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The 1st International Online Conference on Gels

3–5 December 2025 | Online



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3–5 December 2025
Online

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Conference on Gels

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Welcome from the Chair

Dear Colleagues,

It is my pleasure to announce **the 1st International Online Conference on Gels (IOCG 2025)**. This conference has been organized by the MDPI open access journal *Gels* (ISSN 2310-2861, Impact Factor 5.3) and will be held online from **3 to 5 December 2025**.

The conference will provide an opportunity for scientists and engineers in academia and industry to present their latest research and to participate in discussions and exchange ideas to advance the development of materials with a three-dimensional network structure. The themes of the conference include the following:

1. The supramolecular structure and properties of gels;
2. Hydrogels, organogels, xerogels, and aerogels;
3. Gels in agriculture and food;
4. Gels in medicine, regenerative medicine, pharmacy, and personal care products;
5. Gels in electro-magneto-mechanical devices, 3D printing, and manufacturing;
6. Gels in chemical processing, energy, and environment.

We would like to invite you to submit abstracts and participate in this virtual meeting of the interdisciplinary community to discuss the latest breakthroughs in fundamental science and the technology of gels, such as hierarchical and self-assembled, self-healing, colloidal, polyelectrolyte, smart and stimuli-responsive gels, and their impact on food, agriculture, environment, medicine, and energy sectors. This conference will be a celebration of the contributions of *Gels* and will feature six awards given for best oral and poster presentations at the conference.

This event will solely be an online conference, which allows for the participation of scientists from all over the world without travel limitations. Participation in this online conference is free of charge.

We look forward to your participation.



Prof. Dr. Esmail Jabbari
Conference Chair

Department of Chemical
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gels

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The journal *Gels* (ISSN 2310-2861) is an international, open access journal on physical (supramolecular) and chemical gel-based materials. Our aim is to encourage scientists to publish their experimental and theoretical results in as much detail as possible. Therefore, there is no restriction on the maximum length of the papers, and full experimental details must be provided so that the results can be reproduced. Short communications, full research papers and review papers are accepted formats for the preparation of the manuscripts.

Gels aims to serve as a reference journal with a focus on gel materials for researchers working in both academia and industry. Therefore, papers demonstrating practical applications of these materials are particularly welcome. Occasionally, invited contributions (*i.e.*, original research and review articles) on emerging issues and high-tech applications of gels are published as special issues.

Impact Factor: 5.3 (2024); **5-Year Impact Factor:** 5.4 (2024)

Session Chairs



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Program at a Glance

	Day 1	Day 2	Day 3
Morning	Session 6. Gels in chemical processing, energy, and environment	Session 1. The supramolecular structure and properties of gel	Session 4. Gels in medicine, regenerative medicine, pharmacy, and personal care products
Afternoon	Session 5. Gels in electro-magneto-mechanical devices, 3D printing, and manufacturing Flash Poster Session	Session 2. Hydrogels, organogels, xerogels, and aerogels	Session 3. Gels in agriculture and food

IOCG 2025 Program

3th December 2025 (Wednesday)

Session 6. Gels in Chemical Processing, Energy, and Environment

Time: 9:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)

CET Time	Speaker	Title
9:00–9:05	<i>Prof. Dr. Esmail Jabbari</i> <i>Welcome from the Event Chair</i>	
9:05–9:10	<i>Prof. Dr. Annarosa Gugliuzza</i> <i>Welcome from the Session Chair</i>	
9:10–9:35	Prof. David Chelazzi Keynote Speaker	Innovative and sustainable gels for the preservation of works of art
9:35–10:00	Prof. David Díaz Díaz Keynote Speaker	Gels and catalysis: A marriage of convenience
10:00–10:20	Dr. Giulia Rando Invited Speaker	Bio-based Gels and Sol-Gel Coatings Embedding Natural Functional Compounds for Circular Manufacturing in Textile Sector
10:20–10:40	Dr. Silvia Sfameni Invited Speaker	Smart Gels and Functional Hybrid Nanomaterials for Environmental Monitoring and Remediation
10:40–10:55	Andrea Ravicini Selected Speaker	Zein-Derived Polymer Gels: Design of Crosslinked Networks for Sustainable Soft Materials
10:55–11:10	Andra-Cristina Enache Selected Speaker	From Ionotropic Gelation of Chitosan to Reusable Magnetic Sorbents for Wastewater Treatment
11:10–11:25	Alberto Alejandro Pujol Pozo Selected Speaker	Polysaccharide-based decontamination gels for the radioactive decontamination of metal parts within radioactive waste management

Session 5. Gels in electro-magneto-mechanical devices, 3D printing, and manufacturing

Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)

CET Time	Speaker	Title
14:00–14:10	<i>Dr. Vincenzo Guarino</i> <i>Welcome from the Session Chair</i>	
14:10–14:40	Prof. Dr. Aldo Boccaccini Plenary Speaker	Design and Characterization of Nanoparticle and Ion Loaded Hydrogels for Biofabrication
14:40–15:00	Dr. Teresa Russo Invited Speaker	Shaping the future of regenerative medicine: Injectable magnetic gels and 3D Printing strategies toward next generation of bioinspired devices.
15:00–15:15	Giovanni Lo Bello Selected Speaker	Tunable Hydrogel Platforms to Mimic Breast Cancer Microenvironments via 3D Bioprinting
15:15–15:30	Emanuele Mauri Selected Speaker	3D printed hierarchical hydrogel-nanogel scaffolds for controlled delivery of nonsteroidal anti-inflammatory drugs
15:30–15:45	Nergis Zeynep Renkler Selected Speaker	Optimization of cross-linked PVA functionalization with pani: in situ strategies to design electro-conductive fibrous platforms for brain applications
	FLASH POSTER SESSION	
15:45–15:50	Konstantina Zampouni Poster Presenter	Microstructural, textural and rheological properties of edible bigels designed for 3D food printing
15:50–15:55	Abhishek Tyagi Poster Presenter	Synthesis of advanced Biopolymers through Chemo-selective Approach for Enhanced Oil Recovery from Non-producing Reservoirs
15:55–16:00	Nainsi Chauhan Poster Presenter	Design a novel biodegradable hydrogel scaffold for cultured meat production
16:00–16:05	Ana Isabel Ribeiro Poster Presenter	Development of chitosan-pectin hydrogels for controlled drug release

16:05–16:10	Debora Mondini Poster Presenter	Formulation strategies for pharmaceutical use of pNIPAM microgel
16:10–16:15	Hongji Zhang Poster Presenter	Boosting engineered cartilage formation with recombinant spider silk
16:15–16:20	Annu Yadav Poster Presenter	Recent Advancements in Gel Materials for Green Chemical Processes, Clean
16:20–16:25	Astha Vishwakarma Poster Presenter	Time optimized genipin chitosan aerogels for catalytic applications
16:25–16:30	Monica Raduly Poster Presenter	Bioactive sol-gel coatings obtained by network embedding of phytosynthesized selenium nanoparticles
16:30–16:35	Markus Fabian Lorke Poster Presenter	Tailoring in situ-crosslinked oxidized hyaluronic acid-based hydrogels for soft tissue engineering
16:35–16:40	Ana Valeria Torres-Figueroa Poster Presenter	Humic Acid-Enriched Biopolymer Hydrogels: Water Retention, Biodegradation, and Sorghum Growth
16:40–16:45	Zuemy Hernández-Nolasco Poster Presenter	Novel food-grade bigels structured with wax from the native stingless bee (<i>Scaptotrigona mexicana</i>) and canola oil

4th December 2025 (Thursday)**Session 1. The Supramolecular Structure and Properties of Gel****Time: 9:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
9:00–9:10	<i>Dr. Paula M.T. Ferreira</i> <i>Welcome from the Session Chair</i>	
9:10–9:40	Prof. Srinivasa R. Raghavan Plenary Speaker	How to Stick Gels to Metals as well as Biological Tissues
9:40–10:10	Prof. Saad Khan Plenary Speaker	Nanodiamond-containing Polymer Hydrogels with pH-tunable Rheology and Tribology for UV Protection
10:10–10:30	Dr. Carlo Diaferia Invited Speaker	Low molecular weight peptide-based formulations: from hydrogels to nanogels
10:30–10:45	Alessia Pepe Selected Speaker	Guanosine hydrogels for tissue regeneration: stability and mechanical properties
10:45–11:00	Carmen Cara-Galdeano Selected Speaker	Surface characterisation of thermoresponsive microgels based on oligo(ethylene glycol): adsorption kinetics, dilatational rheology and monolayers
11:00–11:15	Guillaume Pickaert Selected Speaker	From Ionotropic Gelation of Chitosan to Reusable Magnetic Sorbents for Wastewater Treatment
11:15–11:30	Loic Stefan Selected Speaker	Multicomponent nucleopeptide-based hydrogels: from complexity to tunability and potential
11:30–11:45	Franco Maslovski Selected Speaker	Ascorbyl Palmitate Coagels (Coa-ASC16 PEG): Easy-to-Prepare Delivery Systems with Optimal Rheology for Controlled Release

Session 2. Hydrogels, organogels, xerogels, and aerogels**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
14:00–14:10	<i>Prof. Dr. Sidi A. Bencherif</i> <i>Prof. Dr. Andrea Zille</i> <i>Welcome from the Session Chairs</i>	
14:10–14:30	Prof. Alberto Saiani Invited Speaker	Designing self-assembling peptide-based hydrogels for biomedical applications
14:30–14:50	Dr. Philippe Mésini Invited Speaker	Polymorphism in Organogels and Oleogels: Impact on Gel Properties and Phase Behavior
14:50–15:10	Dr. Paola Petrini Invited Speaker	Hydrogels and bacterial: an open crosstalk
15:10–15:30	Prof. Jonathan Dawson Invited Speaker	Nanoclay gels for delivery of regenerative microenvironments
15:30–15:45	Ana-Iglesias Mejuto Selected Speaker	Cellulose-in-cellulose 3D-printed hydrogels and aerogels for soft tissue engineering
15:45–16:00	Gloria Nicastro Selected Speaker	Hydrophobic Eutectics-based Supramolecular Gels and Cellulose-based Nanosponges: Breakthrough Solutions for Water Remediation
16:00–16:15	Mirko D'Urso Selected Speaker	Light-Crafted Landscapes: Maskless Photosculpting of Hydrogels
16:15–16:30	Pietro Tordi Selected Speaker	Soft, Stretchable, and Smart: Alginate/Gelatin Organohydrogels for Wearable Electronics

5th December 2025 (Friday)**Session 4. Gels in medicine, regenerative medicine, pharmacy, and personal care products****Time: 9:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
9:00–9:10	<i>Dr. Aline F. Miller</i> <i>Prof. Dr. Dirk Kuckling</i> <i>Welcome from the Session Chairs</i>	
9:10–9:35	Prof. Dr. Rita Cortesi Keynote Speaker	Topical nanogels in medicine and cosmetics: an overview
9:35–9:55	Dr. Luca Fiorillo Invited Speaker	Efficacy of Essential Oil Biogels in the Surgical Healing of Oral Soft Tissue
9:55–10:10	Vinny George Selected Speaker	Surface-Localised Photosensitizer Nanocomposite Hydrogels for Photodynamic Inactivation
10:10–10:25	Marianna Roca Selected Speaker	Advancing Nanomaterial Immunomodulation with Engineered ECM-Mimicking Matrices
10:25–10:40	Guillermo Conejo-Cuevas Selected Speaker	Optimized enzyme matrices for 3D-printed microneedle biosensors
10:40–10:55	Nicholas A. Kurniawan Selected Speaker	A cytocompatible photoresponsive hydrogel to study cell response to dynamic topographies
10:55–11:10	Zoe Giorgi Selected Speaker	Electroconductive hydrogels for spinal cord regeneration
11:10–11:25	Almudena Moreno-Borralló Selected Speaker	Redox-Responsive Boronic Acid-Based Hydrogel for Controlled Drug Delivery and Theranostic Applications
11:25–11:40	Andreea Luiza Mîrț Selected Speaker	Multifunctional ADA-GEL hydrogels reinforced with iron loaded dendritic bioactive glass nanoparticles for bone regeneration

Session 3. Gels in Agriculture and Food**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
14:00–14:10	<i>Prof. Dr. Alfonso-Trujillo-Cayado</i> <i>Welcome from the Session Chair</i>	
14:10–14:40	Prof. Dr. Esmail Jabbari Plenary Speaker	Hydrogels in the production of in vitro cell-based cultured meat in food industry
14:40–15:05	Dr. Maria Rosaria Plutino Keynote Speaker	Advanced Hybrid gel-based Materials for Precision Agriculture: A New Frontier in Sustainable Innovation
15:05–15:25	Prof. Dr. Saphwan Al-Assaf Invited Speaker	Hydrocolloids gels: properties quality and applications
15:25–15:45	Dr. Eduardo Costa Invited Speaker	Perspectives into the use of bigels for nutraceutical applications
15:45–16:00	Carmen M^a Granados-Carrera Selected Speaker	Chitosan- alginate-based hydrogels for agricultural and horticultural applications
16:00–16:15	Filippo Rossi Selected Speaker	Innovative agriculture: bicontinuous structures as delivery systems for fertilizers and pesticides
16:15–16:30	Zoha Ali Selected Speaker	Characterization of mozzarella cheese analogue with reduced saturated fats using soybean oil and beeswax oleogels
16:30–16:40	Prof. Dr. Esmail Jabbari Conference Chair	Closing Speech

Session 1. The Supramolecular Structure and Properties of Gels

sciforum-147997: Ascorbyl Palmitate Coagels (Coa-ASC16_{PEG}): Easy-to-Prepare Delivery Systems with Optimal Rheology for Controlled Release

Franco Maslovski ^{1,*}, Sofía Brignone ², Bruno Barrientos ^{3,4}, Santiago Palma ^{3,4}, Belkys Maletto ^{5,6}, Laura Leiva ^{1,7}, Luciano Fusco ^{1,7}

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Introduction: Hydrogels have received increasing attention as versatile platforms for bioactive compounds delivery, due to their viscoelasticity, injectability, and to provide sustained release. Among them, systems based on ascorbyl palmitate (ASC16) have exhibited shear-thinning behavior, biocompatibility, and the ability to form stable coagels, although their preparation requires relatively high formulation temperatures. It is known that the incorporation of polyethylene glycol 400 (PEG₄₀₀) significantly lowers the critical micelle temperature, enhancing their potential for biomedical applications.

