सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India

CSIR RESEARCH SIMPLIFIED

Science at a Glance

October 2025

Council of Scientific & Industrial Research (CSIR)

Designed & Developed
by
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(SCDD)
CSIR Headquarters, New Delhi

सत्यमेव जयते

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सचिव, वैज्ञानिक और औद्योगिक अनुसंधान विभाग
महानिदेशक, वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्

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Secretary, DSIR and Director General, CSIR

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भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
वैज्ञानिक और औद्योगिक अनुसंधान विभाग
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
Government of India
Ministry of Science and Technology
Department of Scientific & Industrial Research
Council of Scientific & Industrial Research

Preface

It gives me immense pleasure to present this publication, CSIR Research Infographics Initiative, which brings together the first 100 infographics prepared to visually communicate the remarkable breadth of CSIR's scientific contributions.

CSIR Scientists publish about 6,000 papers each year in reputed journals—an outstanding achievement that reflects both the depth and diversity of our research. Yet, the real impact of science lies in its ability to reach and inspire people beyond the academic community. This initiative by the Science Communication & Dissemination Directorate (SCDD) is a step in that direction—translating complex research into simple, engaging visuals that resonate with a wider audience. It also reinforces the importance of proactive science communication in today's world, where visibility and societal connect are key to measuring research impact.

I congratulate the participating laboratories and the entire team of SCDD for launching this pioneering effort. I am confident that this initiative will serve as a model for all CSIR laboratories, inspiring them to develop similar approaches to communicate their innovations—be it research papers, patents, or technologies—in simple, impactful formats.

Let this effort be the beginning of a larger movement across CSIR to make our science and research not just world-class in its outcomes, but also widely understood and appreciated.

N. Kalaiselvi

(N. Kalaiselvi)

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CSIR Research Infographics Initiative

CSIR publishes close to 6,000 research papers every year, many of them in high-impact factor publications. To take this wealth of research to a wider public, the Science Communication & Dissemination Directorate (SCDD), CSIR, embarked on an initiative to prepare simple infographics based on these research outputs. Using generative tools for initial simplification, further refined by human effort, these infographics have been regularly shared over the past few months on CSIR's social media channels.

The first 100 infographics prepared under this effort have now been compiled and released as a booklet. Shri R. Achuthan of SCDD has been instrumental not only in designing and preparing all these infographics but also in meticulously putting this entire compilation together. It is heartening to note that several of these infographics have received considerable attention. Some were picked up by mainstream newspapers, while many others were reshared on social media and bookmarked—an indication of their enduring value. This reinforces the point that simplifying scientific research for wider audiences, though challenging, is both possible and impactful when human creativity is combined with generative tools.

This initiative marks the beginning of a broader effort. With the availability of many digital tools including SARAL, research outputs can be converted into infographics, posters, or even audiovisual content. While it is not feasible for SCDD alone to create infographics for all ~6,000 papers annually, this effort can be replicated across CSIR laboratories. Labs may adapt their own methods to simplify and share not just research papers, but also other intellectual outputs such as patents, trademarks, and copyrights for wider dissemination.
Some CSIR labs are already doing commendable work in this direction, with dedicated social media teams actively sharing research content. To strengthen this effort further, it is recommended that each lab "cherry-pick" its best research papers for wider communication. Importantly, such content should ideally be simplified and shared immediately upon publication, since modern research impact metrics now go beyond conventional citations to include internet footprints such as downloads, shares, and social media engagement.

While it is preferable that individual labs take ownership of this activity, SCDD will continue to extend support wherever needed. For this purpose, labs are requested to send the DOI of published papers to SCDD for preparation of infographics. As of now, 22 labs have provided such information, with some such as CSIR-IHBT, CSIR-IIIM, and CSIR-CFTRI sharing more actively than others. We look forward to greater participation from all labs in making CSIR's cutting-edge research more accessible, visible, and impactful.

G Mahesh
Head, Science Communication and
Dissemination Directorate

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HOW CELLS PROOFREAD GENETIC CODE FOR SURVIVAL

What's the Study About?

Scientists at **CSIR-CCMB** studied enzymes, AlaRS-Ed and ThrRS-Ed, involved in error correction during protein synthesis. They found that difference in Zn^{2+} binding by these two enzymes results in differences in their function during stress.

Key Findings

AlaRS-Ed uses Zn^{2+} to keep protein synthesis super accurate during stress.

ThrRS-Ed lets a few errors slip—potentially helping cells survive during tough times.

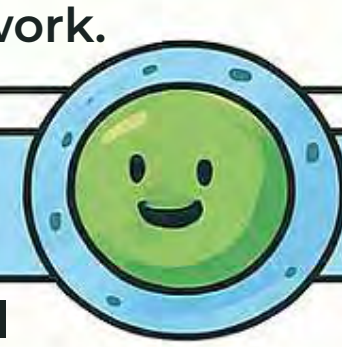
This change happened ~3.5 billion years ago!

Evolutionary Significance

Controlling mistakes helped life adapt to Earth's changing conditions.

Special metals like Zn^{2+} and redox signals differentially affect how these proofreading enzymes work.

Why It Matters?



This study uncovers a natural error-control mechanism in protein synthesis, showing how cells balance accuracy and adaptability to survive under stress.

https://doi.org/10.1038/s41467-025-58787-2

UNDERSTANDING BIODIVERSITY PATTERNS ON THE PENINSULAR INDIA

What's the study about?

Scientists at **CSIR-CCMB**, studied how different species of animals and plants came into existence and disappeared over millions of years across peninsular India. They used data from 33 groups of closely related species to understand how nature has changed.

How was the study conducted?

- Researchers used mathematical models and family trees of species to trace when and how new species formed or vanished.
- They compared species with common ancestors and looked at how climate and geography affected their growth over time
- The focus was on how stable forests and changes in temperature and rainfall influenced the spread or shrinkage of different species

Key findings

- About half the species groups grew slowly but steadily over time, especially in the stable forests of peninsular India.
- The other half showed ups and downs, with fast changes during a period 11–3 million years ago due to rising dryness and changing monsoons.
- Groups that were closely related—like different kinds of lizards—had similar patterns of growth and loss.

Why it matters?

This study enhances understanding of evolutionary dynamics in tropical biodiversity hotspots, revealing how biogeography, climate, and lineage history jointly shape species richness essential for conservation planning and ecological forecasting.

https://doi.org/10.1111/ele.70160

ENSURING ACCURACY IN BACTERIAL CELL WALL BUILDING

What's the study about?

Researchers at **CSIR-CCMB** have identified PgeF, an editing enzyme that maintains the quality of peptidoglycan (PG)—the protective layer around bacterial cells—by ensuring correct amino acid placement during its synthesis.

How was the study conducted?

Studied *E. coli* mutants lacking pgeF, which misincorporated amino acids like L-serine or glycine instead of the essential L-alanine.

Used mass spectrometry and biochemical tests to track PG precursor changes and enzyme function.

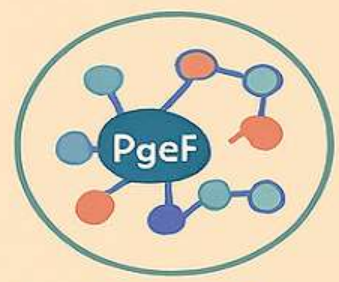
Compared PgeF homologs across bacteria and vertebrates to understand evolutionary conservation.

Why it matters?

This proofreading pathway is essential for bacterial survival and resistance, opening new doors for antibiotic strategies targeting PG assembly and quality control.

Key findings

- PgeF edits PG precursors, removing incorrect amino acids and preserving structural integrity.
- Its absence leads to weaker cell walls and heightened sensitivity to certain antibiotics.



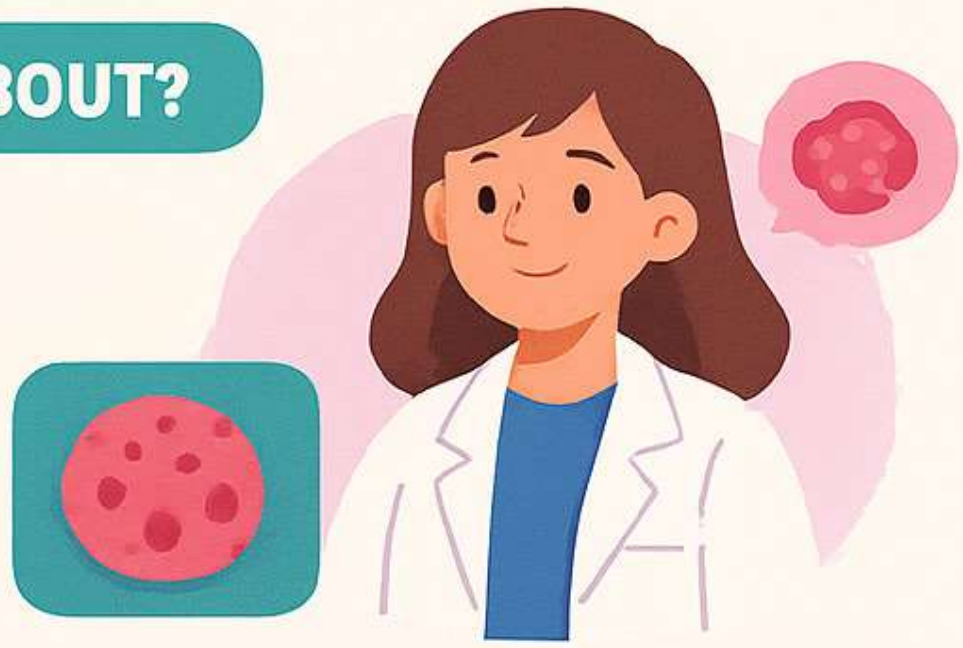
- Though PgeF-like proteins exist in vertebrates, PG editing is exclusive to bacterial versions.

https://doi.org/10.1073/pnas.2505676122

TARGETED DRUG DELIVERY FOR BREAST CANCER TREATMENT

WHAT'S THE STUDY ABOUT?

Scientists at **CSIR-CDRI** have developed specially engineered carriers to deliver Dasatinib (DST), an anti-cancer drug directly to the tumour.



HOW IT WORKS?

- Macrophage derived exosomes (small extracellular vesicles released by cells, Exo) were modified with the YIGSR peptide, which recognizes laminin receptors on tumours.
- These YIGSR-Exo were fused with LPNP membranes using the freeze-thaw method, creating fused hybrid YIGSR-Exo which were then loaded with DST.
- The final formulation, DST-FuNP\@YIGSR-Exo, was used for breast cancer targeting.

KEY FINDINGS

This approach resulted in effective tumor targeting, better drug absorption, and significant tumor shrinkage, ensuring precise delivery, extended drug effectiveness, and reduction in cancer growth.

Why it matters?

This study highlights the potential of DST-FuNP\@YIGSR-Exo as an advanced drug carrier, showing better tumor targeting and enhanced chemotherapy effectiveness, paving the way for biologically derived nanocarriers in cancer treatment.

https://doi.org/10.1002/adhm.202402673

ENHANCING CONCRETE DURABILITY WITH RECYCLED PLASTIC WASTE

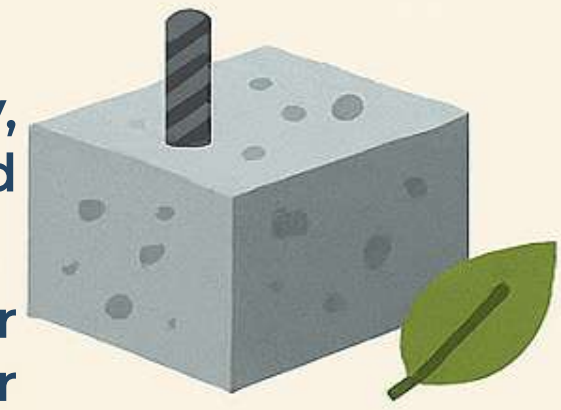
WHAT'S THE STUDY ABOUT?

This study by **CSIR-CECRI** explores the corrosion behavior of steel rebar in concrete containing recycled plastic waste (RPW), assessing its potential as a sustainable fine aggregate replacement.

HOW WAS THE STUDY CONDUCTED?

- RPW was chemically treated to improve bonding with the cement matrix.
- Five RPW content levels (0–20%) and two RPW types (treated & untreated) were evaluated.
- Concrete permeability and corrosion resistance were analyzed using electrochemical techniques and exposure tests.

KEY FINDINGS



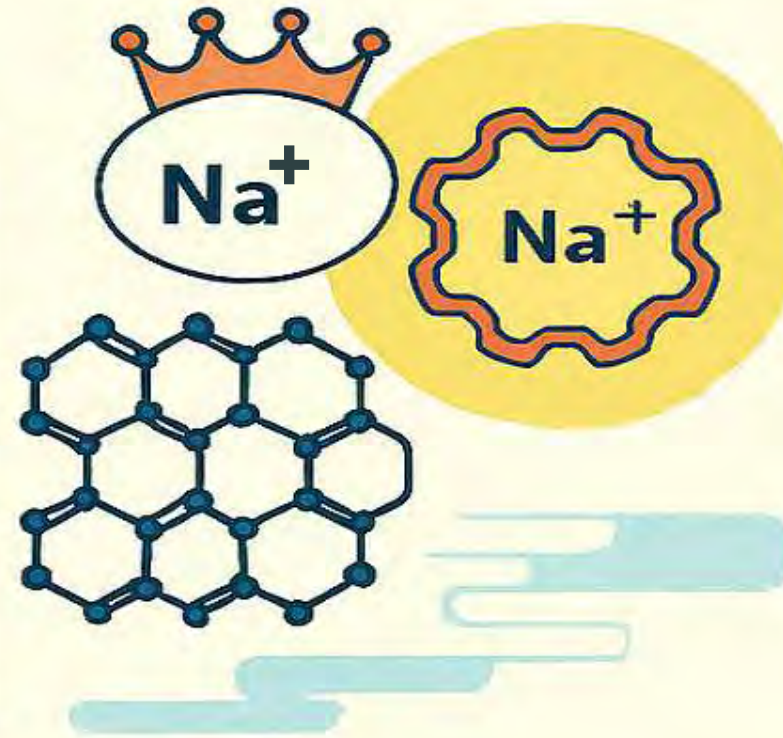
- Treated RPW (T-RPW) improved durability, reducing water absorption by 16.1% and chloride ion penetration by 17.3%.
- Corrosion rate for T-RPW was 50% lower than untreated RPW, enhancing rebar protection.
- RPW offers an eco-friendly solution for reducing reliance on conventional sand while maintaining concrete stability.

WHY IT MATTERS?

This study highlights RPW as an eco-friendly construction alternative for sustainable and durable infrastructure developments.

https://doi.org/10.1177/1478422X251335438

CROWN ETHER-ENHANCED COF CATALYSTS FOR WATER SPLITTING

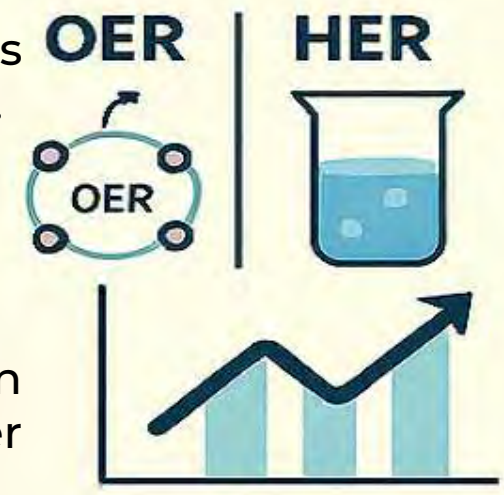


What's the study about?

This study by **CSIR-CECRI** introduces a new design strategy for covalent organic framework (COF) electrocatalysts that enhances water-splitting efficiency by incorporating crown ether units, which coordinate with alkali metals in the electrolyte to improve performance.

How was the study conducted?

- Synthesized COFs with different crown ether sizes to tune alkali metal binding and polarity induction.
- Tested their activities for oxygen and hydrogen evolution reactions (OER and HER) in alkaline and neutral electrolytes.
- Compared performance across different metal-ion conditions and assessed stability and efficiency over time.



Key findings

- Crown ether integration improved charge transfer and suppressed unwanted side reactions, leading to more efficient catalysis.
- The best-performing COF showed strong water-splitting activity and remained stable during long-term testing.
- The catalyst also worked effectively in neutral conditions, showing flexibility across pH ranges.

Why it matters?

This approach offers a metal-free alternative to conventional electro-catalysts, unlocking new possibilities for durable and tunable water-splitting systems using organic materials—an exciting step toward scalable clean energy solutions.

https://doi.org/10.1021/jacs.5c02083

HYDROVOLTAIC ENERGY HARVESTING VIA WATER EVAPORATION

WHAT'S THE STUDY ABOUT?

CSIR-CECRI reviewed recent advances in hydrovoltaic technology, which converts thermal energy from water evaporation into electricity. The study highlights its potential as a clean, sustainable energy source for self-powered systems.

HOW WAS THE STUDY CONDUCTED?

Surveyed a wide range of materials—carbon black, graphene derivatives, metal oxides, and composites—used in hydrovoltaic devices.

Analyzed how material properties and device design influence voltage output and energy efficiency.

Explored applications in energy storage, sensing, and water desalination, along with future development pathways.

WHY IT MATTERS

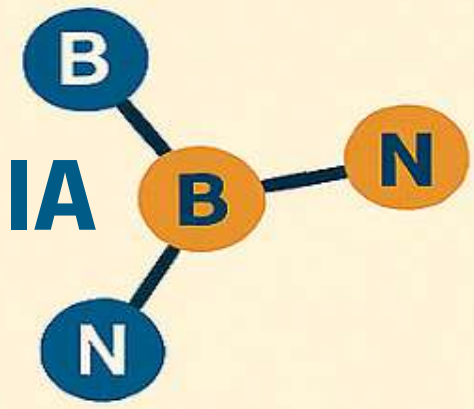
This review bridges the gap between lab-scale innovation and real-world application of hydrovoltaic energy. It positions water evaporation as a viable route for renewable energy integration, especially in resource-constrained environments.

KEY FINDINGS

- Material engineering plays a critical role in optimizing evaporation induced electricity generation.
- Device architecture significantly affects output voltage and scalability.
- Hydrovoltaic systems show promise for powering low-energy devices and supporting sustainable infrastructure.

https://doi.org/10.1039/D5SE00313J

CATALYSTS FOR SUSTAINABLE AMMONIA PRODUCTION



What's the study about?

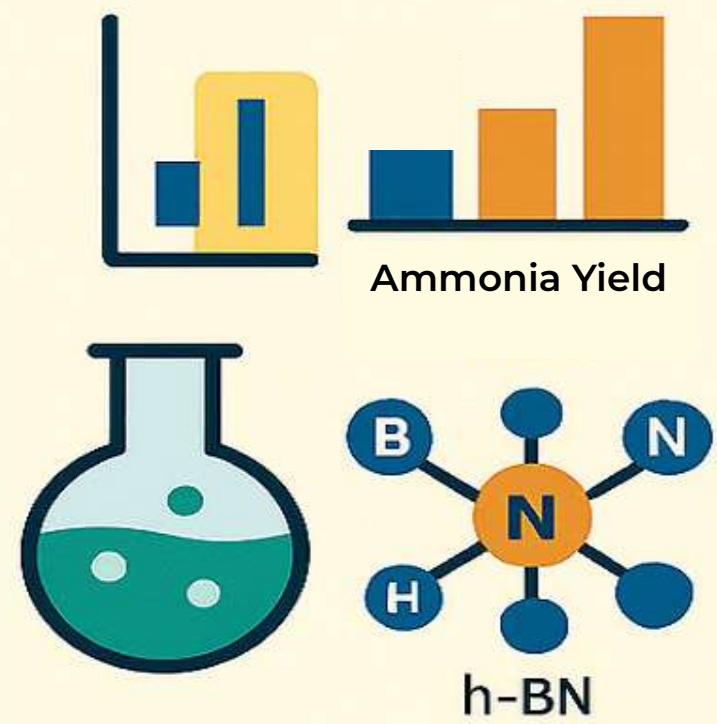
CSIR-CECRI investigated how boron and nitrogen codoping in carbon materials enhances the electrocatalytic nitrogen reduction reaction (eNRR), offering a metal-free route for green ammonia production.

How was the study conducted?

- Synthesized B–N codoped carbon catalysts by annealing polyaniline and boric acid.
- Tuned nitrogen functionalities and h-BN content to study their effect on catalytic activity.
- Tested performance in acidic conditions using electrochemical methods.

Why it matters

The study shows that nitrogen coordination boosts boron-active sites, paving the way for efficient, metal-free catalysts in sustainable ammonia production.



Key findings

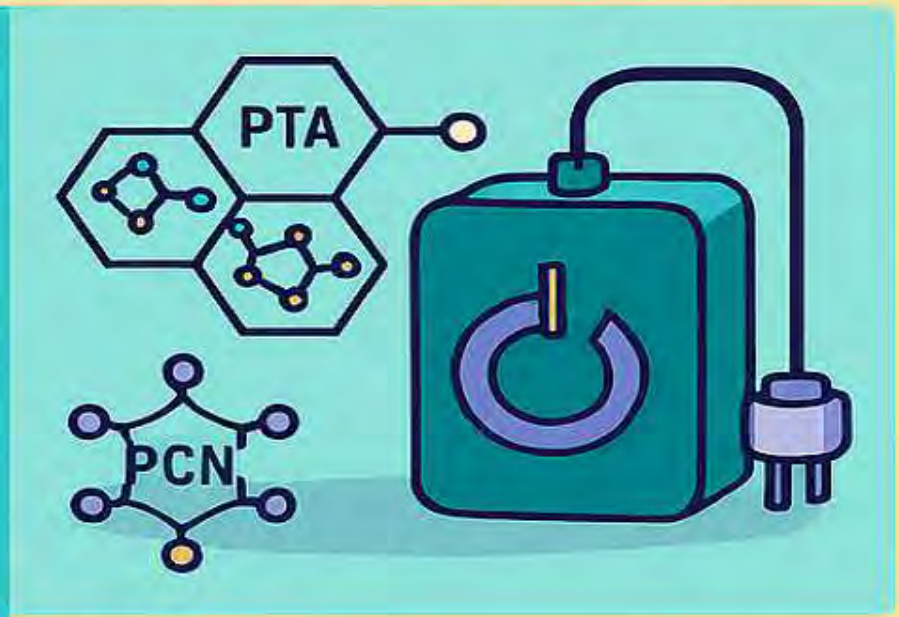
- The best-performing catalyst (BNC-2–1000) achieved 23.5 μ g/h/mg_{cat} ammonia yield and 18.1% Faradaic efficiency.
- Pyridinic-N and B–N sites boosted nitrogen activation and adsorption.
- Codoping promoted stable C–N–B structures for improved performance.

https://doi.org/10.1021/acsaenm.5c00204

ENHANCING FUEL CELL PERFORMANCE USING IMPROVED MEMBRANE

What's the study about?

CSIR-CECRI developed a proton conductive membrane using phosphotungstic acid (PTA) stabilized with graphitic carbon nitride (PCN) and embedded in Aquivion ionomer. The goal was to enhance fuel cell performance using stabilized phosphotungstic acid, especially under low-humidity conditions.



How was the study conducted?

- Synthesized PTA–PCN nanohybrids via a hydrothermal method.
- Incorporated them into Aquivion, a short-side-chain ionomer, to create a composite membrane.
- Evaluated proton conductivity and fuel cell performance under varying humidity levels.

Key findings

- Achieved high proton conductivity: 0.228 S/cm at 80 °C, 95% RH.
- Fuel cell peak power density improved by 34% with the composite membrane.
- Maintained 44% performance at low humidity (30% RH), showing strong water retention and conductivity.

Why it matters

This study offers a major boost to energy conversion technologies, enabling efficient fuel cell operation even in dry conditions. It addresses the key challenges like low conductivity and performance under low-humidity conditions, paving the way for durable and high-performing energy systems.

https://doi.org/10.1021/acsami.4c17363

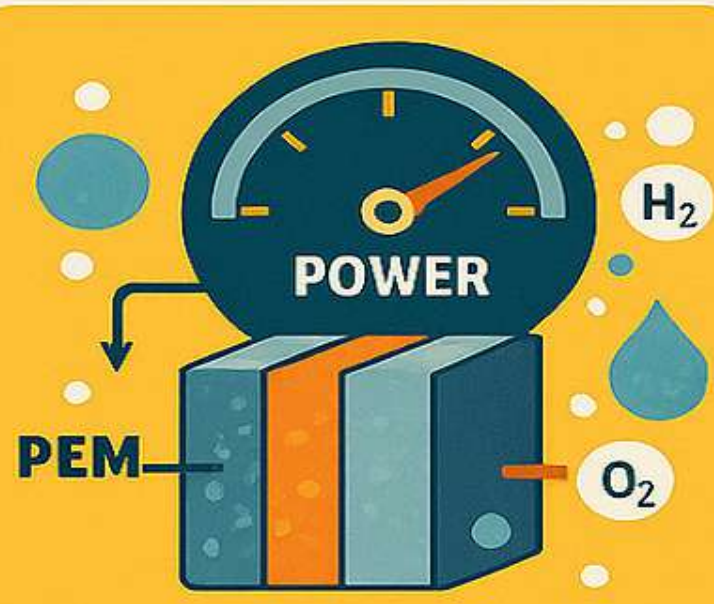
IMPROVING FUEL CELL LIFESPAN & EFFICIENCY

WHAT'S THE STUDY ABOUT?

This **CSIR-CECRI and CSIR-CSMCRI** collaborative study tackles the issue of proton exchange membrane (PEM) degradation in hydrogen fuel cells due to radical attacks. Researchers developed a method to improve radical scavenging and membrane durability.

HOW WAS THE STUDY CONDUCTED?

- Incorporated bimetallic oxides into sulfonated PEEK (sPEEK) membranes.
- Compared three variants—SPZr, SPZn, and SPMn—each with 2% filler.
- Evaluated their performance under real-time fuel cell conditions and chemical stress tests.



KEY FINDINGS

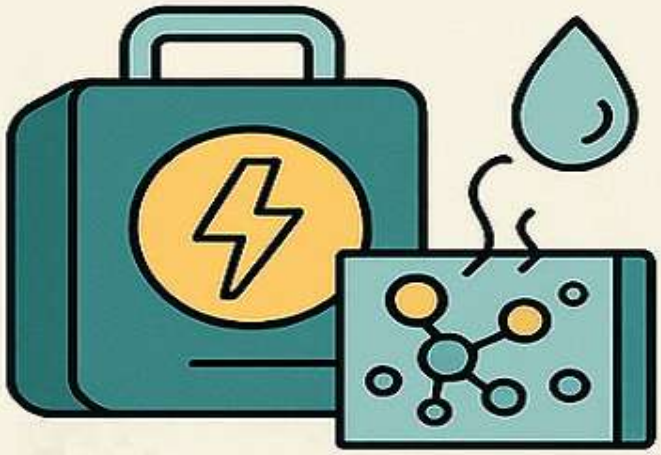
- SPZr outperformed others, thanks to Zr's synergy with ceria—enhancing redox activity and membrane stability.
- The membrane resisted mass loss and conductivity decline under radical exposure.
- SPZr delivered higher power output and better durability, maintaining performance across voltage and temperature tests.

WHY IT MATTERS?

This study strengthens the case for radical-resistant PEMs, improving fuel cell lifespan and efficiency—especially for clean energy technologies facing real-world stress.

https://doi.org/10.1016/j.memsci.2025.124159

IMPROVING HYDROGEN FUEL CELL PERFORMANCE

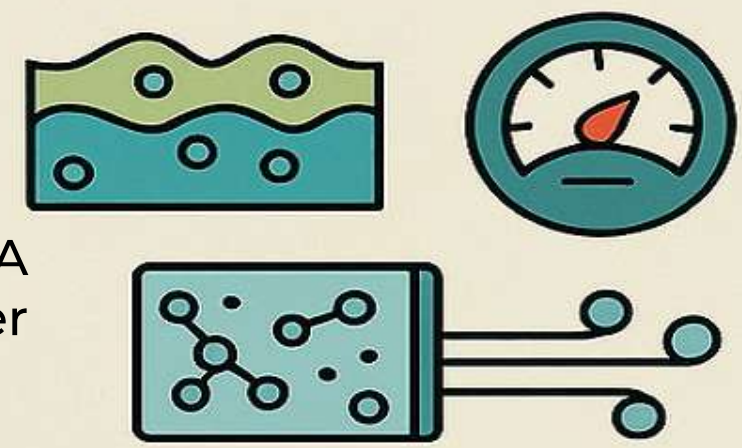


What's the study about?

This study by **CSIR-CECRI** focuses on enhancing hydrogen fuel cell membranes that struggle under low humidity, where poor water connectivity slows ion movement and reduces efficiency.

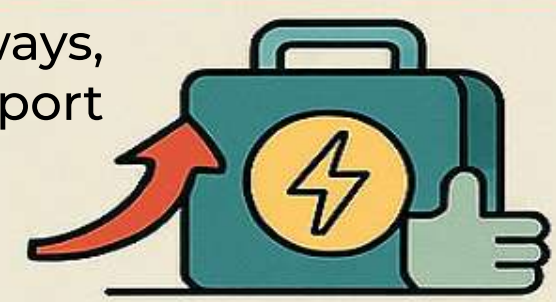
How was the study conducted?

- Developed a modified membrane by grafting sulfonic acid-rich polymers onto carbon nitride.
- Incorporated the material into a PFSA ionomer matrix to strengthen water networks and improve conductivity.
- Evaluated proton conduction, mechanical strength, and stability under dry and humid conditions.



Key findings

- The new membrane maintains water pathways, reducing resistance and boosting ion transport in dry environments.
- Achieved higher current output and remained stable under mechanical stress and prolonged operation.
- Shows strong potential for fuel cells to perform reliably across different humidity levels.



Why it matters?

This study focuses on enhancing hydrogen fuel cell membranes that struggle under low humidity, where poor water connectivity slows ion movement and reduces efficiency.

https://doi.org/10.1039/D4NR04913F

ADVANCING ZINC-ION BATTERIES VIA ANTI-SOLVENT ELECTROLYTE ENGINEERING

WHAT'S THE STUDY ABOUT?

This review from **CSIR-CECRI** highlights how antisolvent-modified aqueous electrolytes can resolve key limitations in zinc-ion batteries (ZIBs), boosting their stability, performance, and energy density.

HOW WAS THE STUDY STRUCTURED?

- Summarizes recent work on modifying electrolyte properties and solvation structures in aqueous ZIBs.
- Explains the mechanism of antisolvents in suppressing side reactions, preventing zinc dendrites, and improving ion transport.
- Discusses selection criteria for antisolvents based on their impact on cycle life, conductivity, and electrochemical window.

KEY FINDINGS

- Antisolvent methods improve stability, deterring unwanted reactions.
- Modified solvation structure leads to better ion insertion/extraction, enhancing cycle life and voltage range.
- CECRI's contributions include tuning transport properties and water coordination for efficient electrolyte design.

WHY IT MATTERS?

