JOSEPH SARWUAN TARKA UNIVERSITY MAKURDI
INNOVATION AND SERVICE

INDCHEMPRENEUR CONCEPTS | Bimonthly Newsletter

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Bimonthly Newsletter on Industrial Chemistry Entrepreneurship

Issue 2 | December, 2025

Tone and Approach

Our tone is professional yet approachable, blending technical rigor with entrepreneurial inspiration. We speak directly to the chemist entrepreneur — someone who is passionate about science and driven to create impact through business. We aim to inform, inspire, and equip our readers with the tools to turn their chemical innovations into sustainable enterprises.

Empowering Innovation at the Intersection of Chemistry and Entrepreneurship

MISSION

INDCHEMPRENEUR CONCEPTS is a bimonthly newsletter dedicated to empowering the next generation of chemical innovators, Researcher-entrepreneurs, and industry professionals. Our mission is to bridge the gap between cutting-edge chemical innovation and entrepreneurial success by delivering actionable insights, inspiring stories, and industry-specific strategies that transform ideas into thriving businesses that go beyond traditional chemistry or business publications.

VISION

We envision a world where industrial chemistry pioneers lead the charge in solving global challenges through sustainable, innovative, and commercially viable solutions. INDCHEMPRENEUR CONCEPTS serves as the premier resource for chemists, engineers, and entrepreneurs who dare to reimagine the future of industry.

WHAT SETS US APART

Unlike others, INDCHEMPRENEUR CONCEPTS is laser-focused on the intersection of industrial chemistry and entrepreneurship. We don't just report on science or business trends; we connect the dots between laboratory breakthroughs and market success. Our content is tailored to the unique challenges and opportunities faced by chemical startups, from navigating regulatory landscapes to scaling sustainable manufacturing processes. Each issue offers:

1. Actionable Insights: Practical strategies for funding, prototyping, and market entry, grounded in real-world applications.
2. Case Studies: In-depth analyses of successful chemical ventures, highlighting replicable strategies and lessons learned.
3. Exclusive Interviews: Conversations with industry trailblazers who share their journeys, challenges, and triumphs.
4. Specialized Focus: Topics like green chemistry, process optimization, and lab-to-market transitions, curated for industrial chemistry innovators.

OUR CONTENT

Published bimonthly, INDCHEMPRENEUR CONCEPTS delivers a carefully curated blend of:

1. Featured Articles: Deep dives into emerging trends, such as sustainable chemical manufacturing or novel materials.
2. Entrepreneur Spotlights: Stories of chemists-turned-entrepreneurs who are reshaping the industry.
3. Industry News: Updates on regulatory changes, market shifts, and technological advancements.
4. Practical Tips: Guidance on securing venture capital, building scalable processes, and fostering innovation.

WHY IT MATTERS

In a rapidly evolving world, industrial chemistry plays a crucial role in addressing critical challenges such as climate change, resource scarcity, and improving industrial efficiency. INDCHEMPRENEUR CONCEPTS is more than a newsletter; it's a movement to empower innovators to build businesses that drive progress while prioritizing sustainability and impact.

By focusing exclusively on the intersection of industrial chemistry and entrepreneurship, INDCHEMPRENEUR CONCEPTS stands alone as the essential guide for those who seek to transform the chemical industry, one innovation at a time.

EDITORIAL DESK

Editorial Note from the Editor-in-Chief

As the last issue of the year 2025, it's fitting to highlight the International Union of Pure and Applied Chemistry's Top Ten Emerging Technologies in Chemistry, which include additive manufacturing, Carbon Dots, Direct Air Capture, Electrochemical Carbon Capture and Conversion, Multimodal Foundation Models for Structure Elucidation, Nanochain Biosensors, Single-Atom Catalysis, Synthetic Cells, Thermogelling Polymers, and Xolography.

Additive Manufacturing

Additive manufacturing, often referred to as 3D printing, represents a transformative approach in chemistry that enables the layer-by-layer construction of complex structures from chemical materials, enhancing sustainability and precision in production processes. This technology facilitates the creation of customized chemical reactors and advanced materials, reducing waste and energy consumption compared to traditional subtractive methods. It integrates innovations such as multi-material printing and artificial intelligence for process optimization, with applications spanning from biomedical implants to aerospace components. As highlighted in recent analyses, additive manufacturing trends in 2025 emphasize speed improvements and material diversity, positioning it as a key driver for industrial efficiency and innovation.

Carbon Dots

Carbon dots are nanoscale carbon-based particles with unique optical and electronic properties, making them versatile for applications in sensing, imaging, and catalysis. These nanomaterials exhibit high photoluminescence quantum yields and biocompatibility, enabling their use in healthcare for targeted drug delivery and bioimaging. Recent advancements have focused on enhancing their luminescence across various bands, including near-infrared, through precise synthesis methods that control size and surface functionalization. As part of emerging chemical technologies, carbon dots offer sustainable alternatives to traditional quantum dots, avoiding toxic heavy metals while providing tunable properties for environmental monitoring and therapeutic applications.