Objective: This study aimed to develop and characterise an ASC16 coagel (Coa-ASC16) in PEG₄₀₀ (Coa-ASC16_{PEG}) through a novel formulation procedure, distinct from previously reported methods, as a low-cost and easy-to-prepare matrix for the encapsulation and controlled release of biomolecules, using ophidian venom proteins (OVP) as a model.

Methods: The Coa-ASC16_{PEG} was prepared at 2.5% (w/v) using a mixture of PEG₄₀₀ and water in a 4:1 ratio. ASC16 was dissolved in PEG₄₀₀ in glass tubes and heated to 64 °C until complete solubilization was achieved (≤ 2 minutes). The mixture was then cooled to 40 °C and allowed to reach thermal equilibrium, after which OVP dissolved in water were added and mixed for 10 seconds (Coa-ASC16_{PEG/OVP}). The formulation was characterized using dynamic rotational rheology tests, a three-interval thixotropy test (3ITT), encapsulation efficiency measurements, and *in vitro* release assays.

Results: Coa-ASC16_{PEG/OVP} demonstrated high encapsulation efficiency ($96.42 \pm 1.06\%$), retained stability under protein overload, and enabled a sustained release of OVP over time ($23.41 \pm 6.12\%$ at 360 minutes). Rheological analyses confirmed its viscoelastic behavior, while 3ITT revealed a robust capacity to recover the original viscosity following mechanical stress.

Conclusions: Coa-ASC16_{PEG} represents a simple, low-cost platform with favorable rheological properties and high protein loading capacity. Its ability to withstand mechanical stress while providing sustained release highlights its potential as a controlled-release system for biomolecules, with potential applications in biomedical research.



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sciforum-148218: Gelation of solvents with amphiphilic amino-acid derivatives: Use of molecular spectroscopy to elucidate self-assembly process

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Molecular gels are materials that have been growing in popularity over the last twenty years. In addition to their potential applications in cosmetics, pharmacology, cell culture, and catalysis [1], their intrinsic physicochemical properties make them fascinating objects of study. The gelator used are low molecular weight molecules (less than 2000 g mol⁻¹) capable of self-assembling via weak interactions to generate a fiber-like three-dimensional solid network, in which solvent molecules are trapped [1,2]. Changes to the chemical structure of gelators, as well as the nature of the solvent to be immobilized can induce spectacular changes in the mechanical properties of the final gel. Thus, they are crucial parameters to consider during the various stages of the sequential self-assembly process, particularly during the first one: nucleation. These molecular gels can be viewed as crystallizations that have gone wrong. Instead of having well-defined crystals, crystallization occurs randomly throughout the entire volume of solvent. This raises the following question: What is the real impact of the chemical structure of gelling agents, and the resulting intermolecular interactions, on the macroscopic properties of the materials obtained?

In our group, we work on amphiphilic amino acids (leucine, phenylalanine, and lysine [3]) based gelators. Those molecules bear an alkyl chain of different length at the N-terminal extremity and a carboxylic acid or derivatives (ester, hydrazide...) at the C-terminal extremity. With these gelators, we can immobilise, among a wide range of various fluids, alkanes, DMSO/water mixtures or oils. Using molecular analysis techniques, such as FT-IR and NMR, we examine the behaviour of gelling agents at the molecular level in different solvents.

Reference

1. Raeburn, J.; Adams, D. *ChemComm.* **2013**, *51*, 5170–5171.
2. Collin, D.; Covis, R.; Allix, F.; Jamart-Gregoire, B.; Martinoty, P. Jamming transition in solutions containing organogelator molecules of amino-acid type: rheological and calorimetry experiments. *Soft Matter.* **2013**, *9*, 2947–2958.
3. Rangel Euzcateguy, G.; Parajua-Sejil, C.; Marchal, P.; Chapron, D.; Averlant-Petit, M.-C.; Stefan, L.; Pickaert, G.; Durand, A. *Polym. Int.* **2021**, *70*, 256–268.



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sciforum-142827: Guanosine hydrogels for tissue regeneration: stability and mechanical properties

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It is well known that guanosine hydrogel (G-hydrogel) is a supramolecular and physical biomaterial, composed of guanine derivatives, such as guanosine (Gua) and guanosine 5'-monophosphate (GMP). These molecules self-assemble, first forming the planar tetrameric structures called G-quartets, and then the G-quadruplexes through pi-pi stacking interactions [1,2]. The balance between the negatively charged GMP and the uncharged Gua gives rise to the formation of a hydrogel with a water concentration of up to 99% v/v, which appears transparent and stable at room temperature. The wide range of fields in which the G-hydrogel may find applications is remarkable. Indeed, we demonstrated its use as a molecular filter for pollutant remediation, as a drug delivery system, but also in tissue engineering. Regarding this point, the G-hydrogel can be used as a scaffold for cell growth. In this regard, modulating the chemical-physics properties is essential not only to avoid the dissolution of the hydrogel within the cell medium but also to ensure the formation of spheroids [3].

We report a systematic structural and rheological characterization of G-hydrogels prepared under different conditions. The chosen hydrogel composition has a molar ratio Gua/GMP 1:1 and 90% water. Moreover, samples were formulated by varying the concentration of additives that act as stabilisers of the 3D network, such as spermine, spermidine, MgCl₂ and glycerol. Samples were analyzed using rheology, dynamic light scattering (DLS), X-ray diffraction (XRD) and small-angle X-ray scattering (SAXS). Swelling behaviour and transition temperatures were also evaluated. The combined data provide insight into how different additives modulate gel viscosity, stiffness, internal structure, elasticity, and thermal response, contributing to the rational design of tunable guanosine-based soft materials for biotechnological applications, such as tissue engineering.

Reference

1. Carducci, F.; et al. *Soft Matter* **2018**.
2. Pepe, A.; et al. *Nanoscale* **2023**.
3. Pepe, A.; et al. *J. Phys. Chem. B* **2025**.



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sciforum-141870: Low molecular weight peptide-based formulations: from hydrogels to nanogels

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Peptide-based supramolecular low-molecular-weight gelators have emerged as promising materials across various fields, including healthcare, cosmetics, and bioanalysis. Their advance highlights the increasing importance of gels as foundational elements and tools in next-generation technologies. Advances in the structural, functional, and production-related aspects of peptide-based gels – combined with their biocompatibility, responsiveness to chemical modifications, and suitability for rational *de novo* design – are accelerating their adoption in pharmaceutical science, too. Among recent innovations, peptide-based nanogels have gained particular interest. These injectable, nanoscale objects are closely related to hydrogels organization in their core and are stabilized by a surfactant shell. Formulated using self-assembling ultrashort peptides (e.g. Fmoc-FF), they are produced through a refined top-down approach that enables precise control over particle characteristics. This optimized methodology has positioned peptide nanogels as versatile platforms for expanding the scope of gel-based applications. These formulations have demonstrated an ability to encapsulate a wide range of active pharmaceutical ingredients (APIs), such as doxorubicin, dexamethasone, short interfering RNA (siRNA), gadolinium-based contrast agents, and chemical exchange saturation transfer (CEST) agents. Their colloidal stability, capacity for drug inclusion, controlled release profiles, and selective targeting potential underline their functionality in therapeutic and diagnostic contexts. Overall, peptide-based nanogels represent a significant advance in the formulation of responsive, biocompatible delivery systems, offering new possibilities in targeted drug delivery and biomedical imaging.



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sciforum-148195: Minimalistic Tryptophan-Based Supramolecular Hydrogel as a Versatile Catalytic Scaffold

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Single amino acids and their derivatives possess a remarkable propensity to self-assemble into ordered nanostructures that can exhibit catalytic functions [1,2]. Although there are numerous instances of catalysis using peptide nanostructures inspired by amyloid fibres [3,4], hydrogel-based catalysts produced from a single amino acid are few. In this study, we demonstrate the self-assembly of N-fluorenylmethyloxycarbonyl-L-tryptophan (FT) into a nanofibrous hydrogel capable of catalyzing the hydrolysis of p-nitrophenyl acetate. The FT hydrogel exhibits pathway complexity, progressing from kinetically trapped nanofibers to thermodynamically stable semicrystalline aggregates with improved catalytic efficiency, as evidenced by comparative studies with the monomers and the gel fibers⁵. Functional attributes were further improved by nanoengineering the FT network with graphene oxide and graphene quantum dots, yielding composites with enhanced mechanical strength and enzyme-like hydrolase activity, supported by Michaelis-Menten kinetic analysis. Furthermore, in situ reduction of Au³⁺ within the FT gel scaffold produced AuNPs without external reducing agents, leveraging the reductive capability of the indole moiety. This FT/AuNPs nanohybrid gel enables rapid reductive degradation of both cationic and anionic dyes in aqueous media. For enhanced handling and practical applications, we fabricated alginate-supported FT/AuNPs core-shell hydrogel beads, which retained structural integrity and high catalytic efficiency, achieving more than 90% dye removal with a single 20 µL bead [5]. Altogether, this showcases the potential of single amino acid-derived self-assembled hydrogels/semicrystalline aggregates and their nanohybrids as effective, tunable, and sustainable catalytic systems for both synthetic and environmental applications.

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sciforum-148155: Multicomponent nucleopeptide-based hydrogels: from complexity to tunability and potential

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While most hydrogels are traditionally formed from polymers, biomolecules can also undergo gelation, as exemplified by proteins (e.g., collagen), enabling numerous applications. Peptide-based low-molecular-weight hydrogels (LMWHs), composed of amino acids, have emerged as innovative materials with broad biomedical and biotechnological potential, attracting commercial interest in the 2010s [1]. However, natural peptides composed solely of proteinogenic amino acids present several limitations, requiring structural or chemical modifications to enhance their performance [2]. In parallel, multicomponent approaches, which combine multiple building blocks to form hydrogels, have recently gained prominence as a promising strategy for developing more versatile and efficient systems [3].

In this context, we explore emerging hybrid molecules—peptides functionalized with DNA bases (adenine (A), thymine (T), guanine (G), and cytosine (C))—known as nucleopeptides. These compounds have shown encouraging results, yet much remains to be explored to unlock their full potential [4]. We designed and investigated innovative multicomponent nucleopeptide-based hydrogels, functionalized with one or two DNA nucleobases *via* peptide nucleic acid (PNA) moieties to enhance stability and supramolecular assembly. Recently, two series were studied: ^{PNA}[TG]-FEFK/^{PNA}[AC]-FEFK [5] and ^{PNA}[T or C]-FEFE/^{PNA}[A or G]-FKFK [6], the latter exploiting electrostatic complementarity between peptide segments. Using a systematic multi-scale approach, we evaluated the influence of charge and/or nucleobase-pair complementarity on gelation kinetics, thermal stability, stiffness, stress resistance, network morphology, and intermolecular interactions. Our results demonstrate that careful component selection enables fine-tuning of hydrogel properties, yielding highly stiff materials (storage modulus > 1 MPa). Unexpected behaviors were also observed, underscoring the complexity of these hybrid systems and reinforcing their potential for the development of high-performance supramolecular hydrogels.

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sciforum-141559: Structural properties of supramolecular metallogel derived from vanadium and hydrazone ligand: Metallogelation triggered by hydrogen bonding, pi-pi-interactions and other non-covalent interactions

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An approach to develop a facile strategy for the synthesis and characterization a new vanadium-metallogels was developed. In this study, vanadium was selected for the current investigation because only few vanadium-based gels have been reported in the literature. The gelation experiments were carried out successfully using vanadium acetylacetonate and hydrazone ligand in different solvents. The metallogel shows excellent gelation ability with 1.7 wt% minimum gelator concentrations and the gel-sol dissociation temperature, T_{gel} is 55 °C (water/methanol). The viscous and elastic characteristics of gel materials were also studied and the strength of the metallogel was characterized by storage (G') and loss modulus (G''). It was found that the storage modulus (G') value was significantly larger compare to loss modulus (G'') value, which confirmed the gel nature of the material. The structural properties of the metallogel were studied by using single crystal x-rays crystallography. The crystal structure data analysis of the metallogel shows the presence of various interactions such as hydrogen bonding, pi-pi-interactions, pnictogens bonding and other weak non-covalent interactions which stabilised the structure of the metallogels. The present of various intra and intermolecular interactions significantly influence the behaviour and properties of the metallogels. These intermolecular interactions play an important role for gel formation and affect the properties like swelling behaviour, viscosity and elasticity.



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sciforum-148294: Supramolecular gels and its modification for electrochemical application

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Supramolecular gels with tailored optoelectronic behavior are of increasing interest for applications in soft electronics, sensing, and energy-related devices. In this study, we examined the donor–acceptor interactions of three aromatic amine donors 2-aminoanthracene, 1-aminopyrene, and 2-aminonaphthalene, with diphenylalanine as the acceptor in both solution and gel phases. In solution, molar ratio studies revealed that the 2-aminoanthracene–diphenylalanine system displayed the strongest charge-transfer interaction, evident from a pronounced color change within 24 hours. The pyrene and naphthalene systems showed weaker responses under identical conditions. By increasing the gelator concentration, stable supramolecular gels were obtained, where similar charge-transfer trends were observed. Anthracene–diphenylalanine gels exhibited the fastest and most prominent optical and spectroscopic changes, followed by pyrene and then naphthalene. The mechanical strength of the gels was evaluated, and structural characterization by PXRD, FTIR, TEM, and fluorescence microscopy confirmed the presence of crystalline fibrous networks across all systems. Conductivity and photocurrent measurements further demonstrated that anthracene–diphenylalanine gels possessed superior electronic performance compared to the other donor–acceptor assemblies. To further enhance the functional properties, nanomaterials such as graphene oxide (GO), graphene quantum dots (GQD), and carbon nanotubes (CNT) were incorporated into the gels. Notably, CNT-doped gels exhibited the most significant improvements, showing enhanced conductivity and electron storage capacity. This enhancement is attributed to improved charge delocalization and the creation of efficient transport pathways within the fibrous matrix.

