synthesis with Iron and Gallic acid. • Technical Report; Synthesis of Iron – Gallic acid complex for quantitative applications.
<p>Recovery of Halal Gelatin for Food and Cosmetics from Untanned Leather Wastes</p>	<ul style="list-style-type: none"> • Various experiments were conducted with different chemical compositions to optimize the extraction process. Ultimately, we successfully recovered halal gelatin through lab trials. • A process for the recovery of Halal protein from leather wastes has been developed. • Completion report is under process. • Publication is under process.
<p>Preparation of Eco-Friendly Finishing Binder for Patent Leather</p>	<ul style="list-style-type: none"> • A process has been developed for Eco-friendly Finishing of Patent Leather. • Prepared binder formulation from acrylic chemicals. • Physical characterization has carried out to check the suitability of prepared product. The results provide satisfactory performance limits. • Different Splits leather have been coated with lab prepared binders. • Physical properties have been characterized which found satisfactory.
<p>Development of State-of-the-Art Testing Facilities at Leather Research Centre (LRC) to Comply with ZDHC, REACH, LWG & CE Marking to Support Export Oriented Leather Sector of Pakistan.</p>	<ul style="list-style-type: none"> • The project has been completed as per the tender requirement. • The training on newly installed equipment has been provided by technical expert. • New safety tests on newly installed equipment were added to the accreditation scope. The PNAC auditor team has recommended all our tests after some minor nonconformity. An ISO-17025-2017 audit has been conducted on 18-19th November 2024.

PCSIR Laboratories, Hyderabad

Name of Laboratory/ Centre/ Unit:
PCSIR Laboratories, Hyderabad

Title of Project: Bioremediation of Heavy Metals Using Bacteria Isolated from Polluted Environment

Name & Designation of Project Director:
Ms. Saniya Soomro, SO

Name & Designation of Project Associate(s):
Mr. Barkat Ali Solangi, PSO
Ms. Ammarah Kanwal, SO
Mr. Muhammad Yaqoob Kapri, JTO

Area(s) of Research:
Microbiology, Environmental Science, Biotechnology and Chemistry.

Duration:
02 Years.

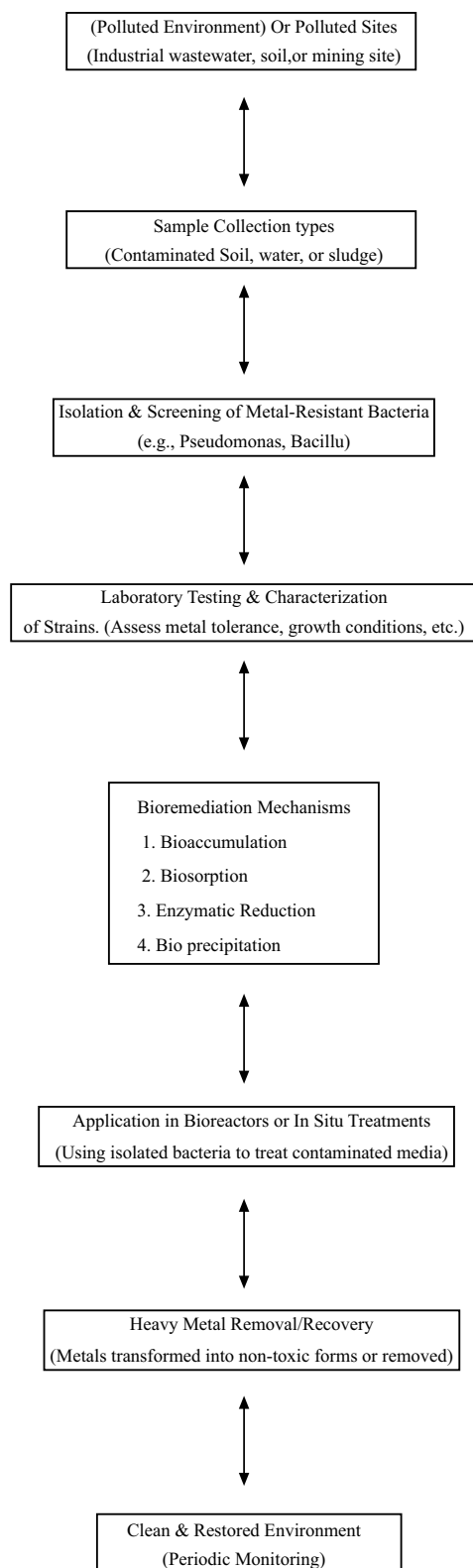
Date of Initiation:
July, 2025

Project Brief:

Heavy metals such as lead, cadmium, mercury and chromium are persistent environmental contaminants that pose serious health risks. Unlike organic pollutants, they cannot be degraded but must be removed or transformed into less toxic forms. Bacteria isolated from polluted environments have shown remarkable potential for bioremediation due to their natural ability to survive and thrive in high concentrations of heavy metals. These metals are non-biodegradable, persist in the environment and accumulate in the food chain, leading to severe ecological and public health consequences. The objectives are:

- To address the scientific, environmental, technological and socio-economic aspects of bioremediation using heavy metal-resistant bacteria.
- To develop sustainable, cost-effective and efficient solutions for mitigating heavy metal pollution, protecting ecosystems and improving public health.

Graphical Abstract:



Quarterly Work Plan:

1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	<p>Project Planning and Preparation</p> <ul style="list-style-type: none"> • comprehensive literature review. Identify and select polluted sites for sampling. • Obtain necessary permissions for sample collection. • Procure lab equipment, reagents and materials. • Assemble and train the research team. 	<p>Sample Collection and Isolation of Bacteria</p> <ul style="list-style-type: none"> • Collect soil, water and sediment samples from polluted sites. • Isolate heavy metal-resistant bacteria on supplemented agar plates. • Perform preliminary characterization (e.g., Gram staining, colony morphology). 	<p>Identification and Characterization of Bacteria</p> <ul style="list-style-type: none"> • Extract DNA from isolated bacteria. • Perform 16S rRNA gene sequencing for species identification. • Study heavy metal resistance mechanisms (e.g., biosorption, bioaccumulation). • Determine minimum inhibitory concentration (MIC) for heavy metals. • This initiative is feasible for the textile, metal and leather sectors that generate significantly contaminated wastewater. It has the potential to decrease pollution levels by as much as 50 percent, even when utilizing biological treatment. 	<p>Optimization of Bioremediation Conditions</p> <ul style="list-style-type: none"> • Study the effects of environmental factors (e.g., pH, temperature, nutrient availability) on bacterial activity. • Optimize conditions for maximum heavy metal removal. • Develop bacterial consortia for enhanced bioremediation.

2nd Year	5th Quarter	6th Quarter	7th Quarter	8th Quarter
	<p>Bioremediation Experiments</p> <ul style="list-style-type: none"> • Conduct lab-scale bioremediation experiments using optimized conditions. • Measure heavy metal concentrations before and after treatment using AAS or ICP-MS. • Perform toxicity assessments using bioassays. 	<p>Application and Field Trials</p> <ul style="list-style-type: none"> • Apply bacterial cultures to contaminated sites for in situ bioremediation. • Set up ex situ bioremediation systems (e.g., bioreactors, constructed wetlands). • Monitor heavy metal levels and bacterial activity over time. 	<p>Monitoring and Evaluation</p> <ul style="list-style-type: none"> • Analyze heavy metal concentrations in treated samples using advanced techniques (e.g., AAS, ICP-MS). • Conduct long-term monitoring of remediated sites. • Perform ecotoxicological tests to assess environmental safety. 	<p>Data Analysis, Reporting and Dissemination</p> <ul style="list-style-type: none"> • Analyze experimental data using statistical software. • Prepare a comprehensive research report. • Write and submit research papers to scientific journals. • Present findings at conferences and workshops. • Engage with stakeholders (e.g., communities, industries, policymakers).