Direct Air Capture

Direct air capture involves the extraction of carbon dioxide directly from ambient air using chemical sorbents or solvents, followed by storage or utilization, contributing to negative emissions strategies for climate mitigation. Technologies employ solid sorbents like zeolites or liquid solvents, with regeneration through heat or electrochemical means to release concentrated CO_2. Innovations in 2025 focus on reducing energy intensity and scaling up operations, with projects demonstrating capacities up to 500 kt CO_2 per year. This approach addresses low-concentration CO_2 sources, integrating with renewable energy for cost-effective deployment in sectors like transportation fuels and materials synthesis.

Electrochemical Carbon Capture and Conversion

Electrochemical carbon capture and conversion utilizes electrical energy to capture CO_2 from sources like flue gas or air and transform it into valuable chemicals or fuels, bypassing energy-intensive thermal processes. Systems integrate capture media such as amines or ionic liquids with electrocatalysts, achieving simultaneous sequestration and valorization into products like CO, ethylene, or methanol. Advances emphasize electrode design, including single-atom catalysts for enhanced selectivity, and reactor configurations that minimize energy losses. This technology supports circular carbon economies, with economic analyses indicating viability at costs below $100 per ton when powered by renewables.

Multimodal Foundation Models for Structure Elucidation

Multimodal foundation models integrate diverse data types, such as spectra and structural information, to predict and elucidate molecular structures using machine learning frameworks pretrained on vast datasets. These models leverage self-supervised learning to achieve superior performance in property prediction and material discovery, encoding emergent features that reveal scientific insights. Applications include screening stable compounds with targeted properties and accelerating drug design through latent space analysis. As an emerging tool in computational chemistry, they bridge gaps in traditional methods by handling complex, heterogeneous data for precise structure determination.

Nanochain Biosensors

Nanochain biosensors employ one-dimensional nanostructures, such as modified nanoparticles linked in chains, to detect biomolecules with high sensitivity and selectivity through electrical, optical, or electrochemical signals. These sensors target diseases like cancer or infections by incorporating biomarkers on non-metallic nanoparticles, enabling point-of-care diagnostics. Innovations include printable formats for personalized testing and integration with wearable devices for real-time monitoring. Their versatility supports applications in healthcare, environmental analysis, and food safety, addressing challenges in scalability and biocompatibility for broader clinical adoption.

Single-Atom Catalysis

Single-atom catalysis disperses individual metal atoms on supports to maximize atomic efficiency, enhancing selectivity and reducing material usage in reactions like CO_2 conversion and hydrogen production. This approach combines heterogeneous stability with homogeneous precision, utilizing abundant metals like iron or copper for sustainable processes. Recent developments include dual-atom and alloy variants to tune activity, with applications in environmental remediation and energy technologies. As a cost-effective alternative to nanoparticle catalysts, it promotes recyclability and minimizes waste in industrial catalysis.

Synthetic Cells

Synthetic cells are engineered constructs mimicking natural cellular functions, assembled from molecular components to perform tasks like chemical production or drug delivery. These bottom-up systems integrate modules for metabolism, replication, and response, offering platforms for studying biology and biotechnology. Advances focus on biosafety, equity, and ethical guidelines in global collaborations to achieve functional prototypes. Potential impacts include biofuel synthesis and medical therapies, with ongoing efforts addressing module compatibility and scalability for practical applications.

Thermogelling Polymers

Thermogelling polymers undergo a reversible sol-gel transition with temperature changes, forming injectable hydrogels for biomedical uses like drug delivery and tissue engineering. Composed of amphiphilic blocks, they enable sustained release of therapeutics and scaffold formation for cell growth. Recent designs enhance biocompatibility and mechanical properties, with applications in ocular repair and wound healing. This technology supports minimally invasive procedures, addressing challenges in degradation rates and integration with biological systems for clinical translation.

Xolography

Xolography is a volumetric 3D printing technique that uses photochemical reactions to solidify polymers in three dimensions simultaneously, overcoming layer-by-layer limitations for faster, more precise fabrication. It employs dual-wavelength light to activate polymerization in specific volumes, enabling complex structures without supports. Applications include optics, microfluidics, and biomaterials, with potential for scalable manufacturing. As an innovative fusion of chemistry and engineering, it enhances detail and efficiency in polymer printing for sustainable production These innovations collectively embody the forward-thinking industrial-entrepreneurial drive and vision that our publication endeavors to project, harnessing chemical sciences to propel sustainable manufacturing, advanced materials development, carbon mitigation strategies, and biomedical breakthroughs, thereby charting a course toward resilient and prosperous global industries in the years ahead.