In summary, this work establishes diphenylalanine based donor–acceptor gels, particularly those incorporating 2-aminoanthracene, as versatile materials with promising optoelectronic features. The incorporation of CNT provides a simple yet effective strategy to boost conductivity and energy-storage performance, opening new opportunities for developing soft, hybrid materials for advanced electronic and energy applications.



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sciforum-148261: Supramolecularly Reinforced Hydrogel Scaffolds for Advanced Tissue Engineering

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The regeneration of articular cartilage is hindered by the absence of intrinsic repair mechanisms and the lack of scaffolds that integrate both biochemical functionality and mechanical resilience. Conventional hydrogels capture certain aspects of the native niche yet remain limited by weak supramolecular cohesion and insufficient load-bearing capacity. To overcome these barriers, a hybrid hydrogel was engineered by coupling decellularized cartilage extracellular matrix (dECM) with the self-assembling peptide: fluorenylmethoxycarbonyl-modified amino acids (Fmoc-xx). Hydrogels derived from dECM retain native proteins and signaling motifs but typically collapse under physiological stresses, restricting their therapeutic value. While dECM offers native adhesion sites and instructive biochemical cues, Fmoc-xx nanofibers form a supramolecular framework that interpenetrates ECM macromolecules through hydrogen bonding and aromatic π - π stacking. These cooperative interactions generate a hierarchically organized network that transforms the mechanically fragile dECM hydrogel into a resilient, load-bearing construct. This molecular reinforcement elevated the storage modulus by nearly three orders (~1000 fold increase) of magnitude while preserving hydration and network stability. Furthermore, the hybrid scaffold provided a cell-compatible niche that enabled rapid chondrocyte adhesion as well as sustained proliferation. The hybrid hydrogel could maintain the chondrogenic phenotype, underscoring the synergy between structural resilience and biological fidelity. By uniting supramolecular self-assembly with native matrix bioactivity, this work advances a materials strategy that converts fragile dECM gels into robust, functional scaffolds. Such reinforced hydrogels do not merely mimic tissue microenvironments but actively integrate strength with bioactivity, positioning them as next-generation platforms for cartilage regeneration and broader tissue engineering applications.



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sciforum-147792: Surface characterisation of thermoresponsive microgels based on oligo(ethylene glycol): adsorption kinetics, dilatational rheology and monolayers.

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Introduction: Biocompatible microgels based on oligo(ethylene glycol) (OEG-based microgels) represent a new generation of microgels designed for biomedical applications. OEG-based microgels undergo swelling or collapse in bulk in response to external stimuli such as temperature or pH. Gaining a deeper understanding of the surface properties of OEG-based microgels is essential for the proper development of stimuli-responsive emulsions and foams.

Methodology: Combination of colloidal and surface experimental techniques; hydrodynamic diameter, electrokinetics, analysis of Langmuir and Gibbs monolayers with Atomic Force Microscopy and dilatational rheology in linear and non-linear regime provide new insights into the surface conformation of OEG-based microgels.

Results: Swelling and electrokinetic response of OEG-based microgels are initially examined as a function of pH and temperature to establish the Volume Phase Transition Temperature (VPTT) at various pHs. Langmuir monolayers of OEG-based microgels show a "fried-egg" structure typical of thermoresponsive microgels, below and above the VPTT, exhibiting similar surface coverage but protruding slightly further into the subphase in collapsed state. Gibbs monolayers of OEG-based microgels reveal that collapsed OEG-based microgels diffuse and adsorb faster onto the surface but rearrange similarly to swollen OEG-based microgels. Finally, the slightly greater protrusion of collapsed OEG-based microgels ultimately determines their dilatational behavior in both linear and nonlinear regimes.

Conclusions: Surface conformation of OEG-based microgels show very subtle stimuli responsiveness, which in principle, should not compromise their use as emulsion stabilizers. However, they may need to be considered for fine applications of OEG-based microgels as stabilizers in the rational development of stimuli-responsive foams and emulsions.



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sciforum-147625: The Spectral Viscoelasticity of Gels, Fast and Slow

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Gels uniquely combine elasticity and viscosity, making them effective for damping, impact absorption, and noise control. In adhesives, this duality provides both structural strength and vibration management. Viscoelastic behavior arises from two contributions: permanent elasticity, described by the equilibrium modulus G_0 , and a spectrum of transient relaxation modes (eigenmodes) with relaxation times that range from milliseconds to a longest relaxation time $\tau_{\max}$ extending hours or longer. The fast/slow interplay of eigenmodes governs applications of viscoelastic materials yet often remains obscured in classical rheology. We address this limitation with the **SCOPE framework** (Spectral Characterization of Process and Eigenmodes). To each eigenmode, SCOPE assigns a spectral Deborah function D and spectral Weissenberg function W , which provide natural, physically transparent criteria for gel classification. T

The **Deborah function** (Winter, Rheologica Acta 2025) compares an eigenmode's relaxation time with the characteristic timescales of a process. When $D < 1$, the eigenmode relaxes before the process is completed, giving rise to a predominantly viscous response. When $D > 1$, relaxation is incomplete, and the eigenmode contributes predominantly to elastic behavior.

The **Weissenberg function**, by contrast, spectroscopically measures the strain accumulated during a relaxation time τ . It quantifies how much deformation an eigenmode “remembers” before relaxing. For $W > 1$, deformation grows more rapidly than relaxation can erase memory, separating eigenmodes that generate secondary flow effects (e.g., rod climbing in shear, strain hardening in extension) from those that do not. In addition, W provides a **spectroscopic criterion for the onset of nonlinearity**: when W exceeds a critical strain γ_c the specific eigenmode leaves the linear regime. The condition $W/\gamma_c = 1$ therefore marks the threshold between linear and nonlinear eigenmodes.

Interactions of G_0 , D , and W within SCOPE offer complementary spectroscopic perspectives on gel behavior. This will be demonstrated using IRIS Rheo-Hub, a machine learning tool for rheology data analysis, modeling, and visualization.



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Session 2. Hydrogels, Organogels, Xerogels, and Aerogels

sciforum-141661: Development of a Janus Nanocomposite Hydrogel Based on Lignin and Polyelectrolyte sIPN for Enhanced Wastewater Treatment via Interfacial Solar Steam Generation

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Introduction:

This study aims to develop a multifunctional Janus hydrogel composed of lignin, fumed silica nanoparticles, and a polyelectrolyte semi-interpenetrating network (sIPN) for interfacial solar steam generation (ISSG) and ion-exchange-based wastewater treatment. Addressing salt fouling and low contaminant removal efficiency in current ISSG systems, the proposed Janus hydrogel integrates both hydrophilic and hydrophobic domains to optimize water transport, evaporation, and contaminant rejection.

Methods:

The Janus hydrogel was synthesized by integrating lignin as a bio-based functional filler and fumed silica as a nanostructured backbone into an sIPN composed of partially neutralized acrylic acid. The hydrophilic layer was designed using covalently crosslinked polyelectrolytes rich in carboxyl and hydroxyl groups, while the opposing hydrophobic layer was fabricated by surface-modifying fumed silica using long-chain alkyl silanes. The Janus interface was formed via controlled casting to ensure a stable interface between the two layers. Characterization techniques included FTIR, SEM, AFM, swelling ratio, ion-exchange capacity, and water evaporation efficiency under simulated solar irradiation.

Results:

The hydrogel demonstrated a swelling capacity exceeding 1000%, an ion-exchange capacity of 3.1 mmol/g, and over 90% heavy metal ion removal efficiency. The Janus structure enabled directional water transport and minimized salt accumulation at the surface. Solar steam generation efficiency reached 87% under 1 sun, with stable performance in saline and heavy-metal-contaminated wastewater.

Conclusions:

This novel Janus nanocomposite hydrogel offers a promising platform for sustainable wastewater treatment by combining lignin's functional versatility, silica's structural reinforcement, and the sIPN's tunable transport properties. The approach supports efficient and eco-friendly water purification using solar energy, aligned with global water sustainability goals.



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sciforum-148337: Structural, Textural, and Rheological Attributes of Emulgels for Cocoa Butter Replacement

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Cocoa butter is an essential component in chocolate production, contributing to its texture, crystallization, and sensory attributes. However, its fatty composition and high production costs, sustainability concerns, and health issues have led to the search for alternatives to partially replace this fat. Understanding the rheological and textural characteristics of cocoa butter is essential to ensure the stability of the final product. This research aimed to evaluate the structural, rheological and textural attributes of emulgels for partial cocoa butter substitution in chocolate production. A total of nine distinct emulgels were created using coconut oil, high oleic sunflower oil, rice bran wax, and monoglycerides as the foundational components of the formulations. These were combined with hydrocolloids, including pectin (P), gelatin (G), or xanthan gum (X), at concentrations of 1%, 2%, and 3% in the aqueous phase, maintaining a ratio of 8:2 (v/v). Analyses such as rheology, texture, and visual were performed. The visual analysis revealed a homogeneous, solid-like material with no signs of phase separation in all samples. The microscopy analyses confirmed that the samples presented well-formed crystalline networks with small homogeneous crystals. Emulsions containing G exhibited higher viscoelasticity compared to those containing P and X. However, an important observation was that samples containing more than 2% hydrocolloid displayed black spots resembling holes in the micrographs. These structural discontinuities suggest the presence of voids or phase separation, which likely disrupted the integrity of the crystal-polymer network. Consistently, these samples showed a direct impact on their rheological parameters, indicating that excessive hydrocolloid concentrations negatively influenced the uniformity and stability of the matrix. The sample containing 2% rice bran wax, 5% monoglycerides, and 3% gelatin showed good oil entrapment and good rheological and texture characteristics and is an excellent candidate for partially replacing cocoa butter in chocolate manufacturing.



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sciforum-142905: Cellulose-in-cellulose 3D-printed hydrogels and aerogels for soft tissue engineering

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Introduction

Bacterial cellulose is one of the cellulose derivatives with the greatest purity and porosity, so it has sparked interest in the regenerative medicine field [1]. Nevertheless, the addition of bacterial cellulose nanofibers modifies the rheological properties of 3D printing inks so certain applications of nanocellulose as part of 3D-printed gels have barely been explored.

Methodology

In this work, bacterial cellulose nanofibers are obtained through a well-established protocol from the bacterial strain *K. xylinus* [1–3] and were added into methylcellulose inks to manufacture 3D-printed hydrogels and aerogels. Polyurea crosslinking was explored as a method to enhance the performance of the cellulose-in-cellulose gels. Scanning and transmission electron microscopies as well as printing fidelity measurements were employed to characterize the gels. Cell studies and hemolytic activity tests were conducted to ensure the absence of toxicity of the formulations.

Results and Discussion

Bacterial cellulose nanofibers were obtained with a diameter close to 50 nm and were incorporated into methylcellulose inks, with shear-thinning properties adequate for 3D printing. Nanocellulose adding into gels decreased their volume shrinkage and increased their printing fidelity. Polyurea crosslinking yielded biocompatible gels with enhanced structural properties. Results obtained encouraged future research of these gels as soft tissue grafts.

Conclusions

Bacterial cellulose nanofibers were incorporated into 3D-printed methylcellulose hydrogels and aerogels, yielding structures with morphological properties suitable for soft tissue engineering. The polyurea crosslinking of the cellulose-in-cellulose gels enhanced their physicochemical performance resulting in promising formulations for regenerative medicine.

Acknowledgments

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sciforum-138339: Preparation of elastic PVA/PAAm double network hydrogel for application to artificial blood vessel materials

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It is well known that polyvinyl alcohol (PVA) forms hydrogels in aqueous solution, and its application in the field of biomaterials has long been anticipated. Recently PVA/polyacrylamide (PAAm) double network (DN) hydrogel has been developed through repeated freeze-thaw cycles method to achieve sufficient mechanical strength. However, the DN gels are sometimes not sufficiently transparent due to the preparation process because of crystallization and its application fields are limited. In this study, we have developed the simple preparation process of thick and transparent PVA/PAAm DN hydrogels. The DN gel was synthesized from crushed PVA gel (the first gel) and AAm solution (monomer of the second gel). 1.32g of PVA (saponification degree 98~99 mol%) was dissolved in DMSO/water (a mass ratio of 2:8) and the total weight was adjusted to 30 g. The solution was then heated at 90 °C under stirring until the PVA was fully dissolved and cooled at -40 °C for 24 hours.

The resulting PVA gel was finely ground with a mortar and pestle while mixing with an 300g of water solution containing 21.3g of AAm, 0.04g of the polymerization initiator 2-oxoglutaric acid (OA) and 0.04g of the crosslinker N,N' methylenebisacrylamide (MBAA). This mixture was poured into a cubic mold (25 mm per side) made of slide glass, and ultraviolet UV(365 nm) irradiation was applied for to initiate the radical polymerization of AAm. Through this process, a transparent and elastic PVA/PAAm DN hydrogel was obtained. Although the Young's modulus of the DN gel (0.012 MPa) slightly failed to fall within this range for human blood vessels (0.02~3 MPa), its transparency may allow for the measurement of stress interactions between blood flow and vessel walls using photoelasticity. The thick and transparent DN gel using PVA—produced at low cost—is also expected to be applied as a biomimetic material.



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sciforum-140201: A High-Adhesion Polymer Gel for Polytetrafluoroethylene

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Polytetrafluoroethylene (PTFE) is valued for its low dielectric constant and loss tangent but has low surface free energy (SFE), hindering adhesion to other materials. Our group developed a copolymer gel, poly(2-(diethylamino)ethyl methacrylate-co-dodecyl acrylate) (P(DEAE-co-DA)), with exceptional adhesion to PTFE. Gel sheets were synthesized via photo-radical bulk polymerization, alongside homopolymer gels poly(2-(diethylamino)ethyl methacrylate) (PDEAE) and poly(dodecyl acrylate) (PDA) for comparison. These were assessed using 90° peel tests, contact angle measurements, and oscillatory frequency sweep tests. The 90° peel tests revealed that P(DEAE-co-DA) exhibited 4–6 times higher peel strength than PDEAE and PDA. SFE was highest for PDEAE, followed by P(DEAE-co-DA), PTFE, and PDA. Theoretical adhesive work (W_a) to PTFE was 48.41 mJ/m² for PDEAE, 44.99 mJ/m² for P(DEAE-co-DA), and 36.51 mJ/m² for PDA, suggesting PDEAE's superior adhesion. However, experimental peel tests showed P(DEAE-co-DA) had the highest peel strength. To explore this discrepancy, oscillatory frequency sweep tests measured storage modulus, loss modulus, $\tan\delta$, relaxation time (τ), and activation energy (E_a). P(DEAE-co-DA) displayed higher $\tan\delta$, shorter τ , and a significantly lower E_a (8.03 kJ/mol) compared to PDEAE (49.7 kJ/mol) and PDA (15.9 kJ/mol). This low E_a enhances chain mobility, enabling side chains to align with the PTFE surface, strengthening van der Waals interactions. The superior peel strength of P(DEAE-co-DA) primarily stems from enhanced viscoelastic energy dissipation, explaining its outstanding adhesion despite a lower theoretical W_a .