This review fosters advanced, safer, energy-rich aqueous ZIBs for grid storage and flexible electronics via electrolyte chemistry innovations.

https://doi.org/10.1039/D5CC01155H

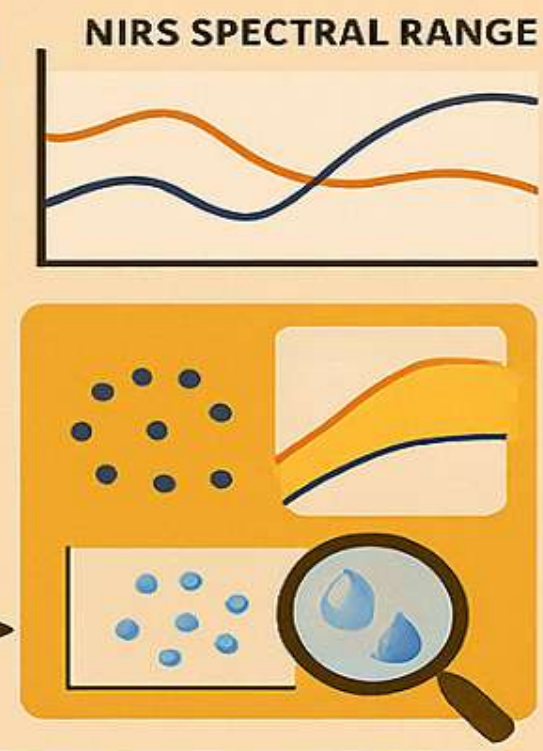
AUTHENTICATING HONEY
WITH NEAR-INFRARED AQUAPHOTOMICS

What's the study about?

This study by **CSIR-CEERI** introduces a highly accurate, non-destructive method to detect honey adulteration, using Near-Infrared Spectroscopy (NIRS) combined with aquaphotomics and chemometric analysis, validated with Stable Carbon Isotope Ratio Analysis (SCIRA).

How was the study conducted?

- Various honey samples and common adulterants (from C3 & C4 plants) were analyzed.
- NIRS spectral range (600–2600nm) focused on water-characteristic wavelengths, enhanced through aquaphotomic expansions (1940, 1960, and 2100 nm).
- Machine learning algorithms (PCA, k-means, LDA, SVM for classification; PCR, SVR, PLS for regression) were applied for pattern recognition and quantification.



Key findings

- Achieved 100% classification accuracy and R^2 of 0.999, confirming precise adulteration detection.
- Water-based spectral signatures were pivotal in distinguishing genuine from adulterated samples.
- SCIRA validation reinforced the credibility of the NIRS aquaphotomic approach.

Why it matters?

This work empowers the honey industry and regulatory authorities with a rapid, accurate, and eco-friendly tool for combating food fraud—safeguarding consumer trust, public health, and market integrity.

https://doi.org/10.1016/j.jfca.2025.107735

HARNESSING RADIO FREQUENCY ENERGY FOR SUSTAINABLE IoT OPERATIONS

What's the study about?

This study by **CSIR-CEERI** explores radio frequency energy harvesting (RFEH) as a viable method to power wireless IoT devices, addressing challenges related to power density, antenna efficiency, and receiver sensitivity

How was the study conducted?

- Antenna design trade-offs (size, frequency, gain) were evaluated to optimize RF energy retrieval.
- A proof of concept experiment demonstrated the ability to power a Texas Instruments CC1350 SOC sensor node using RFEH.
- Thermal analysis and energy generation tests compared performance with existing RFEH systems.

Key findings

- RFEH successfully powered and sustained multiple IoT sensor nodes, eliminating battery dependence.
- Charging a supercapacitor to 3.3V yielded 2 mW, maintaining sensor operation with 1-minute data recording intervals.
- A high-gain antenna significantly improved energy harvesting efficiency.

https://doi.org/10.1109/TIM.2025.3550955

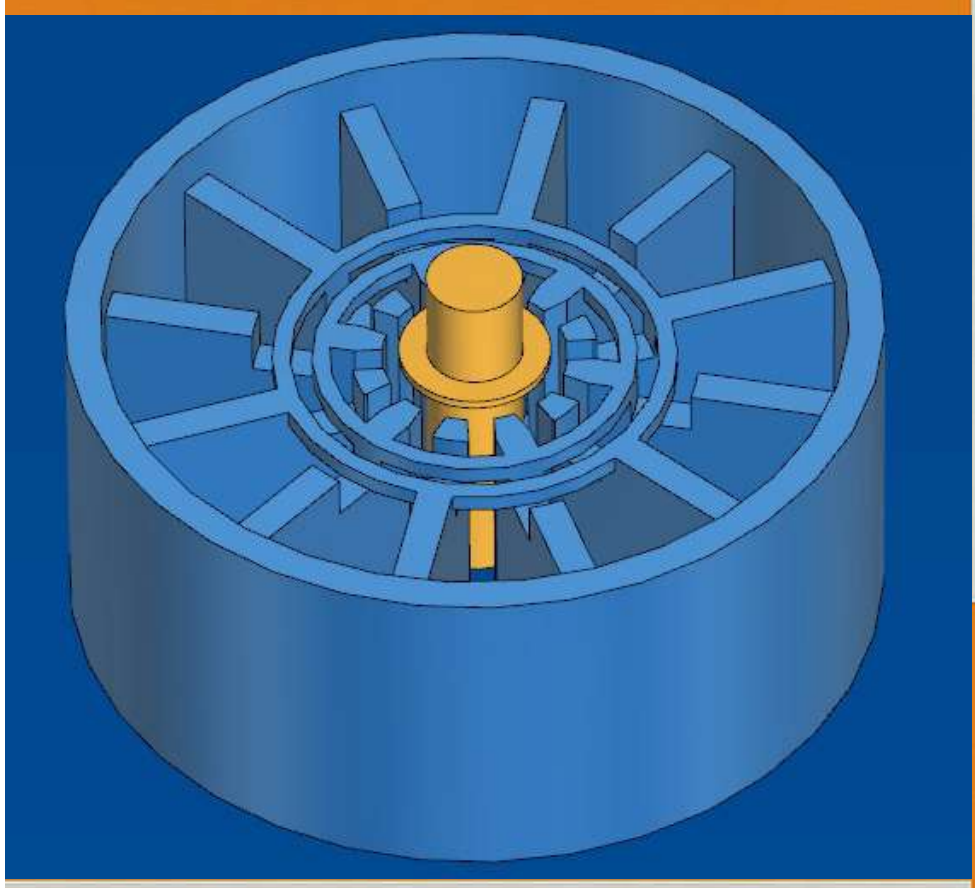
Why it matters?

This study highlights RFEH as a sustainable solution for powering IoT ecosystems, paving the way for battery-free, energy-efficient sensor networks in smart technology applications.

ENHANCING MAGNETRON EFFICIENCY THROUGH ANODE VANE MODIFICATION

What's the study about?

This study by **CSIR-CEERI** demonstrates how modifying the shape of anode vanes in a magnetron can significantly enhance power output and efficiency, using 3D PIC code CST particle studio simulations.



How was the study conducted?

- Axial edges of the anode vane tips facing the cathode were chamfered.
- Optimized chamfer radius (0.75 mm) and angle (20°) were determined.
- Comparative analysis of unchamfered and modified vanes for power, efficiency, and oscillation spectrum.

Why it matters?

These improvements in magnetron efficiency can enhance microwave-based applications, including radar, communication, and industrial heating systems.

Key findings

- Power output increased by ~44%, reaching 2.3 kW with modification.
- Efficiency improved to 80%, enhancing operational performance.
- Oscillation spectrum became purer, improving overall stability.

https://doi.org/10.1080/09205071.2025.2478272

Revolutionizing BAKERY FAT

A HEALTHIER FUTURE WITH OLEOGELS

What's the study about?

Scientists at **CSIR-CFTRI** studied the use of oleogels enriched with unsaturated fatty acids and nutraceuticals to enhance fat quality in bakery products by partially replacing conventional shortening.

How was the study conducted?

- A blend of rice bran oil and soybean oil fortified with β-sitosterol was used to create oleogels.
- Chitosan was cross-linked with vanillin through an emulsion-template technique.

- Cookie formulations with oleogels were tested for texture, trans-fat reduction, and overall fat quality.

Key findings

- Cookies with 50% oleogel replacement had significantly reduced trans-fat content.
- The olegels maintained the properties of the stock oil confirming their structural effectiveness.

Why it matters?

Oleogels present an effective solution for reducing trans-fat-in bakery products while maintaining texture and quality.

This approach supports healthier formulations without sacrificing functionality.

https://doi.org/10.1016/j.ijbiomac.2024.139130

ROOTS OF *ASPARAGUS RACEMOSUS*

NUTRIENT-RICH AND MEDICINALLY PROMISING

What's the study about?

This study by **CSIR-CFTRI** investigates the nutritional, phytochemical, and flavour composition of the roots of Asparagus racemosus, highlighting its potential as a functional food and medicinal resource.

How was the study conducted?

- Nutrient analysis included carbohydrate profiling, glycemic index measurement, and mineral content determination.
- Phytochemicals were identified using UHPLC–Mass Spectrometry, targeting bioactive compounds.
- Volatile compounds contributing to flavour and aroma were examined to characterize its sensory profile.

Key findings

- Roots are high in complex carbohydrates (78.6%), with a low glycemic index (3.5), and rich in dietary fiber and fructo-oligosaccharides.
- Identified oxylipins, lignans, flavonoids, saponins, and phenolics, supporting antioxidant and anti-inflammatory potential.
- Nineteen aroma compounds were characterized for the first time, adding value to its flavour profile.

https://doi.org/10.1016/j.fbio.2025.106677

Why it matters?

This study highlights *A. racemosus* for its rich nutrition, healing phytochemicals, and delightful flavors, making it a prime contender for functional foods and traditional medicine systems.

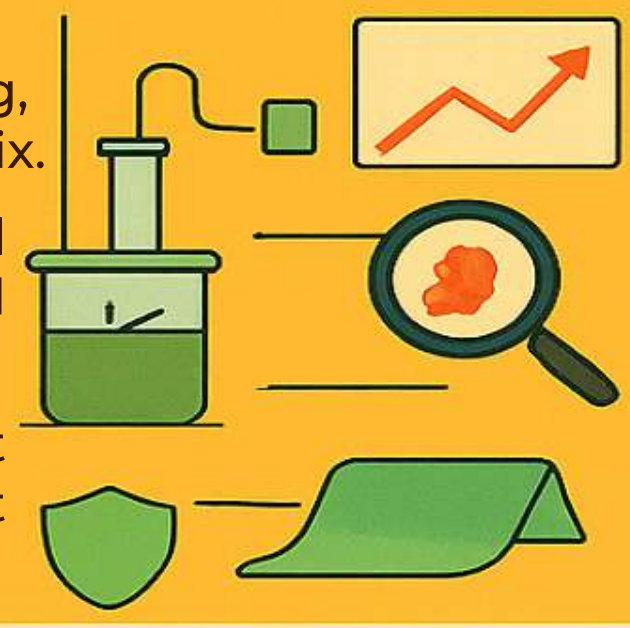
ENHANCED PLA FILMS FOR FOOD PACKAGING

What's the study about?

CSIR-CFTRI developed multifunctional polylactic acid (PLA) films by incorporating cardanol oil (CA) and amine-functionalized graphene (AFG) to improve mechanical, thermal, and antioxidant properties for active food packaging applications.

How was the study conducted?

- Fabricated PLA films using solution casting, blending CA and AFG into the polymer matrix.
- Characterized structural and functional changes using FTIR, XRD, DSC, TGA, and surface morphology analysis.
- Evaluated mechanical strength, antioxidant capacity, and antimicrobial activity against *Salmonella typhi*.



Key findings

CA increased elongation by 153%, while AFG boosted tensile strength by 35%.

Antioxidant activity improved 28× with CA and 12× with AFG.

Films extended mango shelf-life by 15 days and showed moderate antimicrobial effects.

Why it matters

This study demonstrates how bio-based additives like cardanol and graphene can transform PLA into smart packaging materials—enhancing durability, food preservation, and safety.

It offers a sustainable alternative to conventional plastics in handling and storage.

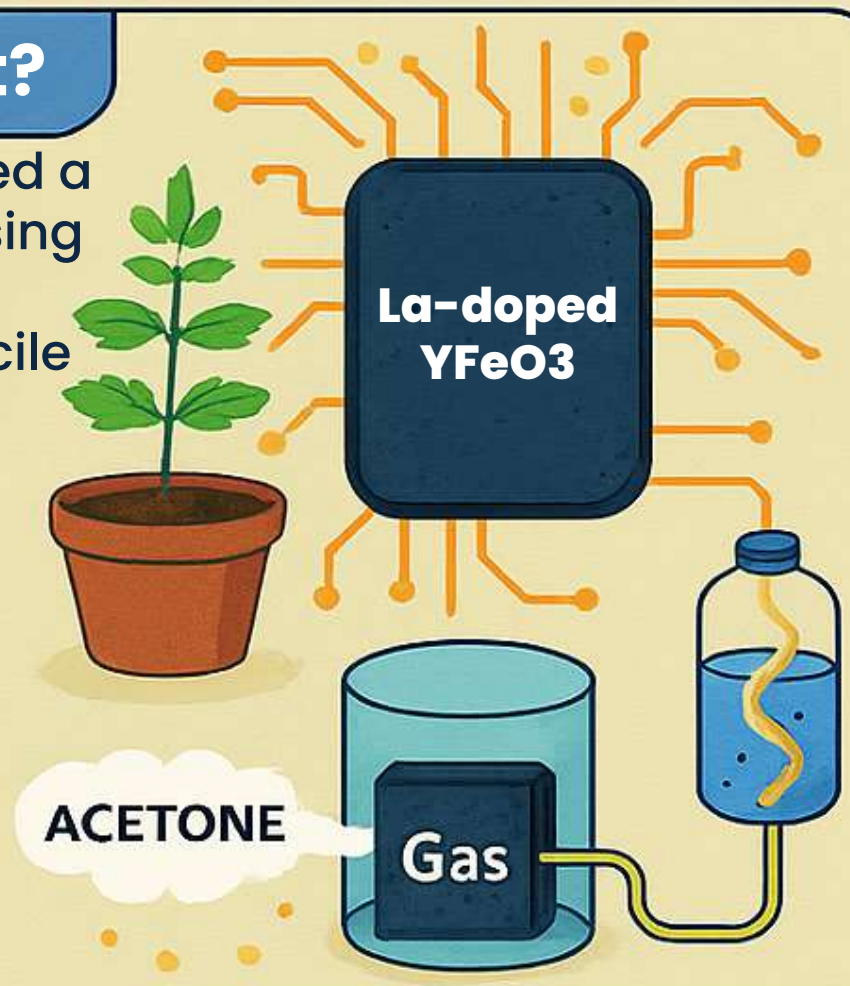
https://doi.org/10.1016/j.ijbiomac.2025.139849

SMARTER WAY TO DETECT ACETONE

For non-invasive diabetes diagnosis

What's the study about?

Scientists at **CSIR-CGCRI** developed a highly sensitive acetone sensor using yttrium lanthanum ferrite (YLF) nanomaterial synthesized by a facile aqueous sol-gel route using in organic nitrate, capable of detecting trace concentrations of acetone.



How was the study conducted?

- La-doped YFeO3 based sensors were fabricated.
- The sensor's response to acetone (1–10 ppm) was tested under various conditions.
- Stability, selectivity, and real-world performance were evaluated over time.

Key Findings

- The sensor demonstrated high sensitivity, detecting acetone as low as 1 ppm.
- It remained stable for over 150 days without performance loss.
- It effectively distinguished acetone levels in breath samples, aiding diabetes detection.

Why it matters?

This research supports the development of long-lasting, selective acetone sensors that can be used for early disease detection and environmental monitoring.

https://doi.org/10.1007/s42114-025-01241-0

UNDERSTANDING HOW PLANTS HANDLE CADMIUM STRESS

What's the study about?

Scientists at **CSIR-CIMAP** explored the role of miR408-encoded peptide (miPEP408), in *Arabidopsis* (a model plant used for studying plant biology), in responding to cadmium (Cd) stress by influencing sulfur-related processes in plants.

How was the study conducted?

- Researchers created plant variants with and without miPEP408 to study its effects.
- They tested how plants responded to cadmium by measuring growth and detoxification ability.
- Synthetic peptides were also applied to analyze changes in gene activity.

Key findings

- Plants with miPEP408 showed reduced detoxification ability and increased sensitivity.
- Plants without miPEP408 showed improved protection and cadmium resistance.
- miPEP408 influences how plants absorb and transport cadmium.

Why it matters?

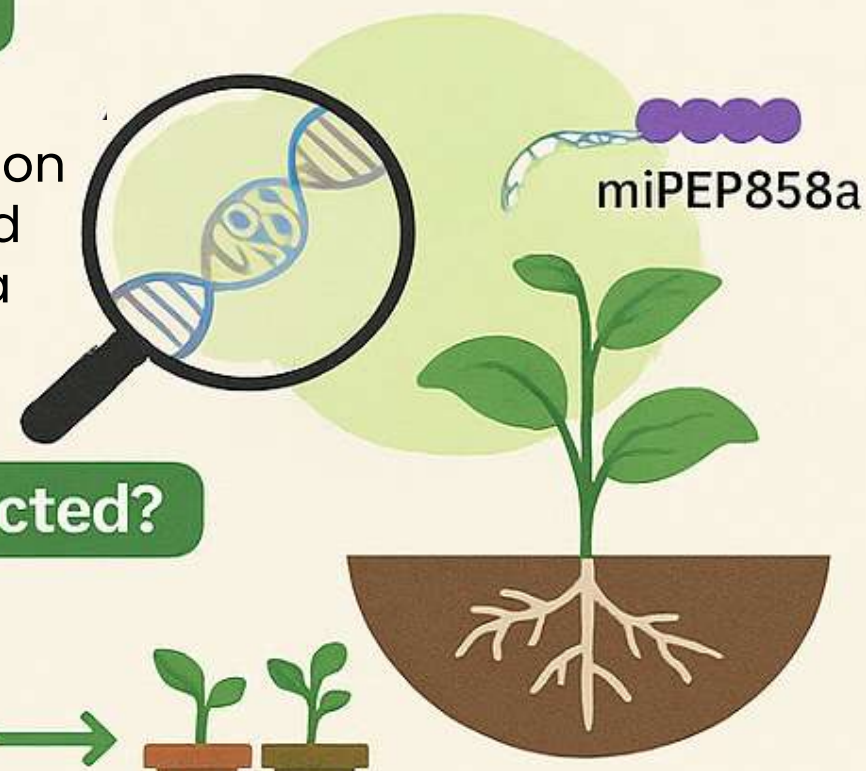
This research helps scientists understand how plants handle heavy metal stress, which could lead to improved strategies for making crops more resilient in polluted environments.

https://doi.org/10.1016/j.jhazmat.2025.138420

FUNCTIONAL ROLE OF PLANT GROWTH PEPTIDES IN REGULATION AND PLANT DEVELOPMENT

What's the study about?

This study by **CSIR-CIMAP** investigates the molecular function of miPEP858a, a peptide encoded by pri-miR858a in *Arabidopsis* (a model plant used for studying plant biology).



How was the study conducted?

- DNA-protein interaction assays identified how miPEP858a binds to the MIR858 promoter.
- Researchers tested the effects of miPEP858a's C-terminal region using synthetic peptides.
- Mutant plants lacking miPEP858a were compared to those with peptide treatment.

Key findings

- The C-terminal region of miPEP858a is essential for its function.
- Peptide application enhanced MIR858 expression and led to observable plant changes.
- Mutant plants showed altered flavonoid biosynthesis, confirming miPEP858a's regulatory role.

Why it matters?

This study helps identify functional miPEP domains, potentially lowering peptide synthesis costs and improving crop traits without complex genetic modifications

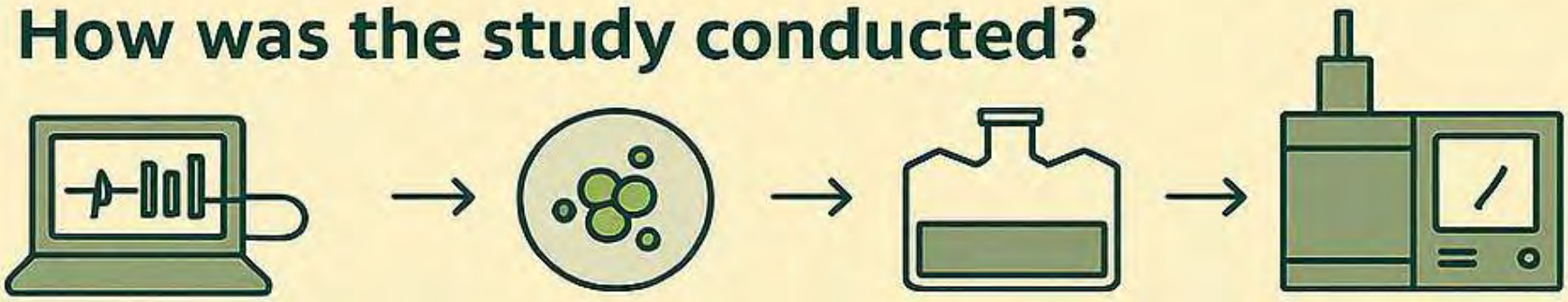
https://doi.org/10.1093/plphys/kiaf152

UNLOCKING FLAVONOID BIOSYNTHESIS IN *Ocimum tenuiflorum*

What's the study about?

This study by **CSIR-CIMAP** explores a newly identified flavonoid glucosyltransferase gene (OtUGT) in Ocimum tenuiflorum, aiming to enhance the biosynthesis of apigetrin, a medicinally valuable flavonoid.

How was the study conducted?



- Gene mining and qRT-PCR analysis identified OtUGT, confirming its high expression in Ocimum tenuiflorum.
- The OtUGT protein was expressed in *E. coli* and tested with flavonoid substrates.
- Advanced techniques like HPLC, LC-QTOF, and NMR verified apigetrin production.

Key findings

- OtUGT exhibited activity with apigenin and UDP-a-D-glucose, forming apigetrin.
- Overexpression increased apigetrin levels in transgenic Nicotiana tabacum plants.
- Hairy root transformation in Ocimum tenuiflorum did not significantly boost apigetrin content.

Why it matters?

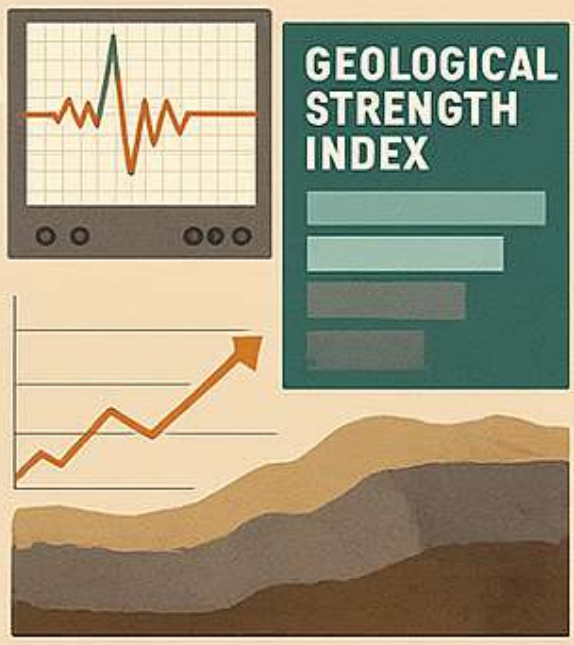
Understanding OtUGT-mediated apigetrin biosynthesis opens doors for optimized production in plants or engineered systems, paving the way for cost-effective medicinal applications.

https://doi.org/10.1111/tpj.70111

IMPROVING BLAST-INDUCED VIBRATION PREDICTION USING GEOLOGICAL PARAMETERS

WHAT'S THE STUDY ABOUT?

This study by **CSIR-CIMFR** introduces a new predictive model for estimating blast-induced ground vibration, incorporating Geological Strength Index (GSI) to improve accuracy in vibration attenuation calculations.



HOW WAS THE STUDY CONDUCTED?

- The scaled-distance concept was analyzed for estimating peak particle velocity.
- Geological Strength Index (GSI) was integrated into the USBM model for better attenuation predictions.
- The proposed model was validated against unused blast monitoring data.

KEY FINDINGS

- GSI improves vibration prediction accuracy, accounting for geological variations.
- The USBM model was successfully modified, enhancing efficiency for different geological settings.

WHY IT MATTERS?

By considering geological characteristics, this model offers a more precise tool for blast design, leading to safer and more effective mining and infrastructure projects.

https://doi.org/10.1007/s12665-025-12303-3

PREDICTING COAL BUMPS FOR SAFER MINING OPERATIONS

What's the study about?

This study by **CSIR-CIMFR** develops a new predictive model for coal bump (a sudden, violent release of energy) occurrences in underground mines, incorporating both geological and operational factors for better accuracy.

How was the study conducted?

A burst energy coefficient was introduced to assess coal bump probability.

Numerical modeling analyzed stress–strain curves of coal pillars.

The model was validated using real coal bump events from underground mines.

Key findings

- Depth of cover is the most influential factor in coal bump occurrences.
- Stronger roof strata increases coal bump risk.
- Other key parameters influence coal bump are RMR, w/h ratio of coal pillars, and Young's modulus of roof and coal.

Why it matters?

This study provides a field-applicable tool for predicting coal bumps, improving mine safety and risk management by helping engineers classify events based on their probability of occurrence.

https://doi.org/10.1007/s10064-025-04289-w

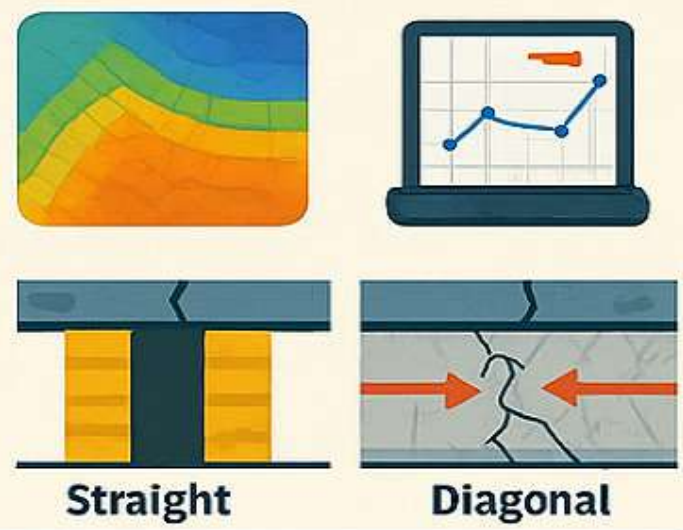
OPTIMIZING COAL PILLAR EXTRACTION FOR SAFER UNDERGROUND MINING

What's the study about?

This study by CSIR-CIMFR examines the optimal line of extraction in Bord and Pillar (B&P) mining, comparing straight vs. diagonal extraction methods to improve productivity and stability in underground coal mines.

How was the study conducted?

- Numerical modeling using FLAC3D (v5.0) and extensive field observations analyzed stress distribution.
- Strata monitoring instruments tracked roof displacement and rock load variations.
- Plate theory was applied to interpret roof deflection during depillaring.



Key findings

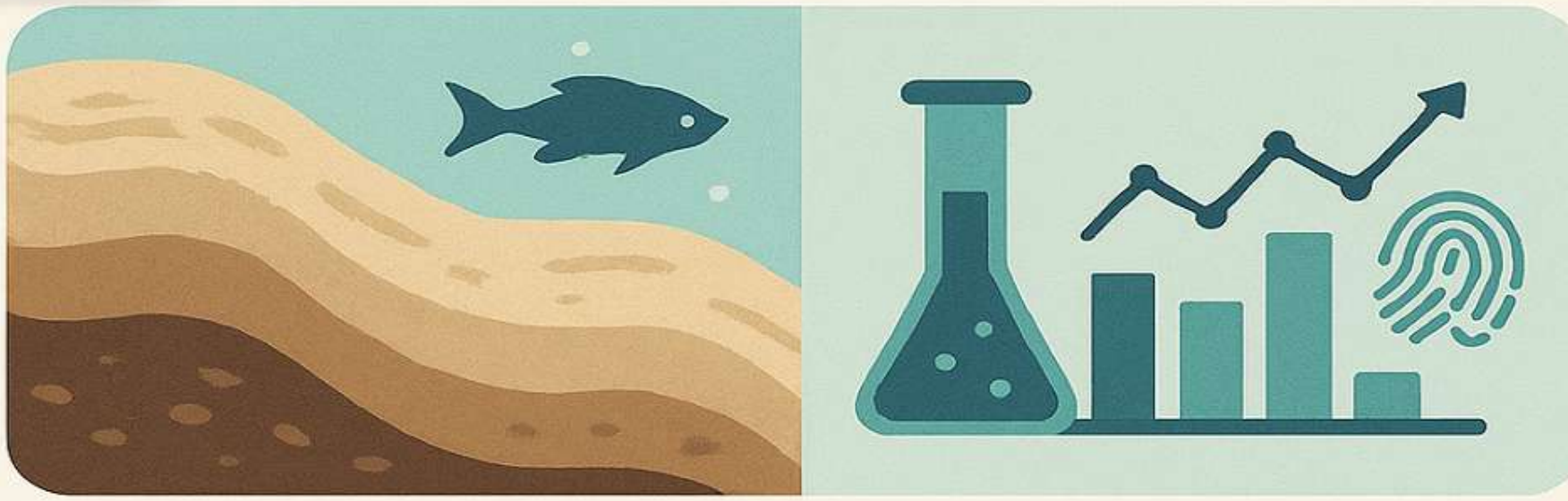
- Straight-line extraction proved safer, reducing ground instability compared to diagonal methods.
- Diagonal extraction led to higher stress surges, delays in major falls, and increased rock load buildup.
- Field and modeling results confirmed straight-line extraction as the optimal choice for continuous miner (CM) operations.

Why it matters?

This study provides data-driven insights to enhance underground coal mining safety, optimizing pillar extraction to minimize hazards and improve operational efficiency.

https://doi.org/10.1061/IJGNAI.GMENG-10788

MARINE INFLUENCE AND ORGANIC MATTER IN PERMIAN SEDIMENTS



What's the study about?

This study by **CSIR-CIMFR** analyzes Lower Permian coals and shales from the Ib River sub-Basin to assess their hydrocarbon potential, depositional environment, and signs of marine interaction.

How was the study conducted?

- Approaches taken involve Rock-Eval pyrolysis, kerogen kinetic studies, biomarker research, alongside carbon isotope analysis.
- Compared Barakar and Karharbari formations to evaluate organic input sources, thermal maturity, and environmental conditions.

Key findings

- Samples are rich in organic matter with high hydrocarbon potential, but show low maturity, limiting immediate commercial value.
- Barakar Formation indicates marine influence with stratified, saline conditions; Karharbari reflects swampy, oxygen-rich deposition.
- Climatic shifts and vegetation sources, both terrestrial and aquatic played a major role in shaping organic composition.

Why it matters?

This study offers insights into Permian-era environmental dynamics and helps identify future exploration targets for coalbed methane and gas recovery.

https://doi.org/10.1111/jpg.12881

PORES IN COAL AND ITS IMPACT ON GAS STORAGE

WHAT'S THE STUDY ABOUT?

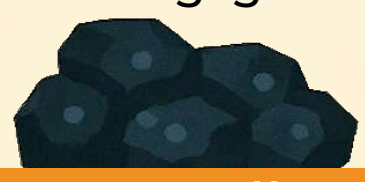
Researchers at **CSIR-CIMFR** investigated coal samples from the Raniganj and Jharia Basins to understand how pore structure, thermal maturity, and organic makeup influence coalbed methane recovery and CO_2 storage potential.