Chem. Dr Obinna Ofoegbu, the principal investigator of the Polymer and Nano Materials Research Group, Department of Industrial Chemistry, JoSTUM, is an industrial polymer chemist pioneering sustainable biomaterials research projects. His pioneering research work on millipede-derived chitosan establishes it as a viable, terrestrially sourced alternative for non-coastal regions, transforming local biodiversity into a commercially promising venture demonstrating strong profitability (405.6% ROI) while promoting import substitution and environmental sustainability.

TRANSFORMING WASTE POLYETHYLENE INTO VALUE THROUGH PYROLYSIS TECHNOLOGY

BY DR. N. SURMA

The consumption of plastic waste has been on the increase over the years and the concern with their waste generation too. There is therefore need to effectively manage these wastes in order to reduce the burden on the environment. This can achieve through efficient waste plastic recycling processes which is a way of making this waste (polyethylene) become more useful. The current plastic reclamation technology options are generally grouped into four types: primary recycling, secondary or mechanical recycling, feedstock or tertiary recycling and quaternary or energy recycling.

Pyrolysis, a tertiary recycling method also known as chemical recycling was utilized by Dr. N. Surma an Industrial Chemist at Joseph Sarwuan Tarka University to transform polyethylene waste to useful fuel gases, Pyrolysis technology involves breaking down plastics to into smaller molecular compounds at high temperatures in an oxygen free or low oxygen environment. Under these elevated temperature conditions, the plastic molecular chains break down triggering a series of complex thermochemical reactions such as cracking, dehydrogenation, cyclization and condensation. Ultimately the waste plastic is converted into gaseous, liquid and solid products

Name of Product

Pyrolysis gases which are combustible in nature, these include: methane, ethane, propane, butane, pentane, hexane, heptanes, octane, nonane and decane etc.

Purpose of the Product

A profitable venture for turning low-value waste into a source of energy geared towards generating revenue instead of constituting a menance to the environment.

Key features and specification

1. **Resource recovery –** Produces valuable products like combustible gases, pyrolysis-oil, which can be used as a source of fuel and chemicals.
2. **Circular economy** – Promotes a circular economy model by turning waste into a resource for new products and materials.
3. **Alleviating resource shortages** – Converts plastic waste into basic chemical raw materials source for plastic production.
4. **Waste reduction –** Significantly decreases the volume of plastic waste sent to land fills.
5. **Pollution control** – Plant are designed to heat, vapourize and collect the condensed vapour thereby minimizing secondary pollution.
6. **Recycling difficult plastics** – It is particularly useful for mixed plastics waste that cannot be processed through conventional mechanical methods.
7. **Creating new materials** – Plastics are converted into secondary raw materials that can be used to create new chemicals and fuels.
8. **Provides heat source for the pyrolysis process** - The combustible gases produced can be recycled back for heating the reactor.
9. **Energy diversions** – Promotes a more resilient energy system, avoiding dependence on single source.
10. **Complimentary solution** – It is a complementary solution to mechanical recycling helping to reduce the amount of plastic waste that goes into landfills or incineration.
11. **Lower carbon foot print** – Generates fewer greenhouse gas emissions than traditional incinerations

Benefits of Pyrolysis Technology

1. Waste reduction
2. Resource and energy recovery
3. Lower environmental impact compared to incineration and other methods

Applications and potential uses of the product

1. The C1-C4 gases ranging from methane, ethane, propane, and butane can be fractionated and packaged as a source of heat for domestic cooking, industrial reactors and for powering compressed engines.
2. The C5-C10 gases can be into gasoline range products and other organic solvents
3. The pyrolysis gases obtained can serve as primary chemicals which can be utilized in the production of secondary chemicals

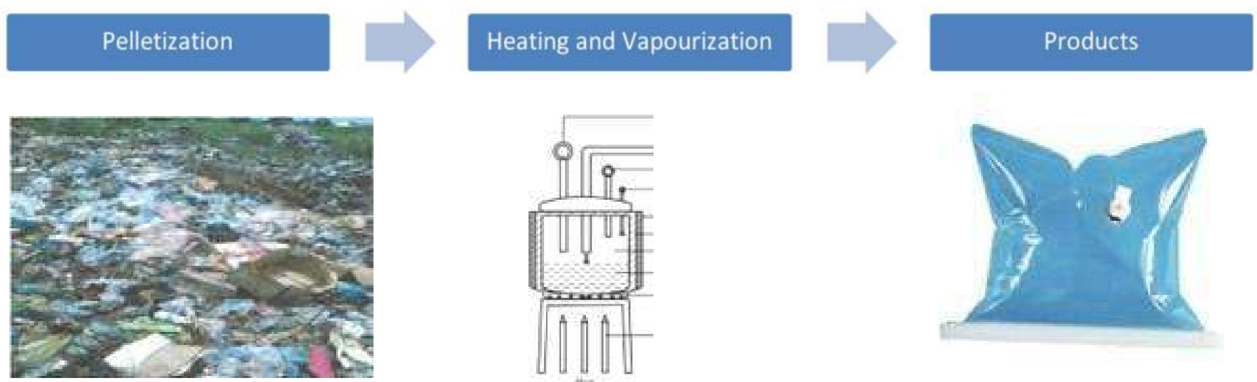
Unique selling points or innovations

Pyrolysis converts plastic waste to valuable products like combustible gases, fuel oil, and char; while also creating a more circular economy by reusing materials that are difficult to mechanically recycle. The volume of plastic waste which could formed part of landfills or ended up in the ocean were significantly reduced.