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Tangible Outcome:

- Development of Microbial Bioremediation Technologies
- Biofertilizers products
- Wastewater treatment process & soil restoration process.
- Economic beneficiaries for Industries, Farmers, Governments & Municipalities

Achievements:

New Project



Completed Projects

Title of Project	Achievements
Extraction and Utilization of Fiber from Banana Stem	<ul style="list-style-type: none">• Successfully conducted a literature review on fibre extraction methods and applications, alongside initial laboratory-scale trials.• Optimization of mechanical extraction methods has begun, with various pre-treatment techniques tested on a small scale.• Chemical extraction trials have also been completed to refine the process. Fibre characterization is currently in progress, focusing on physical properties such as tensile strength and flexibility, along with initial chemical property analysis.

PCSIR Laboratories, Skardu

Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories, Skardu

Title of Project: Cultivation/Propagation & Development of Value-added Products of Blackberry

Name & Designation of Project Director:

Mr. Tariq Umar Khan, Director/CSO

Name & Designation of Project Associate(s):

Mr. Muhammad Iqbal Khan, SSO

Mr. Muhammad Arif, Engineer

Area(s) of Research:

Agriculture/Food

Duration:

03 Years

Date of Initiation:

2025

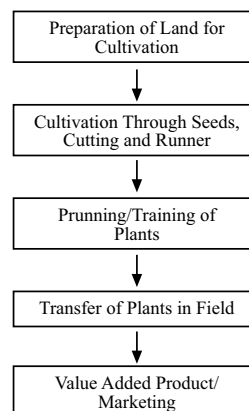
Project Brief:

Blackberries (*Rubus fruticosus*) belong to rosaceae are popular fruit known for their distinct taste and nutritional benefits. They are indigenous to continents including Asia, Europe, North and South America. Due to improved cultivars, effective marketing initiatives and increasing demands of consumers, blackberries have now become a common fruit in marketing outlets around the world. Blackberries grow well in temperate and cool-climate regions in fertile, well-drained soils with adequate moisture. Blackberries can be reproduced primarily using tissue culture techniques, runners and cuttings that have been rooted. With the help of these vegetative methods of reproduction, blackberry plants are efficiently multiplied, enabling successful cultivation and greater accessibility to this delicious fruit. Due to its therapeutic and beneficial qualities, Blackberry plants (*Rubus fruticosus*) have been extensively utilized in herbal medicine. They exhibit antimicrobial, anticancer, anti dysentery, anti diabetic and anti diarrheal effects, along with high antioxidant activity Vitamin C, niacin, pectin, sugars and

anthocyanins are blackberries’ essential components. Due to the high concentration of the phenolic compounds (flavanols and ellagitannins), they have a significant potential to act as an antioxidant. According to some researchers, these phenolic compounds protect against age-related neuro-degenerative diseases, oxidative stress-related disorders and bone loss. The objectives are given below:

- Technology development for black berry farming in Gilgit-Baltistan.
- Model farming for entrepreneur, farming community and interested grower.
- Developed experimental field / land for cultivation of black berry.
- Conduct research for product development from black berry fruit,

Graphical Abstract:



Quarterly Work Plan:

Quarters	First Year	2nd Year	3rd Year
1st Quarter	Literature Survey Preparation of land for cultivation.	Selection of best variety and planting in the field	Collection of Blackberry fruits
2nd Quarter	Collection of Different varieties of Blackberry Plants.	Application of fertilizer, irrigation etc	Preparation of different products (Jam, candies, blended jam with other fruits)

Quartes	First Year	2nd Year	3rd Year
3rd Quarter	Plantation of Black berry in the field.	Do	Evaluation of shelf life of the prepared products.
4th Quarter	Irrigation and hoeing of field	Do	<ul style="list-style-type: none"> • Phhsico chemical analysis of the products • Technical report • Publication

Funding Source (PSDP/SGI/RD&I/etc):

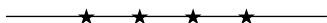
In-House

Tangible Outcome:

- Cultivation of Blackberry fruit plants.
- Introduction of blackberry in the area.
- Product development of blackberry fruits.