HOW WAS THE STUDY CONDUCTED?

- Used low-pressure CO_2 and N_2 adsorption techniques to assess pore features in five coal samples of varying maturity.
- Focused on calculating micropore complexity (from CO_2 data) to understand pore behavior.
- Analyzed links between coal composition, thermal maturity, and gas adsorption potential using Rock-Eval pyrolysis and organic analysis.

KEY FINDINGS

- Postmature coals showed more complex micropores and greater storage potential.
- CO_2 adsorption data was more effective than N_2 in revealing micropore behavior.
- Micropore complexity closely correlate with coal maturity and organic content—offering a reliable tool for estimating gas adsorption capacity.



WHY IT MATTERS?

These insights can help design better strategies for methane recovery and CO_2 sequestration by identifying coal types with superior micropore complexity and storage efficiency.

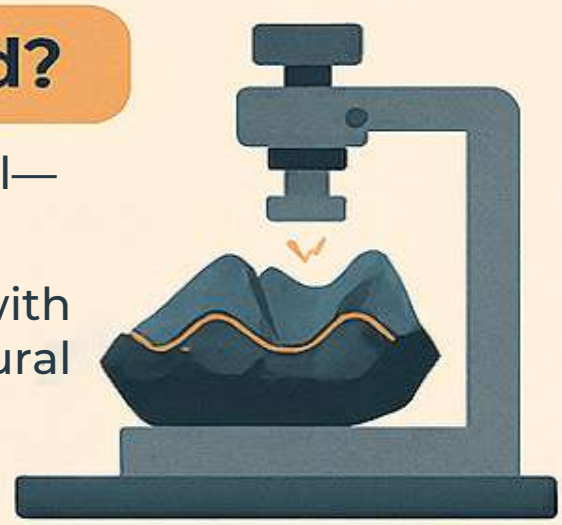
https://doi.org/10.1021/acs.energyfuels.5c00021

TRI-AXIAL STRESS ANALYSIS OF COAL

What's the study about?

This study from **CSIR-CIMFR** investigates how anthracite (highest grade of coal) samples respond to stress, focusing on elastic anisotropy (direction dependent), which affects their structural reliability in subsurface energy extraction and storage applications.

How was the study conducted?



- Tested three coal types—Primrose, Lattimer, Mt. Carmel—under triaxial stress conditions.
- Measured P-wave and S-wave velocities, along with Thomsen anisotropy parameters to evaluate structural integrity.
- Applied principal component analysis to link mechanical response with coal composition.

Key findings

- Primrose coal showed strongest resistance to stress, with stable wave velocities and low porosity.
- Lattimer coal was more vulnerable to microcracking and lost anisotropy beyond 45 MPa stress.
- Mt. Carmel coal displayed moderate resilience, maintaining some directional properties under stress.

Why it matters?

This study reveals how coal's internal structure affects stress response, aiding safer decisions in methane extraction, CO_2 storage, and underground engineering

https://doi.org/10.1016/j.coal.2025.104740

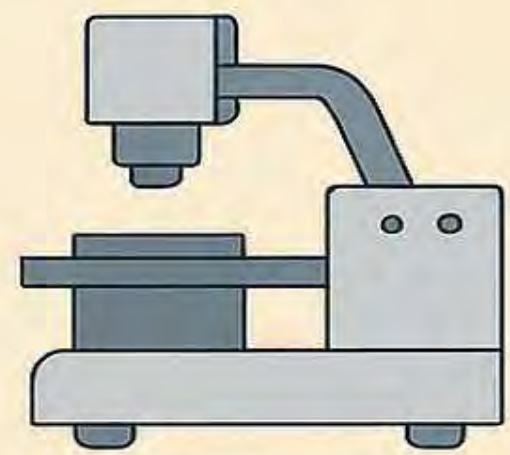
STUDY ON PORE STRUCTURE IN COAL VS. SHALE

What's the study about?

CSIR-CIMFR investigated the microstructural differences between coal and shale to assess their potential for gas storage. The study focuses on porosity, connectivity, and surface features, especially under conditions like CO_2 injection.

How was the study conducted?

- Coal and shale samples were collected from a common reservoir depth.
- Researchers used scanning electron microscopy (SEM), gas adsorption analysis, and mineralogical assessments.
- Metrics analyzed included micropore and mesopore surface area, average pore width, surface roughness, and degree of pore connectivity.

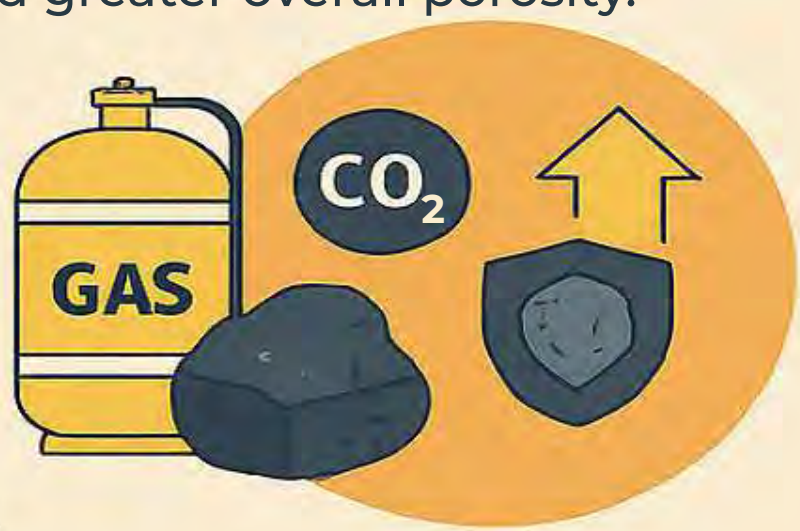


Key findings

- Coal has 2.5× higher micropore surface area than shale; its mesopore area is lower.
- Higher organic carbon in coal contributes to finer pore widths and greater overall porosity.

Why it matters?

Coal's porosity enhances gas storage, yet CO_2 injection may swell coal and shale, affecting stability. These insights help refine Enhanced Coalbed Methane(ECBM) and shale gas recovery for safe, sustainable energy extraction.



https://doi.org/10.1016/j.fuel.2025.135185

METAL CONTAMINATION AND HEALTH RISKS

IN COAL MINING REGION

WHAT'S THE STUDY ABOUT?

CSIR-CIMFR assessed metal trace element (TE) contamination in soils of the Eastern Raniganj basin, linking pollution sources to human health risks.

HOW WAS THE STUDY CONDUCTED?

- Collected 83 surface soil samples post-monsoon and analyzed for 12 trace elements.
- Used Positive Matrix Factorization (PMF) to identify pollution sources.
- Applied Human Health Risk (HHR) models to estimate exposure and cancer risk for adults and children.

KEY FINDINGS

- Most TEs exceeded background levels; coal mining was the dominant pollution source.
- Children faced higher health risks via ingestion, dermal, and inhalation routes.
- Chromium (Cr) was a key contributor to carcinogenic risk across all exposure pathways.

WHY IT MATTERS

This study outlines a framework to identify pollution sources and health effects in coal mining areas, emphasizing urgent strategies to safeguard vulnerable groups, particularly children, from toxic exposure.

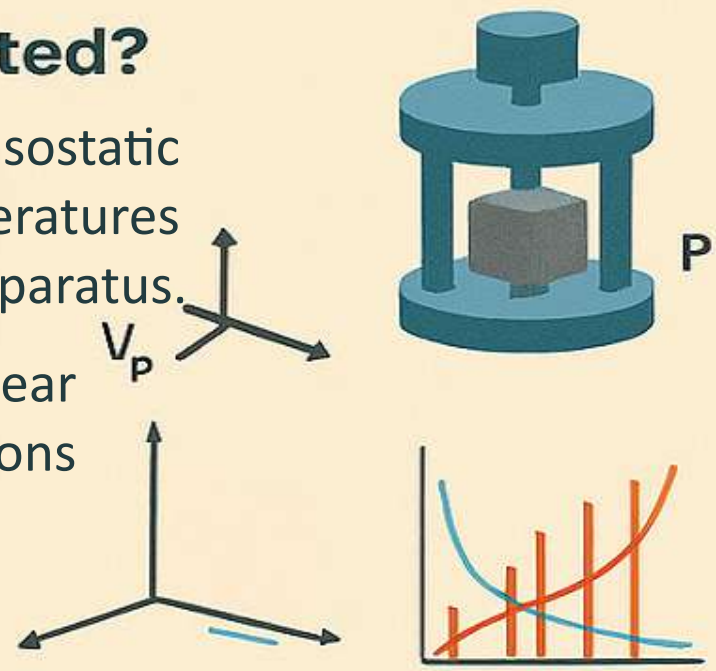
https://doi.org/10.1016/j.jece.2025.116567

UNDERSTANDING UNEVEN STRENGTH OF SHALE ROCKS

CSIR-CIMFR studied how pressure and temperature affect seismic wave behavior in grey shale (GSH) and silty shale (SSH) from the Barakar Formation, using true-triaxial tests on cubic specimens to simulate subsurface stress.

How was the study conducted?

- Shale samples were tested under isostatic pressures (8–51 MPa) and temperatures (20–200 °C) using a polyaxial loading apparatus.
- Measured compressional (Vp) and shear wave (Vs) velocities in three orientations relative to bedding.
- Analyzed bulk modulus (K) and Thomsen anisotropy parameters (ε, γ) to assess elastic behavior.



Key findings

- Vp and Vs increased with pressure, indicating stiffening due to microcrack closure.
- GSH showed higher wave velocities and more linear bulk modulus response than SSH.
- Anisotropy decreased with pressure, suggesting a shift toward isotropic behavior.

Why it matters

The findings support better subsurface imaging and reservoir modeling. True-triaxial testing offers a more accurate way to assess shale elasticity under realistic geological conditions.

https://doi.org/10.1016/j.ijrmms.2025.106100

REVITALIZING MINING DUMPS
WITH BIODEGRADABLE JUTE GEOTEXTILES

What's the study about?

This study by **CSIR-CIMFR** explores the use of jute geotextiles for stabilizing mining reject dumps and enhancing floral biodiversity over a 12-year period at an iron ore mine in Maharashtra, India.

How was the study conducted?

- Jute geotextiles were applied on dump slopes to improve soil stability and plant growth.
- 21 plant species were monitored for survival and ecological impact.
- Soil parameters (pH, moisture, organic carbon) and biodiversity indicators were analyzed to evaluate ecosystem resilience.

Key findings

- Jute geotextiles degraded within 1–2 years, effectively supporting vegetation growth.
- Moderate increase in biodiversity and ecosystem resilience was observed over time.
- Predictive models provided insights for future mine rehabilitation projects

Why it matters?

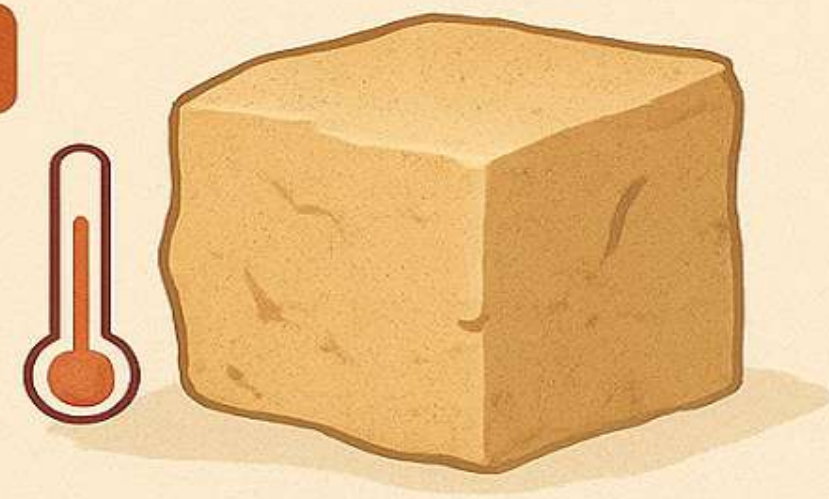
This study demonstrates how biodegradable jute geotextiles offer a sustainable and effective approach for mine reclamation, supporting soil health, biodiversity, and ecological restoration.

https://doi.org/10.1080/15226514.2025.2501426

HEAT-INDUCED CHANGES IN SANDSTONE PROPERTIES

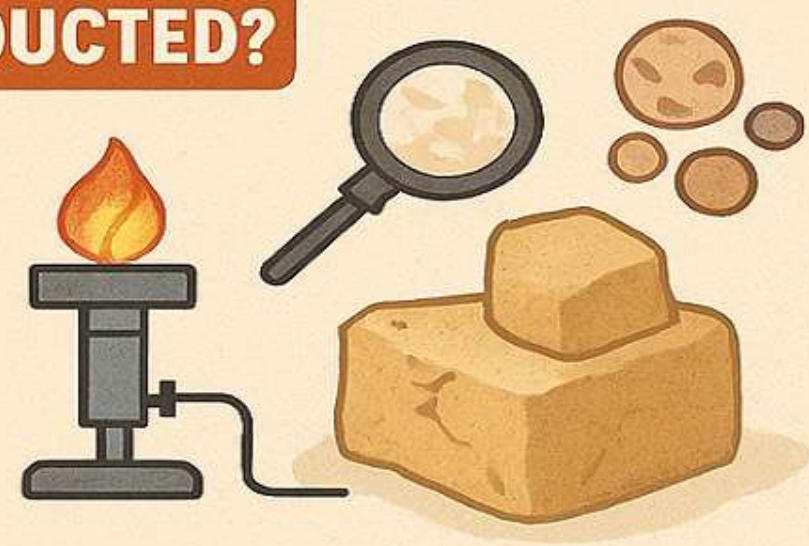
WHAT'S THE STUDY ABOUT?

CSIR-CIMFR examined how heat treatment affects the physical and mechanical properties of sandstone, focusing on strength, density, and wave velocity changes across different temperature levels.



HOW WAS THE STUDY CONDUCTED?

- Heat-treated sandstone samples at 35 °C to 800 °C.
- Analyzed changes using XRF, SEM, and thin section techniques.
- Validated results through numerical modeling with FLAC3D.



KEY FINDINGS

- Higher temperatures caused strength reduction and lower primary wave velocity.
- Crack formation increased due to stress concentrations and grain size variations.
- Higher temperatures caused strength reduction and lower primary wave velocity.

WHY IT MATTERS

This study helps understand how heat impacts rock integrity, offering insights for mining, construction, and geotechnical applications involving thermal exposure.

https://doi.org/10.3390/mining5020030

DUMP SLOPE HAZARD RATING IN OPENCAST MINES

WHAT'S THE STUDY ABOUT?

CSIR-CIMFR evaluated two dump slope rating systems to assess the safety and stability of waste dumps in opencast mines.

KEY FINDINGS

- Hawley & Cunning system used 22 parameters, offering deeper hazard insights.
- Mines A & B shifted from moderate to high hazard class under the newer system.
- Mine C shifted from low to moderate hazard, reflecting broader evaluation criteria.

HOW WAS THE STUDY CONDUCTED?

- Compared two rating systems: BCMWRPRC (1991) and Hawley & Cunning (2017).
- Conducted field visits and numerical simulations across three mines.
- Assessed slope conditions using parameters like foundation, geometry, and material quality.

WHY IT MATTERS

This study supports the use of detailed rating systems to better identify slope risks, helping improve safety and operational planning in opencast mining.

https://doi.org/10.17491/jgsi/2025/174137

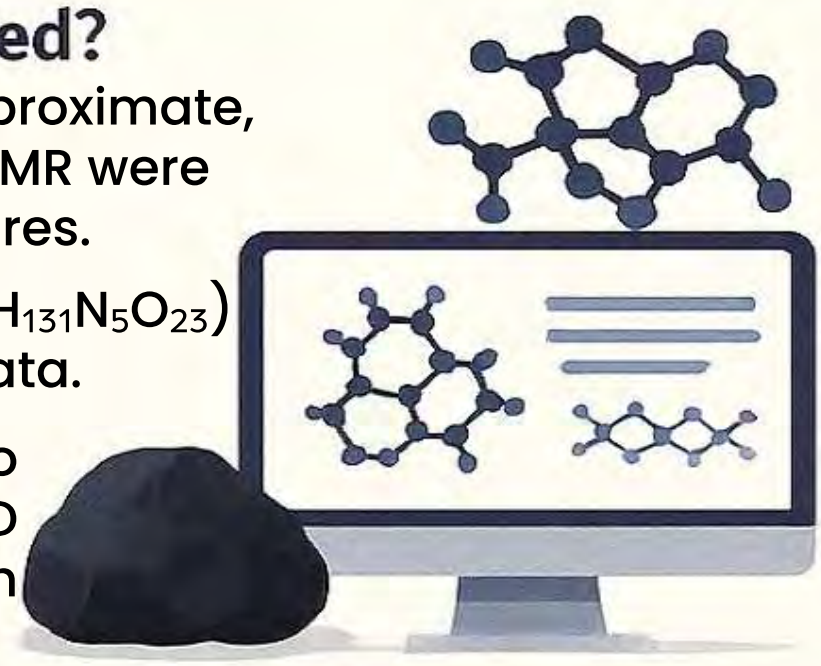
SIMULATING THE MOLECULAR BLUEPRINT
WARDHA VALLEY COAL

What's the study about?

This study by **CSIR-CIMFR** develops a 2D–3D macromolecular model of Wardha Valley Coal (WVC) using multi-technique spectral data, to understand the structural composition of high-volatile bituminous coal and validate its simulated architecture.

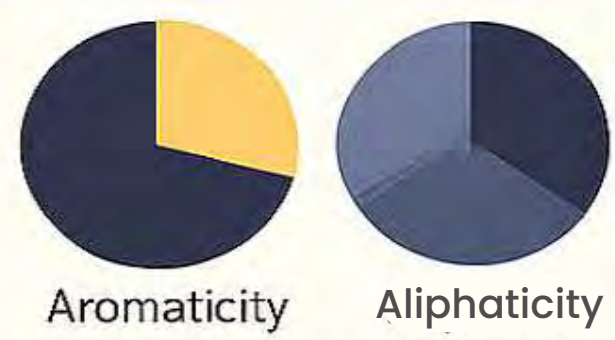
How was the study conducted?

- Spectroscopic analyses including proximate, elemental, Raman, FTIR, and 13C-NMR were performed to map molecular features.
- A detailed molecular formula ($C_{134}H_{131}N_5O_{23}$) was derived from compositional data.
- ChemDraw and Materials Studio were used to simulate a 2D–3D molecular structure, matched with experimental spectral data.



Key findings

- Aromaticity (fa = 0.61) and aliphaticity (fal = 0.39) values revealed a predominance of aromatic units such as benzene, naphthalene, and pyrrole.



- Functional groups included carbonyl, carboxyl, hydroxyl, methyl, and methylene, pointing to complex oxygen-containing side chains.
- Functional groups included carbonyl, carboxyl, hydroxyl, methyl, and methylene, pointing to complex oxygen-containing side chains.

Why it matters?

This modeling method provides insights into coal structure, essential for assessing combustion, reactivity, and cleaner carbon technology development.

https://doi.org/10.1007/s12040-025-02526-0

AI-BASED PREDICTION MODEL FOR AIR OVERPRESSURE IN MINES

What's the study about?

This study by CSIR-CIMFR focuses on minimizing harmful effects like air overpressure (AOp) caused by blasting in open-cast mines by developing an AI-based prediction model.

How was the study conducted?

- Collected data from 699 blasts across 33 Indian mines.
- Used 10 blasting parameters including hole depth, charge per delay, and distance.
- Developed and tested several models including MARS, CART, SVR, and traditional predictors.

Key findings

- The MARS model performed best, accurately predicting AOp across diverse mine conditions.
- Large dataset and multiple input variables helped improve reliability and adaptability.
- The AI model can be used to optimize blast designs and reduce environmental impact.

Why it matters?

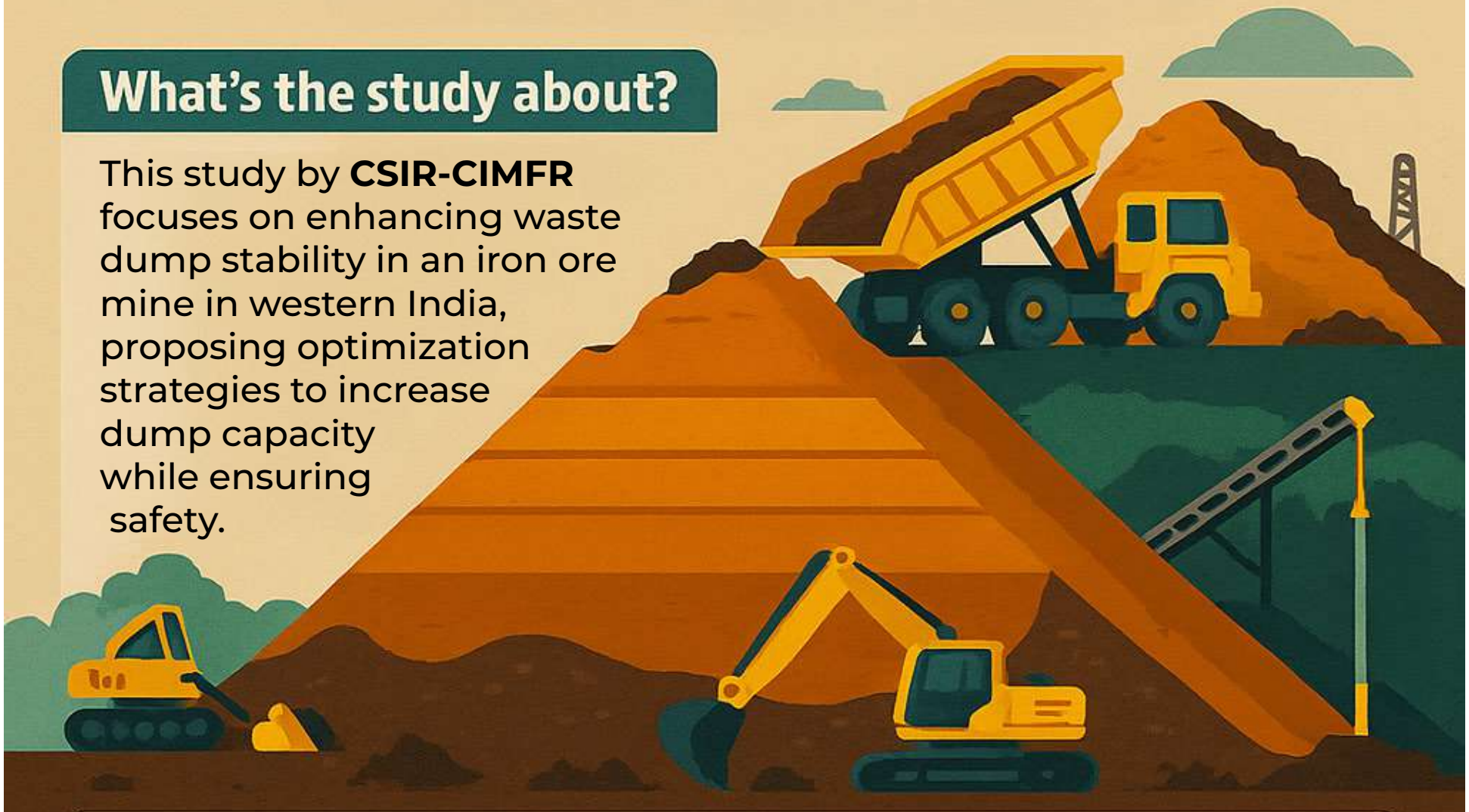
This work enables safer and smarter mining by offering a practical tool to control blasting nuisances, protect nearby structures, and enhance operational sustainability across different mining environments

https://doi.org/10.3397/1/37736

OPTIMIZING WASTE DUMP STABILITY FOR SUSTAINABLE MINING

What's the study about?

This study by **CSIR-CIMFR** focuses on enhancing waste dump stability in an iron ore mine in western India, proposing optimization strategies to increase dump capacity while ensuring safety.



How was the study conducted?

- Field investigations, laboratory testing, and numerical modeling assessed slope stability using the limit equilibrium method.
- Factor of Safety (FoS) analysis determined the dump's adherence to Indian regulations.
- Slope adjustments (30°–35°) and height modifications were evaluated for capacity enhancement.

Key findings

- Existing dump stability confirmed, with FoS values ranging from 1.407 to 1.996.
- Optimization boosted dump area by 1.01 hectares and capacity by 1.16 million tons safely.
- Enhanced monitoring needed during adverse weather to maintain long-term stability.

Why it matters?

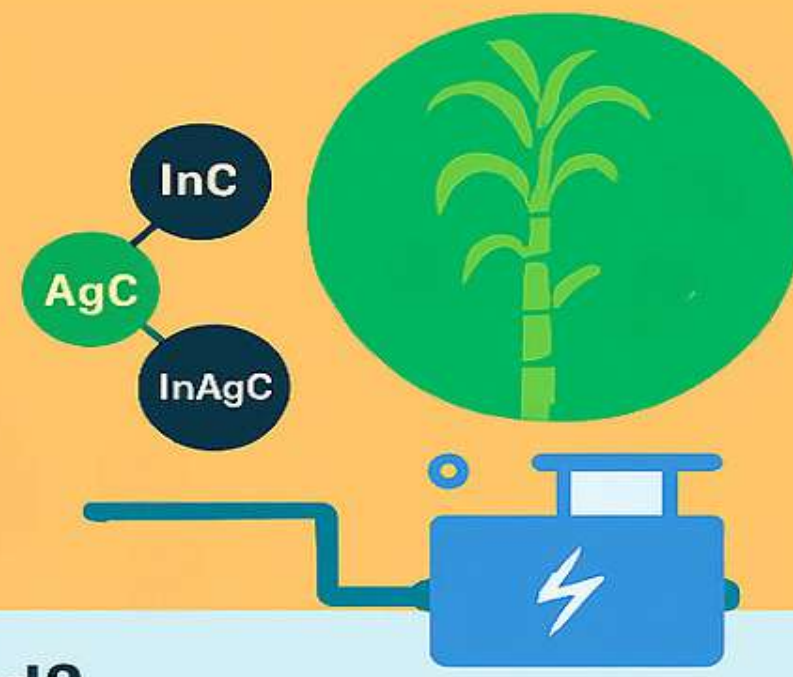
This study advances sustainable mining practices, providing an efficient and safe waste dump expansion strategy, ensuring environmental compliance and operational reliability.

https://doi.org/10.12989/gae.2025.40.1.069

NANOCOMPOSITES FOR EFFICIENT WATER ELECTROLYSIS

What's the study about?

CSIR-CIMFR has developed bimetallic nanocomposites (InC, AgC, InAgC) supported on mesoporous carbon derived from giant cane to enhance the oxygen evolution reaction (OER) for clean hydrogen production via water electrolysis.



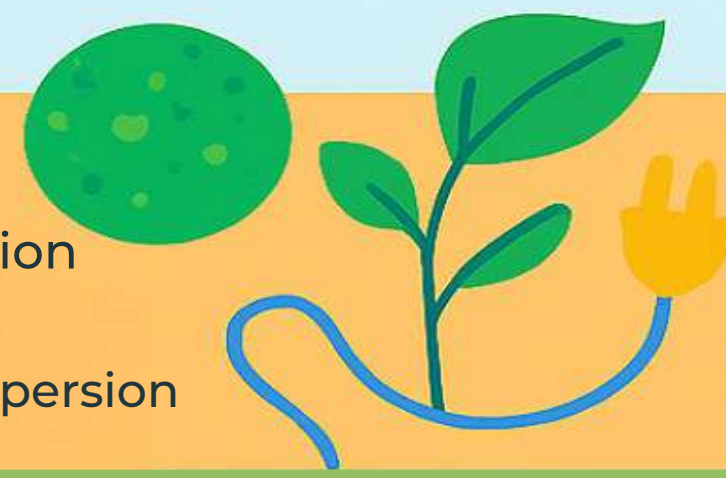
How was the study conducted?

- Synthesized nanocomposites using a hydrothermal method and characterized their structure and morphology.

- Evaluated OER performance through electrochemical tests.
- Compared electrochemical double-layer capacitance (Cdl) to assess active site accessibility.

Key findings

- InAgC showed superior oxygen evolution reaction (OER).
- Its spherical morphology and uniform dispersion enhanced catalytic efficiency.
- InAgC had the highest Cdl, indicating more accessible active sites than other composites.



Why it matters?

This study highlights giant cane-based carbon and bimetallic nanocomposites as scalable solutions for efficient and sustainable hydrogen energy.

https://doi.org/10.1039/D5NR01088H

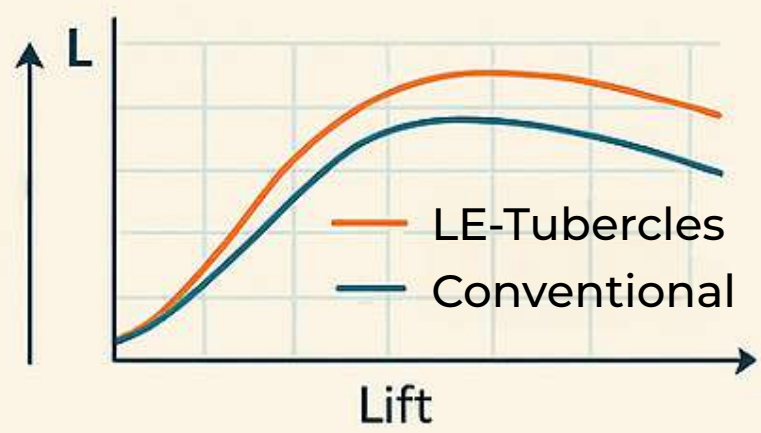
AERODYNAMIC BENEFITS OF LEADING-EDGE TUBERCLES IN UAV WING DESIGN

What's the study about?

This study by **CSIR-CMERI** explores how reducing wing platform areas and incorporating leading-edge tubercles impact the aerodynamic performance of unmanned aerial vehicles (UAVs) at high angles of attack.

How was the study conducted?

- ANSYS Fluent simulations analyzed flow at various angles of attack and Reynolds numbers.
- Results were validated using wind tunnel experiments with a six-component external pyramidal balance.



Key findings

- Wings with leading-edge tubercles maintained higher lift at large angles of attack post-stall & showed improved aerodynamic stability.
- Flow analysis through vorticity, turbulent kinetic energy, and pressure distribution plots revealed that the enhanced lift production was resulted from the presence of low pressure zones caused by the vortices originating from tubercles similar to delta wings.

Why it matters?