Production process

Collection of waste polyethylene materials
Sorting according to society for plastic industry (SPI) code
Cleaning
Pelletizing
Heating in order to vapourize
Recovery of the finished products

Diagrammatic Outline of the Process



Highlights

1. Process overview – Collection, sorting, cleaning, palletization, heating and recovery
2. Benefits of the process – The quantity of the polyethylene waste that would serve as a menace to the environment has been significantly reduced to useful combustible gases
3. Success profile – Pyrolysis of LDPE, HDPE, and PET waste collected from dumpsites around Makurdi metropolis yielded valuable products that are relevant as raw materials in the energy sector. The products recovered from the pyrolysis process are also valuable as primary chemicals needed in our chemical industries.

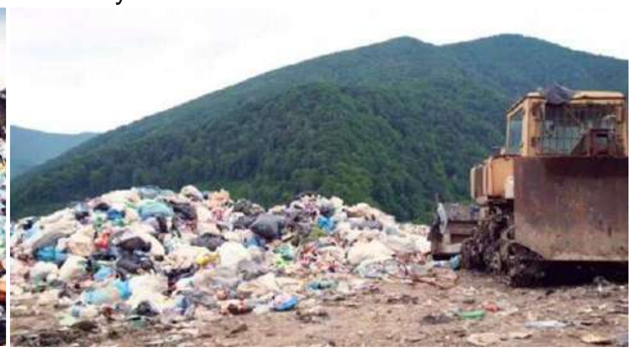
This study did not just reduce the volume of waste polyolefin materials that could end up in landfills and oceans but has also served as a possible way of obtaining valuable materials like combustible gases and black char. The method if well harnessed holds potential for employment and industrial diversification.

*Dr. N. Surma of the Department of Industrial Chemistry, JOSTUM is an industrial chemist specializing in *Petroleum/hydrocarbon science and sustainable waste management. With extensive experience in chemical technology, she contributes insights on turning environmental challenges into opportunities through innovations like pyrolysis.*

EcoResins

Prof. S.I Irtwange, Prof. G.A Abu, Prof. L.A Nnamonu
(ENACTUS JOSTUM Advisors)

Greek mythology introduces us to a Ouroboros, the snake that devores itself. Like this snake while plastic packaging serves as a dear need in society it devores itself with a numerous harmful effect accompanying its use and subsequent disposal. The United Nations environment program reveals that plastic bottles and food containers can leach harmful chemicals that cause health issues such as cancer. Over 400 million tons of plastic are produced annually, 90% of these are not recycled and endued in land and water bodies.

This Global crisis is more pronounced in Africa, in fact the centre for Earth works in Nigeria calls plastic pollution a national crisis on the other hand the United Nations Food and Agriculture Organization ranks Nigeria as the leading producers of cassava in the world, unfortunately processing this cassava for food production generate gallons of acidic waste water containing starch which is improperly disposed off destroying hectars of agricultural lands and harming marine life outcries from the locals have even forced the Benue State Government to shut down Purebiotech a cassava processing company in our state due to its improper disposal of liquid waste into the River Benue. Thus, we recognize two environmental threats, plastic waste and cassava processing waste and turn these into a single sustainable solution through our project today we introduce Ecoresins a project that develops three highly market relevant products providing innovative solutions across industries while promoting sustainable and social impact project. Ecoresin develops biopolymer resins from cassava starch extracted from acidic waste water in cassava processing. These resins are used to make eco-friendly plastic-like packaging container and single-use shopping bags. To develop our resins we extract starch from waste water generated in cassava processing. Heat treatments then convert the acidic molecules to longer more stable polymer chains for elasticity and strength Finally we add food great additives to complete the transformation, producing eco-friendly resin pellets. The resin pellets are blown into packaging containers and single-use shopping bags.