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sciforum-140292: Biobased Derivatives From Olive Oil for Tuning Physically Crosslinked Poly(Vinyl Alcohol) Hydrogel Properties

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Vegetable oils, commonly discarded by kitchens and restaurants, comprise unsaturated triglycerides, and the double bonds present in triglyceride units can be readily converted into interesting precursors through various synthetic methods. In this contribution, we present a straightforward chemical methodology for the revalorization of cooking oil, towards using waste vegetable oil as a source to produce new building blocks for various applications. Specifically, the epoxidation of olive oil primarily yields an epoxidized oil derivative. This same epoxidation pathway can be applied to generate hydroxylated derivatives, such as diols.

These oil-based derivatives were then incorporated into the formulation of physically crosslinked PVA hydrogels. Notably, hydrogels containing a 5 wt% diol derivative exhibited the highest compressive Young's modulus, suggesting a significant interaction between PVA and the diol.

Although no apparent changes were observed in the spectroscopic response of the PVA-based hydrogels, molecular dynamics simulations indicated a profound interaction between PVA and diol molecules. Additionally, all synthesized PVA-based hydrogels demonstrated a bacteriostatic effect against *L. monocytogenes*, compared to pristine PVA hydrogel. This suggests that PVA-based hydrogels containing olive oil derivatives could have promising applications in various fields, including the tailored control of diol structures to modulate not only the mechanical properties of the hydrogels but also their antibacterial properties



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sciforum-147323: Biopolymeric Hydrogel Platforms Integrated with Colorimetric Indicators for Sustainable Intelligent Packaging

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Intelligent packaging is gaining increasing attention as a sustainable approach to enhance food safety, monitor food quality, and minimize waste throughout the supply chain. An agarose-based biopolymeric hydrogel was developed and optimized as a platform for integrating ferric reagent mixtures as colorimetric indicators. The interaction between the hydrogel-embedded reagent and phenolic compounds associated with food quality was systematically examined under controlled conditions. Optimization of the hydrogel composition provided suitable porosity, transparency, and stability, enabling uniform distribution of the indicator and consistent, reproducible color responses. Visual changes were documented using a smartphone camera, followed by quantitative evaluation in the RGB color space. Color intensity values were converted into greyscale and correlated with phenolic concentrations. The system was tested up to 1 μM phenolic concentration and exhibited a clear concentration-dependent response with good reproducibility. Results from smartphone-based digital image analysis showed strong agreement with spectrophotometric measurements, confirming the accuracy, sensitivity, and reliability of the approach. The hydrogel sensor responded rapidly, required minimal sample preparation, and maintained stability during storage and handling. Its straightforward design and environmentally benign composition underline the practical feasibility of incorporating such systems into real-world food monitoring practices. Overall, biopolymeric hydrogel-colorimetric platforms represent a sustainable and promising alternative to petroleum-based packaging materials. Their integration into intelligent packaging systems has significant potential to enhance food safety, improve consumer confidence, minimize waste, and contribute to circular economy goals by combining eco-friendly materials with real-time freshness and quality monitoring.



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sciforum-136695: Conductive Dual-Network Hydrogel for Flexible Sensing Motif

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A dual-network hydrogel was prepared for a smart sensing application. Tannic acid (TA) and polyvinyl alcohol (PVA) was gelled as the first network and sodium alginate (SA) was further cross-linked by Ca^{2+} as the second network. The dual-network structure of the SA/PVA/TA hydrogel was investigated by SEM and XRD. The dual-network was composed of multiple hydrogen bonds between PVA, SA, and TA as well as the ion bonds between SA and Ca^{2+} . A large number of hydroxyl groups of TA are combined with the network structure of PVA and the chain structure of SA, which improves the toughness and strength of the hydrogel. Further characterization showed that the conductive hydrogel can adhere well to iron, glass, plastic, and finger joints. The hydrogel with TA showed better mechanical properties. After crosslinking in CaCl_2 solution, the tensile strength and conductivity of the SA/PVA/TA hydrogel increased with the increase in immersion time. The SA/PVA/TA hydrogel soaked for 30 min experienced with the extension of external force, and its sensitivity also changed accordingly; the maximum elongation at break of the hydrogel reached 123.8%, while the tensile strength of the hydrogel reached 0.35 MPa. This conductive hydrogel showed good adhesive and tensile properties when adhering to iron, glass, plastic, and finger joints. Then, the hydrogel was deformed while the impedance curve was recorded. The results showed that the dual-network hydrogel can be used as a strain sensor, which provides the new idea that SA/PVA/TA conductive hydrogel can be used as a conductive flexible sensor.



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sciforum-142794: Design a novel biodegradable hydrogel scaffold for cultured meat production

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Cultured meat is emerging as a sustainable alternative to conventional livestock farming, but its large-scale development depends on the creation of edible, biocompatible scaffolds that can support muscle cell growth and organization into tissue-like structures. Hydrogels derived from food-safe materials are particularly attractive because of their high-water content, tunable viscoelasticity, and alignment with clean-label requirements.

In this study, we investigate the potential of KF8K self-assembling peptide hydrogels as scaffolds for cultured meat applications. Hydrogels were prepared at varying concentrations and crosslinked using food-grade salts (NaCl and CaCl₂) to modulate their mechanical and structural properties. Rheological analysis revealed storage modulus (G') values in the range of 1–10 kPa, comparable to the stiffness of native skeletal muscle. Gelation occurred within 2–5 minutes, and the hydrogels exhibited stability across a physiologically relevant pH range (3.0–7.5). Preliminary findings also revealed distinct differences in microstructural density and viscoelastic behaviour between monovalent and divalent salt conditions, suggesting the potential for tailoring scaffolds to mimic muscle versus adipose tissue environments.

The biological performance of KF8K hydrogels was evaluated using C2C12 mouse myoblasts. Preliminary studies showed >85% cell viability after 7 days, with clear evidence of attachment and proliferation within the hydrogel matrix. Importantly, the selected formulations align with clean-label, food-grade requirements and demonstrate compatibility with scalable processing conditions, strengthening their translational potential for cellular agriculture.

Overall, this work establishes KF8K peptide hydrogels as promising edible scaffolds for cultured meat. By combining tunable mechanics, biological compatibility, and food safety, this study demonstrates how rationally designed peptide hydrogels can bridge the gap between biological functionality and industrial feasibility, advancing the realization of structured cultured meat.



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sciforum-142746: Design and Development of an Injectable Hydrogel for Cartilage Repair

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Articular cartilage injuries present a significant clinical challenge due to the tissue's limited intrinsic capacity for self-repair. Without effective treatment, such defects progress to osteoarthritis, severely impacting the patient's mobility and quality of life. Existing clinical strategies, including microfracture and autologous chondrocyte implantation (ACI), are often associated with complications such as fibrocartilage formation and donor site morbidity. Injectable hydrogels offer a minimally invasive strategy with defect-conforming properties with the ability to deliver bioactive cues, yet conventional bulk 'filler' hydrogels are hindered by nanoporosity that limits nutrient transport and cell migration.

To overcome these limitations, a granular injectable hydrogel system was developed, composed of microparticles assembled from fragmented bulk hydrogels, thereby introducing interstitial microporosity to enhance cellular interactions and tissue integration. The hydrogel formulation was composed of gelatin methacryloyl, hyaluronic acid methacryloyl, and methacryloyl modified platelet lysate. Bulk formulations were first optimized through live/dead viability assays, DNA and glycosaminoglycan quantification, and immunofluorescent staining for hyaline cartilage-specific markers. Granular hydrogels were fabricated by extruding and fragmenting the optimized bulk gels into microparticles, followed by centrifugation and photoannealing ($\lambda=365\text{nm}$). These constructs were evaluated using the same in vitro assays and further tested in an ex vivo osteochondral defect model.

Fabrication yielded large and small microparticles of $230 \pm 82 \mu\text{m}$ and $46 \pm 18 \mu\text{m}$, respectively, with interstitial porosity ranging from 3–11% depending on centrifugation speed. While the optimized bulk hydrogel supported chondrocyte viability (+90%) and hyaline-like matrix production, granular hydrogels substantially improved repair outcomes. By day 31, GAG/DNA ratios reached 0.79 and 0.72 for small particle and large particle groups, compared to 0.677 for bulk gels. Enhanced microporosity facilitated cell infiltration, more extracellular matrix deposition, and better integration with host cartilage. Immunostaining confirmed that the regenerated tissue was rich in type II collagen and aggrecan, resembling native hyaline cartilage.



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sciforum-143634: Design of core-shell aerogel particles combining AI tools and supercritical drying for oral drug delivery

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Core-shell aerogels can be prepared by combination of air-assisted coaxial dripping systems with subsequent supercritical drying, obtaining particles with aerogel inherent properties and the presence of coatings. This methodology involves numerous processing parameters, making artificial intelligence (AI) tools invaluable for optimization and understanding the effect of each variable on particle characteristics.

In this work, AI tools were employed to develop aerogel particles using alginate (Alg) solutions as drug-loaded cores and konjac glucomannan (KGM) solutions as coatings. Initially, various system variables were tested to establish the limits of the design space. Subsequently, DataForm® software was utilized to create a balanced design, incorporating variables such as Alg and KGM concentrations, airflow rate, Alg and KGM pump pressures, and different nozzle sizes at three levels. After preparing the gel particles, their Feret diameter, circularity, coating thickness, core position, and nozzle blockage were analyzed. The relationship between the operational variables and the formulation characteristics was studied using FormRules® and INForm® software to identify key influencing variables and establish the optimal conditions for the intended formulation.

The results revealed that core positioning was significantly affected by nozzle configuration and the balance between pump pressures. Optimal formulations with sizes around 2 mm and coatings around 300 μm were obtained, according to the predicted results. Using these processing conditions, different gel formulations loaded with vancomycin or dexamethasone were prepared and dried with supercritical fluids.

The resulting aerogels had specific surface areas higher than 200 m^2/g , log-normal particle size distributions with average sizes of 1.77 μm , and the unexpected immediate release of both drugs.

This work provides initial insights into the production process of core-shell aerogel particles via coaxial dripping for drug delivery and the use of KGM as a raw material for the preparation of multiparticle aerogel formulations.



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sciforum-147719: Enhancing the Biocontrol Potential of *Bacillus amyloliquefaciens* by Hydrogel Encapsulation for Combating Intestinal Pathogens

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Abstract

Introduction

Probiotics are beneficial microorganisms that enhance host health by modulating gut microbiota and inhibiting pathogens. *Bacillus amyloliquefaciens* is a promising probiotic due to its resilience to gastrointestinal stress and bioactive metabolite production. Sodium alginate hydrogel encapsulation improves probiotic stability, protects against environmental stress, and enables controlled release, enhancing survival and therapeutic efficacy. This study focuses on isolating and characterizing *B. amyloliquefaciens* from pearl millet, evaluating probiotic traits, and enhancing delivery through alginate encapsulation. Structural confirmation, metabolic profiling, and antibacterial activity were assessed to establish potential food and pharmaceutical applications.

Methods

B. amyloliquefaciens was isolated from pearl millet and evaluated for acid tolerance, hemolytic activity, cell surface hydrophobicity, auto-aggregation, NaCl tolerance, and phenol tolerance. Cells were encapsulated in sodium alginate hydrogel, confirmed using Fourier-Transform Infrared Spectroscopy (FTIR) to identify functional groups. X-ray Diffraction (XRD) determined encapsulation structure and crystallinity, while Gas Chromatography–Mass Spectrometry (GC-MS) profiled bioactive metabolites. Encapsulated beads were tested for survival under gastrointestinal-like acidic conditions. Antibacterial activity of the cell-free supernatant was analysed using agar well diffusion against *Escherichia coli* and *Shigella*.

Results

The isolate exhibited strong probiotic traits, including acid and phenol tolerance, high auto-aggregation, hydrophobicity, and no hemolytic activity. FTIR confirmed encapsulation via characteristic sodium alginate functional groups. XRD showed a short-range diffraction peak at $2\theta = 11.848^\circ$, indicating an amorphous structure with minor crystallinity, suggesting efficient encapsulation. GC-MS identified 65 metabolites, with 1,2-Benzenedicarboxylic acid, diethyl ester dominant. Encapsulated cells showed high survival under acidic conditions, demonstrating hydrogel protection. The supernatant exhibited antibacterial activity, with inhibition zones of 14 mm against *E. coli* (125 μ l) and 17 mm against *Shigella* (100 μ l).

Conclusion

B. amyloliquefaciens from pearl millet showed strong probiotic potential. Sodium alginate encapsulation improved survival, preserved metabolic activity, and enabled controlled release. Hydrogel encapsulation is highlighted as a key strategy for improving probiotic survival, controlled release, and efficacy in next-generation formulations.



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sciforum-148026: Formulation of Curcumin Nanoemulsion Gel for Squamous Cell Carcinoma

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Introduction:

Squamous cell carcinoma (SCC), the second most common non-melanoma skin cancer globally, is attributed to ultraviolet radiation exposure. Current therapeutic approaches including surgery, radiotherapy, and chemotherapy present limitations in patient compliance and systemic toxicity. Curcumin, a natural bioactive compound with anticancer properties, faces challenges in topical delivery due to poor aqueous solubility and limited bioavailability. This study aimed to develop a curcumin-loaded nanoemulsion gel for SCC treatment.