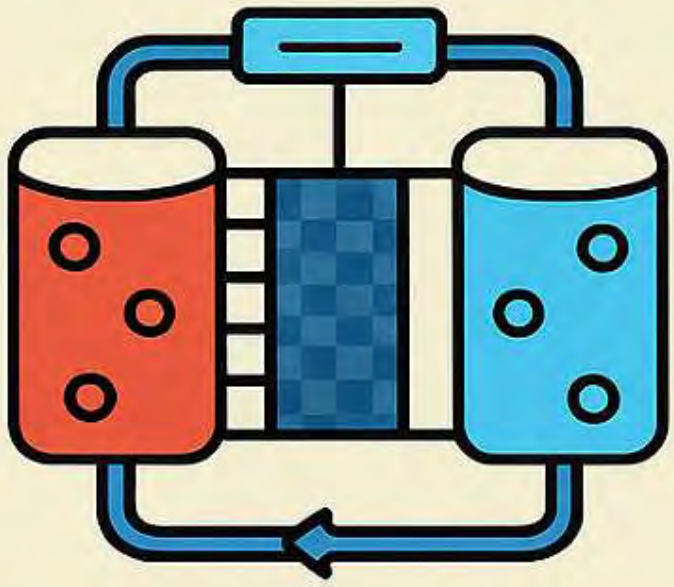
The findings highlight the potential of leading-edge tubercles for improving UAV performance, making them ideal for applications requiring enhanced lift and stability, such as aircraft, surveillance drones, and underwater vehicles.

https://doi.org/10.1063/5.0266689

ADVANCING REDOX FLOW BATTERIES WITH AMPHOTERIC MEMBRANES

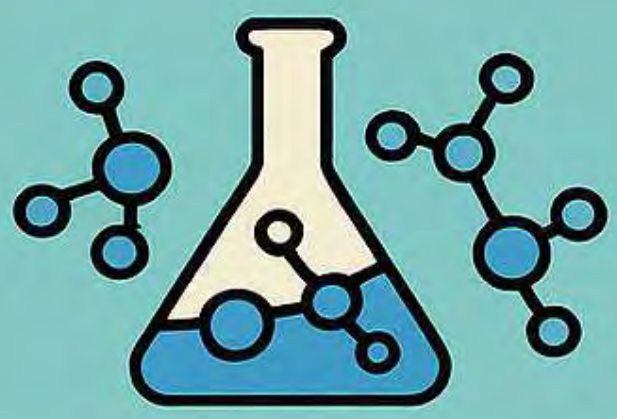
What's the study about?

This study by **CSIR-CSMCRI** presents the design and synthesis of an amphoteric membrane, improving ion selectivity and cycling stability in vanadium redox flow batteries (VRFB) and aqueous organic redox flow batteries (AORFB).



How was the study conducted?

- Postmodification of polystyrene-co-acrylic acid to develop a styrene and 2-vinyl benzimidazole copolymer.
- Electrochemical and physicochemical characterizations assessed membrane performance.
- Battery cycle testing validated efficiency and capacity retention in VRFBs and AORFBs.



Why it matters?

This study introduces a more efficient, high performance membrane for redox flow batteries, improving battery stability, energy efficiency, and long-term durability for sustainable energy applications.

https://doi.org/10.1021/acsaem.5c00465

Key findings

- Enhanced ion selectivity, reducing unwanted crossover of redox-active molecules.
- VRFB delivered over 200 cycles at 150 mA cm–2, with high efficiency and capacity retention.
- AORFB delivered 220 cycles at 100 mA cm–2, with high efficiency and capacity retention.

NOVEL MEMBRANE THAT SEPARATES DYES AND SALT

What's the study about?

Researchers at **CSIR-CSMCRI** developed a novel membrane using self-assembled copolymer micelles that selectively separates dyes from salts, offering a promising tool for industrial wastewater treatment.

How was the study conducted?

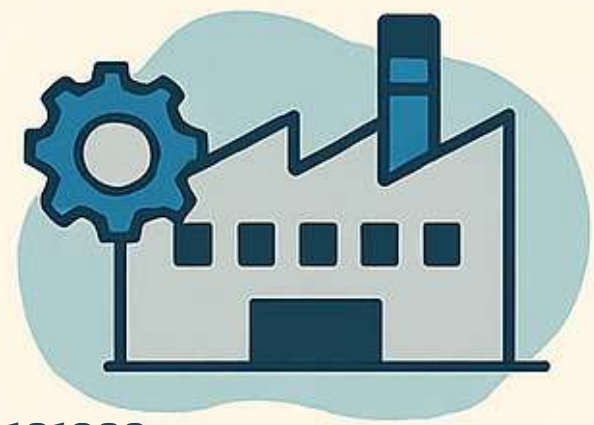
- Used a partially alkylated PMMA-co-PDMAEMA copolymer, with C-8 alkyl groups.
- Created membranes via evaporation-induced self-assembly, forming structured interstices.
- Characterized using surface analysis and permeation experiments with charged and neutral solutes.

Key findings

- Membranes showed >99.5% rejection of dyes (e.g. Congo red, Direct red-80) and 7–9% rejection of salts, enabling selective separation.
- Demonstrated strong stability and antifouling performance during dye–salt mixture separation.
- Formation of permeation channels is driven by local concentration rise and alkyl chain entanglement, allowing sub-ultrafiltration precision.

Why it matters?

This work introduces a simple, tunable, and low-cost approach to fabricate molecular-selective membranes, paving the way for efficient dye-salt separation in textile and chemical industries.



https://doi.org/10.1016/j.cej.2025.161392

RED ALGAE EXTRACT BOOSTS *PATCHOULI* PRODUCTIVITY AND ESSENTIAL OIL YIELD

What's the study about?

The joint study by **CSIR-CIMAP** and **CSIR-CSMCRI** evaluates the impact of seaweed extract from red algae (*Solieria chordalis*) (SCE) on patchouli (*Pogostemon cablin*) growth and essential oil yield, through field trials across two growing seasons.

How was the study conducted?

- Foliar applications of SCE (2.5%, 5%, and 7.5%) were tested alongside recommended doses of chemical fertilizer (RDF).
- Parameters measured included dry herbage yield, oil yield, essential oil recovery, and oil composition.
- Analysis of 14 major oil constituents, including the marker compound patchouli alcohol, was performed.

Key findings

- 7.5% SCE + RDF significantly enhanced productivity, increasing dry herbage yield by 23.6% and oil yield by 37.6% compared to RDF alone.
- Essential oil recovery remained stable, and oil composition was unaffected, with patchouli alcohol ranging from 44.40% to 49.70%.
- Lower SCE concentrations were less effective, confirming 7.5% as the optimal dose for performance enhancement.

Why it matters?

This study supports the use of seaweed-derived biostimulants for sustainable crop improvement, demonstrating that SCE can effectively boost industrially valuable aromatic plants like *patchouli* without compromising oil quality.

https://doi.org/10.1007/s10811-025-03537-6

Non-Diary Probiotics for Better Health & Weight Management

What's the Study About

Scientists at CSIR-IHBT studied how certain probiotics can help fight obesity and improve health by reducing fat buildup and boosting insulin sensitivity.

Key Findings

- The probiotic strain LGM:16 worked best in controlling fat accumulation
- It lowered fat levels and helped regulate metabolism

Probiotic Drink Development

LGM:16 was used to make a non-dairy probiotic drink with honey and mushrooms, designed to be nutritious, tasty, and rich in antioxidants.

Why It Matters

This study shows that ethnic food derived probiotics can be a natural way to manage body weight, improve metabolism and overall health benefits

https://doi.org/10.1007/s12602-025-10525-2

सीएसआईआर
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भारत का नवाचार इंजन
The Innovation Engine of India

AI HELPS FARMERS DETECT TEA PLANT DISEASE

WHAT IS THE STUDY ABOUT ?

Scientists at CSIR-IHBT have developed a smart method using AI and hyper-spectral remote sensing to detect blister blight, a fungal disease that harms tea plants (*Camellia sinensis*) and reduces crop quality.

HOW THE STUDY WAS CONDUCTED?

- Researchers scanned five tea varieties using a special handheld sensor.
- They processed the data using advanced techniques to spot disease patterns.

KEY FINDINGS

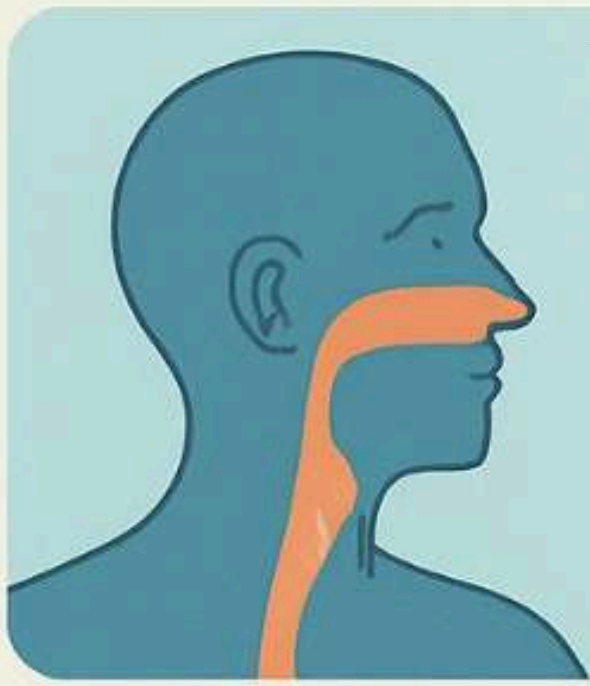
- ANN (Artificial Neural Network) a ML-Algorithm, identified affected leaves with high accuracy (92%).
- It worked well when tested on Kangra Asha tea leaves, confirming its reliability.

WHY IT MATTERS?

This AI-powered method can help tea farmers detect disease early, allowing them to protect crops, improve tea quality, and increase yield with less manual effort

https://doi.org/10.1002/agj2.70060

A New Approach to fight Head and Neck Cancer



What's the Study About?

Scientists at **CSIR-IHBT** researched new anticancer molecules called MK2-inhibitors to treat Head and Neck Squamous Cell Carcinoma (HNSCC).

Key Findings

- MK2-inhibitors stopped cancer cells from growing and spreading.
- These molecules made radiation treatment more effective, helping kill more cancer cells.
- They also blocked cancer cells from repairing DNA damage, making them weaker.

Animal Testing Results

- In mice, up to 300 mg/kg dose was found to be safe.
- These new anticancer molecules were quickly absorbed, worked well in the body, and left the system fast, making it more useful.

Why It Matters ?

This research opens the door to better cancer treatments that are less toxic and more effective, helping patients fight head and neck cancer with improved results.

https://doi.org/10.1002/ddr.70062

Helping Farmers Optimize German Chamomile Cultivation

What's the Study About?

Scientists at **CSIR-IHBT** studied the effect of weather conditions on the growth and yield of German chamomile (*Matricaria chamomilla L.*), a medicinal and aromatic crop.

How the Study Was Conducted?

A two-year field experiment (2018–2020) was conducted under acidic soil conditions in Western Himalayan region regions.

Four different sowing times from 20 Nov to 20 Jan were tested with salicylic acid applications at different levels.

Agrometeorological indices such as Growing Degree Days (GDDs), Photothermal Units (PTUs), and Heliothermal Units (HTUs) were analyzed.

Key Findings

- Delayed sowing resulted in faster progression through phenological stages.
- **Early sowing on 20 Nov resulted in higher accumulation of GDDs, PTUs, and HTUs, leading to improved flower and essential oil yield.**
- Salicylic acid influenced agrometeorological indices with irregularity.

Why It Matters?

This study helps farmers optimize chamomile cultivation by selecting the right sowing time and understanding weather-related growth patterns ensuring better profitability and sustainability.

https://doi.org/10.3390/horticulturae11050485

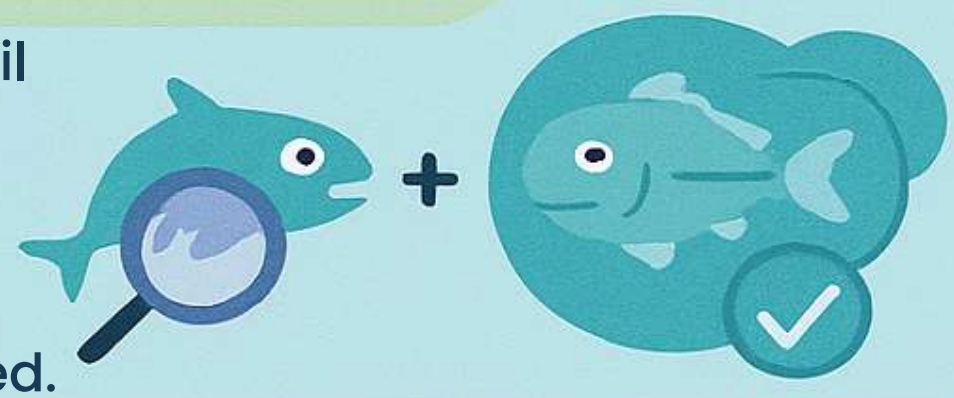
POTENTIAL OF FLAXSEED OIL IN EPILEPSY MANAGEMENT

WHAT'S THE STUDY ABOUT?

This study by **CSIR-IHBT** explores flaxseed oil as a non-pharmacological intervention for epilepsy. Omega-3 fatty acids in flaxseed oil support brain function and help maintain the blood-brain barrier (BBB) integrity, potentially reducing seizure susceptibility.

HOW WAS THE STUDY CONDUCTED?

- Researchers tested flaxseed oil in zebrafish larva with Pentylenetetrazole induced seizures.
- The effects on seizure activity and BBB integrity were analyzed.



KEY FINDINGS

- Flaxseed oil reduced hyperactive responses and increased seizure latency
- It down-regulated c-Fos expression and maintained BBB integrity.
- Treated fish showed increased expression of Neurotrophic genes like bdnf and GABAA receptor subunits.

WHY IT MATTERS?

This research provides early evidence of flaxseed oil's potential in managing childhood epilepsy. Further studies in higher mammals are needed to confirm its safety and efficacy.

https://doi.org/10.1016/j.fbio.2025.106701

TREELINE BIODIVERSITY IN THE WESTERN HIMALAYA

What's the study about?

This study by **CSIR-IHBT** examines the species richness and diversity of treeline communities in Himachal Pradesh, Western Himalaya, highlighting the impact of human activities on these fragile ecosystems.

How was the study conducted?

- Six treeline sites (three disturbed, three undisturbed) were selected for vegetation sampling.
- Trees, shrubs, and herbs were surveyed using nested plots.
- Soil properties, including pH and available nitrogen, were analyzed across treeline sites.

Key findings

- 221 vascular plant species from 47 families and 140 genera were recorded.
- Undisturbed sites exhibited higher species richness compared to disturbed sites.
- High densities of *Betula utilis* were observed, alongside *R. campanulatum* and *R. anthopogon*.
- Several threatened species, including *Aconitum heterophyllum* and *Picrorhiza kurroa*, were documented.

Why it matters?

This study provides insights into treeline biodiversity and emphasizes the need for conservation efforts to prevent habitat fragmentation and plant displacement due to ongoing land-use activities.

https://doi.org/10.1007/s11629-024-8965-5

MICROALGAE

A NUTRITIONAL AND NUTRACEUTICAL SOURCE

What's the study about?

This study by **CSIR-IHBT** evaluates the nutritional and nutraceutical potential of three *Tetradesmus* strains—*T. acutus, T. obliquus*, and *T. abundans*—highlighting their protein, lipid, micronutrient, and bioactive compound profiles.

How was the study conducted?

- Protein, lipid, and micronutrient content were analyzed in all three strains.
- In vitro digestion assessed the bioaccessibility of phenolics and antioxidant properties.
- Growth and composition comparisons identified the most promising strain.

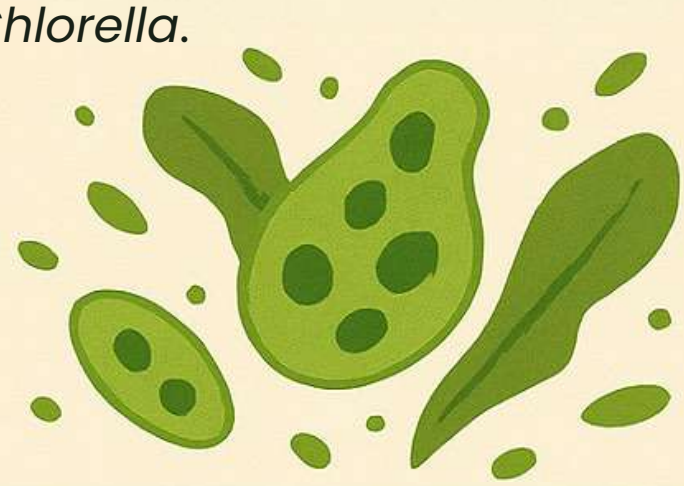
Key findings

- *Tetradesmus* proteins were nutritionally superior to cereals but below eggs and dairy.

- High unsaturated fatty acid content suggests potential health benefits.
- *T. acutus* exhibited optimal growth and nutritional composition.

Why it matters?

These findings highlight *Tetradesmus acutus* as a promising microalgae for dietary applications, offering an alternative nutritional source alongside *Spirulina* and *Chlorella*.

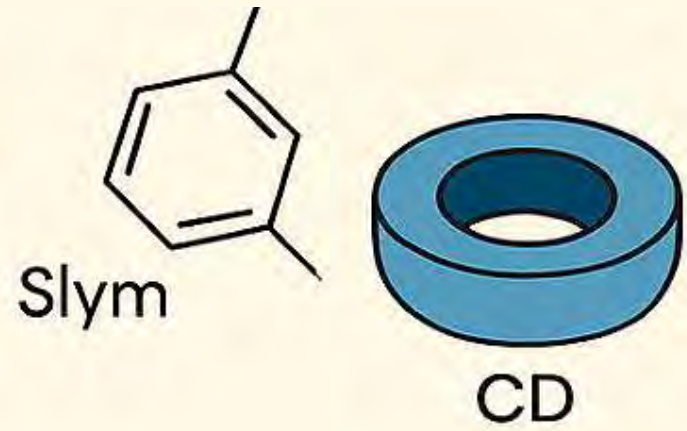


https://doi.org/10.1021/acsfoodscitech.4c01032

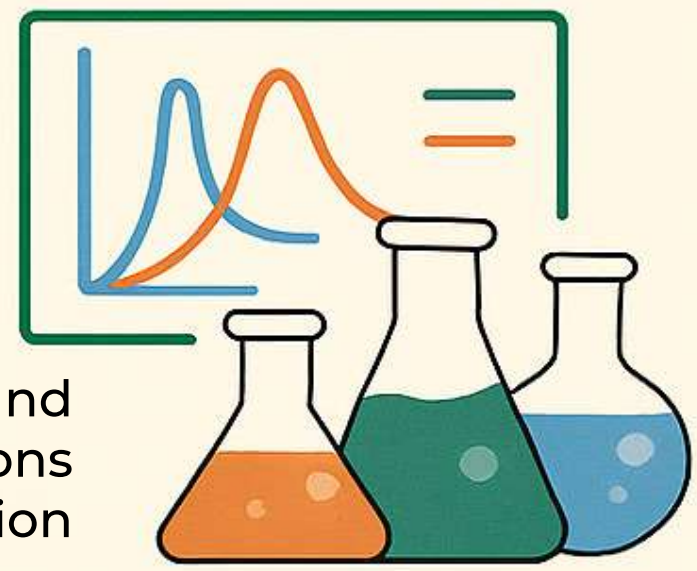
ENHANCING SOLUBILITY OF SILYBIN A USING CYCLODEXTRINS

What's the study about?

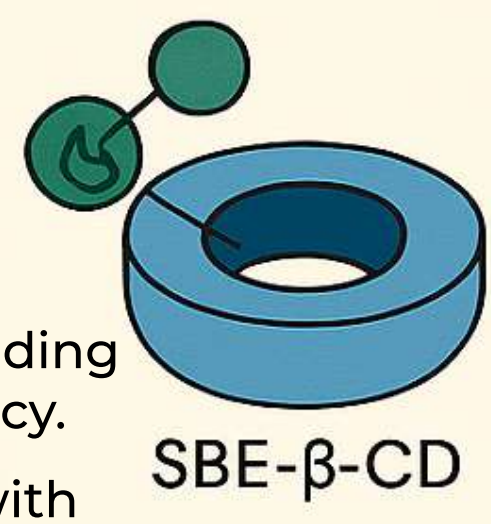
This study by **CSIR-IHBT** explores how cyclodextrins (CDs) can improve the solubility of Silybin A (Slym), a key therapeutic compound with poor bioavailability.



How was the study conducted?



- Various CD derivatives were tested for their binding efficiency with Slym.
- Molecular dynamics simulations and quantum mechanics-based calculations assessed the stability and complexation energy of CD-Slym interactions.
- Experimental IR spectrum comparisons validated the computational findings



Key findings

- Certain CD derivatives exhibited stronger binding affinity and enhanced encapsulation efficiency.
- SBE-β-CD formed the most stable complex with Slym, showing the highest complexation energy.
- Nonbonded interactions played a crucial role in maintaining complex stability over time.

Why it matters?

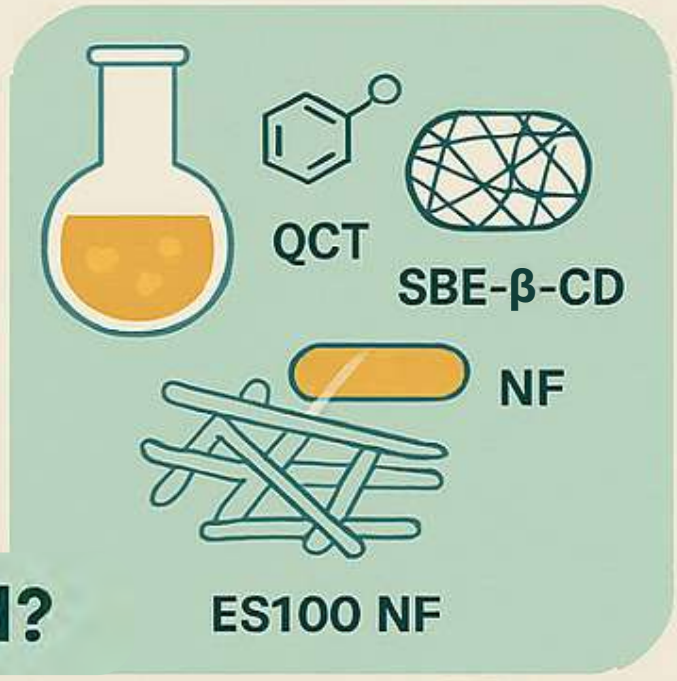
Optimizing CD-based carriers for Slym can enhance its pharmaceutical efficacy, making it more effective for therapeutic applications

https://doi.org/10.1021/acs.jcim.5c00625

TARGETED COLON DELIVERY OF QUERCETIN USING NANOFIBERS

What's the study about?

This study by **CSIR-IHBT** focuses on developing and characterizing quercetin (QCT)-loaded sulfobutylether-β-cyclodextrin (SBE-β-CD) inclusion complexes (IC) incorporated into Eudragit S100 (ES100) nanofibers (NF) for colon-specific drug delivery.

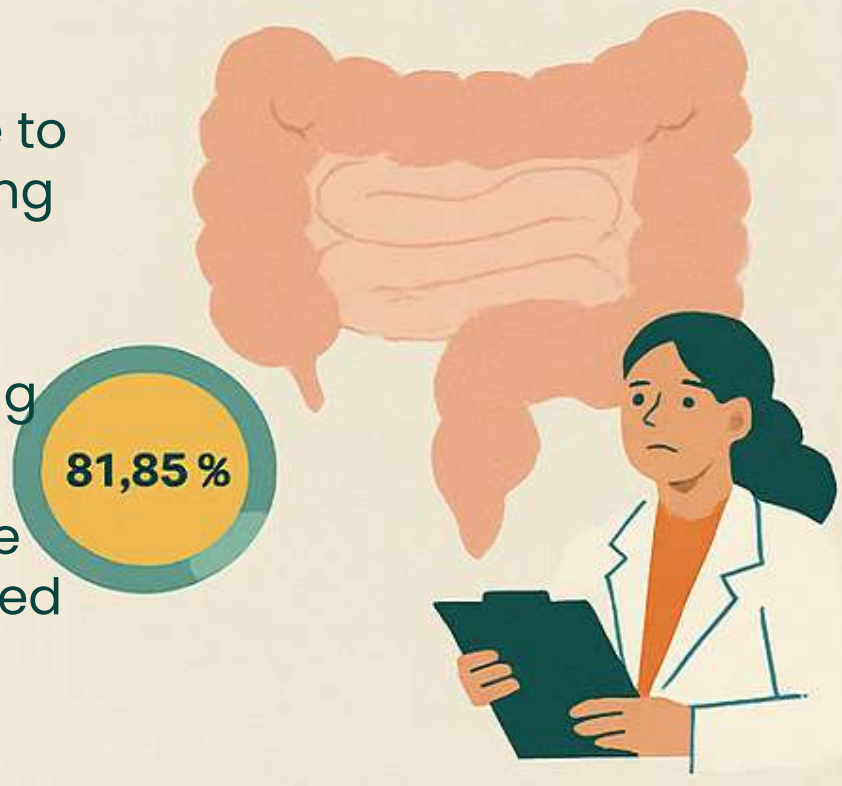


How was the study conducted?

- NMR experiments identified spatial correlations between QCT and SBE-β-CD.
- Solid-state analyses (FTIR, XRD, TGA/DSC) confirmed molecular interactions and stability.
- In-vitro release studies measured colon-targeted delivery efficiency.

Key findings

- QCT transitioned from crystalline to stable amorphous form, improving thermal stability.
- Nanofibers exhibited a uniform, hydrophobic structure, supporting controlled release.
- 81.85% of QCT was released in the colonic phase, confirming targeted delivery efficacy.



Why it matters?

This study presents a synergistic strategy that combines inclusion complexation with electrospinning to achieve colon-specific release of quercetin (QCT).

https://doi.org/10.1016/j.molstruc.2025.142652

UNLOCKING TEMPERATURE MEDIATED FLOWERING IN SAFFRON

What's the study about?

This study by **CSIR-IHBT** investigates how temperature influences flowering induction in saffron, revealing key metabolic and molecular mechanisms that regulate the process.

How was the study conducted?

- HPLC-MS/MS metabolic analysis identified and quantified key metabolites.
- Transcriptomic integration pinpointed genes involved in saffron floral induction.
- Co-expression gene regulatory network (GRN) was developed to identify key molecular regulators.

Key findings

- 118 metabolites were identified, with 97 differentially expressed across temperature conditions.
- Temperature shifts at 25°C vs. 8°C directly influenced gene expression and metabolite profiles.
- Raffinose metabolism, terpenes, and phenylpropanoids showed significant changes in flowering vs. non-flowering buds.

Why it matters?

This study provides new insights into saffron flowering regulation, helping improve cultivation strategies for enhanced yield and optimized flowering cycles

https://doi.org/10.1007/s00344-025-11741-4

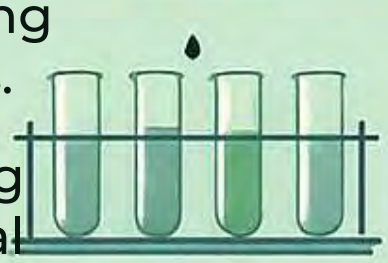
DISCOVERING PHYTOCHEMICAL ALTERNATIVES TO *SWERTIA CHIRAYITA*

What's the study about?

This study by **CSIR-IHBT** investigates the phytochemistry of unexplored Swertia species (*S. purpurascens* and *S. cordata*), identifying potential pharmaceutical alternatives to critically endangered *Swertia chirayita*.

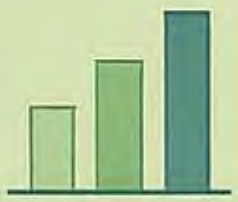
How was the study conducted?

- GC-MS and UPLC-DAD analyses identified and quantified key bioactive compounds.
- UHPLC-QTOF-IMS and metabolomics screening detected a broad spectrum of 181 metabolites.
- Comparative phytochemical profiling assessed species suitability as a medicinal alternative.



Key findings

- *S.purpurascens* exhibited the highest number of compounds, including major bioactives from *S.chirayita*.
- Swertianolin and swertiamarin were significantly higher in *S.purpurascens*, reinforcing its medicinal potential.



Why it matters?

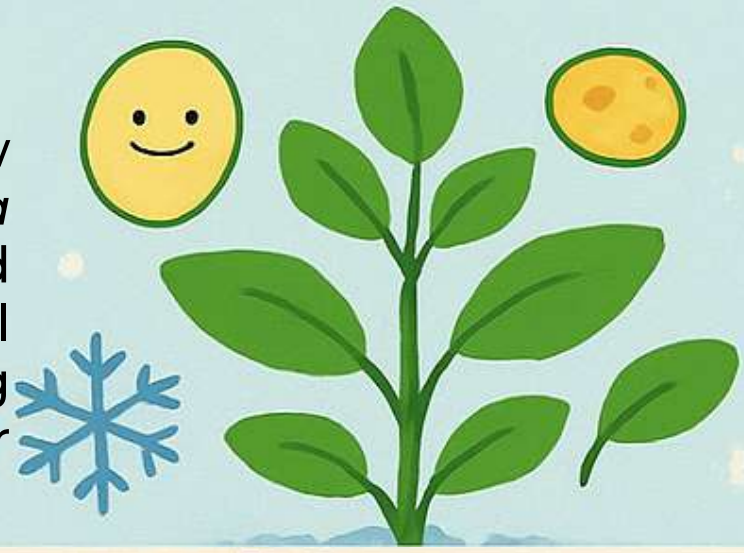
This study provides a scientific basis for identifying viable substitutes for *Swertia chirayita*, supporting sustainable herbal medicine development and conservation of endangered medicinal plants.

https://doi.org/10.1016/j.jics.2025.101781

PLANT-ASSOCIATED YEASTS ENHANCING COLD TOLERANCE

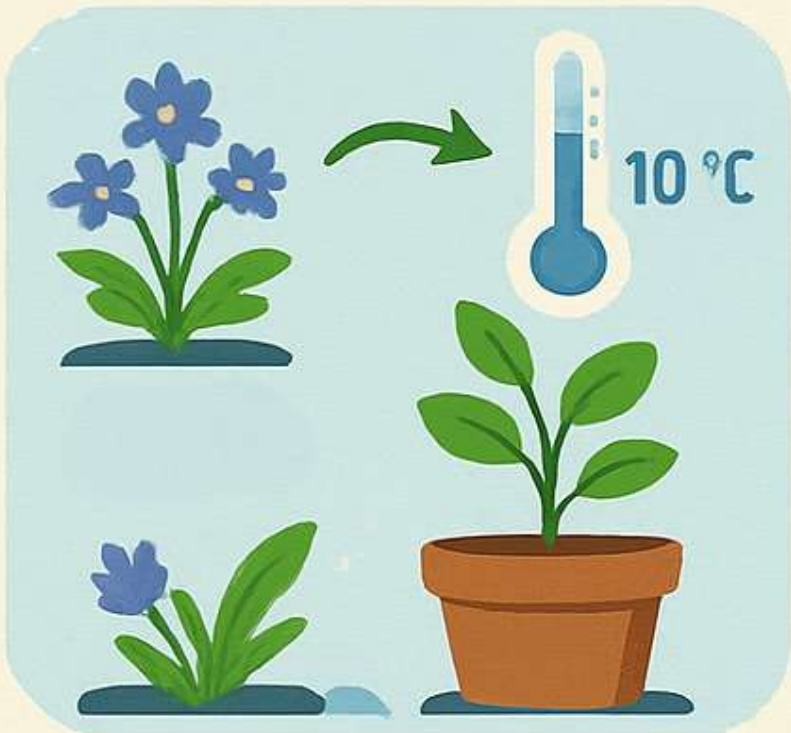
What's the study about?

This study by **CSIR-IHBT** investigates how psychrophilic yeast endophyte *Naganishia liquefaciens* strain ARY7 enhances cold tolerance in *Arabidopsis thaliana* (a model plant for studying plant biology), shedding light on plant-microbe interactions under environmental stress.



How was the study conducted?