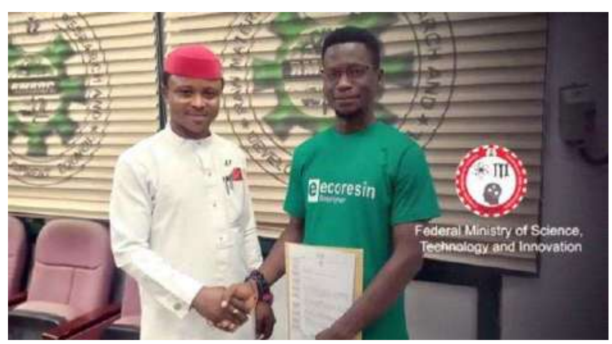
Eco-friendly resin pellets

The global plastic packaging industry is currently worth over $260 billion and is projected to heat $385.00 manufacturers who seek eco-friendly alternatives these pellets seamlessly replace traditional petroleum- based resins in the manufacturing of plastic containers and single use shopping bags to drive market adoption we partnered with Oracle plastic industry one of the largest plastic producers in Nigeria by integrating our ecoresin pellets into their existing production lines. Oracle seamlessly transitions from harmful petroleum-based resins to our eco-friendly alternative without disrupting their operations. These innovative partnerships position us to scale quickly and replace traditional plastic packaging on a national level within a few years our second product line focuses on takeout containers and shopping bags targeting restaurants food vendors and retail chain made from our durable biopolymer resins. These containers provide an affordable eco-friendly alternative to plastic packaging by partnering with major restaurant chains like Chicken Republic Restaurants and chilling point as well as retailers like Sudo P Supermarket. We've positioned ecoresin products as the go-to choice for sustainable packaging in Nigeria to ensure broad adoption across market segments. Ecoresin offers competitive pricing our biopolymer pellets are priced at 1,200 naira per 5 kg, 20% lower than the regular petroleum-based resins our take away sell for 1,400 naira per dozen. While plastic containers are sold at 2,400 naira. Additionally, our branded shopping bags are priced at 1,400 naira per 100 pieces compared to 2,400 naira for their traditional counterparts. Ecoresins product deliver both environmental benefits and cost savings to businesses and this is our unique selling proposition.

Listen to our partner Chilling Point Restaurant and see how ecoresin is making a difference in their business "Hello I'm Sam the General Manager of Chilling restaurant JOSTUM Campus, we really glad to partner with ENACTUS JOSTUM for encouraging Biopolymer products. The shopping bags and containers are much affordable and help us to significantly reduce our running cost, we now price our products and services more competively earning us more customers and increased profit margin using the ecoresin p roductourbrandnow contribute to environmental sustainability and that's something we are very proud of".

Mr. Ogbu Samuel, The General Manager of Chilling restaurant JOSTUM Campus

Hear our latest partners, the Federal Ministry of Science, Technology and Innovation and the World Bank Centre for Innovation in procurement Environmental and Social Standards (CIPESS) and how working to fund the acquisition of machinery for producing single use shopping bags and expanding our container varieties to include both bottled containers, this support will enable us to scale production by over 100% and diversify our product range. Currently it cost 1,117,000 naira to produce 1 ton of our biopolymer resins. However, with these advancements in machinery and increased economics of scale, we anticipate reducing production cost by 30%.

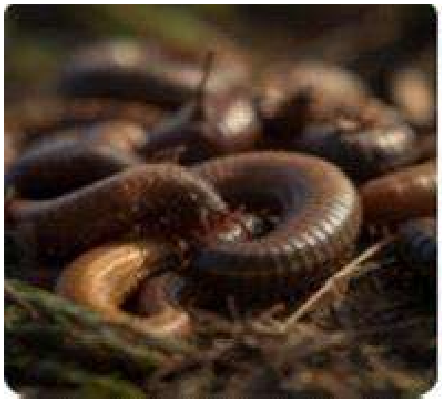


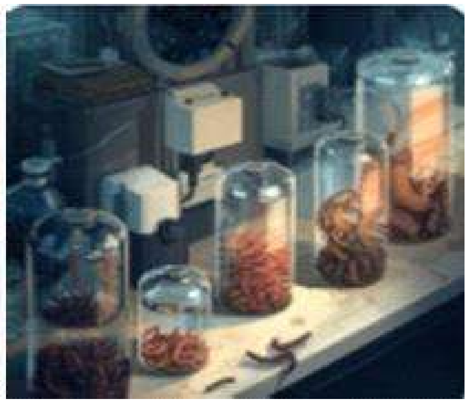
Federal Ministry of Science, Technology and Innovation

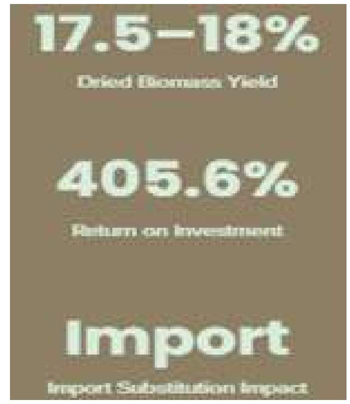
Prof. S.I. Irtwange, Prof. G.A. Abu, and Prof. L.A. Nnamonu are distinguished faculty advisors for Enactus JOSTUM. Their expertise in environmental science, food processing, and sustainable materials guides the innovative Ecoresin project, transforming cassava wastewater into durable, biodegradable resins for eco-friendly packaging and shopping bags.