Methods:

Curcumin nano emulsions were prepared using spontaneous emulsification technique following preformulation studies. Solubility screening identified optimal oil phase, while surfactant and co-surfactant combinations were evaluated. Various oil-to-surfactant/co-surfactant (SCOS) ratios were investigated. Selected formulations underwent stability testing, particle size analysis using dynamic light scattering, zeta potential measurement, and polydispersity index determination. Optimized nanoemulsions were incorporated into carbopol gel matrix and evaluated for physicochemical characteristics, entrapment efficiency, pH, viscosity, and spreadability. Drug release studies were conducted using Franz diffusion cells. Cytotoxicity evaluation was performed using MTT assay.

Results:

Capmul CMC demonstrated superior curcumin solubility (90 ± 0.18 mg/mL) and was selected as optimal oil phase. Tween 20 and PEG 400 served as surfactant and co-surfactant respectively. Two formulations were developed: F6 (oil:SCOS 1:6) and F8 (oil:SCOS 1:8). F8 formulation exhibited superior characteristics with globule size of 125.3 nm, zeta potential of -18.3 mV, and polydispersity index of 0.310, indicating enhanced stability. The nanoemulsion gel demonstrated 99% entrapment efficiency. Release studies revealed sustained drug release, with F8 releasing 59.41% compared to F6's 66.11%. Cytotoxicity studies demonstrated anticancer activity with IC_{50} values of 59.63 μ g/mL.

Conclusions:

Curcumin nanoemulsion gel system enhanced drug solubilization and provided controlled, sustained release characteristics for SCC treatment. This delivery system offers improved bioavailability, patient compliance, and reduced systemic toxicity, representing advancement in topical cancer chemotherapy.



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sciforum-142205: Foxy5-Loaded Thermosensitive Hydrogel Incorporating Hyaluronic Acid for Bone defects Applications

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Introduction: Bone defects present a significant clinical challenge, making efficient repair crucial [1]. Hyaluronic acid (HA), a biocompatible polysaccharide, binds effectively to CD44 receptors, which are overexpressed in inflammation and cancer. This interaction is essential for bone regeneration, particularly in therapies for bone defects, addressing the increasing demand for regenerative solutions [2]. This study aims to formulate HA-based hydrogels using different molecular weights of HA, along with Poloxamer 407 (P) and tannic acid (TA), to develop thermosensitive hydrogels. Foxy5, a Wnt5a-mimicking peptide, enhances the proliferation, differentiation, and migration of type H endothelial cells, synergizing with BMP2's paracrine effects to regulate vascular-osteogenic coupling.

Method: The hydrogel was developed by formulating it with HA of various molecular weights (0.5%), P (22%) (HyHA), TA (1%) (HyHAT), and Foxy5-loaded hydrogels (HyHAF, HyHATF). Morphology, gelation, osmolality, viscosity, swelling, biodegradation, and total drug dispersion properties were studied. The physical stability of all hydrogel formulations and the chemical stability of Foxy5 within the hydrogel were analyzed. In vitro the release of Foxy5 was assessed via HPLC.

Results: All hydrogels demonstrated good chemical and physical stability over 14 days, with gelation within 50 seconds at 27°C, a viscosity of 534.43 cP, and a pH of 7.62. The formulations could be smoothly injected at 4°C and underwent rapid gelation at 37°C, filling complex defect geometries while maintaining shape stability. Swelling and biodegradation were controlled, with only 27% mass loss after 15 days. SEM analysis revealed a 3D crosslinked network conducive to sustained drug release and cell ingrowth. The Foxy5 load was approximately 90%, and release studies demonstrated that HyHATF significantly increased Foxy5 release.

Conclusion: The thermosensitive hydrogel system provides an effective carrier for the Foxy5, enhancing type H vessel-mediated bone repair. This strategy significantly promotes efficient bone tissue regeneration and offers an innovative solution for clinical bone defect treatment.



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sciforum-142273: Generation of Carrageenan-Based Nanoporous Structures as Green Alternatives for Enhanced Water Uptake

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Superabsorbent polymers (SAPs) are an interesting class of materials, known for their ability to elastically swell and deswell in the presence of water: they are used in agriculture, as personal hygiene products, etc. However, most of the available commercial SAPs are synthetic, or bio-based and crosslinked with acrylates or other substances suspected of being toxic.

We propose using a hydrophilic algae-based polymer (i.e., k-carrageenan) as a greener alternative. Specifically, we aimed at enhancing water uptake capacity by engineering k-carrageenan nanoporosity: in this research, supercritical CO₂-assisted drying has been performed on carrageenan gels, crosslinked by means of K⁺ and Ca²⁺. Different samples were produced, changing the relative concentration of potassium and calcium ions to carrageenan weight. Dried gels were observed by FESEM analysis accompanied by image analysis to compute pore size distribution. Then, water uptake capacity and mass loss were calculated at regular intervals of time, to assess the best-performing and most stable material.

Key findings regard nanostructured materials water-responsiveness. k-carrageenan undergoes severe volume reduction after supercritical drying, but, surprisingly, regains its hydrogel state after contact with water rather than just accommodating it. Morphologically speaking, the obtained k-carrageenan dried gels are dense but offer nanopores available for water intrusion: however, when Ca²⁺ ions concentration increases after a certain threshold, an alginate-like organization is observed. During swelling tests, it was observed that the coexistence of monovalent and divalent cations can result in material solubilization after a few hours; the best result has been achieved using the salt-free gel, reaching a water uptake capacity of 50 g/g and stability over days with no significant mass loss.

In conclusion, k-carrageenan-based porous devices are valid alternatives to their synthetic counterparts; although water absorption capacity could be further enhanced, these results represent the first step towards the valorization of bio-based resources for large-scale applications.



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sciforum-146022: Green and Sustainable Energy Storage Using Borax–Chitosan Hydrogel Electrolytes in EDLCs

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The growing concerns over chemical pollution and the rapid accumulation of microplastics necessitate the development of sustainable and high-performance energy storage systems. Among these, electrical double-layer capacitors (EDLCs) stand out for their remarkable cycling stability, yet their practical utility is often limited by their low energy density and their reliance on environmentally harmful liquid electrolytes. In this work, we present a facile, eco-friendly synthesis of a borax-crosslinked chitosan hydrogel membrane electrolyte (BCCHME). Borax simultaneously facilitates ionic and covalent crosslinking, thereby reinforcing the mechanical strength and enhancing ion mobility within the membrane. The optimized BCCHME demonstrates a 182 % water uptake, 14.65 % dissolution ratio, and a semi-crystalline framework with 16.59 % crystallinity, supported by a uniform porous morphology. Structural verification through FTIR confirms the dual crosslinking, while elemental mapping reveals the presence of Na, B, C, N, and O. Electrochemical evaluation shows a high dielectric constant, an ionic conductivity of $7.03 \times 10^{-4} \text{ S cm}^{-1}$, an ion transference number of 0.93, a diffusion coefficient of $4.19 \times 10^{-9} \text{ m}^2 \text{ s}^{-1}$, and electrochemical stability up to 2.24 V. A solid-state EDLC fabricated using BCCHME and Black Pearls' carbon (BPC) electrodes achieves an areal capacitance of 378 mF cm^{-2} , an energy density of $52.5 \text{ } \mu\text{Wh cm}^{-2}$, and a power density of $5000 \text{ } \mu\text{W cm}^{-2}$ at 5 mA cm^{-2} . The device also exhibits outstanding cycle life, maintaining performance for 53,000 cycles at 2 mA cm^{-2} and 30,000 cycles at 5 mA cm^{-2} . Furthermore, a prototype configuration powered a 1 V LED for 1.83 minutes. Overall, this study demonstrates BCCHME as a biodegradable and non-toxic hydrogel electrolyte, merging sustainability with practical device-level performance for next-generation supercapacitors.



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sciforum-148212: Hydrogel-Like Biofilms of *Candida tropicalis*: Biofouling of Polymeric Prosthetic Materials and Emerging Antifungal Strategies

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The non-*albicans* *Candida* species *Candida tropicalis* is an opportunistic fungal pathogen that forms robust gel-like biofilm on polymeric prosthetic materials. These biofilms are embedded in an extracellular polymeric substance that retains large amounts of water, giving rise to a hydrogel-like matrix that protects fungal cells, increases antifungal resistance, and also leads to biofouling of these prosthetic materials. Biofouling is the unwanted colonization and accumulation of microbial communities on material surfaces, which alters their function and compromises clinical performance. Clinically, it is significant because it is linked to recurrent urinary tract infections, bloodstream infections, and persistent device-related infections, which often result in therapeutic failure and device malfunction. Polymers such as silicone elastomer, polypropylene, polystyrene, polyurethane, polyethylene, and polyvinyl chloride are widely used in catheters, surgical meshes, implants, and prostheses because of their durability, flexibility, and biocompatibility, yet their surface properties often encourage microbial adhesion and biofilm formation. This review emphasizes that the gel-like biofilm architecture of *C. tropicalis* underpins its persistence and resistance, while also highlighting promising antifungal strategies being developed to mitigate these infections. Notably, palmitic acid has been shown to disrupt mature biofilms by lowering ergosterol and inducing oxidative stress, whereas C-10 massoia lactone damages the extracellular matrix and suppresses hyphal growth. Drug repurposing approaches, such as combining minocycline with fluconazole, restore susceptibility in resistant isolates and demonstrate synergistic antibiofilm activity. Additionally, biomaterial-based interventions, such as chitosan coatings on silicone surfaces, significantly reduce fungal adhesion and biofilm formation. Together, these findings reflect a translational shift toward integrating natural products, repurposed drugs, and functionalized biomaterials into antifungal development. Understanding biofouling & these emerging strategies is crucial for developing effective control measures against *C. tropicalis* biofilms and for guiding the design of infection-resistant prosthetic devices.



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sciforum-148222: Hydrophobic Eutectics-based Supramolecular Gels and Cellulose-based Nanosponges: Breakthrough Solutions for Water Remediation

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Clean water is a fundamental goal of the 2030 Agenda for Sustainable Development [1] and the European Green Deal's Zero Pollution Action Plan[2], making water remediation a critical focus in research. Conventional extraction techniques like dispersive liquid-liquid and solid-liquid microextraction face challenges, including the use of volatile organic solvents and non-sustainable sorbents with limited capacity.

This study addresses these challenges by introducing new classes of sustainable materials based on hydrophobic non-ionic eutectic solvents (HES) [3]. HES offer several advantages, including being chloride-free and easy to prepare from natural precursors, 100% atom economy, and high sustainability [4]. To expand their use, two innovative HES-based materials are developed: hydrophobic eutectogels (HEG) and HES-loaded cellulose nanosponges (HECS).

HEG are supramolecular gels formed by the rapid thermoreversible self-assembly of low molecular weight gelators [3]. HECS are materials obtained by combination of HES with peculiar aerogels composed of derivatized cellulose [5], a crosslinker (either a branched polyethyleneimine or gelatin) and a co-crosslinker [6,7].

The materials' properties are being investigated both morphologically and mechanically by a multi-technique approach.

Preliminary studies with HEG and HECS have demonstrated promising extraction abilities in water remediation. In particular, HEG and HECS were used to extract bisphenol A from water, obtaining extraction efficiencies >90%. While menthol leaching rates appeared to be limited (0,35%).

This comprehensive materials study allows for precise control over their properties, making our systems highly adaptable for various applications.

The development of HEGs and HECS marks a breakthrough in sustainable water treatment. By overcoming the limitations of current extraction methods, this research offers a safer, more efficient, and eco-friendly solution for removing harmful contaminants. The easy production, combined with easy recovery from the medium, pave the way to a possible large scale use. These materials have the potential to play a crucial role in achieving global clean water goals and advancing the field of green chemistry.



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sciforum-142901: Impact of Storage on the Structure Stability of Starch-Based HPP Hydrogels Loaded with Natural Extracts

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Starch-based hydrogels have garnered significant interest in recent years due to their potential applications in various fields. Their characteristic stable structure enables functionalization, allowing their use as smart carriers of the bioactive compounds of natural extracts. In this study, the physical stability of starch-based hydrogels loaded with natural extract produced via high-pressure processing (HPP) was evaluated. For this purpose, stability measurements, including swelling power, texture, pH, and organoleptic properties, were determined at various time intervals during storage at 5°C and 25°C. Hydrogels were developed using tapioca starch, which contains approximately 20.2% amylose. Tapioca starch was suspended in distilled water to prepare a 20% (w/w) suspension containing 2% (w/w) natural extract. The mixture was then subjected to high-pressure processing (HPP) at 600 MPa for 15 minutes to induce starch gelatinization and facilitate hydrogel formation. The results showed that during storage, a decrease was observed in swelling power from 1.35 to 0.28 g/g, indicating a reduction in the hydrogel's ability to retain water, likely due to the structural rearrangements of polymer chains. Additionally, texture analyses revealed an initial decrease in hardness, cohesiveness, and springiness values at 15 days, followed by their increase after 30 days. These changes may be related to hydrogel reorganization, where initial relaxation reduces texture properties but longer-term polymer chain rearrangement or crosslinking enhances stability. Furthermore, changes in color parameters (L^* , a^* , and b^*) suggest ongoing chemical transformations within the hydrogel matrix. Throughout the storage period, pH values remained stable at approximately 5, indicating limited acid-base interaction within the hydrogel system. Based on these findings, it can be concluded that more research is warranted to clarify molecular mechanisms and optimize release behavior for targeted nutraceutical and functional food applications.



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sciforum-137017: Influence of the dimethylsulfoxide–water mixtures on the properties of poly(vinyl alcohol) cryogels.

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Introduction.

Poly(vinyl alcohol) cryogels (PVACGs) are the noncovalent macroporous gels formed as a result of freeze-thaw processing of concentrated PVA solutions. Such cryogels are widely used as biomedical materials due to their mechanical durability, biocompatibility and also viscoelastic properties similar to those of soft biological tissues.

In some cases, the application of PVACGs is limited by the yet insufficient rigidity of these materials. There are several ways to enhance the physico-mechanical properties of PVACGs, e.g., by increasing the initial polymer concentration, by inserting kosmotropic additives, by performing additional “freezing-thawing” cycles. We suggested another decision for increasing the elasticity of PVACGs by their treatment with water-DMSO mixed solutions.