- ARY7, isolated from cold-desert plant *Arnebia euchroma*, was inoculated into *Arabidopsis*.
- Physiological and molecular analyses assessed biomass, photosynthetic efficiency, and stress responses at 10°C.
- Gene expression studies examined cold-responsive and salicylic acid (SA) signaling pathways.



Key findings

- ARY7-inoculated plants showed higher biomass and photosynthetic efficiency at low temperature.
- Auxin and SA signaling enhanced root development and cold tolerance mechanisms.
- Reduced expression of cold-responsive genes indicated lower sensitivity to environmental stress.

Why it matters?

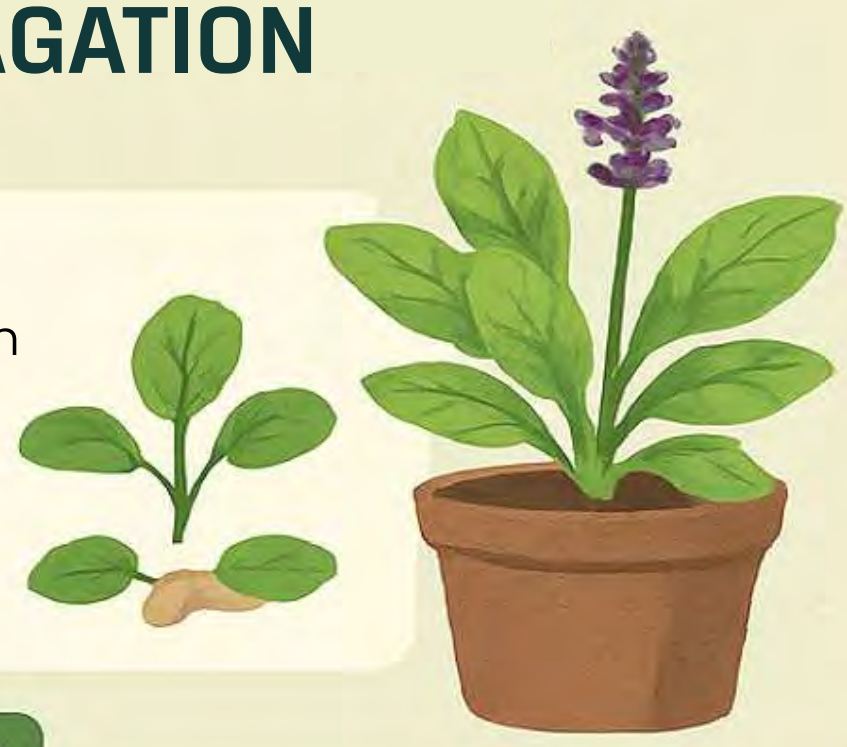
This study highlights the potential of psychrophilic yeasts in improving plant resilience to cold stress, offering insights for sustainable agriculture and stress-resistant crop development.

https://doi.org/10.1111/ppl.70267

SCALING UP *AJUGA PARVIFLORA* FOR MEDICINAL APPLICATIONS VIA IN VITRO PROPAGATION

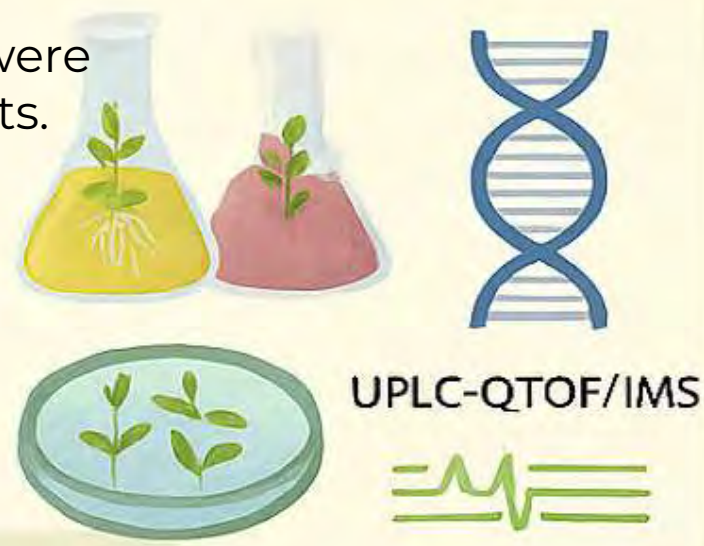
What's the study about?

This study by **CSIR-IHBT** establishes a highly reproducible in vitro propagation protocol for *Ajuga parviflora*—a medicinally significant, traditionally valued plant—to support its large-scale cultivation and phytopharmaceutical use.



How was the study conducted?

- Direct and indirect organogenesis methods were developed using leaf, petiole, and root explants.
- Optimized hormone combinations (e.g., TDZ, NAA, BAP, Kinetin, IBA) for induction of callus and regeneration of shoots and roots.
- Genetic and metabolic fidelity of cloned plants was confirmed using molecular and metabolic markers.



Key findings

- Nearly 100% direct shoot regeneration was achieved with MS +TDZ + NAA, and 86.6% rooting success with MS + IBA + kinetin.
- Leaf explants showed the highest regeneration potential in indirect organogenesis.
- Cloned plants retained genetic and metabolic profiles similar to the mother plant.

Why it matters?

The study presents a scalable micropropagation system for *A. parviflora*, ensuring industrial scale production of bioactives and aiding conservation of native medicinal plants.

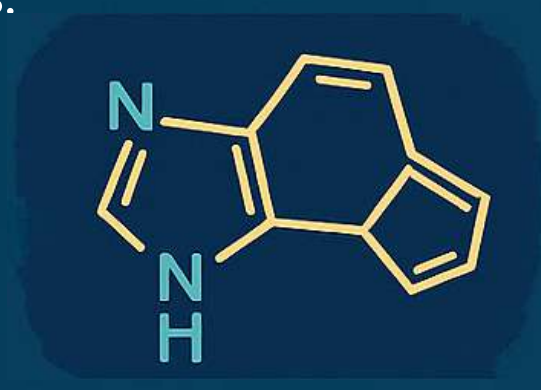
https://doi.org/10.1007/s11627-025-10525-5

EFFICIENT SYNTHESIS OF FUSED PYRROLE RINGS USING PALLADIUM-CATALYZED REACTIONS

WHAT'S THE STUDY ABOUT?

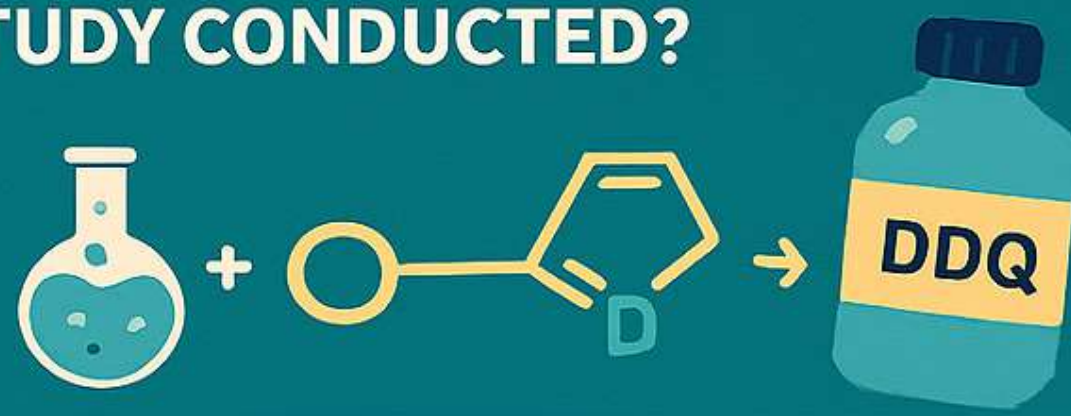
Scientists at **CSIR-IICB** developed a method to construct fused pyrrole rings using palladium-catalyzed reactions.

Fused pyrroles are nitrogen-containing ring structures with applications in pharmaceuticals and materials science.



HOW WAS THE STUDY CONDUCTED?

- Specific chemicals were combined to form key intermediates.
- These intermediates were treated with DDQ (a chemical reagent) to complete the reaction.



- Researchers studied how single electron transfer (SET) processes affected the transformation.

KEY FINDINGS

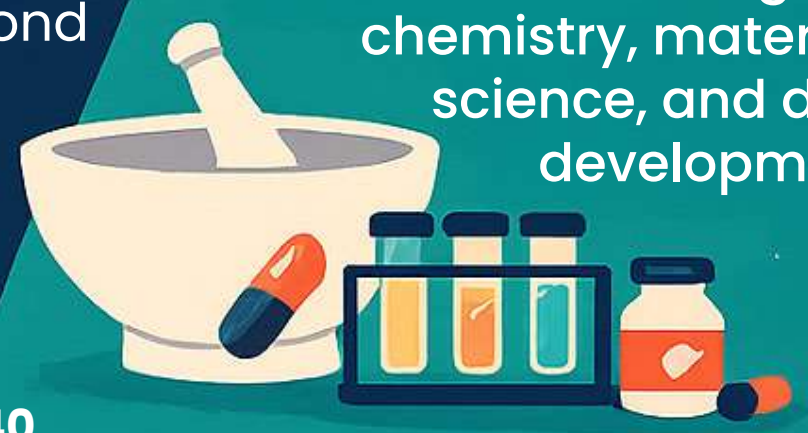
This method efficiently creates fused pyrrole rings through rapid intermolecular assembly.

SET processes play a crucial role in carbon-carbon bond formation.

Photophysical studies identified promising products for advanced applications.

WHY IT MATTERS?

This approach simplifies the synthesis of complex fused pyrrole structures, paving the way for advancements in organic chemistry, materials science, and drug development.

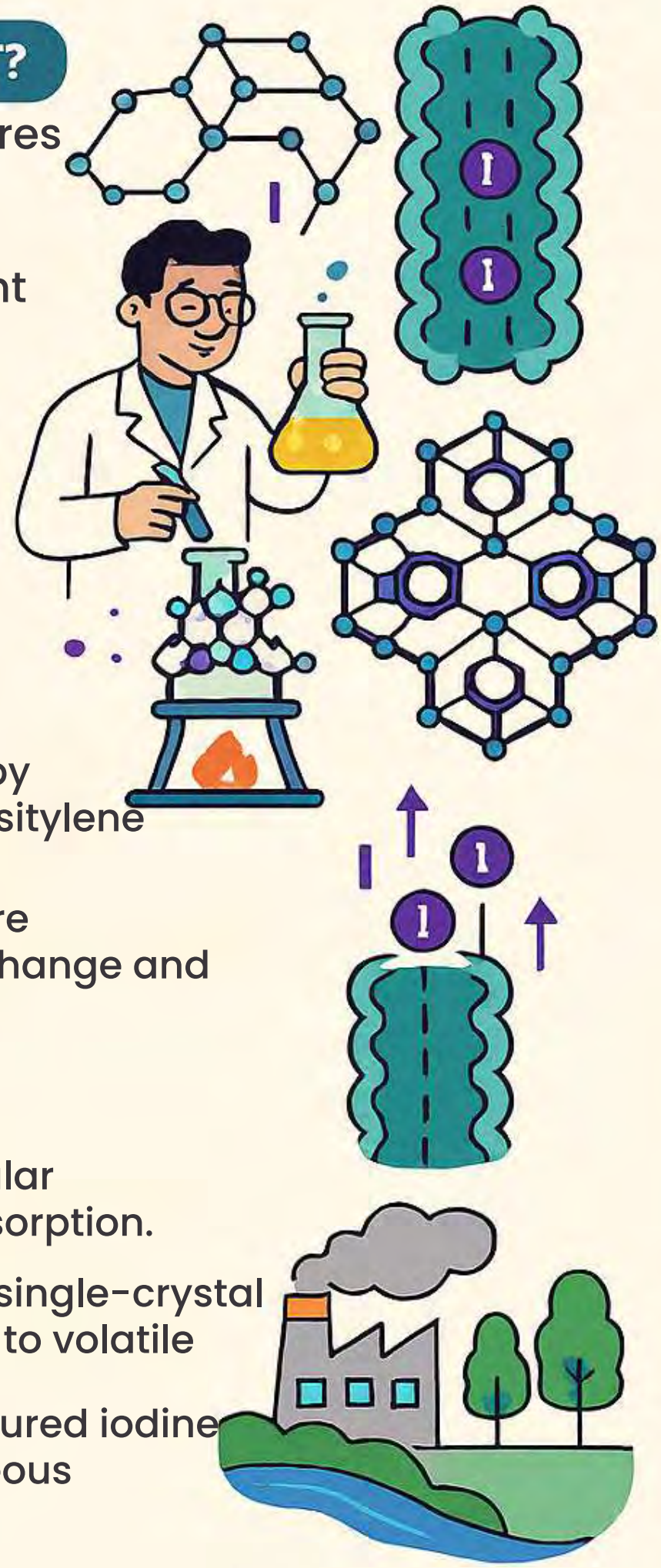


https://doi.org/10.1002/chem.202500240

EFFICIENT IODINE CAPTURE USING SUPRAMOLECULAR ORGANIC FRAMEWORKS

WHAT'S THE STUDY ABOUT?

This study by CSIR-IICB explores supramolecular organic frameworks (SOFs) with nanotubular pores for efficient iodine capture.



HOW WAS THE STUDY CONDUCTED?

- Scientists synthesized SOFs using a chiral imine cage via dynamic covalent chemistry and self-sorting.
- The resulting framework (BM-PIC-SOF) was stabilized by dispersion forces between mesitylene rings.
- Structural transformations were examined through solvent exchange and high-temperature processing

KEY FINDINGS

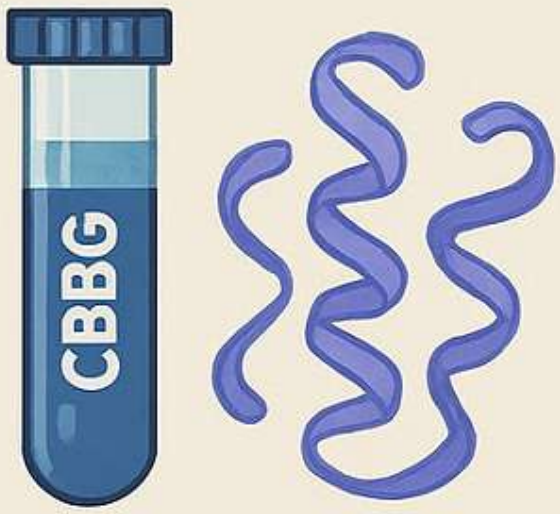
- BM-PIC-SOF formed nanotubular pores that enhance iodine adsorption.
- It underwent single-crystal to single-crystal transformation when exposed to volatile solvents.
- The framework efficiently captured iodine from vapor, organic, and aqueous mediums.

WHY IT MATTERS

This research advances iodine adsorption technology, offering insights into SOF design for environmental applications, including pollutant capture and material separation.

https://doi.org/10.1002/smll.202502761

KEEPING INSULIN STABLE
THE POWER OF COOMASSIE BLUE



What's the study about?

This study by **CSIR-IICB** investigates how Coomassie Brilliant Blue G-250 (CBBG) interacts with bovine insulin (BI) to prevent fibril formation and stabilize its α-helical structure.

How was the study conducted

Thermodynamic analysis assessed the binding of CBBG to BI.

Surface-enhanced Raman scattering detected insulin's structural stability in the presence of CBBG.

Computational simulations identified key molecular interactions.

Key findings

- CBBG inhibits amyloidogenic region zipping, delaying insulin fibril formation.
- It strengthens α-helical stability and reduces structural fluctuations in BI.

Why it matters?

These findings suggest CBBG as a potential stabilizer for insulin, aiding therapeutic formulations by reducing fibrillation risks.

https://doi.org/10.1021/acs.jpcb.5c00846

DHEA AS A POTENTIAL IMMUNE BOOSTER IN VISCERAL LEISHMANIASIS (KALA AZAR)

WHAT'S THE STUDY ABOUT?

This study by **CSIR-IICB** examines the imbalance of cortisol and dehydroepiandrosterone (DHEA) in kala azar, investigating how DHEA supports immune responses to counteract cortisol-induced suppression.

HOW WAS THE STUDY CONDUCTED?

- Leishmania donovani-infected BALB/c mice and macrophage models were studied.
- Effects of DHEA treatment on cortisol levels and immune signaling were assessed.
- Molecular interactions, including PPAR-ɣ binding and glucocorticoid receptor regulation, were analyzed.

DHEA

KEY FINDINGS

- Cortisol levels increased while DHEA levels decreased, correlating with parasite burden.
- DHEA treatment inhibited cortisol production, increasing pro-inflammatory responses.
- DHEA regulated glucocorticoid receptors, blocking immunosuppressive signaling.

DHEA

WHY IT MATTERS?

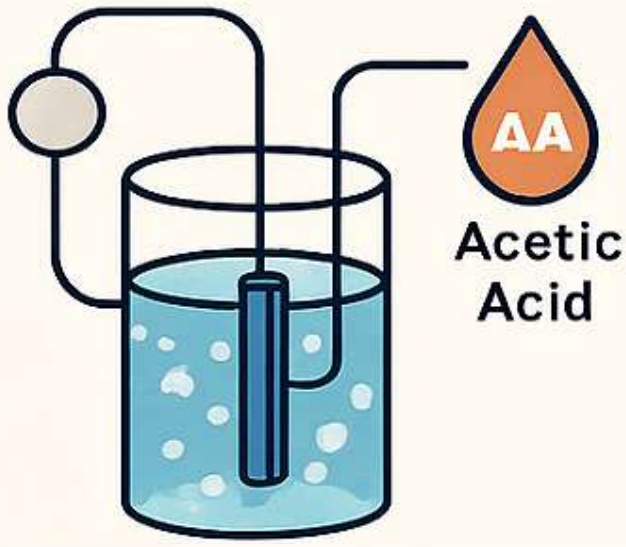
These findings highlight DHEA's potential as an immune booster, offering a possible therapeutic approach to restore immune balance and reduce parasite burden in kala azar.

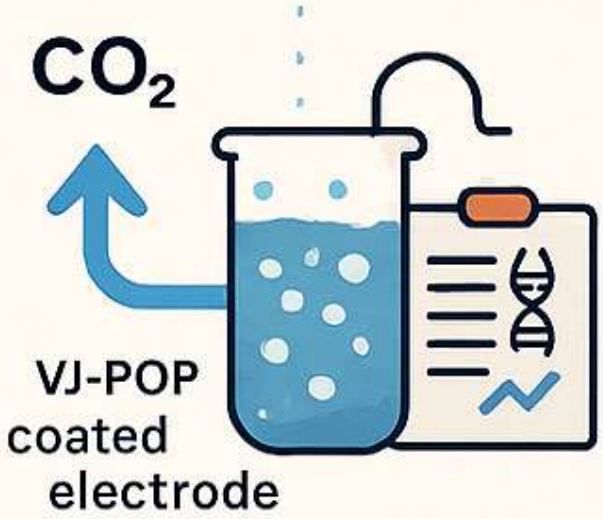
https://doi.org/10.1093/infdis/jiaf223

BOOSTING ACETIC ACID BIOSYNTHESIS THROUGH ELECTROFERMENTATION

What's the study about?

This study by **CSIR-IICB** introduces a novel electrofermentation platform utilizing VJ-POP-coated electrodes to enhance selective acetic acid (AA) biosynthesis by Bacillus subtilis, integrating CO2 capture and biohydrogen production.

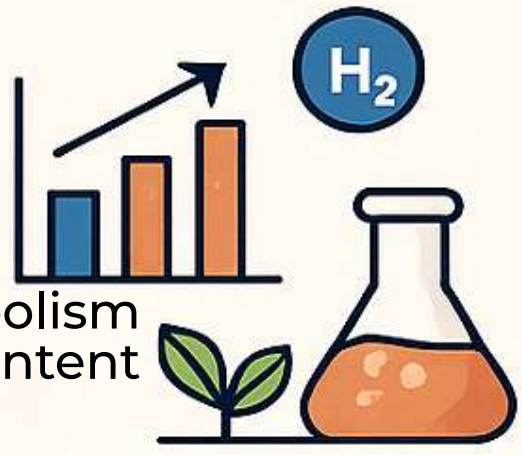




How was the study conducted?

- VJ-POP-coated electrodes were used to improve electron transfer and metabolic efficiency.
- Bioreactor testing evaluated AA production and biohydrogen content in the system.
- Gene expression analysis identified metabolic shifts ensuring AA selectivity.

Key findings



- VJ-POP-coated electrodes were used to improve electron transfer and metabolic efficiency.
- CO2 sequestration and microbial metabolism synergistically boosted biohydrogen content to 52%.
- Enhanced electron transfer and reduced charge-transfer resistance were confirmed via electrochemical analysis.

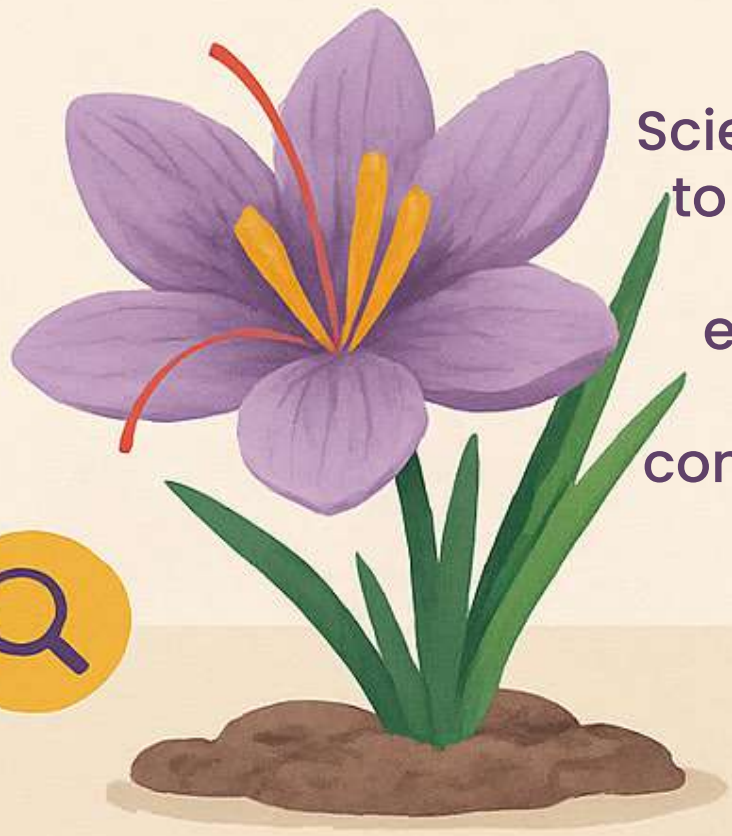
Why it matters?

This study presents a scalable biocatalytic framework for CO2 valorization, bridging material science and microbial electrochemical systems for sustainable acetic acid production and biohydrogen advancement.

https://doi.org/10.1002/anie.202508070

Harnessing Saffron's Potential

Boosting Crocin Production and Stress Resilience



WHAT'S THE STUDY ABOUT?

Scientists at **CSIR-IIIM** discovered a way to improve saffron (*Crocus sativus*) by making a small change in one of its enzymes. This change helps the plant produce more crocin, a valuable compound responsible for saffron's rich color and health benefits.

KEY FINDINGS

- The mutation helped saffron flowers produce more crocin.
- The plant maintained its natural functions while increasing its valuable compounds.
- It improved stress tolerance, allowing them to grow better under challenging conditions.

HOW WAS STUDY CONDUCTED?

- A specific mutation was introduced in saffron's enzyme to enhance crocin production
- Scientists tested this change in saffron flowers to see it effects.

WHY IT MATTERS

This discovery can help farmers grow saffron with higher crocin content, making it more valuable for food, medicine, and cosmetics. It also opens new possibilities for improving plant-based health products and ensuring better crop resilience.

https://doi.org/10.1007/s00425-024-04515-x

EXPLORING BIO-ACTIVE COMPOUNDS IN MICRO-WORM

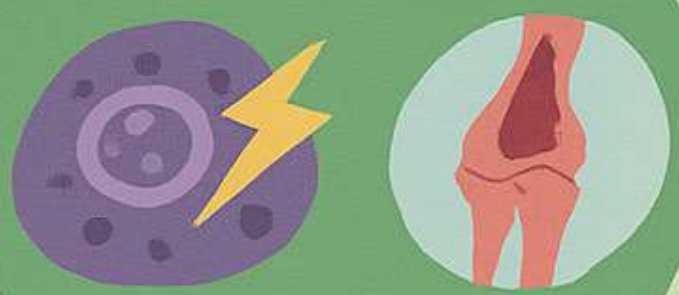
What's the study about?

Scientists at **CSIR-IIIM** conducted a study on the metabolite profiling and bio-activity of fungal endofauna in ***Xiphinema nuragicum***, a tiny worm-like organism found in Ashwagandha.

How was the study conducted?

- Researchers isolated *Xiphinema nuragicum* and studied its gut fungi, identifying *Fusarium fujikuroi* (R3) as the most potent isolate.
- Scientists extracted and tested its bio-active compounds for anti-cancer and anti-inflammatory activities.

Key findings



Identified Bio-active compounds showed :

- Strong effects against cancer cells lines.
- Notable anti-inflammatory effects.
- Demonstrated bio-remediation potential.

Why it matters?

These findings emphasize the therapeutic and ecological importance of nematode-fungal interactions, paving the way for future research into novel bio-active compounds and sustainable bio-remediation strategies.

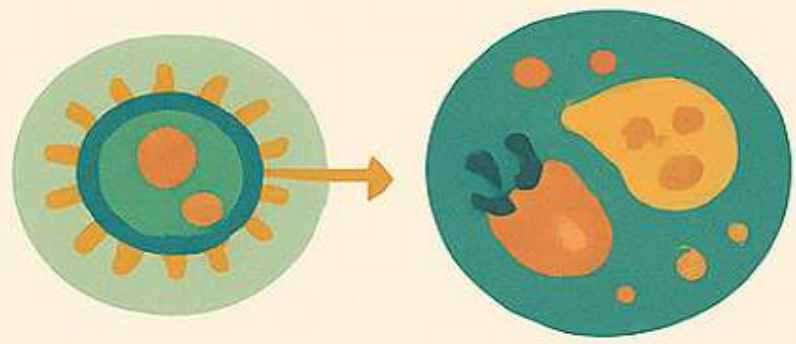
https://doi.org/10.1007/s11356-025-36228-3

BIOSURFACTANTS
AS NEXT-GEN THERAPEUTICS
A REVIEW FROM CSIR-IIIM

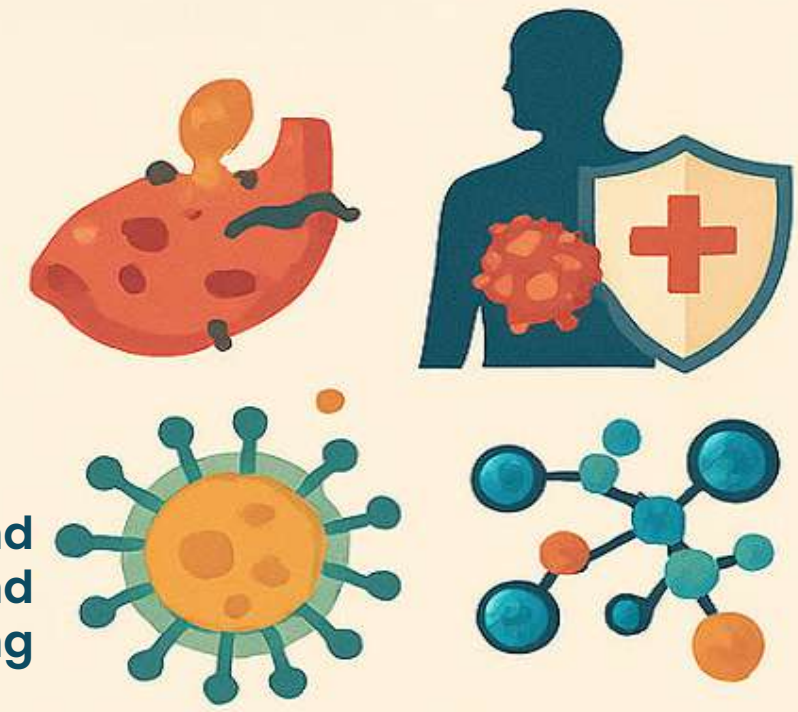
What's the study about?

This review by **CSIR-IIIM** focuses on the diverse biomedical applications of biosurfactants, highlighting their role in combating antimicrobial-resistant pathogens, enhancing drug delivery, and supporting advanced therapeutic strategies.

Key findings



- **Biosurfactants destabilize microbial membranes, leading to pore formation and leakage—especially effective against resistant bacteria and viruses like HIV and herpes.**
- **They break down microbial biofilms, making pathogens more vulnerable to antibiotics and reducing infection persistence.**
- **Biosurfactants prevent bacterial colonization on medical implants, helping reduce device-associated infections.**
- **They influence immune responses and regulate cell growth, apoptosis, and differentiation useful in treating inflammation and tumors.**
- **Their amphiphilic nature allows them to form micelles that encapsulate drugs, improving solubility, stability, and targeted delivery.**
- **When paired with antibiotics or nanoparticles, biosurfactants enhance efficacy, reduce toxicity, and help combat microbial resistance.**



Why it matters?

The study positions biosurfactants as eco-friendly, multifunctional tools in healthcare bridging microbiology, pharmacology, and nanotech to shape the future of safer, smarter therapeutics.

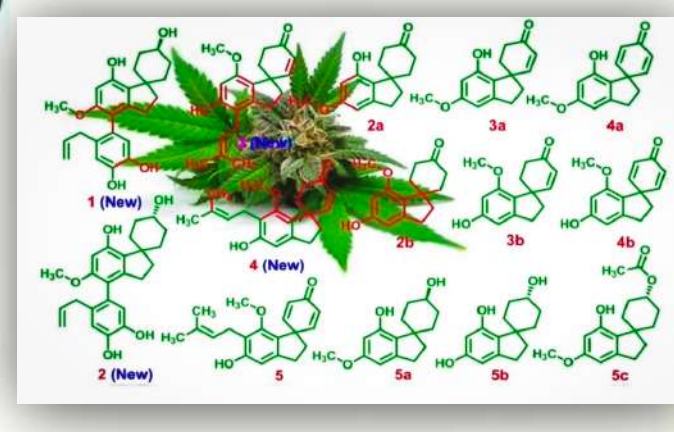
https://doi.org/10.1016/j.ijpharm.2025.125887

NOVEL SPIRINDAN COMPOUNDS IDENTIFIED IN *CANNABIS SATIVA*

WHAT'S THE STUDY ABOUT?

Researchers at **CSIR-IIIM** Jammu investigated spiroindans—rare, non-cannabinoid metabolites in *Cannabis sativa*—with the goal of isolating them, determining their structures, and correcting previous misassignments to advance understanding of cannabis chemistry beyond cannabinoids.

HOW WAS THE STUDY CONDUCTED?



- Leaves from CSIR-IIIM's Chatha farm were extracted with DCM:MeOH (1:1), fractionated on HP20 resin, and purified using silica gel, Sephadex LH-20, and RP-HPLC.
- Structural elucidation employed NMR (1D, 2D), HRMS, SC-XRD, and DFT calculations for comprehensive analysis.