THE MILLIPEDE to CHITOSAN ECONOMY:

Ofoegbu Obinna, Umah Nnamdi J







The millipede-derived chitosan offers a terrestrially sourced alternative to conventional crustacean-based production, with particular advantages for non-coastal regions. It demonstrates strong commercial viability, particularly advantageous for non-coastal regions other than Port Harcourt, Lagos, Calabar, Bayelsa, etc., in Nigeria, where aquatic chitosan sources are less accessible. The venture offers excellent returns while addressing import substitution and environmental sustainability.

This feasibility study is based on the research output from "Deracination of chitosan from locally sourced Millipede (Eurymerodesmus spp.) and its spectroscopic and physico-chemical properties," carried out and published by **Ofoegbu Obinna, Umah Nnamdi J., and Aliyu Samuel Jacob.** Polymer, Nano materials and Molecular Recognition Research Group, Department of Industrial Chemistry, College of Science, Federal University of Agriculture, Makurdi, Benue State, Nigeria. Published in GSC Biological and Pharmaceutical Sciences.

Key research findings:

1) Chitosan yield: 17.5-18% from dried millipede biomass
2) Optimal demineralization: 5% HCl treatment
3) Degree of deacetylation: 66.3% (comparable to commercial standards)
4) Product characterization: FTIR, SEM, TEM confirmed chitosan structure

B. Assumptions & Limitations

1. Millipede reproduction rates based on general Diplopoda literature (actual *Eurymerodesmus spp*. rates may vary)
2. Market prices based on 2023-2025 global chitosan market data
3. Local market demand in Nigeria has not yet been quantified
4. Scaling from laboratory (20g batches) to commercial production requires process validation
5. Regulatory requirements for chitosan production in Nigeria are assumed to be similar to food/chemical processing

Lab-to-Industry:
For establishing a millipede-based chitosan production cottage industry with an annual production capacity of 1 tonne.

KEY HIGHLIGHTS:

Financial Performance:

A. **ROI: 405.6%** over 5 years
B. **Payback Period: 20 months**
C. **NPV: ₦40.2 million** (at 15% discount rate)
D. **IRR: 98.5%**
E. **Profit Margin: 60%** (steady state)

Investment Required:

a) Total CAPEX: ₦18 million (USD 22,500)
b) Annual OPEX: ₦14 million

Critical KPIs Defined:

1) Production yield rate ≥17%
2) Degree of deacetylation ≥65%
3) Millipede survival rate ≥80%
4) Quality rejection rate <5%
5) Capacity utilization: 95%+

Raw Material Requirements:

1. 5,714 kg dried millipede biomass annually
2. Farm size: 200-300 m²
3. Initial breeding stock: 15,000-20,000 millipedes

References

1. Ofoegbu, O., Umah, N. J., & Aliyu, S. J. (2019). GSC Biological and Pharmaceutical Sciences, 7(2), 95-107.
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Umah Nnamdi Jeremiah is of the Department of Physical Chemistry, an aspiring Material scientist specializing in nanomaterials science and sustainable materials environment. With extensive experience in chemical technology, he contributes insights on turning environmental challenges into opportunities through innovations like synthesising eco-friendly materials from biological sources and designing an optimized route for the production of propylene using Gallium catalyst.