Methods.

PVACGs were prepared by the “freezing-thawing” technique originating from the 100 g/L aqueous solutions of this polymer that have been frozen and incubated at -20°C for 12 h. Further the temperature was raised to 20°C at the rate of $0.03^{\circ}\text{C}/\text{min}$. The resultant samples were then saturated with the water-DMSO mixed solutions of different volumetric ratio: 100/0, 75/25, 50/50, 25/75 and 0/100. , and Thereafter the Young's modulus and the fusion temperature values of the resultant cryogels were measured.

Results.

It was shown that the rigidity grew with an increase in DMSO share in mixed solutions. With that the highest gel strength and heat endurance was in the case of PVACGs saturated with the 50/50 (v/v) water-DMSO mixture. The Young's modulus increased by ~ 30 times (up to 235 ± 4 kPa) comparing to the PVA cryogel (7.5 ± 0.6 kPa) prepared from the aqueous polymer solution. After rinsing “saturated” cryogels with pure water their rigidity decreased (till 79 ± 2 kPa), but not critically so the high rigidity of PVA cryogels was saved. Tf values of the corresponding samples were as follows: 92.6 ± 0.9 °C and 77.8 ± 0.8 °C.

Conclusion

It is supposed that these materials based on such PVA cryogels could be of interest in various areas of application.



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sciforum-142838: Light-Crafted Landscapes: Maskless Photosculpting of Hydrogels

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Introduction: Engineering physiologically relevant cell culture substrates requires decoupling multiple environmental cues, such as substrate stiffness and surface topography. Existing hydrogel patterning approaches are limited by complex fabrication, inflexible design space, and feature collapse on soft substrates. Here, we introduce a **maskless, contact-free UV-sculpting technique** that enables fully programmable microscale topographies (from 2 μm to DMD dimensions as limit) directly onto a wide range of hydrogels both synthetic (e.g. pAA, pNIPAM, PEG) and natural (GelMA, gelatin) with tunable resolution and topographical amplitude using digital designs and adjustable UV exposure or photoinitiator concentration.

Method: This approach leverages a digital micromirror device (DMD) to project any grayscale mask pattern onto hydrogel surfaces pre-treated with a photoactivator. Within minutes, spatially defined chemical modifications induce sculpting with micrometric fidelity. Feature height or depth (z-scale) can be precisely controlled by varying technique parameters, enabling rapid exploration of design structure relationships across hydrogels properties and physical cues.

Results: As representative benchmarks, GelMA exhibits extrusions of $2.877 \pm 0.405 \mu\text{m}$ and pNIPAM $2.140 \pm 0.426 \mu\text{m}$, while pAA and PEG show invaginations of $0.117 \pm 0.050 \mu\text{m}$ and $0.286 \pm 0.043 \mu\text{m}$, respectively, under standard exposure, and GelMA height scales with dose up to 1500 mJ/mm^2 . Design flexibility is demonstrated with arbitrary shapes and grayscale gradients faithfully reproduced on hydrogels with stiffness from ~ 1.6 to 200 kPa, enabling independent tuning of topography and mechanics.

Conclusions: This technology provides a fast (5 min fabrication), digital, versatile, and high-throughput platform for generating multi-cue hydrogel substrates. The ability to independently tune mechanical and topographical parameters enables systematic studies in more physiologically relevant microenvironments. Future applications could extend to dynamic platforms, further enhancing spatiotemporal control over cell material interactions.



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sciforum-142860: Nanofibrous Hyaluronic Acid/Gelatin Methacrylate Hydrogels Enhance Cartilage Regeneration

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Introduction Various forms of hyaluronic acid (HA)-based hydrogels are widely utilized in cartilage tissue engineering due to their intrinsic bioactivity, biocompatibility, and anti-inflammatory properties. However, the high viscosity of HA solutions limits their processability into fibrous structures that mimic the nanofibrous nature of the hyaline cartilage extracellular matrix. To address this, gelatin is often incorporated to improve electrospinnability while simultaneously providing bioactive cell adhesion motifs and enhanced mechanical properties. In this study, a hyaluronic acid methacrylate/gelatin methacryloyl nanofibrous hydrogel was developed to mimic native ECM architecture and promote chondrogenic activity for cartilage regeneration.

Materials and Methods HA (200-500 kDa) and gelatin were methacrylated, achieving degrees of modification of approximately 18% and 60%, respectively, as confirmed by NMR. Lyophilised HAMA (1, 1.5 and 2% w/v) and GelMA (5, 7.5 and 10% w/v) were dissolved in hexafluoroisopropanol and assessed using box-benkhen design of experiments model combined with rheological analysis to identify suitable concentrations and optimize electrospinning parameters. The optimized formulations were mixed with Irgacure 2959, electrospun into mats (~10 mm × 10 mm, ~2 mm thickness), and UV-crosslinked following immersion in pure ethanol. After crosslinking, the mats were rinsed with PBS and prepared for cell culture.

Results and Discussion SEM images showed the morphology of nanofibers, with diameters of approximately 300 nm for low-HAMA/high-GelMA formulations, whereas higher HAMA content resulted in thicker fibers in the 400–600 nm range. Confocal microscopy demonstrated mats stability for at least 21 days and high chondrocyte viability (>80%), indicating the absence of cytotoxic residues. Finally, GAG/DNA quantification and immunofluorescence staining confirmed the expression of type II collagen and aggrecan, resembling native hyaline cartilage.

Conclusion The results indicate that the HAMA/GelMA fibrous hydrogel represents a promising strategy for cartilage tissue engineering by combining the bioactivity of HAMA with the mechanical and cell-interactive properties of GelMA.



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sciforum-148095: Oxygen-releasing xerogel dressings accelerate healing in diabetic wound models

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Abstract

Introduction:

Diabetic wounds are challenging to manage due to persistent hypoxia, oxidative stress, and poor angiogenesis, which often result in delayed closure and infection. Conventional dressings mainly act as protective barriers and do not actively improve the wound environment. To overcome these limitations, an oxygen-releasing xerogel was developed to deliver oxygen in a controlled manner while providing a structural matrix for tissue repair.

Methods:

A biopolymer-silica xerogel containing calcium peroxide (CaO_2) was prepared and optimized to maintain porosity and ensure steady oxygen release under physiological conditions. Oxygen release profiles, cytocompatibility with fibroblasts and keratinocytes, and antibacterial activity were assessed in vitro. The therapeutic effect was further evaluated in streptozotocin-induced diabetic rats, using gauze and hydrogel dressings as controls. Wound healing was followed over 21 days by measuring closure rates, histological changes, and angiogenesis markers.

Results:

The xerogel released oxygen for up to 72 hours, maintaining concentrations of 40–60 μm , a range supportive of tissue repair. Fibroblast and keratinocyte viability remained above 90%. In vitro antibacterial tests showed nearly 70% inhibition of bacterial growth compared with gauze. In the diabetic rat model, wounds treated with xerogel achieved about 85% closure by day 14, whereas gauze and hydrogel groups showed 55% and 68% closure, respectively ($p < 0.01$). Histological examination revealed improved re-epithelialization, greater collagen deposition, and a 2.5-fold increase in CD31-positive vessels in the xerogel group relative to controls.

Conclusions:

The study demonstrates that oxygen-releasing xerogels can actively enhance diabetic wound repair by supplying oxygen in a sustained fashion, limiting infection, and stimulating tissue regeneration. The quantitative improvements observed highlight their potential as next-generation dressings for chronic wound management.



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sciforum-142834: Phenylalanine-Based Low Molecular Weight Gelators: Synthesis, Supramolecular Characterization and Multicomponent Gelation

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L-Phenylalanine (Phe), a neutral and nonpolar essential amino acid, serves as a key building block for supramolecular assemblies. Several low molecular weight gelators (LMWGs) containing Phe have been developed, with potential applications in different areas such as drug delivery, tissue engineering, and oil spill recovery. Similarly, vicinal dialkylamides have also demonstrated LMWG-forming capabilities, being promising materials for future research and development. In this context, the study of potential gelators was carried out with the synthesis of four Phe derivatives using 4,5-bromo-1,2-phenylenediamine (BPD) or (1R,2R)-(-)-1,2-diaminocyclohexane (DAC) as scaffolds. N-tert-butoxycarbonyl (Boc)-protected Phe was reacted with BPD or DAC (2:1 molar ratio) to yield BPD-1 and DAC-1, respectively. Subsequent deprotection afforded BPD-2 and DAC-2. Gelation ability of the synthesized compounds was tested in a range of solvents by means of the inverted test-tube method. Minimum gelation concentration (MGC) and sol-gel temperature (T_g) were determined for the resulting gels. Additionally, gels were characterized morphologically (SEM), rheologically, and by circular dichroism (CD) spectroscopy at low concentrations. Although not all derivatives prepared could form any gels in common solvents, BPD-1 was found to produce stable gels in carbon tetrachloride, whereas DAC-2 generated an unstable gel in tetrahydrofuran. A multicomponent stable gel in carbon tetrachloride (M1BDP-1) was also achieved by combining BPD-1 with a previously reported LMWG with the same scaffold. SEM revealed fibrous three-dimensional network structures composed of fibers in BPD-1 and M1BDP-1 xerogels. Also, CD spectra display signals that suggest chiral supramolecular aggregation in BDP-1 gels. L-Phenylalanine based gelator BPD-1 can form stable physical gels by its own but also multicomponent gels with a structurally related gelator through a co-assembly process mediated by amide hydrogen bonds. The results indicate that combining L-Phenylalanine with known LMWG fragments can yield new gelating derivatives, highlighting their potential for functional material design.



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sciforum-148210: Silk Based Multiple Shape Memory Organohydrogels

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The hydrophilic and hydrophobic components of biological systems like tissues give them extraordinary properties such as freezing tolerance, elasticity, and adaptability. To achieve similar properties, materials scientists are searching for materials that combine these two opposing properties. Organohydrogels have a biphasic structure containing hydrophilic and hydrophobic regions and are produced by combining water and organic solvents. This duality offers them a variety of applications, including antifreeze materials, environmental engineering, and biomedical products. In this study, organogels were formed in microdomains by dispersing hydrophobic polymers which have different number of side alkyl chain length ($n = 14, 16, 18$) within a silk fibroin-based hydrogel phase. Silk fibroin is one of the most important and widespread proteins used in biomedical applications. Its exceptional mechanical properties, biocompatibility, and biodegradability contribute to its importance. Furthermore, the amphiphilic regions within silk fibroin's structure are the primary reason for its selection for this study. The prepared organohydrogels withstand compression over 90%, have a Young's modulus over 2 MPa, and exhibit effective shape memory and antifreeze properties. Because the use of ternary hydrophobic monomers results in a loss of multiple shape memory properties, the gluing method, which allows for the preparation of each hydrophobic region separately, was used in this study. The resulting organohydrogel exhibits multiple shape memory properties sensitive to temperatures of 40, 30, and 15°C.



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sciforum-132805: Soft, Stretchable, and Smart: Alginate/Gelatin Organohydrogels for Wearable Electronics

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Alginate, a naturally abundant polysaccharide, offers exceptional versatility in functional material design due to its charged backbone and its ability to form ionically crosslinked networks with multivalent cations [1,2]. When combined with gelatin in a glycerol-rich medium, it gives rise to a class of organohydrogels that are not only soft and stretchable, but also responsive, robust, and fully biocompatible.

We harness this platform to engineer multifunctional hydrogels tailored for both sensing and energy-related applications. By tuning the crosslinking chemistry with Cu^{2+} , Mn^{2+} , Fe^{3+} , and Zr^{4+} ions, we access highly adaptable materials that respond sensitively to mechanical strain (gauge factor > 1.6), temperature (0.19 K^{-1}), humidity ($0.022 \text{ RH}(\%)^{-1}$), and light (up to $9.2 \mu\text{A/W}$)—while retaining performance over 2500 mechanical cycles. These multiresponsive materials are ideal candidates for next-generation wearable sensors and electronic skins [3].

Building on this concept, we developed a complementary formulation serving as a gel polymer electrolyte for flexible supercapacitors. Through the synergistic interplay of $\text{Cu}^{2+}/\text{Mn}^{2+}$ crosslinking and Li^+ doping, we modulate nanoscale polymer structure (via SAXS) to enable high capacitance (up to 591.8 mF/cm^2), excellent rate performance, and long-term stability ($> 88\%$ over 5000 cycles). This work demonstrates how ionic coordination directly governs electrochemical function and mechanical resilience [4].

Together, these studies showcase a green, modular strategy for designing biopolymer-based systems that seamlessly integrate soft sensing and energy delivery—offering a scalable path toward self-powered, sustainable devices.

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sciforum-145674: State diagrams for binary monoglyceride mixtures

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Organogels are a unique type of gel formed by trapping an organic solvent within a supramolecular network. In a system like this, a three-dimensional structure occurs from the spontaneous self-assembly of low molecular weight gelator molecules (typically 3000 Da), this usually happen at temperatures below the solubility limit of the gelator in the chosen solvent (i.e. mineral or vegetable oil). Monoglycerides (MG) have been previously studied and recognized for their ability to act as organogelator molecules. In the present study, state diagrams were constructed for binary mixtures of 1-stearoyl glycerol (C18) with 1-myristoyl (C14), 1-palmitoyl (C16), or 1-monobehenin glycerol (C22) in both vegetable and mineral oils. In all cases the total monoglyceride (MG) concentration was held constant at 8% (wt/wt), while varying the molar ratios of the components. Across all systems, a mixed lamellar (L_α) phase was observed, with a transition temperature not affected by changes in the C18 molar fraction, regardless of oil type or MG pairing. On the other hand, the sub- α crystalline phase showed a clear eutectic point at a specific MG molar fraction common to both oils for each MG pair. This eutectic composition, might suggest that the disparity in alkyl chain lengths within the lamellar structures led to inefficient molecular packing, compared to the compositions outside the eutectic range. MG oleogels formed at these eutectic compositions demonstrated significantly higher elasticity (G' at 5 °C $\approx$ between 150×10^3 to 690×10^3 Pa) than those formed at other ratios. This behavior is attributed to the sub- α phase's disordered packing, which likely facilitates greater oil entrapment within the gel network. The results highlight specifically that reduced chain packing efficiency at the eutectic point correlates with improved oil retention and mechanical strength, offering insights into optimizing gel formulations using MG binary systems in various oil media.