KEY FINDINGS

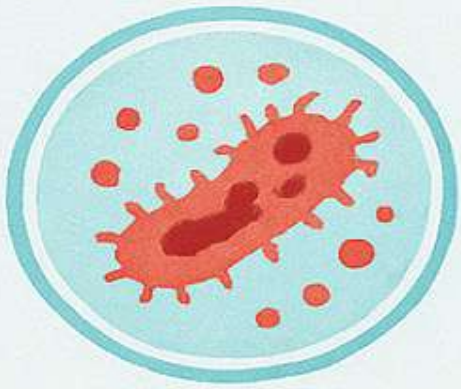
- Discovery of Four New Compounds: β-/ α-chevicospiranol (1, 2), 4-/6-prenylspirenone B (3, 4).
- Developed a 13C NMR Δδ-based rule to distinguish positional isomers.
- Confirmed structures of 2a, 3a, and 5a via SC-XRD.

WHY IT MATTERS?

This research expands *Cannabis sativa*'s known chemical diversity beyond cannabinoids by identifying spiroindans. It introduces a precise spectroscopic-computational method for correcting their molecular structure. These compounds show promise for anti-proliferative and neuroprotective therapies, offering both scientific and medical value.

https://doi.org/10.1016/j.molstruc.2025.141653

COMBATING DRUG-RESISTANT BACTERIA

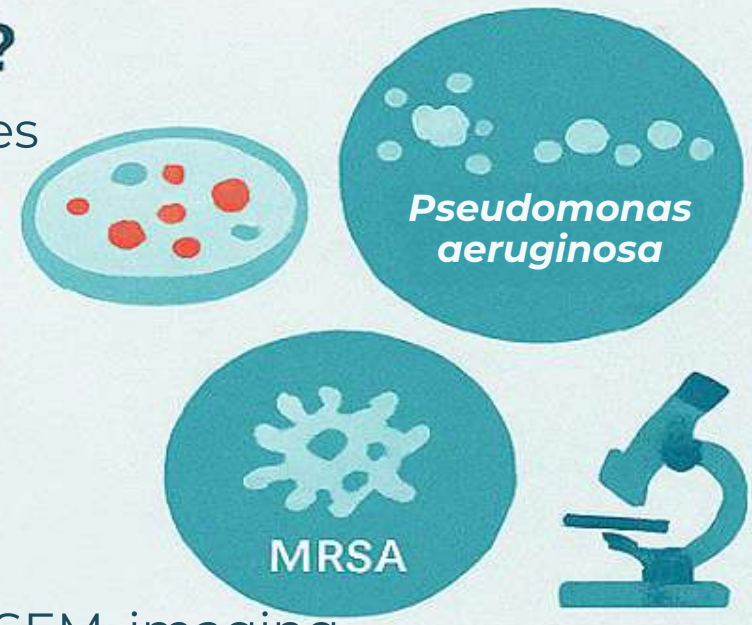


What's the study about?

CSIR-IIIM developed and tested a series of antimicrobial peptides to enhance antibacterial potency and stability against drug-resistant pathogens.

How was the study conducted?

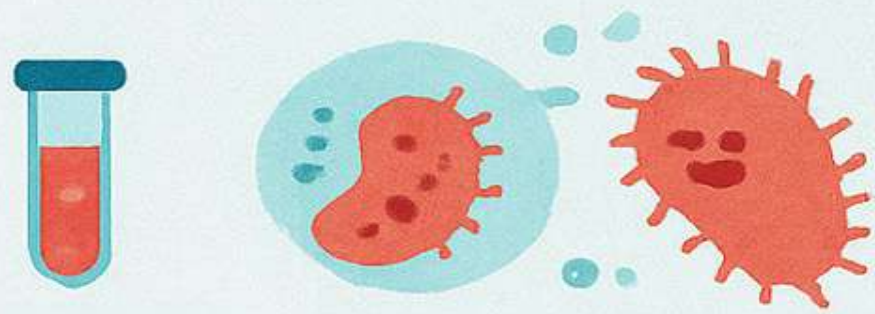
- Synthesized three short cationic peptides with β-amino acids and C12 lipid chains.
- Evaluated their activity against *Pseudomonas aeruginosa* and methicillin-resistant Staphylococcus aureus (MRSA), including multidrug-resistant (MDR) clinical isolates.



- Assessed mechanism of action using SEM imaging, biofilm assays, and ex vivo infection models.

Key findings

- All peptides showed strong antibacterial activity with minimal inhibitory concentration between 0.78–6.25 μM.



- Membrane disruption confirmed as the primary killing mechanism.
- Peptides were non-toxic to mammalian cells and showed low hemolysis at higher doses.

Why it matters

These hybrid peptides offer a promising strategy to tackle MDR bacterial infections, combining potent antimicrobial action with low toxicity. Their design could support future clinical applications in treating resistant pathogens.

https://doi.org/10.1021/acsomega.4c08680

ALTITUDINAL ADAPTATION OF *LEPIDIUM LATIFOLIUM* IN LADAKH

What's the study about?

CSIR-IIIM explored how *Lepidium latifolium* adapts physiologically and biochemically when transplanted across four altitudinal sites in Ladakh, focusing on its response to high light radiation and environmental stress.

How was the study conducted?

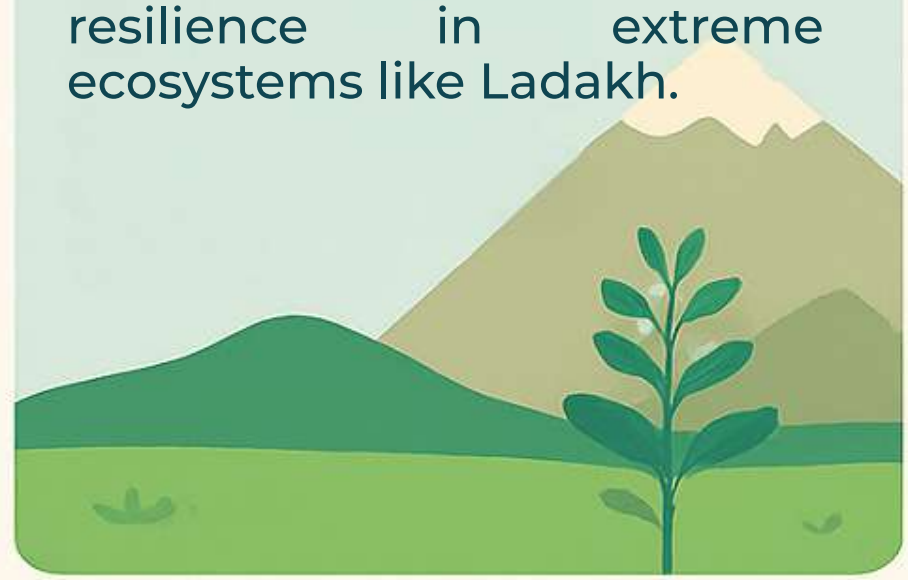
- Transplanted *Lepidium latifolium* at four distinct elevations in Ladakh.
- Measured photosynthetic efficiency, pigment levels, and redox metabolites.
- Assessed photoprotective responses and glucosinolate accumulation.

Key findings

- The plant maintained photosynthesis at high altitudes by modulating photosystem II and enhancing NPQ via zeaxanthin.
- Increased carotenoids and redox metabolites (GSH, ASC) supported stress resilience.
- Glucosinolate levels rose at higher altitudes, aiding environmental adaptation.

Why it matters

The study highlights *Lepidium latifolium's* flexible adaptation strategy across elevations, driven by multiple microenvironmental factors. It offers insights into plant resilience in extreme ecosystems like Ladakh.



https://doi.org/10.1016/j.plaphy.2025.109532

DROUGHT-SALINITY STRESS RESPONSES IN *STEVIA REBAUDIANA*

What's the study about?

CSIR-IHBT investigated how combined drought and salinity (CDS) stress affects Stevia rebaudiana, a key source of natural low-calorie sweeteners, to identify genetic traits for developing climate-resilient cultivars.

How was the study conducted?

- Integrated 936 million transcriptional reads with physiological and metabolomics data.
- Analyzed gene expression (9643 DEGs) under CDS vs. single stress conditions.
- Validated CDS-specific genetic variations in tolerant and susceptible stevia cultivars.

Key findings

- CDS triggered adaptive growth of non-glandular trichomes and enriched stress-linked metabolism.
- Identified key root-expressed genes (AKT1, HAK12, P5CS, MAPKK5) linked to stress response.
- Confirmed amino acid changes in critical genes with translational relevance for breeding.

Why it matters

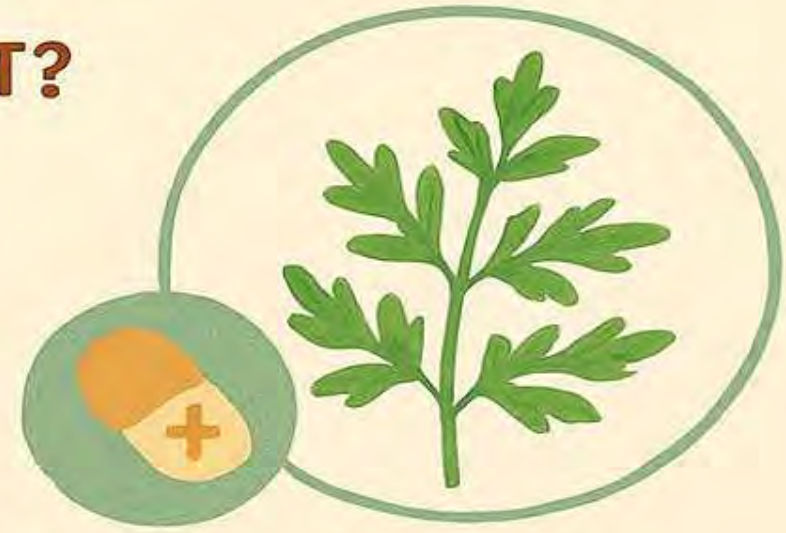
This study provides genomic tools to breed stevia varieties that withstand harsh climates while maintaining sweetener yield, supporting sustainable agriculture and commercial viability.

https://doi.org/10.1111/ppl.70305

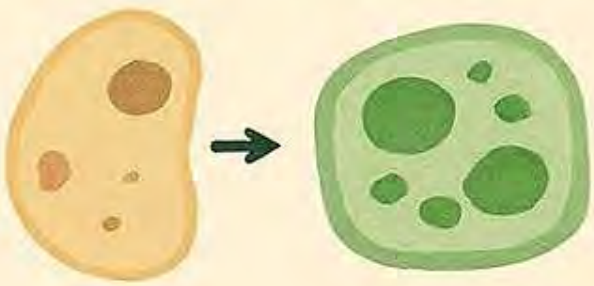
REGULATION OF ARTEMISININ BIOSYNTHESIS

WHAT'S THE STUDY ABOUT?

This study by **CSIR-IIIM** investigated how the transcription factors AaMYC2 and AaMYC2-LIKE regulate artemisinin biosynthesis and trichome development in *Artemisia annua*, the primary natural source of artemisinin used in malaria treatment.



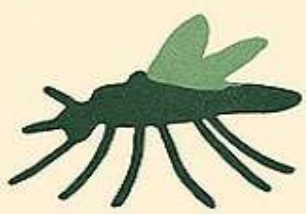
HOW WAS THE STUDY CONDUCTED?



- Tested transcriptional activity and protein interactions in yeast and plant cells.
- Created overexpression and co-expression lines in A. annua.
- Measured gene expression, trichome density, and artemisinin content.

KEY FINDINGS

AaMYC2 + AaMYC2-LIKE
↓
More artemisinin Content
↓
More Drug against Malaria



- AaMYC2 and AaMYC2-LIKE together enhance gene expression and artemisinin production.
- Physical interaction between the two transcription factors confirmed.
- Co-expression lines showed increased trichome density and artemisinin content.

WHY IT MATTERS

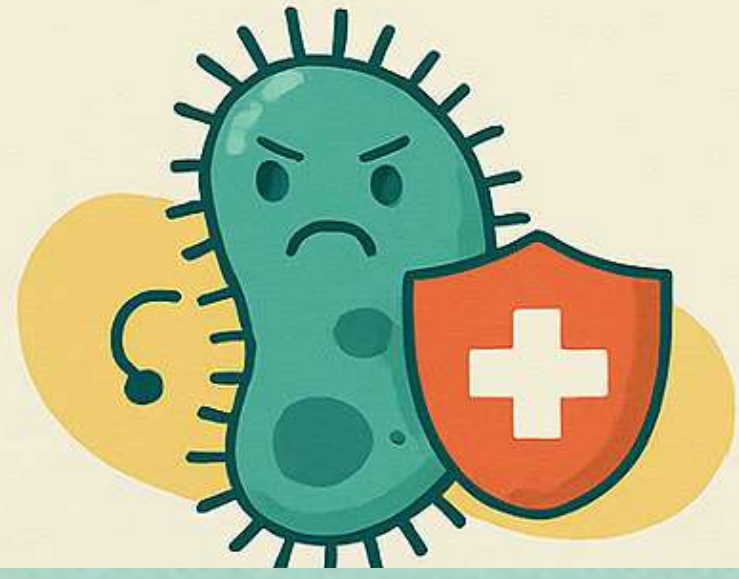
This study provides insights into improving artemisinin production, supporting better malaria treatment and enhancing the economic and medicinal value of *A. annua*.

https://doi.org/10.1016/j.jbiotec.2025.03.007

IDENTIFYING COMPOUNDS
TO OVERCOME ANTIBIOTIC RESISTANCE

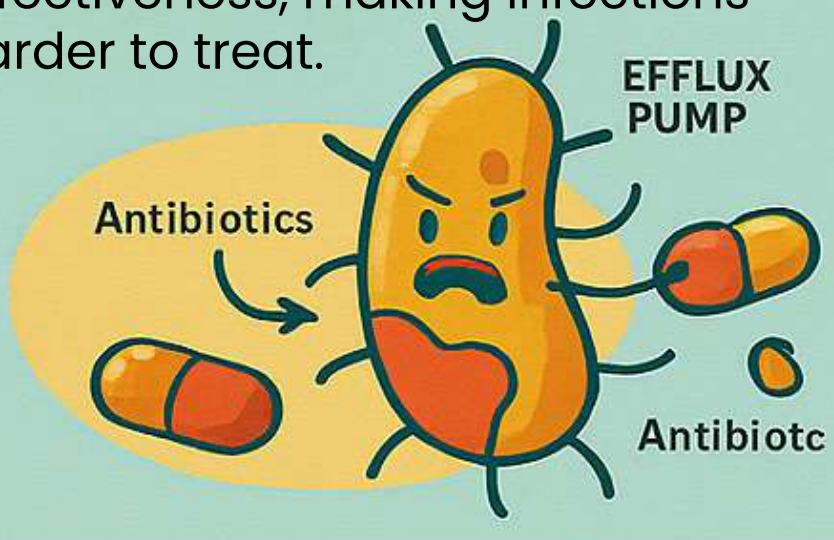
WHAT'S THE STUDY ABOUT?

Scientists at **CSIR-IITR** investigated antimicrobial resistance (AMR) in *Escherichia coli,* which has made common antibiotics ineffective, leading to limited treatment options and rising mortality rates.



KEY FINDINGS

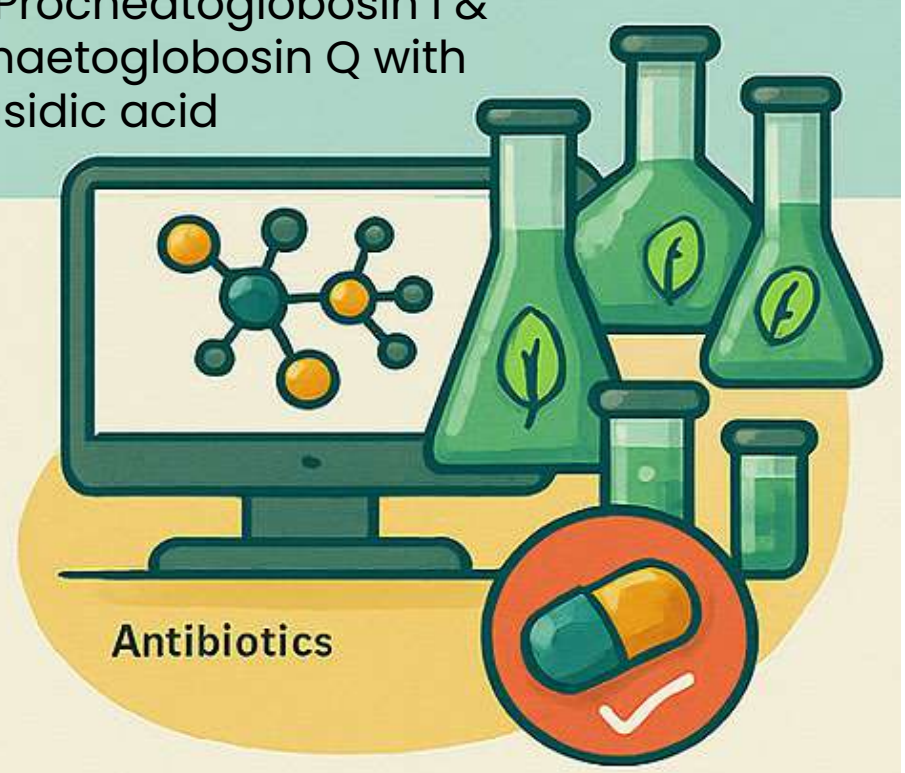
Mutations in the AcrB sub-unit of the efflux pump make bacteria more resistant by helping them push antibiotics out of their cells, reducing drug's effectiveness, making infections harder to treat.



SCREENING FOR EFFLUX PUMP INHIBITORS

Scientists analyzed 40,613 natural compounds to find potential substances that could help antibiotics work better by blocking the AcrB pump. Some promising combination of compounds with specific antibiotics:

- 3-Hydroxyfumiquinazoline A with Erythromycin
- Sungucine & Cheatoglobosin D with Novobiocin
- Procheatoglobosin I & Chaetoglobosin Q with Fusidic acid



WHY IT MATTERS

This study presents a new class of efflux pump inhibitors (EPIs) that could help restore the power of existing antibiotics, offering a new approach to fighting drug-resistant bacteria.

https://doi.org/10.1007/s11030-025-11204-8

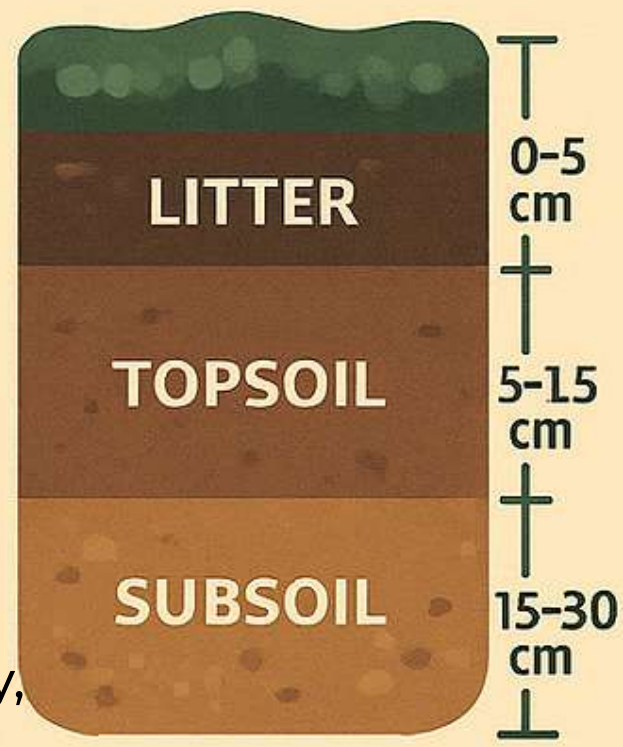
IMPACT OF FOREST FIRES ON SOIL PROPERTIES

What's the study about?

This study by **CSIR-IMMT** examines how human-caused forest fires alter soil characteristics and carbon content in Sulia Reserve Forest, Odisha. Researchers compared burned (BUR), managed (MAN), and unburned (CON) soils to assess changes in physicochemical properties and mineral composition.

How was the study conducted?

- Soil samples were collected from different depths and analyzed for changes in pH, bulk density, water retention, electrical conductivity, and nutrient levels.
- Advanced instruments were used to study mineralogical changes.



Key findings

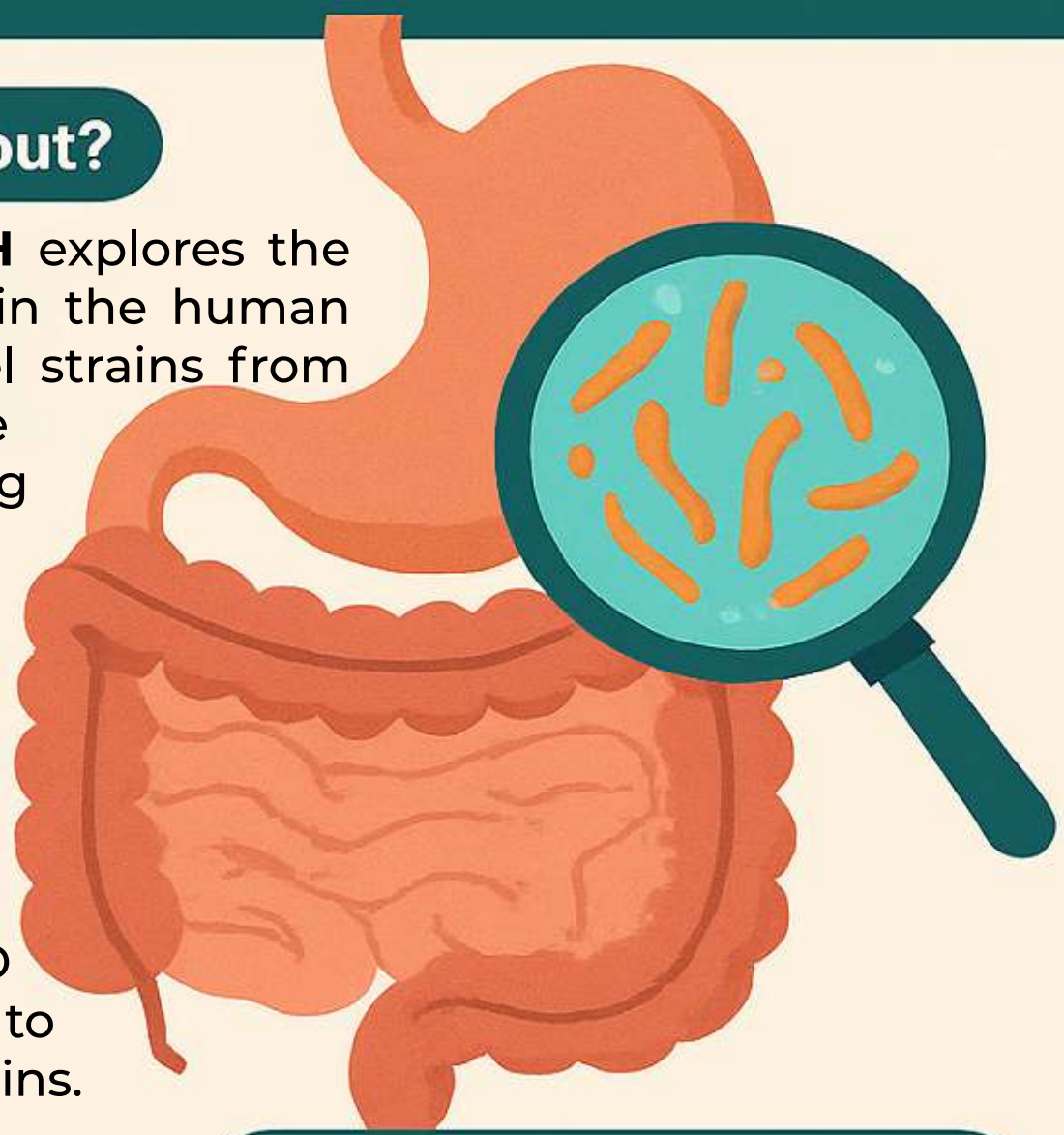
- BUR soil had increased electrical conductivity, oxidisable carbon, total organic carbon, soil organic matter, potassium, and available nitrogen and reduced total nitrogen.
- Significant mineralogical changes were observed, including feldspar, haematite, and kaolinite alterations.

Why it matters?

This study highlights the complex effects of forest fires on soil properties, emphasizing the need for location-specific management strategies to conserve forest ecosystems.

https://doi.org/10.1007/s10661-025-13996-6

DISCOVERING NOVEL MYXOBACTERIA IN THE HUMAN GUT



What's the study about?

This study by **CSIR-IMTECH** explores the presence of myxobacteria in the human gut, identifying three novel strains from inflammatory bowel disease (IBD) patients and proposing a new genus and species classification.

How was the study conducted?

- Fecal samples from IBD patients were analyzed to isolate *Myxococcus* strains.
- 16S rRNA gene sequencing and genome-based phylogeny determined strain relationships.
- Meta-barcoding and genomic comparisons confirmed novel species classification.

Why it matters?

This study challenges previous assumptions about myxobacteria's ecological niche, providing insights into their role in human health and microbial taxonomy.

Key findings

- Three myxobacterial strains (O35, O15, Y35) were isolated, belonging to two distinct clades.
- Novel species *Myxococcus faecalis* sp. nov. O35T and new genus *Pseudomyxococcus* gen. nov. were proposed.
- Myxobacteria presence in human gut expands knowledge of gut microbial diversity.

https://doi.org/10.1128/spectrum.02147-24

PROTECTIVE COATINGS FOR WIND TURBINE BLADES

WHAT'S THE STUDY ABOUT?

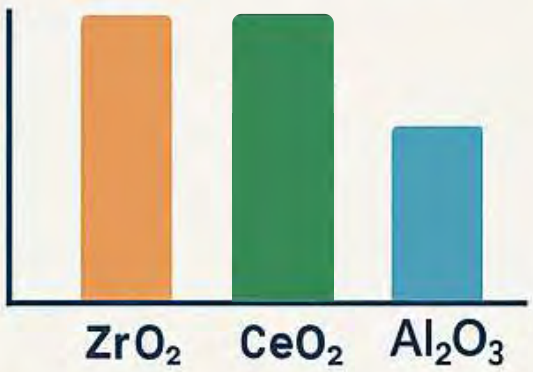
Scientists at CSIR-NAL explored advanced protective coatings for wind turbine blades, aiming to reduce damage caused by solid particle erosion.

HOW IT WORKS ?

Researchers applied epoxy coatings reinforced with Al_2O_3, ZrO_2, and CeO_2 nanoparticles onto glass fiber reinforced polymer (GFRP) via spray coating.

These nanoparticles were synthesized using a solution combustion method .

KEY FINDINGS



- $Zr.O_2$ & CeO_2 outperform Al_2O_3
- Reduced erosion and strengthened blades.
- Provided insights for improved simulation techniques

WHY IT MATTERS ?

This study demonstrates how advanced coatings can significantly improve wind turbine efficiency, helping enhance renewable energy sustainability and supporting global efforts to shift away from fossil fuels.

https://doi.org/10.1016/j.renene.2024.121681

SUPERHYDROPHOBIC COATINGS

For Durable & Hassle-Free Cleaning

What's the study about?

Scientists at **CSIR-NAL** studied a hydrothermal assisted sol-gel method to create superhydrophobic(SH) silica nanoparticle (h-SNP) coatings on polyurethane surfaces, enhancing durability, water resistance, and easy surface cleaning.

How was the study conducted?

- SNPs were hydrophobized by a facile chemical treatment.
- h-SNPs were sprayed onto a partially cured polyurethene (PU) surface.
- Process parameters were optimized for effective grafting of h-SNP in PU matrix.
- Durability was tested through adhesion, abrasion, and accelerated weathering assessments.

Key findings

- It maintained SH property with a water contact angle of 166 ± 2° and a water sliding angle of < 5° during 200 hours of accelerated weathering and forced ice stripping tests.
- It withstood 15 days of water immersion without degradation.
- It effectively resisted emery abrasion cycles demonstrating super robustness and durability with effective easy cleaning properties.

Why it matters?

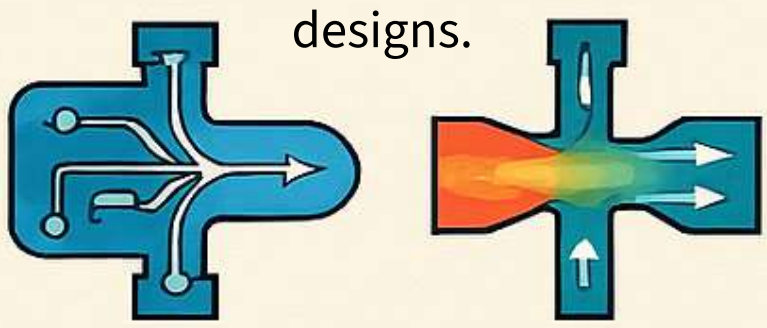
This research reports durable superhydrophobic (SH) coatings that remain functional under extreme conditions, contributing to innovations in water-repellent surfaces, anti-icing technology, and easy-cleaning coatings.

https://doi.org/10.1016/j.apsusc.2024.161707

OPTIMIZING FLUIDIC OSCILLATORS FOR FLOW CONTROL

What's the study about?

This study by **CSIR-NAL** investigates the flow dynamics of fluidic oscillators, focusing on their performance in compressible regimes and comparing feedback-type (FB) and mixing chamber-type (MC) designs.



Key findings

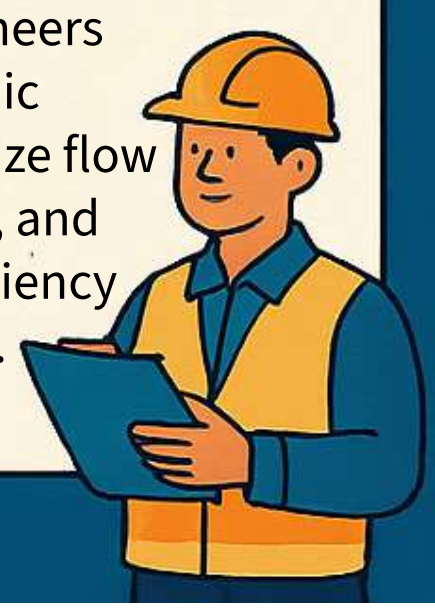
- FB-type centerline velocity profiles did not match previous top-hat profile assumptions.
- MC-type achieved higher jet velocity with less variation than FB-type.
- Fluid dynamic throat was upstream in FB-type and downstream in MC-type.
- MC-type generated more force under identical conditions.

How was the study conducted?

- Detailed stereo particle image velocimetry characterized throat region flow
- Velocity profiles and fluid dynamic throat positioning were analyzed.
- Mass flow rate and momentum flow field were evaluated for engineering applications.

Why it matters?

Understanding fluidic oscillator behavior helps engineers enhance aerodynamic performance, optimize flow control applications, and improve energy efficiency in various industries.