ALKALINE PRODUCTION FROM AGROWASTE FOR DOMESTIC AND INDUSTRIAL USES

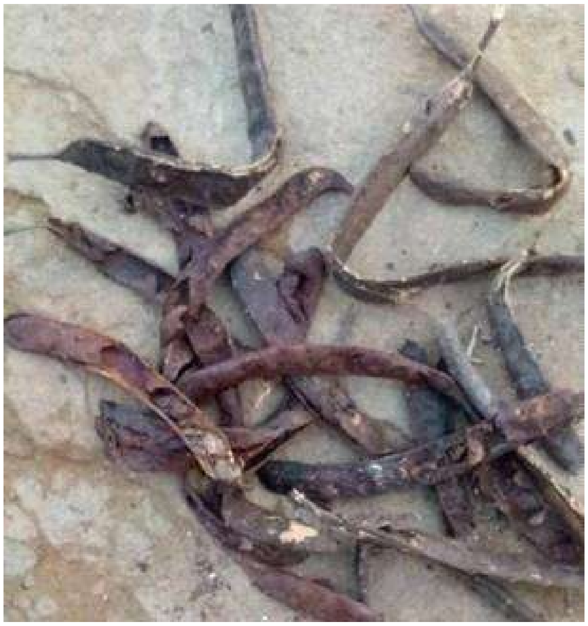
Dr. B.L Gav

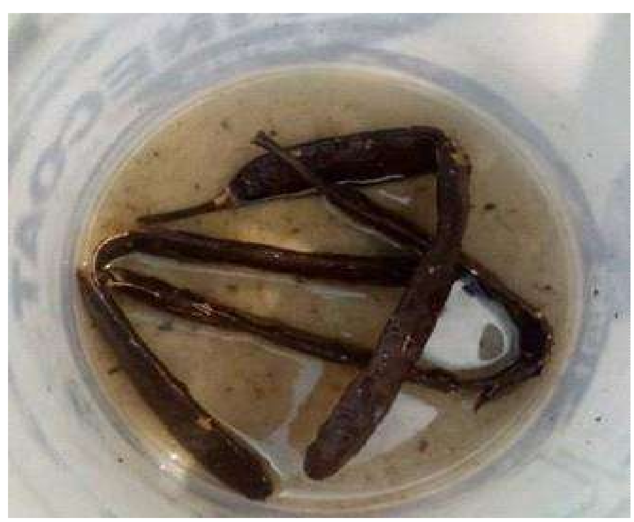
The increasing need for ecofriendly and low-cost alternative to synthetic industrial chemical has driven interest in converting agricultural wastes into useful products. The article highlights ongoing research on alkaline production from agricultural waste at Joseph Sarwuan Tarka University, Makurdi. This study focuses on the production of potash using raw materials derived from peels of Locust Beans obtained at JOSTUM to generate or produce alkaline for domestic and small-scale industrial applications. The alkaline is produced by collecting, drying and ashing of the peels, after which the ashes were leached with distilled water and filtered to obtain the alkaline extracts. The process of crystallization and oven drying was employed to obtain solid alkaline. Standard analytical methods were employed to determine pH and alkalinity. The percentage purity and alkali concentration were calculated to assess the quality and purity of the product. The results revealed that the sample was strongly basic showing higher PH and alkalinity. The purity and alkaline concentration were also high. The findings indicate that this agrowaste is a viable source of natural alkali due to its higher base forming capacity. The study concludes that locust bean peels could serve as a sustainable and economical raw material for alkali production thereby reducing waste and supporting environmental management and local industry development.

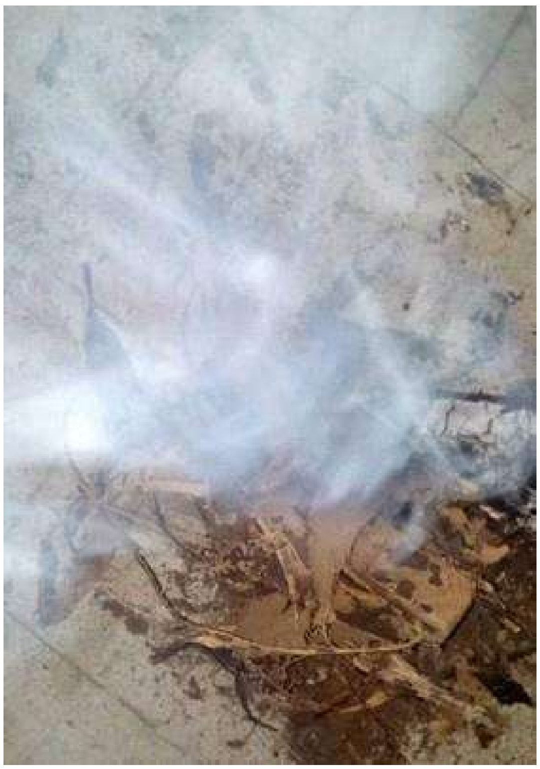
I also conducted research on the peels of locust beans to determine the mineral elements such as Na, K, Mg and Ca. The research revealed higher sodium concentration. It suggests that it is richer in sodium bearing minerals. This enhances its solubility and ability to form strong base when dissolved in water. Sodium ions are also known to increase the conductivity of solutions, supporting higher electrical conductivity. The presence of magnesium ions in the sample helps to stabilize the alkaline solution and contributes to moderate basicity. In soap production, magnesium may form slightly insoluble soaps but in controlled concentrations, it enhances lather stability and firmness. High calcium content enhances the basic strength and stability of alkaline solutions and plays an important role in saponification. High potassium content also confirms its strong base forming potentials. Potassium based alkalis are highly desirable in soap making because it produces soft, smooth soaps that dissolve easily in water.