Achievements:

New Project



Name of Laboratory/Centre/Unit:

PC SIR Labs. Skardu

Title of Project: Embellishment of Artifact Using Semi Precious Stones, River Pebbles and Cobbles.

Name & Designation of Project Director:

Mr. Muhammad Iqbal Khan, SSO

Name & Designation of Project Associate(s):

Mr. Tariq Umar Khan, Director/CSO

Area(s) of Research:

Gems and Minerals

Duration:

03 Years

Date of Initiation:

November, 2023

Project Brief:

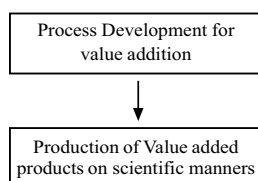
Quartz (Rutile quartz, amethyst, smoky quartz, diamond quartz) Tourmaline, Jade (Green jade, White Jade), Nephrites, Serpentine, Topaz, granite etc are commonly found semi-precious stones and minerals in Gilgit Baltistan. Semi precious stones have hardness range from 4 – 8 and can be cut into different shape and ability to accept polish. These properties make it a popular ornamental gems stone. Serpentine is a mineral ore rock consisting essentially of a hydrous magnesium silicate having green color. Serpentine is also known for its ease of being cut in to different shapes and ability to accept polish. Some varieties of serpentine can be curved into beautiful stone sculptures in different range of size from under 1 cm to several meters in height. It is most often cut into ornaments such as (bowls, vases, desk sets, table clock, Tea set, paper weight, of different shapes and sizes) jewelries (Cabochon, beads, rings, ear ring, bracelet, pendants) can be made from serpentine.

River pebbles and cobbles are known as river rock. Pebble tools are among the earliest known made artifacts. Inland pebbles and cobbles (River Rock) are usually found along the shores of large rivers and lakes. Pebbles and cobbles are often used to cover walk ways and drive waves, around pools in and around plant containers and for land scaping, constructions and as decorative elements. They are an easy material to obtain in Skardu. There are various ways used these stones to create awesome crafts. They are used for purposes, both outdoors and indoors. There is dire need to make a range of ornamental and decorative items such as (Wash Basin, Candle Stand, Lamps, Door Mats, Tables mats, bowls, etc) using local available semi precious stones, river pebbles and cobbles to develop indigenous technology for local people and industry. Most of these items are not much focused in Skardu. Moreover, precious, semi precious stones and minerals deposits are found in Gilgit Baltistan. The properties of many Gems and minerals are still un identified. Due to lack of technology, training and un availability of tools and machinery. These gems are usually wasted during mining. Many precious value added products can be prepared by these Gems Stones and Minerals. There are high demands of ornamental products in market but entrepreneurs in this field could not produce value added products of gems stone and minerals in the local

market. Main objectives are:

- This project aims to establish efficient and effective techniques by developing different value added products to meet the market demand.
- Research on lab scale for students and people belonging to the field of mining sector.
- To identify the most effective method for development of finest value added products on lab scale.
- Minimizing the wastage of semi precious stones from mining.
- Promote and facilitate cottage industries of Gems stone business.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):

In-House

Tangible Outcome:

- Process Development.
- Production of value added products in scientific manner.
- Provision of skills to youth for establishment of cottage industries in the region.
- Meet the market demands.

Achievements:

- Survey of different precious and semiprecious stones has been carried out.
- Collection of quartz, serpentine, river pebbles and cobbles has been collected.
- Developed value added products of semi precious stones like bracelet, ring, pendent, cabochon etc.
- River pebbles are collected for making value added products.
- Beneficiaries include local Miners, Entrepreneurs, Gems industry, Cottage Industry, Tourism Industry.





PCSIR Head Office, Islamabad
1-Constitution Avenue, Sector -G-5/2, Islamabad
Tel: (051) 9225395-99; Fax: (051) 9225372
E-mail: pcsirmemberscience@gmail.com
Website: www.pcsir.gov.pk