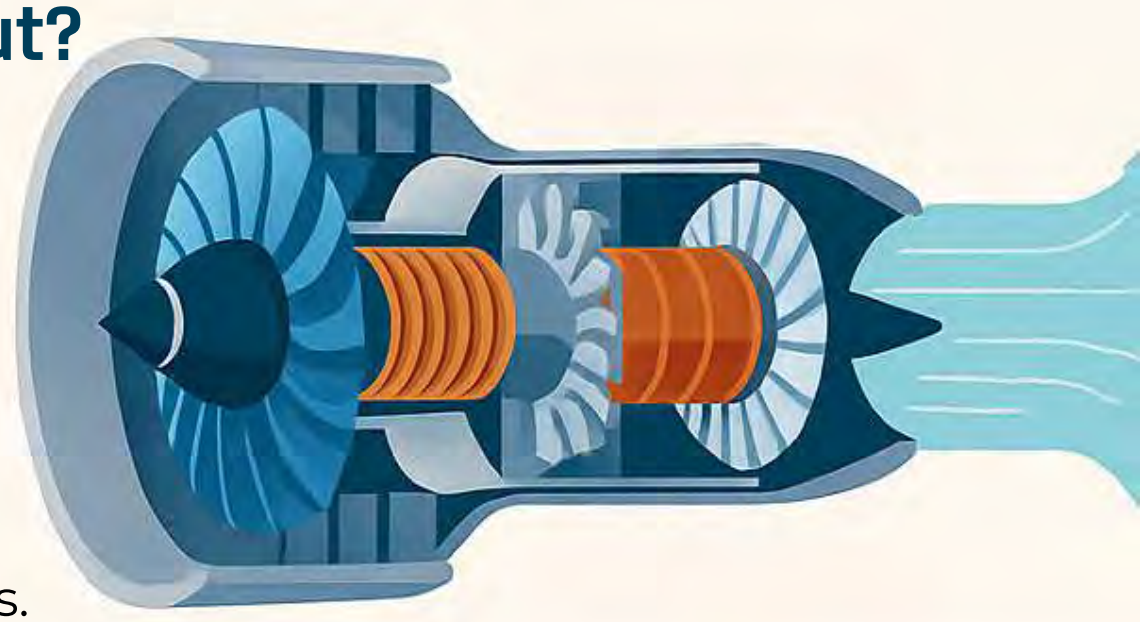


https://doi.org/10.1063/5.0266415

INFLUENCE OF UPSTREAM TRANSONIC COMPRESSOR STAGE ON AERODYNAMIC PERFORMANCE OF INTER-SPOOL DUCT

What's the study about?

This study by CSIR-NAL investigates how the upstream transonic compressor stage affects the inter-spool duct's (ISD) aerodynamic performance and subsequently how to optimize its performance for high-bypass turbofan engines.



How was the study conducted?

- Researchers used design, optimization, high-fidelity unsteady simulations, and experimental validations.
- They analyzed the complex flow interactions, including the effect of rotor shock boundary layer interactions, tip leakage flow, and secondary flow structures from the rotor and stator getting transferred into ISD.
- They assessed the impact of rotor-stator unsteady flow features on ISD performance.

Key findings

- Unsteady wake structures from rotor-stator blades create secondary flow structures and high turbulence levels.
- The flow separation in the stator has caused major pressure losses at the inner wall of the ISD.
- The thick boundary layer developed at the duct end-walls reduced the overall mass flow going into the system by 1.6%.
- ISD losses reduced the system efficiency by 2%. However, the optimized ISD improved the stall margin by 4.8%.

WHY IT MATTERS?

Understanding ISD flow physics aids in developing strategies to enhance efficiency of downstream high-pressure stages, lowering specific fuel consumption and reducing environmental pollution from high-bypass turbofan engines.

https://doi.org/10.1016/j.applthermaleng.2025.125770

ADVANCED DAMAGE DETECTION IN AIRCRAFT COMPOSITES

What's the study about?

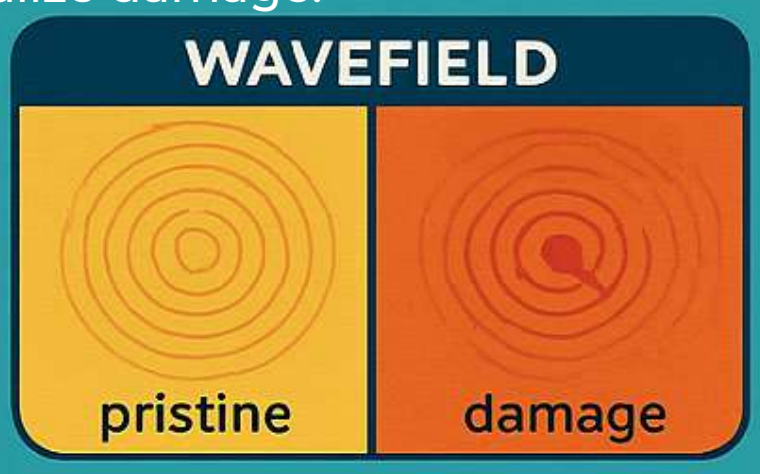
This study by **CSIR-NAL** focuses on developing a non-destructive evaluation (NDE) framework for detecting damage in tapered honeycomb sandwich composites used in aircraft structures, utilizing guided wave propagation techniques.

How was the study conducted?

- A numerical model of a honeycomb composite with debond damage was developed.
- A real helicopter blade specimen was tested for artificial damage using a low-speed impact setup.
- The total focusing method and thresholding techniques were applied to localize damage.

Key findings

- Significant wavefield interruptions indicated damage presence, while pristine structures showed smooth patterns.
- Amplified wave mode responses confirmed damage detection accuracy.
- Effective localization of multiple debond zones validated the robustness of the detection framework.



Why it matters?

This study improves aircraft safety and maintenance through reliable damage detection.

https://doi.org/10.1016/j.ymssp.2025.112539

RECYCLING PLASTIC WASTE INTO USEFUL CHEMICALS

WHAT'S THE STUDY ABOUT?

Scientists at CSIR-NCL have developed a method to convert waste polyethylene into valuable chemicals using a special catalyst ruthenium.

PROCESS OVERVIEW

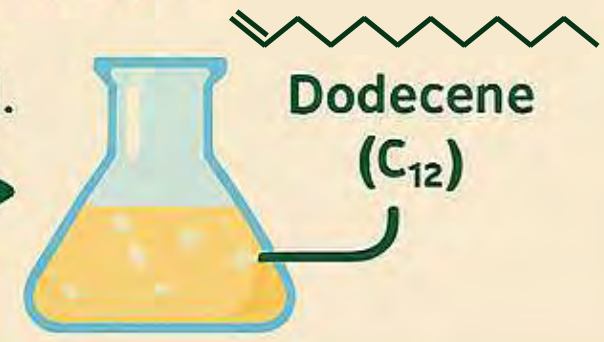
Step: 1 Dehydrogenation

The plastic undergoes a reaction that. introduces double bonds, making it easier to break down.

C=CC

Step: 2 Metathesis Reaction

The modified plastic reacts with ethylene, producing mostly dodecene (C_{12}), a valuable chemical.



KEY FINDINGS

90% of the plastic material was retained after the first step

58 % of the final product consisted of C_{12} compounds, used in various industries

WHY IT MATTERS

This method provides a **sustainable** way to recycle polyethylene waste, converting it into valuable chemicals instead of letting it pollute the environment

https://doi.org/10.1002/anie.202422609

TURNING CO_2 EMISSIONS INTO VALUABLE PRODUCTS

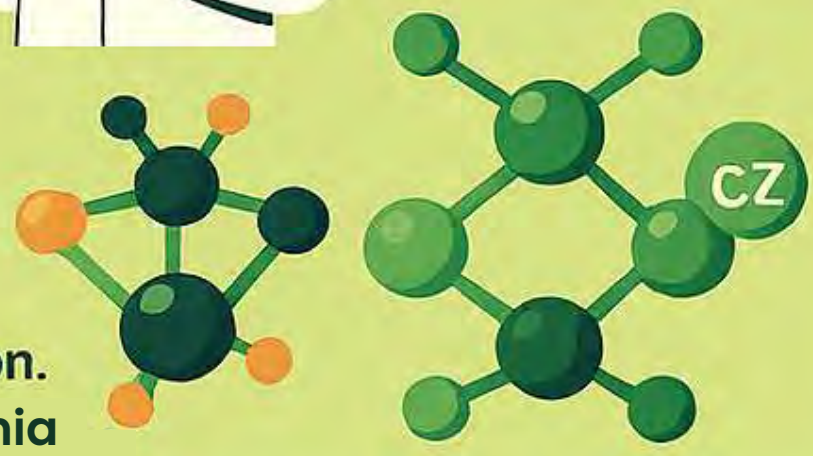
WHAT'S THE STUDY ABOUT?

Scientists at CSIR-NCL developed a new catalyst to efficiently convert CO_2 into useful chemicals, helping reduce global warming and environmental challenges.

The study focuses on improving CO_2 hydrogenation, a process that produces carbon monoxide (CO), methanol, and methane from CO_2.

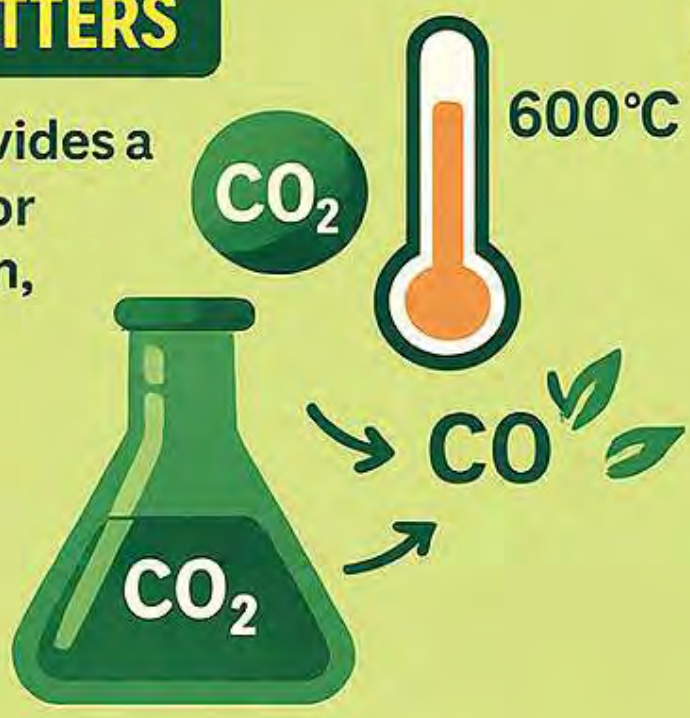
KEY INNOVATIONS

- Cu-Co bimetallic catalyst was designed to optimize CO_2 conversion.
- Oxygen-vacancy-rich ceria-zirconia (CZ) support improved the catalyst's performance.



WHY IT MATTERS

This study provides a new solution for CO_2 conversion, offering a sustainable way to turn emissions into valuable chemicals



PERFORMANE RESULTS

- The catalyst convered CO_2 effectively even when hydrogen was limited.
- Achieved a high reaction rate for CO production at 600°C with 80 % hydrogen utilization, proving its efficiency.

https://doi.org/10.1016/j.cej.2025.160705

COSMIC IMPACT

HOW MICROMETEORITES SHAPE EARTH'S OCEANS

What's the study about?

This study by **CSIR-NIO** investigates how micrometeorites (MMs) influence the chemical composition and biogeochemistry of the ocean, revealing their role in nutrient cycling and carbon sequestration.

How was the study conducted?

- Etching and flux analyses determined the dissolution rates of cosmic spherules in seawater.
- Deep-sea sediment examination provided estimates of extraterrestrial material flux over millions of years.
- CO2 sequestration calculations assessed the long-term environmental impact of cosmic material interactions.

Key findings

95% of cosmic spherules dissolve in seawater, supplying nutrients for phytoplankton.

Olivine dissolution contributes major elements like Mg^{2+}, Fe^{2+}, and silicic acid to the ocean.

Extraterrestrial activity influences oceanic CO2 sequestration, with events like the Veritas impact significantly altering atmospheric carbon levels.

Why it matters?

This study emphasizes the vital yet overlooked influence of cosmic materials on Earth's marine ecosystems and their geological connections.

https://doi.org/10.1016/j.gsf.2025.102078

IMPACT OF HUMAN ACTIVITIES ON BLACK CLAM POPULATIONS

What's the study about?

This study by **CSIR-NIO** investigates how multiple human-induced factors impact the distribution of black clam (*Villorita cyprinoides*) in the Kochi backwaters (KBW), India's largest estuarine system.

How was the study conducted?

- Hydrographic and sediment sampling were conducted across 22 locations during different monsoons.
- Current and historical data were analyzed to assess environmental changes.
- Anthropogenic stressors, especially the Thannermukkom Barrage (TB), were studied for their impact on clam populations.

Key findings

- The black clam prefers mesohaline to oligohaline waters with sand dominant substratum but faces habitat shrinkage due to human activities.
- TB installation altered salinity zones, forcing clam spawning shifts and increased siltation.
- TB shutters cause salt shocks, leading to mass clam mortality on both sides.

Why it matters?

This study highlights the critical ecological impact of human interventions, stressing the need for sustainable water management and conservation strategies to protect black clam populations.

https://doi.org/10.1038/s41598-025-90573-4

GASTROPOD GRAZING AND MEIOBENTHIC COMMUNITY DYNAMICS IN TROPICAL ESTUARIES

What's the study about?

This study by **CSIR-NIO** examines how the cerithiid gastropod (*Pirenella cingulata*) influences meiobenthic community composition, particularly free-living nematodes, in two tropical estuaries—Zuari and Mandovi on India's central west coast.

How was the study conducted?

- Sediment sampling assessed species diversity in gastropod grazing vs. non-grazing sites.
- Meiobenthic taxa analysis identified key shifts in community structure across locations.
- Nematode functional diversity was examined using biological traits analysis.

Key findings

- Gastropod grazing significantly reduced meiobenthic abundance in both estuaries.
- Free-living nematodes were dominant, with 55 recorded species but no clear functional changes linked to grazing behavior.
- Long-term monitoring is essential for sustainable fisheries management and achieving SDG 2 (Food Security) & SDG 14 (Life Below Water).

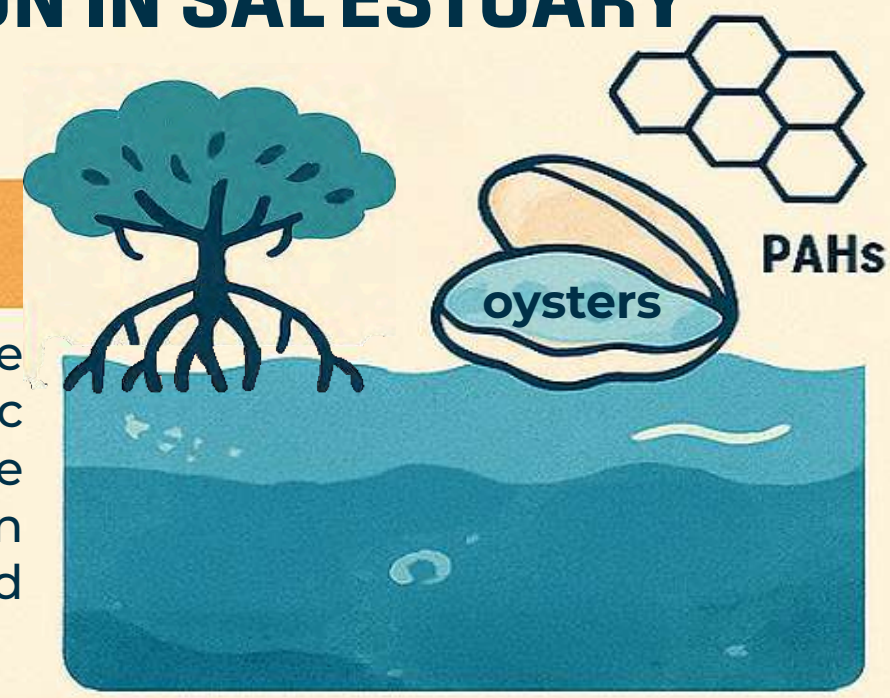
Gastropod grazing

https://doi.org/10.1016/j.marenvres.2025.107224

Why it matters?

This study provides a critical ecological foundation for understanding gastropod driven ecosystem changes, informing coastal conservation and fisheries sustainability strategies.

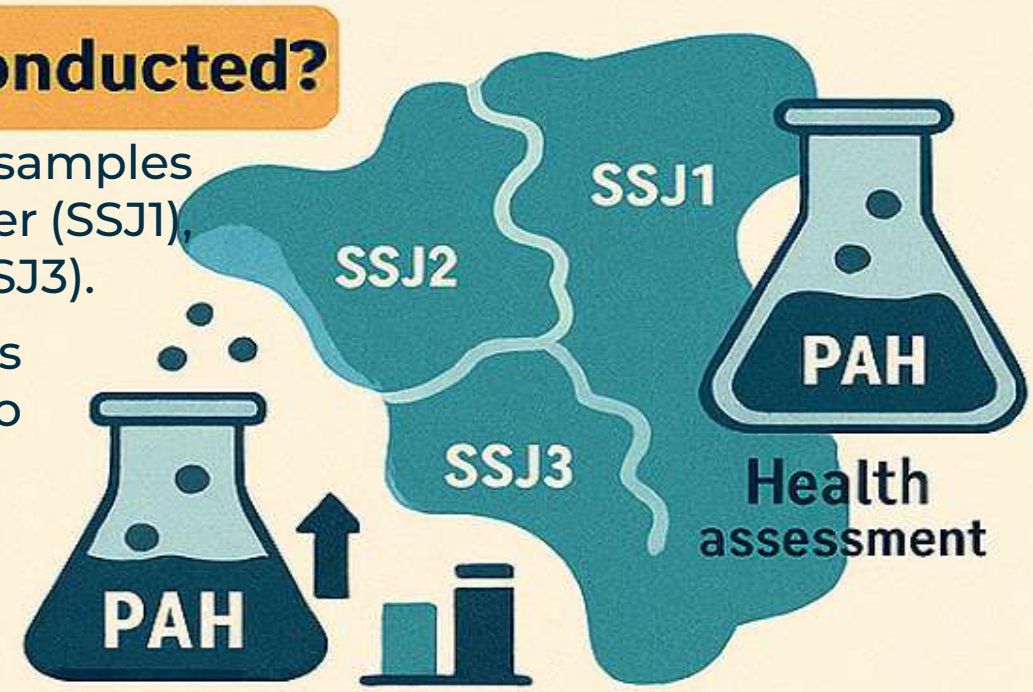
POLYCYCLIC AROMATIC HYDROCARBONS CONTAMINATION IN SAL ESTUARY



What's the study about?

CSIR-NIO investigated the presence and accumulation of Polycyclic Aromatic Hydrocarbons (PAHs) in the water and oysters of the Sal estuary in Goa, assessing pollution sources and potential health risks.

How was the study conducted?



- Collected water and oyster samples from three estuarine zones: upper (SSJ1), mid (SSJ2), and lower regions (SSJ3).
- Measured PAH concentrations and analyzed diagnostic ratios to identify pollution sources.
- Assessed human health risk using EFSA guidelines, calculating Exposure Daily Intake (EDI) and Target Hazard Quotient (THQ).

Key findings

- Highest PAH levels found at mid-estuary (SSJ2): 594.36 µg/L in water and 12,022.2 ng/g in oysters.
- Lowest levels at SSJ1, a mangrove-rich, less disturbed zone.
- Water had more low molecular weight PAHs, while oysters accumulated high molecular weight PAHs due to their lipophilic nature.

Why it matters

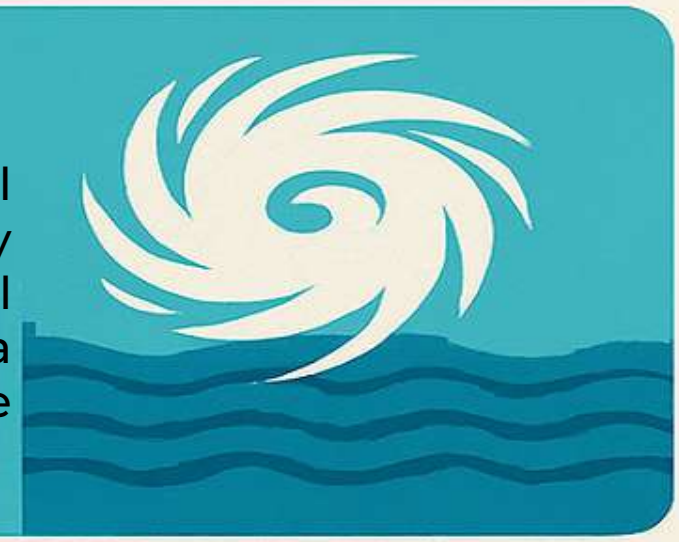
The study highlights how anthropogenic activity and tidal dynamics influence pollutant distribution, reinforcing the need for ongoing monitoring and estuarine conservation.

https://doi.org/10.1016/j.marpolbul.2025.118120

CLIMATE DRIVEN CHANGES IN CYCLONE PATTERNS OVER THE INDIAN OCEAN

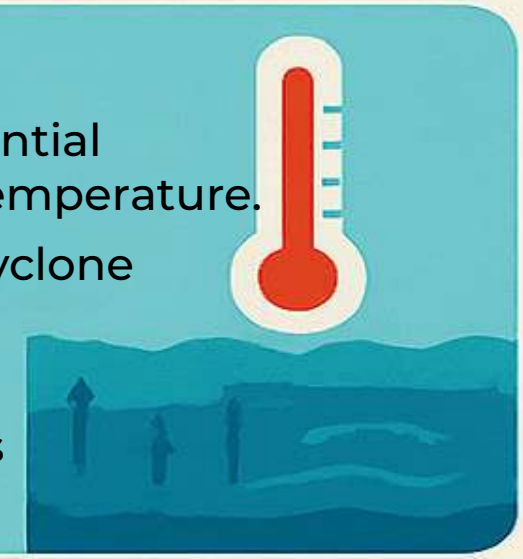
What's the study about?

This study by **CSIR-NIO** investigates how tropical cyclones have changed in frequency and intensity across the Arabian Sea (AS) and Bay of Bengal (BoB) from 1960 to 2022, with a focus on sea warming, cyclone heat potential, and large-scale climate events like the Indian Ocean Dipole (IOD).



How was the study conducted?

- Long-term analysis of cyclone records, heat potential metrics, wind shear, humidity, and sea surface temperature.
- Correlated environmental trends with decadal cyclone patterns in AS and BoB.
- Assessed how IOD phases influenced regional warming and cyclone behavior through changes in Walker circulation and isothermal layer depth.



Key findings

- Arabian Sea warming after 1995 led to more frequent and stronger cyclones.
- Frequent positive IOD events intensified warm water in the AS, boosting cyclone formation, while cooling in the BoB decreased cyclone occurrences.
- Despite no clear trend in cyclone count in the BoB, stronger cyclones still occurred.

Why it matters?

This study provides insights into how warming and atmospheric changes influence cyclone risks in India, aiding disaster preparedness and climate adaptation strategies.

https://doi.org/10.1080/1755876X.2025.2498272

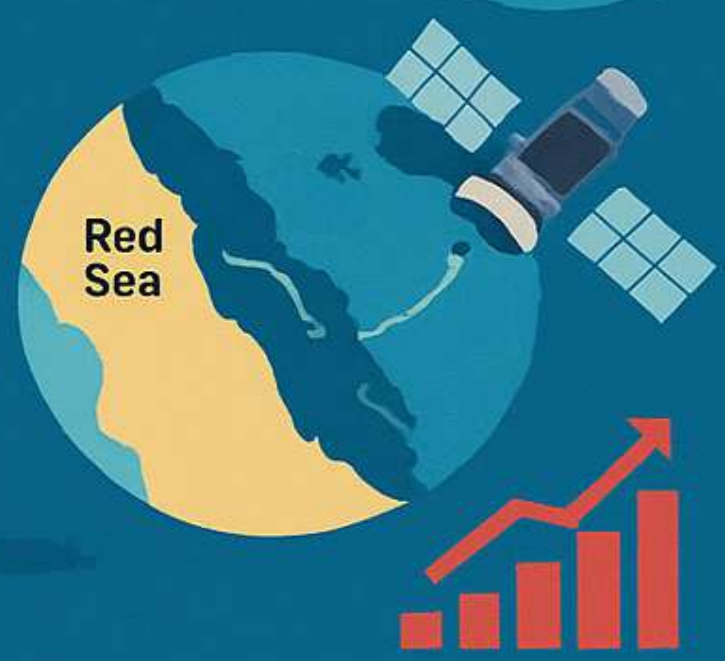
TRACKING THE IMPACT OF OIL SPILLS IN THE RED SEA

What's the study about?

This study by **CSIR-NIO** analyzes the impact of the Iranian tanker oil spill (Oct 11, 2019) on the marine optical properties of the Red Sea, emphasizing real-time tracking using satellite data and modeling.

How was the study conducted?

- MODIS satellite data from Terra assessed key optical parameters, including Kd(490), POC, PIC, and backscattering coefficients.
- GNOME modeling traced the oil spill trajectory, evaluating dispersal patterns.
- Correlation analysis linked satellite observations with environmental factors like wind speed and westward currents.



Key findings

- Significant changes in Kd(490), POC, PIC, and backscattering values were observed after the spill.
- Oil dispersion was largely driven by strong westward currents and wind speeds.
- GNOME simulations closely aligned with satellite tracking, confirming trajectory accuracy.

Why it matters?

This study highlights the critical role of satellite-based monitoring in oil spill impact assessment, helping improve marine ecosystem response strategies and environmental disaster management.

https://doi.org/10.1016/j.rsma.2025.104187

URBANIZATION DISRUPTS MICROBIAL LIFE IN GOA'S COASTAL ECOSYSTEM

What's the study about?

This study by **CSIR-NIO** examines how microbial communities in Goa's seaweed and mangrove habitats—key blue carbon ecosystems—are changing over time, and what that reveals about environmental health and human impact.

How was the study conducted?

- Assessed bacterial diversity in seaweed and mangrove sites using 16S rRNA metabarcoding.
- Compared results with seven earlier studies (2017–2024) across multiple coastal locations.
- Analyzed microbial taxonomy and functional genes, especially those linked to pollution and stress.

Key findings

- Seaweed habitats were dominated by aerobic bacteria (*Proteobacteria, Cyanobacteria*), while mangroves harbored more anaerobic species (*Firmicutes, Planctomycetes*).
- Urban-influenced sites showed higher pathogenic bacteria (e.g. *Bacillus, Clostridium*) and pollution-adapted genetic traits.
- Genes tied to foreign substance removal were elevated—suggesting ecosystems are responding to chemical pollution and urban runoff.

Why it matters?

Microbial changes signal coastal stress, highlighting pollution's impact on ecosystems. The study emphasizes urgent protection of blue carbon habitats vital for climate and biodiversity through focused conservation efforts.

https://doi.org/10.1111/maec.70020

MICROPLASTICS IN SEAFOOD

ECOLOGICAL AND HUMAN HEALTH RISKS REVEALED

What's the study about?

This study from **CSIR-NIO** investigates how microplastics (MPs) accumulate in marine fish and shellfish along Goa's coast, examining their impact on ecosystem health, feeding behaviors, and seafood safety for humans.

How was the study conducted?

- Analyzed 251 fishes from benthic and pelagic fish and shellfish species.
- Assessed MPs in gastrointestinal tracts and gills, comparing species and habitat types.
- Evaluated Polymer Hazard Index (PHI) and nutritional quality indicators in shellfish.

Why it matters?

The study emphasizes the impact of feeding behavior and habitat on marine plastic ingestion, highlighting food safety concerns and the need for pollution management to safeguard ecosystems and human health.

Key findings

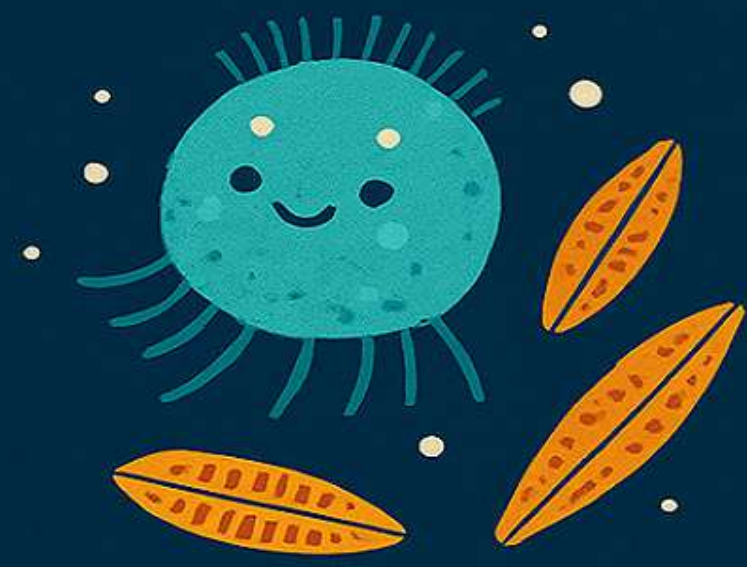
- Benthic habitats and sediments had higher MP contamination than pelagic zones, likely due to fishing and wastewater pollution.
- MPs were most abundant in gastrointestinal tracts, with fibrous types (polyamide, polyester) dominating.
- Shellfish like *Meretrix meretrix* showed reduced nutritional quality.

https://doi.org/10.1016/j.envres.2025.121589

BIO-LUMINESCENCE IN MANDOVI ESTUARY REVEALS MICROBIAL-ECOLOGICAL LINKS

What's the study about?

This study by **CSIR-NIO** documents a rare bloom of the bioluminescent dinoflagellate *Noctiluca scintillans* in the Mandovi estuary (Goa coast), triggered by pre-monsoon upwelling, nutrient-rich conditions, and runoff, offering fresh insights into bloom ecology and microbial interactions.



How was the study conducted?

- Monitored phytoplankton density and species composition, alongside environmental factors like temperature, salinity, and oxygen levels.
- Conducted hydrochemical analyses and metagenomic sequencing to identify bacteria associated with the bloom.
- Compared microbial communities during the bloom and peak conditions.

Key findings

- A unique assemblage of *Noctiluca* and diatoms was observed for the first time in this region.
- Bloom coincided with low oxygen conditions and high ammonia levels, supporting specific microbial activity.
- Dominant microbial players like *Vibrio* and *Methanobrevibacter* may influence bloom dynamics and nutrient cycling.

https://doi.org/10.1016/j.rsma.2025.104178

Why it matters?

This study highlights how environmental triggers and microbial communities shape coastal bloom behavior. It offers clues to ecosystem responses, potential health risks, and guides future monitoring of estuarine biogeochemistry.

MICROBIAL LANDSCAPES IN THE OXYGEN-DEPLETED ARABIAN SEA

What's the study about?

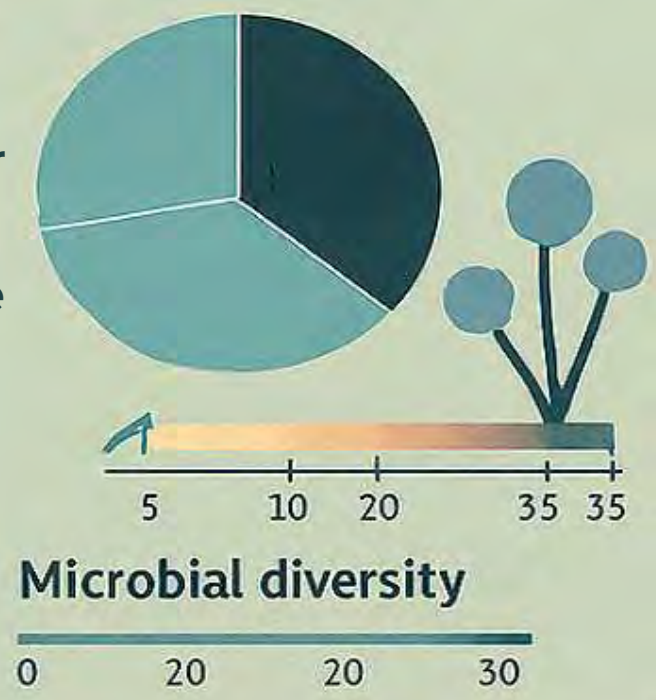
This study by **CSIR-NIO** delves into the microbial ecosystems of the Arabian Sea's oxygen-depleted environments (ODE), assessing how bacterial and fungal communities respond across hypoxic gradients and contribute to global element cycles.