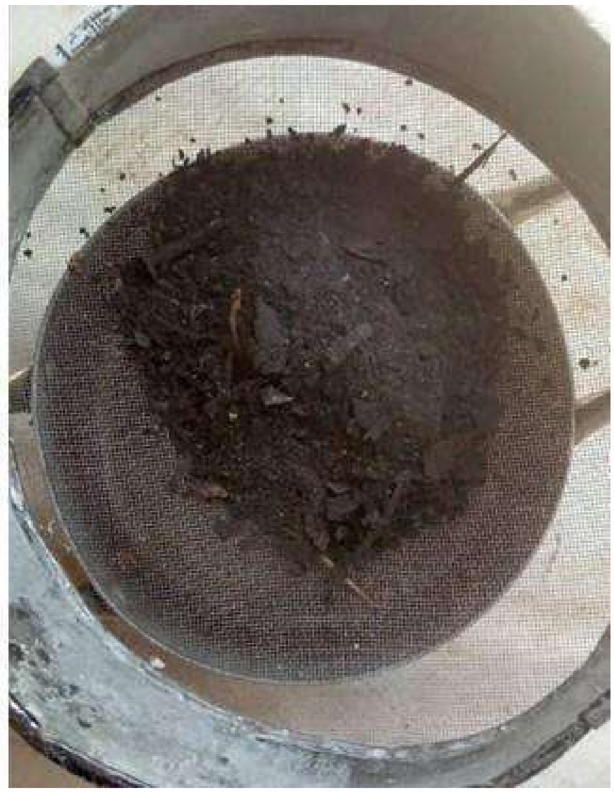
Story Highlights

1. Lab to Market – From bench scale experiment to community scale production.
2. Benefits
   i. These wastes are plentiful and often incur no cost. Processing them into alkalis provide a low-cost alternative to industrial chemicals and creates potential economic opportunities for rural communities.
   ii. converting waste into usable alkali reduces reliance on synthesis chemical processes. It also curbs open air burning of waste, a practice that contributes to greenhouse gas emission and air quality degradation.
   iii. The waste to resource approach promotes circular economy principles and aligns with global sustainability efforts by minimizing waste, reducing pollution and encouraging renewable resource use.
3. Nigeria context - Reduces alkaline scarcity in rural areas.
4. Pictorial Diagram





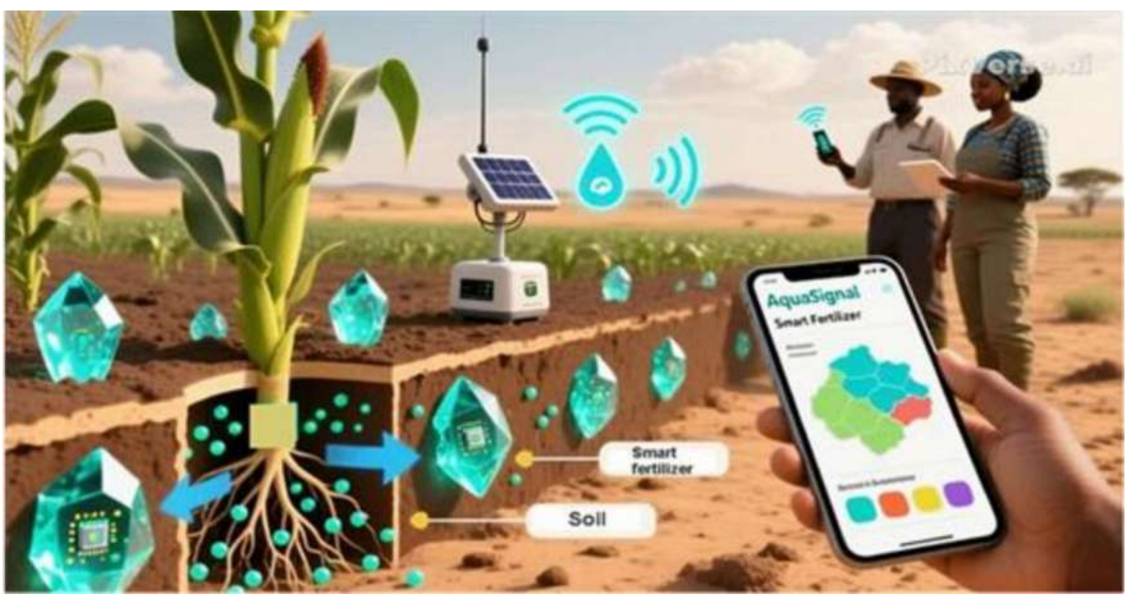




Dr L. B Gav is of the Department of Industrial Chemistry, JOSTUM is an industrial chemist specializing in Environmental Industrial Chemistry. With extensive experience in chemical technology, he contributes insights on turning environmental challenges into opportunities through innovations like waste heat recovery. Green catalysis, circular economy, polymers, smart sensors, and packaging

AQUASIGNAL SMART FERTILIZER

AquaSignal Smart Fertilizer comprises crosslinked hydrogel nano-crystals encapsulating NPK micronutrients from local feedstocks. They swell to store 300x weight in water, deswelling over 6 months to release moisture/nutrients responsively to rhizosphere cues in arid soils. Embedded luminescent nano-sensors and RFID tracers enable wireless depletion monitoring via field transmitters and AI-driven apps.



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Engr. Dr. John Audu is a Senior Lecturer in Agricultural and Biosystem Engineering at Joseph Sarwuan Tarka University, Makurdi, Nigeria. He specializes in AI-driven agricultural machinery, crop processing, automation, and smart sensing systems, with extensive teaching, research, and industry experience.

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We sincerely thank our esteemed guests, partners, faculty, and readers for your unwavering support throughout 2025. Your encouragement has fueled our drive for innovation and impact. As we close this year and step into 2026, we look forward to greater achievements, stronger collaborations, and shared success. May the new year bring you peace, joy, and abundant blessings.