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sciforum-142570: Structurally Stable Aerogel from Marine Biopolymers for Functional Delivery of Virgin Fish Oil

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Virgin fish oil (VFO) is a high-quality source of omega-3 polyunsaturated fatty acids, particularly EPA and DHA, which offer significant health benefits. However, its application remains limited due to poor oxidative stability and undesirable sensory characteristics. Aerogel-based oleogelation presents an innovative non-thermal approach to address these challenges by forming a semi-solid structure that protects bioactive compounds while enhancing formulation flexibility. This study aimed to develop and optimize a marine biopolymer-based aerogel with superior structural capacity for VFO delivery using the Response Surface Methodology (RSM). Optimization was performed using a Box-Behnken experimental design. Three marine biopolymers— κ -carrageenan (0.5–3.0% w/v), chitosan (0.5–4.0% w/v), and gelatin (2–15% w/v)—were evaluated based on two key responses: gel fraction and swelling ratio. The optimized hydrogel was then freeze-dried to produce aerogel. Characterization was conducted using Scanning Electron Microscopy (SEM) for pore morphology, Brunauer-Emmett-Teller (BET) analysis for surface area, Differential Scanning Calorimetry (DSC) for thermal stability, and rheological analysis (frequency sweep) to evaluate oil absorption capacity and viscoelastic behavior. The optimal formula consisted of 0.90% κ -carrageenan, 0.5% chitosan, and 2.02% gelatin, resulting in a gel fraction of 54.50% and a swelling ratio of 23.07%. The resulting aerogel exhibited a mesoporous structure (3–7 nm), a specific surface area of 21.87 m²/g, and an oil absorption capacity of 17.2 g/g. DSC analysis revealed a thermal phase transition peak at 114.2°C and an enthalpy of 80.54 J/g. Rheological testing showed dominant elastic behavior ($G' > G''$, $\tan \delta < 1$), indicating strong mechanical stability. The formulated marine biopolymer-based aerogel proved effective as a structurally and thermally stable VFO delivery system. This innovation shows strong potential for application in functional food products and supports the use of sustainable, clean-label marine-derived materials.



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sciforum-132558: Synthesis and characterization of quaternary ammonium carboxymethyl chitosan grafted onto κ -Carrageenan Hydrogel loaded with Ciprofloxacin For Wound Healing

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Injectable hydrogels capable of undergoing an in situ sol-gel transition are of increasing interest in biomedical applications owing to their minimally invasive delivery, tunable mechanical behavior, and capacity for localized therapy. In this study, we report the development of a κ -carrageenan (κ -CG)/protonated chitosan (CS) hydrogel formed exclusively through physical crosslinking under mild, non-toxic conditions, thereby eliminating the need for chemical grafting or synthetic cross-linkers. Microscopic characterization revealed a uniform and interconnected porous network with smooth internal walls, favorable for nutrient transport and cell infiltration. Rheological analysis demonstrated a high storage modulus, confirming excellent elasticity and structural stability, while compression assays indicated strong mechanical resistance. The hydrogel further exhibited high injectability and strong adhesive properties, enabling precise placement in irregular or deep tissue defects. In vitro cytocompatibility assays using human dermal fibroblasts confirmed high cell viability and enhanced cellular proliferation and attachment, demonstrating a supportive bioactive environment. Importantly, in contrast to previously reported κ -CG/CS hydrogels, this system uniquely integrates injectability, mechanical robustness, and tissue adhesion into a single multifunctional platform for tissue repair. The injectable nature also supports site-specific application and the potential incorporation of therapeutic agents for controlled delivery. Collectively, these results establish the κ -CG/CS hydrogel as a distinct and versatile candidate for wound healing, tissue engineering, and broader regenerative medicine strategies [1,2].



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sciforum-148052: Synthesis of Chitosan–Alginate–Gelatin Aerogel Using Freeze Drying and Dehydrator Techniques as a Matrix for Virgin Fish Oil-Based Oleogel

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Omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are essential components that play a crucial role in maintaining cardiovascular health, brain function, and neurological development; however, their consumption through fish oil faces challenges such as low solubility in aqueous matrices, oxidative instability, and undesirable odor. Oleogelation using porous aerogels is considered a promising approach to enhance the stability and bioavailability of fish oil. This study aims to develop and evaluate dried aerogels based on chitosan, alginate, and gelatin as templates for the synthesis of fish oil oleogels, as well as to compare the effects of two drying methods on the structure and oil absorption capacity of the resulting aerogels. The methods focused on the preparation and characterization of chitosan–alginate–gelatin aerogels using freeze drying and dehydrator drying, as well as their ability to absorb virgin fish oil. Freeze-dried aerogels exhibited an open three-dimensional porous structure with an average pore size of 4.701 nm, whereas dehydrator-dried aerogels displayed a denser (closed-pore) structure with an average pore size of 4.450 nm. The freeze-dried aerogels demonstrated a high oil absorption capacity of 4.48 ± 0.21 g/g and an oil binding capacity of $85.59 \pm 3.73\%$, while the dehydrator-dried aerogels showed no detectable oil absorption and an oil binding capacity that was negligible or close to zero.



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sciforum-142818: Tailoring *in situ* crosslinked oxidized hyaluronic acid based hydrogels for soft tissue engineering

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Mechanical cues at the cellular level play a pivotal role in guiding the development, function, and behavior of neural cells [1]. Understanding how these forces interact with microenvironment is essential for uncovering mechanisms of injury and disease progression in neural tissues [2]. Biomaterials that mimic the extracellular matrix (ECM) and offer tunable mechanical properties are crucial for advancing neural tissue engineering. Hyaluronic acid (HA), naturally present in the brain and biologically favorable, is a promising candidate [3].

We developed ECM-mimicking hydrogels based on oxidized hyaluronic acid (OHA) with tunable mechanical properties for soft tissue applications. HA was oxidized four hours using sodium periodate (NaIO₄), enabling Schiff base formation with gelatin (GEL). The network was further stabilized via enzymatic crosslinking with microbial transglutaminase (mTG) (7.5 mg/ml hydrogel). Thirty minutes of crosslinking at room temperature yielded dual-crosslinked hydrogels with stiffness tunable between 0.3 and 1.2 kPa at 37 °C. Physicochemical characterization showed that increasing GEL from 2.5% to 5% enhanced stiffness. By contrast, higher OHA content (1.25–5%) only slightly improved mechanics and mainly affected swelling, which ranged 40–80%, with a 20–60% wet weight decrease in 28 days in culture medium. The mTG concentration influenced stiffness and proved crucial for degradation resistance compared with lower levels in other approaches. OHA-based hydrogels with lower stiffness supported three-dimensional (3D) culture of various cell types, including primary neurons. Neurons grew and developed best in the softest hydrogels, indicating a cell-friendly, ECM-like environment. These results suggest OHA-GEL hydrogels could mimic neural tissue mechanics in soft tissue engineering.

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sciforum-142863: Time optimized genipin chitosan aerogels for catalytic applications

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Introduction: Natural polymer-based aerogels are gaining prominence as functional catalytic supports in green chemistry. Chitosan crosslinked with genipin forms robust, biodegradable aerogels with tunable surface functionalities and porous structures. In this work, the effect of crosslinking time on the catalytic efficiency and structural properties of chitosan-genipin aerogels is systematically explored.

Methods: Genipin-chitosan aerogels (2.4% w/v chitosan, 1.67% genipin) were prepared with controlled crosslinking times (4, 8, 24, 72 hours) before freeze-drying. Catalytic performance was evaluated using model reactions, while structural evolution was monitored via XRD, SEM, and mechanical testing. Mechanical properties were evaluated using a universal testing machine (Instron 5567, USA) in accordance with ASTM D1621. Repair/healing capability of these materials were analysed and self-healing efficiency was quantified through fracture-repair cycles using water-mediated healing protocols.

Results: Crosslinking time profoundly influenced both catalytic and self-healing properties. Short crosslinking (4-8 hours) preserved 62% self-healing efficiency while maintaining accessible porosity (32-24%) ideal for catalytic applications. Extended crosslinking (24-72 hours) enhanced mechanical strength (2.1-2.4 MPa) but eliminated self-healing capability. Thermal stability improved with crosslinking duration, with main degradation shifting from 274°C to higher temperatures.

Conclusions: Crosslinking time serves as a critical parameter in designing bio-based catalytic systems. This study demonstrates how genipin-crosslinked chitosan aerogels can be tailored for specific catalytic applications by controlling the crosslinking kinetics. The resulting materials offer a sustainable and efficient platform for catalytic processes, aligning with the goals of green and circular chemistry.



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sciforum-142883: Tuning the viscoelastic properties of hydrogels to mimic prostatic cancer microenvironment

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Introduction

Three-dimensional hydrogels are increasingly proposed [1] to mimic biological tissues and micromechanical environments, owing to their tunability. Understanding structure–composition relationships is crucial for tailoring their properties. A prostate cancer (PCa) model was developed using an internally crosslinked [2] alginate/gelatin hydrogel, designed to mimic the micromechanical environment and optimized for bioprinting with human PCa cells.

Methods

Hydrogels were prepared by sequentially mixing solutions/suspensions in 22Rv1 culture medium (final composition of 2% w/v gelatin, 6% w/v alginate, 0.7% w/v CaCO₃, 3.74% w/v GDL, and 3x10⁶ 22Rv1 cells/ml). Hydrogels were then covered with an equal volume of buffered medium. Frequency sweep tests were performed at 20–0.1 Hz at 20 °C, 37 °C, 50 °C using a rotational rheometer. Gelation time was evaluated by time sweep tests.

Results

The hydrogel formed a semi-IPN showing in frequency sweep tests higher G'' at 20 °C and no G' variations upon temperature changes. The timing of the medium addition (t_{add}) was used to control the viscoelastic properties. At 37 °C, 24 h after crosslinking onset, with t_{add} of 60 min, G' reached 5.5 kPa (at 1.05 Hz), within the PCa stiffness range (5–10 kPa) [3], and G'' was 240 Pa. Printability was *a-priori* assessed by rheological analyses and then with a pneumatic 3D bioprinter^{2,4}. The best performance (printability coefficient 1.17) was obtained 30 min after crosslinking onset, with a 25G conical nozzle, 10 mm/s speed, and 70 kPa pressure. After 72 h, cell viability and metabolic activity increased compared to 1 h incubation (slightly below 2- and 1.5-fold, respectively). The initial pH (~6.5) gradually reached neutrality within 2 h (t_{add} 60 min; one medium change after 1 h).

Conclusions

Our study shows how composition and experimental parameters influence the properties of an alginate/gelatin hydrogel, providing a versatile approach for advanced 3D models and other hydrogel-based systems.



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Session 3. Gels in Agriculture and Food

sciforum-148254: Development of Cottonseed Oil-Carnauba Wax-Pectin Emulsion Gels as Innovative Fat Replacers in Processed Meat Products

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Currently fat substitutes using unsaturated oils and emulsifiers are limited, particularly due to thermal instability at processing temperatures above 85°C, which results in emulsion breakdown, phase separation, and loss of functionality. Our Objective was to develop and characterize novel emulgels consisting of cottonseed oil structured with carnauba wax (10% w/w of oil) and pectin (0-10% w/w of oil) as healthy alternative fats for meat products. Emulgels were prepared by mixing heated cottonseed oil-carnauba wax oleogel with glycerol monostearate (2% w/w) containing pectin solutions (0, 2%, 4%, 6%, 8% and 10% concentration). Processing was achieved by controlled temperature processes (oleogel preparation at 85°C, dehydration at 50°C to 25-28% humidity) followed by a subsequent 24-hour stabilization process at 4°C. The systems were evaluated by differential scanning calorimetry, rheology, polarized light microscopy, and oil binding capacity. Even at low concentrations of pectin, onset of melting was delayed. In addition, low concentrations of pectin also improved the viscoelastic characteristics of the emulsions. The oil-binding capacity of the emulsions decreased when 4% or more pectin was added. The 2% pectin emulgel exhibited a high onset temperature (101.71°C) and OBC (95.76%), as well as an improved storage modulus (125.74 kPa), indicating very good structural strength. Cottonseed oil-carnauba wax-pectin emulgels represent an innovation in sustainable fat replacement technology for processed meat. Looking into the microstructure of the emulgels, it is evident that the crystalline structure is maintained with the addition of 2% pectin, resulting in improved rheological properties while preserving gel stability compared to the control (no pectin). However, when pectin is added at levels higher than 2%, a decrease in the bright crystalline structures is observed. This novel approach has the potential to provide the food industry with an innovative solution for developing healthier processed meat products while addressing consumer demands for natural and sustainable ingredients.



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sciforum-142012: Probing Nonlinear Rheological Behavior of Protein-Pectin Crosslinked Networks via Large Amplitude Oscillatory Shear (LAOS)

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Protein-pectin crosslinked networks are increasingly utilized in food science, biomedical engineering, and soft material design due to their biocompatibility, tunable mechanical properties, and functional versatility. While small amplitude oscillatory shear (SAOS) provides insights into linear viscoelasticity, understanding their nonlinear behavior under large deformations is essential for applications involving processing, mastication, or mechanical loading. In this study, we employ Large Amplitude Oscillatory Shear (LAOS) rheology to systematically investigate the nonlinear viscoelastic response of protein-pectin gels formed via enzymatic (e.g., transglutaminase), covalent (Maillard-induced), and ionic crosslinking mechanisms. By combining Lissajous-Bowditch plots with Fourier-transform (FT) rheology and Chebyshev harmonic decomposition, we resolve the contributions of elastic energy storage (G') and viscous dissipation (G'') across strain amplitudes ($\gamma_0 = 0.1\text{--}500\%$). Key nonlinear signatures, including strain-stiffening, yielding, and shear-induced network breakdown, are quantified through the framework of intracycle (elastic/viscous nonlinearities) and intercycle (thixotropic/recovery) dynamics. Our results demonstrate that crosslinking density and polymer ratio dictate the transition from linear to nonlinear regimes, with Maillard-crosslinked networks exhibiting pronounced intercycle softening due to irreversible bond rupture, while ionically crosslinked gels show reversible plasticity. Furthermore, we correlate LAOS-derived parameters (e.g., I_3/I_1 ratio, Q_0) with microstructural changes observed via confocal microscopy or scattering techniques. These findings provide a structure-rheology relationship critical for designing protein-pectin composites with tailored mechanical performance in applications such as 3D bioprinting, controlled release systems, or texture-modified foods. The methodology establishes LAOS as a powerful tool for probing the functional limits of soft biological networks under physiologically and industrially relevant deformations.