How was the study conducted?

eDNA metabarcoding tools were used to analyze sediment samples from four sites (200–1,200 m depth).

Dissolved oxygen levels (5–35 µM) were used to map microbial shifts along the hypoxic gradient.

Species diversity indices assessed richness and distribution of bacterial and fungal taxa.



Key findings

Proteobacteria dominated bacterial communities, while Ascomycota and Basidiomycota led fungal groups.

Highest microbial diversity occurred at 10–20 µM oxygen levels, with noticeable compositional shifts along the gradient.

Mucoromycota was detected only at higher oxygen levels (20–35 µM), indicating oxygen-sensitive niches.

Why it matters?

These insights are vital for grasping microbial roles in biogeochemical cycles, aiding predictive models of deep-sea ecosystems amidst climate change.

https://doi.org/10.1515/bot-2024-0054

SIMULATING MICROMETEORITE HEATING TO UNDERSTAND ISOTOPIC CHANGES

What's the study about?

This study by CSIR-NIO explores how extraterrestrial dust particles (micrometeorites) change in texture and oxygen isotopic composition when entering Earth's atmosphere. Using CI chondrite samples, researchers simulated this process under lab-controlled heating conditions.

How was the study conducted:

- Chips of chondritic dust were flash-heated at 400–1600 °C in atmospheric air for short durations (10–50 seconds).
- Researchers analyzed resulting textures and isotopic shifts using microscopy and mass spectrometry.
- Compared experimental products to natural micrometeorites to assess thermal and chemical transformations.

Key findings

- Peak temperature controls mineral changes; heating time affects vesicle formation and material homogeneity.
- CI chondrite dust is more heat-resistant than CM dust, tolerating ~200 °C higher temperatures before major changes.
- **Oxygen isotopic composition shifts occur due to water release and evaporation, with mixing effects appearing at very high temperatures.**

Why it matters?

This study helps decode how micrometeorites evolve during atmospheric entry, offering clues about their origin, composition, and thermal history—essential for understanding planetary materials and Earth's cosmic dust inputs.

https://doi.org/10.1016/j.gsf.2025.102046

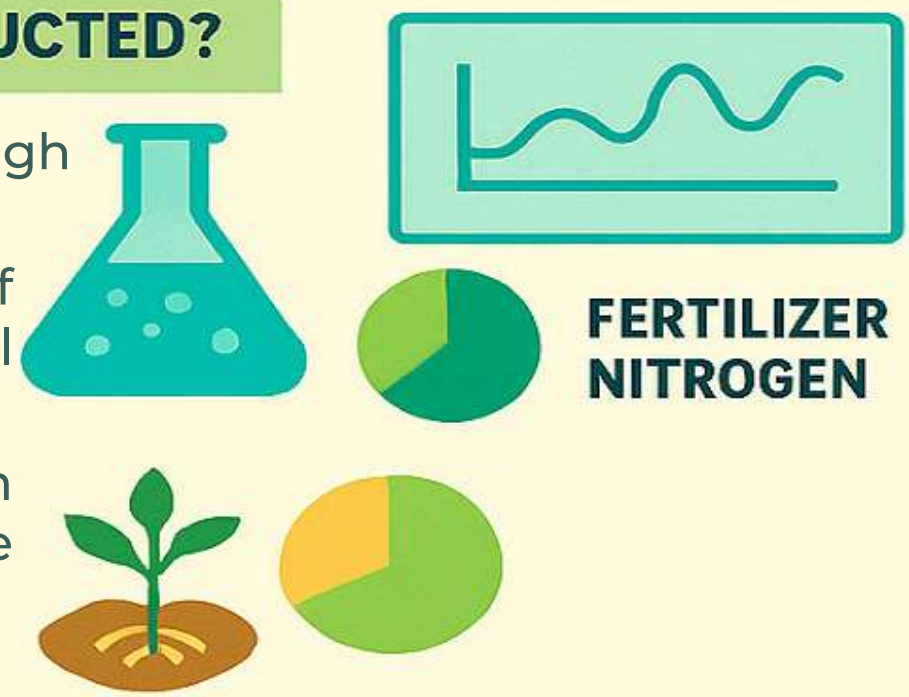
ORGANIC MATTER SOURCES IN THE GODAVARI RIVER

WHAT'S THE STUDY ABOUT?

CSIR-NIO investigated how seasonal river flow influences the sources of particulate organic matter (POM) in the Godavari River, and whether excess nitrogen fertilizers from agriculture significantly contribute to it.

HOW WAS THE STUDY CONDUCTED?

- Collected river samples during high flow and low flow seasons.
- Measured isotopic ratios ($\delta^{13}C$ of POC, $\delta^{15}N$ of PN) and elemental C:N and POC:Chl-a ratios.
- Compared $\delta^{15}N$ PN values with fertilizer signatures to trace agricultural nitrogen inputs.



KEY FINDINGS

- Low flow: ~60% of POM was from in-situ sources like phytoplankton.
- High flow: 75–80% of POM came from terrestrial runoff.
- $\delta^{15}N$ PN values (7.4‰ to 9.4‰) did not match fertilizer nitrogen (0 ± 1‰), indicating minimal direct impact.

WHY IT MATTERS

This study clarifies nutrient pathways, indicating fertilizers impact groundwater more than surface waters, enhancing agricultural management strategies.

https://doi.org/10.1038/s41598-025-99286-0

SUSTAINABLE RECYCLING OF END-OF-LIFE SOLAR PANELS

What's the study about?

This study by **CSIR-NPL** presents an eco-friendly method for recycling end-of-life (EoL) solar panel waste, upcycling recovered high-purity silicon into silica (SNPs) and hydrophobic silica (HSNPs) nanoparticles for innovative applications.

How was the study conducted?

- A wet chemical recycling process was developed to extract and purify silicon.
- Structural, morphological, optical, and spectroscopic analyses characterized SNPs and HSNPs.
- Water contact angle measurements evaluated HSNPs' hydrophobicity for practical applications.

Key findings

- HSNPs showed a high water contact angle of 102.48°, making them ideal for various uses
- Anticorrosion coatings with HSNPs exhibited 99.5% protection efficiency and a 200-fold reduced corrosion rate.

Why it matters?

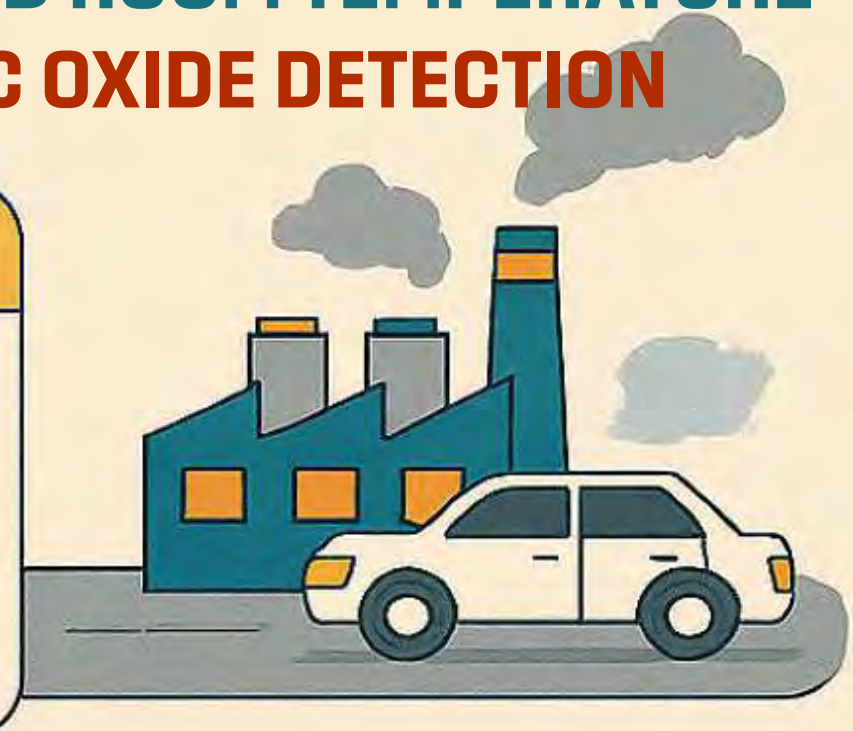
With the growing challenge of solar panel disposal, this research offers a sustainable waste-to-wealth solution, reducing environmental impact while repurposing materials for high-performance industrial applications.

https://doi.org/10.1016/j.resconrec.2024.108059

ULTRAVIOLET-ACTIVATED ROOM TEMPERATURE SENSOR FOR NITRIC OXIDE DETECTION

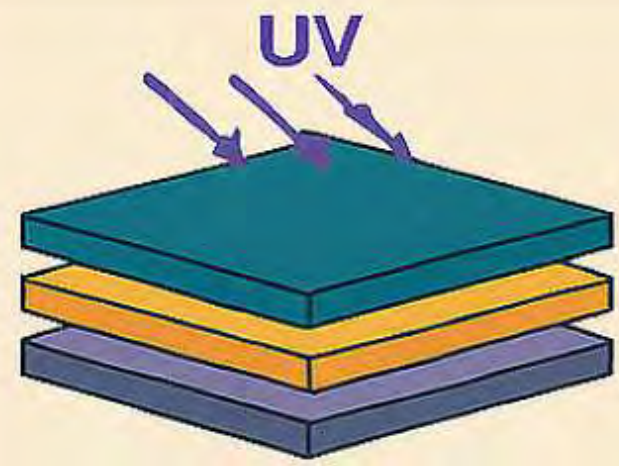
What's the study about?

This study by **CSIR-NPL** presents a light-assisted, room-temperature gas sensing approach using a $MoS_2/WSe_2/GaN$ heterostructure, designed for detecting nitric oxide (NO)—a toxic gas prominent in industrial and vehicular emissions.



How was the study conducted?

- A multi-layered sensor was fabricated combining MoS_2, WSe_2 (both TMDCs), and GaN (a wide-bandgap semiconductor).
- The sensor's performance was tested under varied NO concentrations and light wavelengths, including UV illumination (266 nm).
- Parameters like photocurrent, resistance change, response time, and recovery time were evaluated for comparative sensitivity.



Key findings

- $MoS_2/WSe_2/GaN$ outperformed previous designs, showing a 130% relative response at 266 nm UV excitation.
- Achieved low detection limit (8 ppb) and quick response/recovery times (8.56s/12.82s) for NO gas.
- Demonstrated high selectivity, long-term stability, and repeatability, validating its suitability for field applications.

Why it matters?

This study advances next-gen gas sensing by combining materials innovation with photonic stimulation—offering a low-power, high-performance solution for real-time air quality monitoring and industrial safety, without the drawbacks of high-temperature sensors.

https://doi.org/10.1039/D4TA09078K

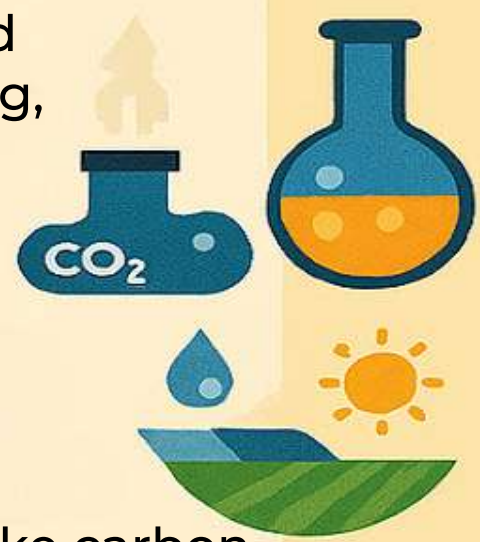
RECYCLING OF SILICON SOLAR PANELS

WHAT'S THE STUDY ABOUT?

This study by **CSIR-NPL** evaluates two methods—thermal treatment and chemical processing—to recover useful materials from discarded silicon solar panels, while analyzing their environmental impacts through Life Cycle Assessment (LCA).

HOW WAS THE STUDY CONDUCTED?

- Thermal method involved high-temperature heating, with emissions analyzed using quartz filters and spectroscopy tools.
- Chemical method used toluene-based solvent extraction.
- LCA compared impacts like carbon emissions, toxicity, water use, and land disruption for both approaches.



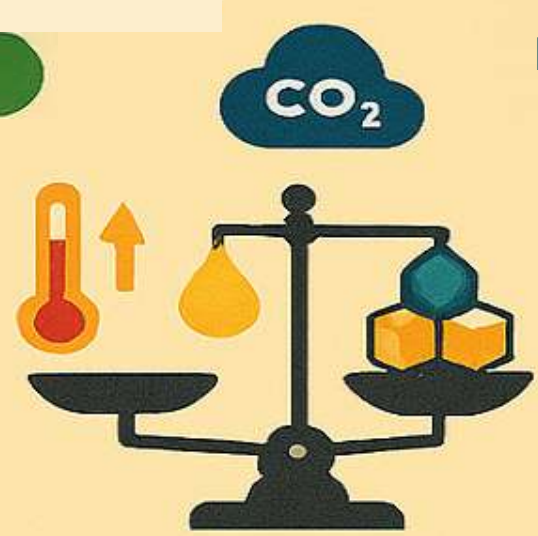
KEY FINDINGS

- Chemical processing recovered more materials, but had higher carbon emissions and energy usage.
- Thermal treatment had fewer climate and health impacts, but slightly affected ozone and land use.

https://doi.org/10.1016/j.solmat.2025.113556

WHY IT MATTERS?

As solar adoption rises, managing panel waste sustainably is crucial. This study helps guide eco-responsible recycling choices, balancing performance with planet-friendly outcomes.

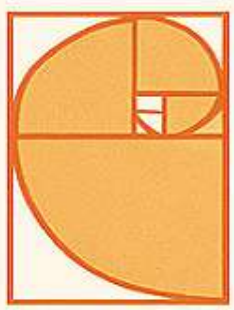


MONITORING RADIATION FROM WIRELESS DEVICES USING SMART ANTENNA DESIGN

What's the study about?

This study by **CSIR-NPL** analyzes Specific Absorption Rate (SAR) levels from everyday wireless devices like mobile phones and routers, using a new antenna-based method to assess radiation exposure at 2.45 GHz.

How was the study conducted?



- Designed a miniaturized antenna using the Golden ratio and Fibonacci sequence, tuned to isolate the main frequency mode at 2.45 GHz.
- Measured SAR across different devices and exposure durations.
- Compared antenna performance with standard E Fields probes on in-house developed technology of human electrical parameters equivalent liquids considered as Tissue Equivalent Liquid (TEL) as per IEC/IEEE 62209-1528:2020.

Key findings

- The custom antenna successfully detected SAR levels across devices with reliable accuracy.
- Radiation gain and frequency coverage matched industrial bands, making the antenna suitable for lab testing.

Why it matters?

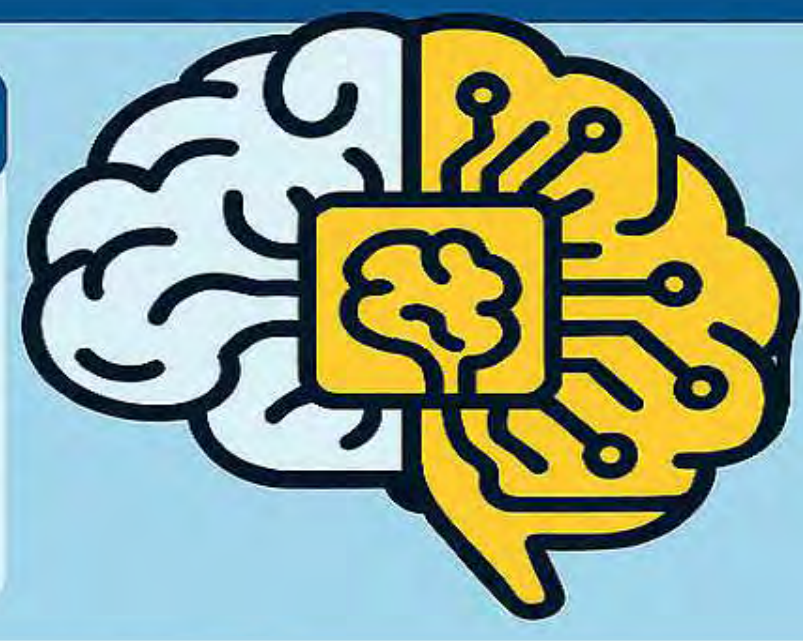
Understanding SAR is critical for radiation safety and device regulation. This method adds a practical tool for assessing EM exposure, especially in labs and industrial setups.

https://doi.org/10.1016/j.measurement.2025.117135

BRAIN-INSPIRED DEVICE FOR ENERGY-EFFICIENT COMPUTING

WHAT'S THE STUDY ABOUT?

This study by **CSIR-NPL** introduces a new MoS_2 (molybdenum disulfide) thin-film device designed for neuromorphic computing, mimicking brain-like operations through energy-efficient and high-speed resistive switching.

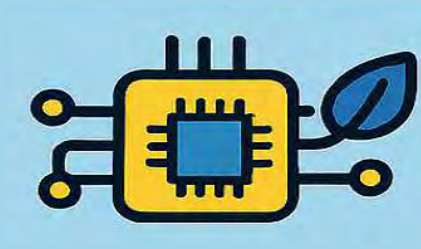


HOW WAS THE STUDY CONDUCTED?

- Developed a vertical resistive switching device using ultra-thin layers of MoS_2.
- Fabricated using a cost-effective, scalable process, with electrode spacing at atomic scale.
- Evaluated for switching speed, voltage thresholds, and energy consumption.

KEY FINDINGS

- Device achieved low switching voltages (~400 mV)—comparable to neural action potentials.
- Showed fast, stable switching and low power consumption, ideal for brain-like computing tasks.
- MoS_2's layered structure enabled efficient ion movement, enhancing performance in neuromorphic systems.



WHY IT MATTERS?

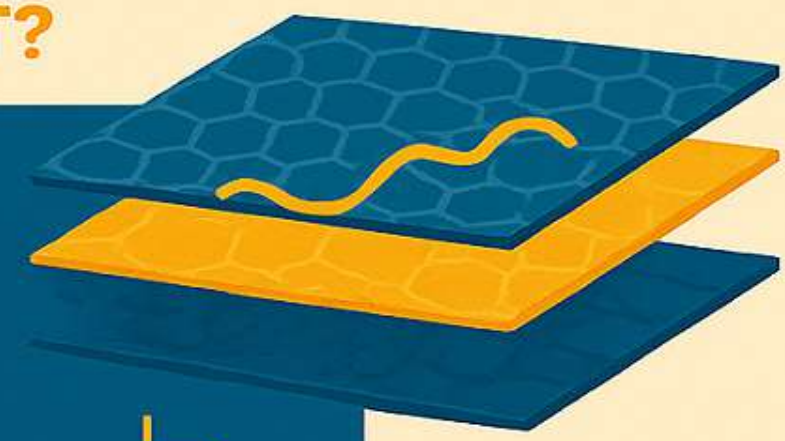
This breakthrough paves the way for next-gen neuromorphic processors that operate with minimal energy, potentially interfacing directly with biological systems and revolutionizing AI hardware design.

https://doi.org/10.1039/D4TC05295A

TERAHERTZ

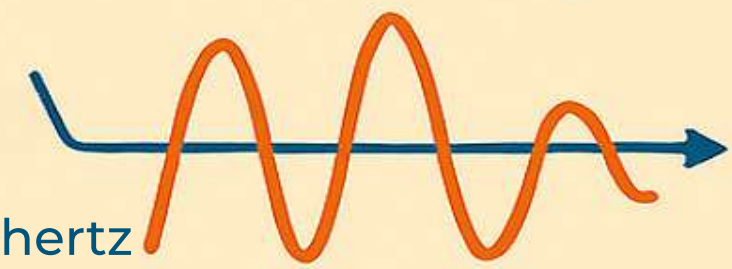
SIGNALS IN ATOM-THIN MATERIALS

WHAT'S THE STUDY ABOUT?



CSIR-NPL explored how terahertz phonons behave in van der Waals heterostructures, specifically in stacked layers of graphene and MoS_2, to advance the design of next-gen quantum optoelectronic devices.

HOW WAS THE STUDY CONDUCTED?



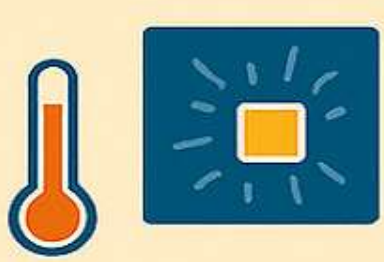
- Used optical pump–terahertz probe and terahertz time-domain spectroscopy to study charge transfer dynamics.
- Investigated temperature-dependent terahertz responses and modeled the behavior using theoretical frameworks.
- Focused on interface interactions between monolayer graphene and MoS_2 under photoexcitation.

KEY FINDINGS

- Real-time charge transfer was observed at the graphene–MoS_2 interface.
- Terahertz response varied with temperature, revealing phonon coupling behavior.
- Atomically thin stacking enables precise control of phonon dynamics in the terahertz regime.

WHY IT MATTERS

These results pave the way for engineering terahertz phonons in thermal and quantum devices, highlighting the importance of 2D heterostructures in terahertz optoelectronics.



https://doi.org/10.1002/adma.202503590

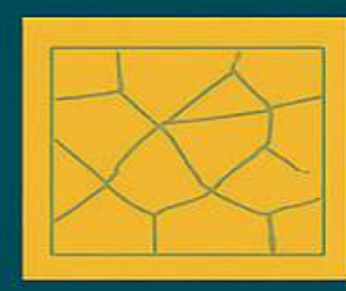
THIN FILMS FOR NO_2 GAS SENSING

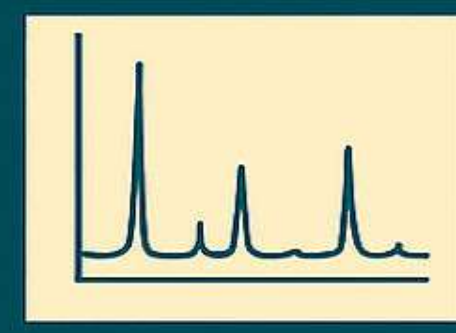
WHAT'S THE STUDY ABOUT?

CSIR-NPL investigated how thermal oxidation temperature affects the performance of WO_3 thin films in detecting nitrogen dioxide (NO_2)—a key pollutant in urban and industrial environments.

HOW WAS THE STUDY CONDUCTED?

- Synthesized WO_3 films by oxidizing 200 nm tungsten layers at temperatures between 400–700°C.
- Analyzed changes in morphology and crystallinity using electron microscopy and X-ray diffraction.
- Evaluated gas sensing performance across operating temperatures from room temperature to 200°C.





KEY FINDINGS

- Films oxidized at 600 °C showed the best response of 687% at 10 ppm NO2 with detection down to 100 ppb when operated at 100 °C.
- Higher oxidation temperature improved crystallinity, surface porosity, and oxygen adsorption.
- Sensors demonstrated strong selectivity, fast response, and good repeatability.

WHY IT MATTERS?

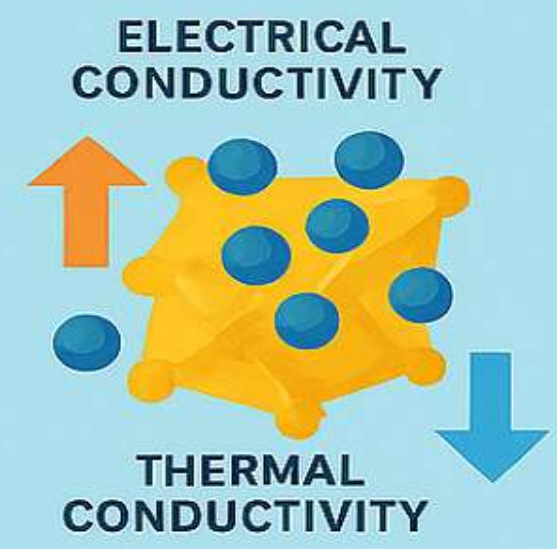
This study showcases WO_3-based sensor's ability to monitor NO_2 in real-time with high sensitivity, crucial for environmental safety and public health.

https://doi.org/10.1016/j.jallcom.2025.181706

NANO COMPOSITE APPROACH FOR IMPROVEMENT IN THERMOELECTRIC PERFORMANCE

What's the study about?

CSIR-NPL improved the thermoelectric performance of ZrNiSn alloy by adding TiO_2 nanoparticles. This approach boosted electrical conductivity and reduced thermal conductivity for better energy conversion.



How was the study conducted?

- Dispersed TiO_2 (0.0–2.5 wt. %) into ZrNiSn using controlled synthesis
- Analyzed structural changes and defect formation, including ZrO_2 and vacancies.
- Measured thermoelectric properties like conductivity and figure of merit (ZT).

Key findings

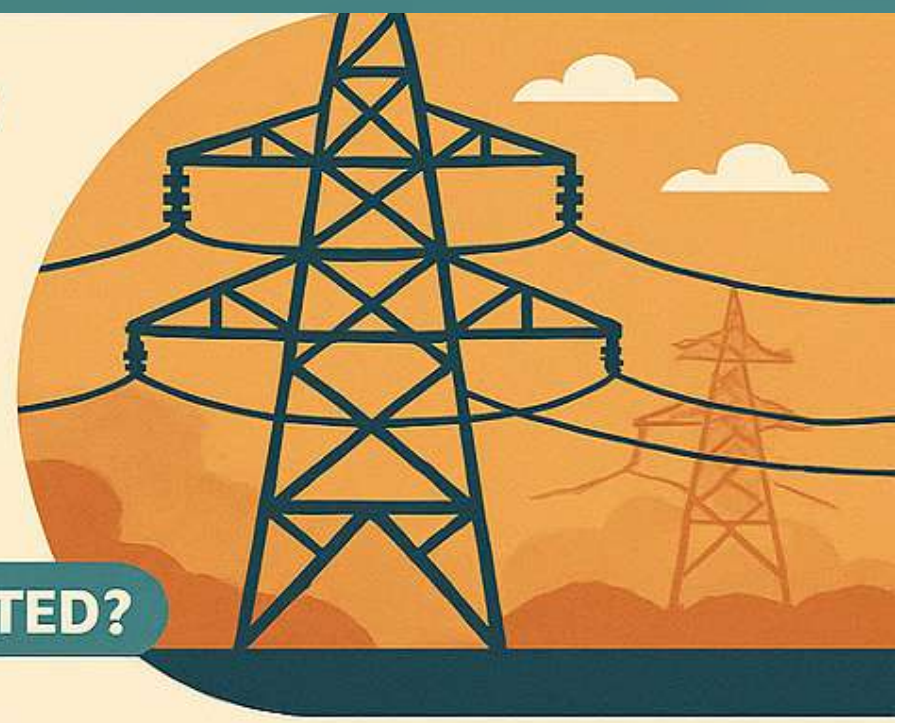
- Enhanced phonon scattering from defects led to lower thermal conductivity.
- Achieved peak ZT of ~0.73 at 775 K for 1.5 wt.% TiO_2/ZrNiSn — a ~57 % improvement.
- Balanced electrical transport with thermal suppression for optimal performance.

Why it matters?

This method can be implemented to other thermoelectric materials to make them more efficient and will boost cleaner energy technologies.

https://doi.org/10.1016/j.materresbull.2025.113369

UNDERSTANDING PREMATURE FAILURES IN TRANSMISSION LINE TOWERS



WHAT'S THE STUDY ABOUT?

This study by **CSIR-SERC** examines premature failures in transmission line (TL) towers during mandatory testing, identifying key structural weaknesses and design flaws.

HOW WAS THE STUDY CONDUCTED?

- Five failed towers were analyzed and categorized based on failure causes.
- General-purpose finite-element software was used to model these failures.
- Test results were compared with design code provisions to assess discrepancies.

KEY FINDINGS

- Improper redundant patterns and design flaws contributed to two failures.
- A mismatch between detailing and design assumptions led to one failure.
- Insufficient bolts in stitch plates and improper detailing caused two failures.

WHY IT MATTERS

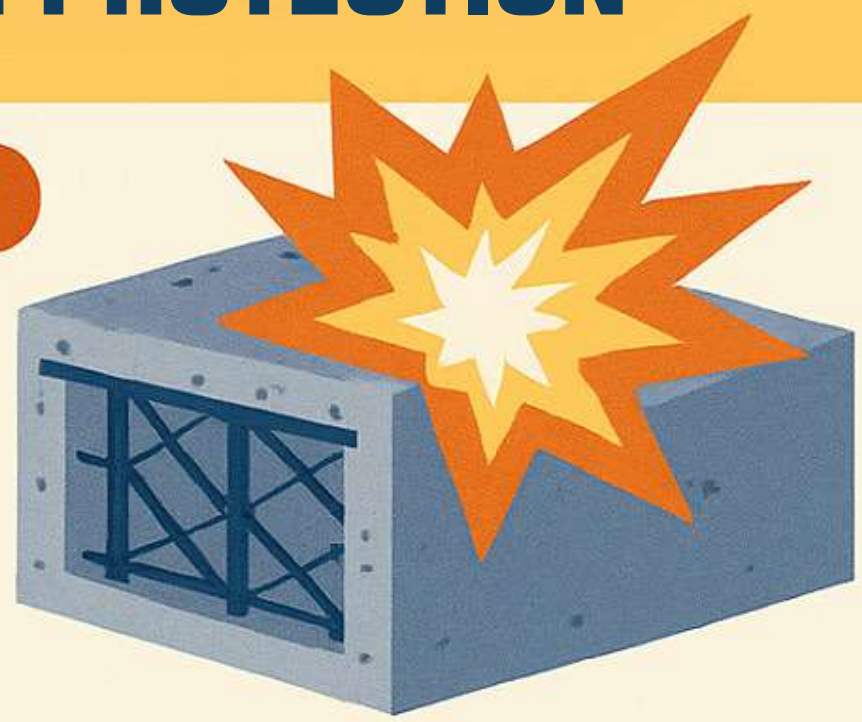
This study highlights the importance of proper detailing and secondary member design in TL towers to prevent premature failures, and ensure safer power transmission infrastructure.

https://doi.org/10.1061/JSDCCC.SCENG-1721

STRONG AND DURABLE STEEL-CONCRETE PANELS FOR BLAST PROTECTION

What's the study about?

This study by **CSIR-SERC** explores integrated Laced Steel-Concrete Composite (i-LSCC) panels, designed to improve load transfer and structural resilience in blast-resistant structures.



How was the study conducted?

- Static tests assessed panel behavior under different loading directions.
- Finite element analysis (FEA) was used to compare numerical predictions with experimental results.

Key findings

- LSCC units function cohesively, with minimal impact from loading direction.
- Support rotations at peak displacement matched target values, validating the integration scheme.
- Panels failed due to tearing of bottom cover plates under flexural loading.
- FEA closely matched experimental findings, accurately capturing local buckling behavior.

Why it matters?

This study demonstrates that i-LSCC panels offer excellent ductile performance, making them a promising solution for blast-resistant structures while enabling efficient construction

https://doi.org/10.1177/20414196251328382

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