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sciforum-148237: Active Edible Coatings for Fresh Food as a Suitable Alternative to Plastic

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Nowadays, it is well-known that plastic is a global problem that affects both the environment and human health. For this reason, different institutions encourage the reduction of plastic use. One way to reduce single-use plastic is using edible gels. These edible coatings serve the purpose of protecting and preserving fruit. This way, the use of petroleum-based plastic would no longer be necessary.

To determine the effect of the edible coatings, fresh tomatoes were used as samples. These were covered with different edible coating solutions, and their evolution was analysed over time. The effects of the concentration of active compounds were studied at 0.5%, 1.0%, and 1.5% in 0.5% chitosan solutions, crosslinked with a subsequent immersion sodium triphosphate pentabasic solution, with the active compounds being carvacrol, curcumin, and polyphenolic extracts obtained from the strawberries and red algae (*Gelidium sesquipedale*). Also, coatings were formulated with β -cyclodextrin inclusion complexes of curcumin and carvacrol. Both complexes were characterised by FTIR spectroscopy to confirm their formation. The tomatoes were stored in a refrigerator at 4 °C.

By a visual analysis, it was determined that the tomatoes coated with curcumin did not show mould proliferation. In contrast, those coated with carvacrol did develop mould. In addition, different decomposition processes were observed depending on the type of active compound. Compared to the control tomatoes, it was noticed that the coatings delayed their decomposition, with the β -cyclodextrin complexes resulting in the longest-lasting tomatoes, followed by the polyphenolic compounds at higher concentrations.

Through this work, the importance of the composition of the coatings in protecting and preserving fresh foods like tomatoes, as well as the influence of the proportions of the active compounds has been determined. Nevertheless, it is advisable to carry out further studies, such as biological analyses, to determine the chemical interactions of coatings with food.



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sciforum-141548: Advancing Sustainable Agri-Food Systems with Biopolymer Hydrogels: From Soil Enhancement to Edible Applications

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Biopolymer hydrogels are synthesized from natural polymers such as chitosan, alginate, cellulose, and starch, each contributing distinct functional properties. Chitosan provides antimicrobial and film-forming abilities, alginate ensures ionic crosslinking and gel stability, cellulose enhances structural reinforcement and water retention, while starch offers biodegradability and tunable swelling capacity, collectively making these hydrogels promising sustainable materials for agri-food systems. These hydrogels are synthesized through cross-linking strategies such as chemical grafting and ionic interactions, which impart tailored network architectures. As a result, they exhibit remarkable water retention (up to 400× their dry weight) and controlled-release capabilities, positioning them as effective materials for soil conditioning and nutrient delivery. Recent studies have demonstrated the efficacy of biopolymer hydrogels in agriculture, particularly in improving soil and nutrient management. For example, crosslinked xanthan guar gum hydrogels sustained soil water retention across 12 wet and dry cycles, while starch polyacrylamide hybrids increased nitrogen use efficiency in wheat by 20 to 30 percent and reduced fertilizer leaching. In food systems, chitosan-thyme oil hydrogel coatings extended the shelf life of fresh-cut fruits by 3–5 days by mitigating moisture loss and oxidative spoilage, and alginate-chitosan encapsulation boosted probiotic survival by 2–3 log units during digestion. Environmental benefits include a 30–50% reduction in greenhouse gas emissions compared to synthetic polymers, alongside biodegradability and waste valorization potential (e.g., dairy by-products acid whey used in hydrogel synthesis). Future research should prioritize large-scale field trials to validate long-term agroecological impacts and optimize cost-effective production methods for global scalability. Despite challenges like variable mechanical strength, advancements in stimuli-responsive (pH/temperature-sensitive) hydrogels and precision agriculture integration promise to further optimize their performance. Collectively, biopolymer hydrogels represent a transformative approach to sustainable agri-food systems, balancing ecological and economic demands while aligning with global sustainability goals.



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sciforum-130836: Characterization of mozzarella cheese analogue with reduced saturated fats using soybean oil and beeswax oleogels

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The excessive consumption of saturated fats has been linked to an increased risk of non-communicable diseases such as cardiovascular disease and type II diabetes. As a result, consumers increasingly seek healthier food options, prompting the food industry to explore innovative ingredients that enhance nutrition and functionality. Oleogels, structured gels made from plant-based oils, are emerging as promising alternatives to traditional solid fats in dairy products due to their ability to improve fat profiles by increasing unsaturated fatty acids and reducing saturated fats. Soybean oil was structured into oleogels with varying yellow beeswax concentrations and evaluated as a solid fat alternative for low-saturated-fat mozzarella cheese analogues. Oleogels showed reduced sensitivity to temperature changes compared to shortening. Replacing shortening with oleogels resulted in cheese samples with harder and more cohesive textures. Moisture content significantly varied across treatments ($p < 0.05$), increasing with oleogel concentration: the control sample (T0) had $53.00\% \pm 0.007$, while T3 had $57.32\% \pm 0.004$. Microscopic analysis reveals that oleogel-based cheese displayed a dense droplet aggregation similar to the control, with increased beeswax content enhancing droplet density and crystal network formation. Textural analysis demonstrated that no significant differences were observed in adhesiveness, springiness, or cohesiveness. However, hardness values were significantly different ($p < 0.05$), increasing from 7.09 ± 0.16 in T0 to 9.97 ± 0.11 in T3. Fracturability also showed a significant difference ($p < 0.05$), with T0 at 6.89 ± 0.11 and T3 at 9.50 ± 0.40 . The SFA/USFA ratio significantly decreased across all treatments ($p < 0.05$), with T1 at 0.0122 ± 0.004 and T3 at 0.0289 ± 0.002 , compared to 0.79 ± 0.02 in the control. Meltability slightly decreased from 83.75 mm in the control (T0) to 81.23 mm in the 4% oleogel sample (T1). L^* values increased significantly ($p < 0.05$) with oleogel, indicating a lighter appearance, while a^* values remained consistent. b^* values increased with oleogel concentration. This research provides insight into the possible uses of oleogels, a milk fat substitute with useful characteristics, in the production of mozzarella cheese.



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sciforum-135165: Chitosan- alginate-based hydrogels for agricultural and horticultural applications

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Introduction: The transboundary pollution of aquatic ecosystems, promoted by the excessive utilization of nitrogen and phosphorus-based fertilizers, is causing an overgrowth of algae. Therefore, the development of controlled-release systems is necessary to avoid the wastage of agrochemical compounds. In this context, this study develops chitosan-alginate-based hydrogels for potential use as a direct nutrient source for plants and for improving water retention.

Methods: Physicochemical properties were determined through Fourier Transform Infrared Spectroscopy (FTIR) and Thermogravimetric Analysis (TGA). Mechanical performance was evaluated using strain and frequency sweep tests, as well as temperature ramps, analyzing the modification through the two-step gelation process. Moreover, microstructural characterization was determined using Scanning Electron Microscopy (SEM). Finally, the water uptake capacity was measured after several cycles.

Results: The results confirmed the feasibility of combining chitosan and alginate to form polyelectrolyte hydrogels with predominantly solid behavior. Particularly, hybrid systems (50-50 CH-ALG) exhibit intermediate behavior in comparison to the unitary systems, combining good mechanical properties, with an elastic modulus similar to the chitosan-based system for shorter immersion times (2500 Pa), while improving its water absorption capacity (4500 %) because of the abundance of carboxylic groups that enhance water-polymer interactions. In terms of microstructure, chitosan exhibited a spongy morphology with increasing porosity as the immersion time increased, while alginate displayed a defined laminar structure. Finally, the material demonstrates good integration and thermal stability over a temperature range of 20–40 °C.

Conclusions: Chitosan-alginate-based hydrogels demonstrate potential for redefining agricultural practices, thereby mitigating ecological damage caused by conventional fertilization methods.

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sciforum-142914: Development and characterization of oleogel foams based on monoglyceride and lecithin in vegetable oil.

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The low-fat food production, the delivery of pharmaceuticals, or cosmetics development have led to research and innovation in gas-in-oil systems (i.e., oleofoams) based on vegetable-based formulations. The objective of this work was to develop stable foams based on monoglyceride (MG) and lecithin (LC) oleogels in vegetable oil for applications in the above systems. Four formulations were evaluated at a fixed MG concentration of 4% with 0%, 0.25%, 0.5%, and 1% (w/w) of LC. Foaming ability was calculated as the overrun percentage; the thermal and mechanical properties were characterized by DSC and rheology, respectively; PLM identified the microstructure; all determinations were performed during storage at 0, 7, 15, and 30 days at 15°C. The results showed that the foam volume doubled the initial volume of the oleogel (i.e., 10 mL to 20 mL), remaining this way for up to 7 days. During this period, 2.5 to 3 mL of oil volume had been released. The foam remained stable for up to 30 days without collapsing. The melting temperature (TM) of each formulation studied was statistically the same after 7 days until 30 days of storage ($p > 0.05$); the TM was higher when the concentration of LC increased in the formulation. The foam rheology was increasing during storage (e.g., 4%MG+0.25%LC at 0 days: 953 Pa $\pm$ 156, 7 days 20240 Pa $\pm$ 1386, 30 days: 27580 Pa $\pm$ 3167; 4%MG+1%LC at 0 days 288 Pa $\pm$ 66, 7 days 14330 Pa $\pm$ 156, 30 days 21610 Pa $\pm$ 382) as the loss oil was released slowly. The foam consisted of a mixed network of MG-LC crystals and air droplets, which were also stable over time. This allowed us to propose an alternative material based on a stable oleofoam of MG-LC for the structuration and/or formulation of food, cosmetic, or pharmaceutical systems.



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sciforum-142489: Development of fresh pasta with carob-xanthan hydrogel and acorn flour: a promising gluten-free and egg-free alternative

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Pasta is a staple food that is deeply rooted in the Italian gastronomic and cultural traditions, often serving as a symbol of tradition and regional identity. In its fresh form, the dough of some pasta types is enriched with eggs, enhancing nutritional, technological and sensory profiles.

The growing demand for plant-based, allergen-free, and environmentally sustainable products is driving innovation in food formulation. However, such products - particularly gluten-free variants - often present structural and sensory limitations, which are typically overcome through the use of complex mixtures of additives. This practice is in contrast to the trend to reduce ingredient lists.

In this context, the present study aims to develop a gluten-free and egg-free pasta formulation that meets the nutritional, technological and environmental needs. A plant-based hydrogel composed of carob seed flour and xanthan gum was utilised to mimic the viscoelastic properties of gluten and eggs. An alternative gluten-free flour, obtained by milling of acorns, was proposed as a total or partial substitute for rice flour, offering a strategy to valorize this neglected ingredient.

The ratio of gel to flour was optimized through preliminary tests. The rheological, physicochemical and nutritional properties were evaluated.

The incorporation of the hydrogel resulted in improved dough elasticity and texture, while the use of acorn flour contributed to a darker color, enhanced sweetness, higher lipid and fiber content, and a notably higher phenols and antioxidant activity.

In conclusion, the present study highlights two key results: the effectiveness of plant-based hydrogels as structural and functional agents in gluten-free and egg-free fresh pasta, and the nutritional and environmental benefits of using acorn flour as an alternative to conventional gluten-free flours.



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sciforum-117469: Efficacy of Chitosan and Alginate-Based Gels for Inhibition of *Botrytis cinerea* and *Penicillium expansum* in Strawberries and Blueberries

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Introduction: Post-harvest fungal decay poses a major challenge to the berry industry, with *Botrytis cinerea* (gray mold) and *Penicillium expansum* (blue mold) being the primary pathogens that reduce fruit shelf life and marketability. The present study evaluates the effectiveness of chitosan- and alginate-based gel coatings, enriched with natural antimicrobial agents, in reducing fungal decay and maintaining quality in strawberries and blueberries. **Methods:** Chitosan (1–2%) and sodium alginate (1–2%) solutions were prepared, adjusted to optimal pH, and applied as coatings to freshly harvested fruits. Control samples were treated with water. All fruits were stored at 4 °C and 20 °C, and fungal decay, fruit firmness, and moisture loss were monitored over a 14-day storage period. **Results:** The results demonstrated that chitosan-based coatings significantly suppressed the growth of *B. cinerea* in strawberries, while alginate gels showed greater efficacy against *P. expansum* in blueberries, reducing decay incidence by 35–40%. Both coatings also reduced water loss and preserved fruit firmness compared to controls. Notably, the shelf life of treated fruits was extended by 4–5 days under both storage conditions. **Conclusion:** Chitosan- and alginate-based gel coatings represent a promising, eco-friendly alternative to synthetic fungicides for managing post-harvest fungal decay in berries. By forming protective barriers and incorporating natural antimicrobials, these coatings not only suppress pathogen development but also maintain fruit quality and reduce food waste. Further research focusing on formulation optimization, synergistic combinations of bioactive compounds, and large-scale application is recommended to facilitate their commercial adoption.



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sciforum-147275: Emulgel structured with citrus fiber as potential delivery system of curcumin (*Curcuma longa*) for food application: viscoelasticity modelling, morphology and in vitro diffusion study

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Citrus fiber is recognized to be a structuring ingredient able to form particle hydrogels (in water) or emulgels (oil droplets entrapped in water phase). Emulgels are used in a wide range of food applications such as low-fat and low-calorie foods or food supplements since they are particularly suitable for the delivery of bioactive molecules. In the present work, emulgels containing citrus fiber and potentially suitable as a food supplement of curcumin were produced by high-speed homogenization and using two different edible oils, Miglyol® 812N and rice oil (both at 0.4 w/w). Viscoelasticity of emulgels and of single phases (hydrogels and oil phases) was investigated by frequency sweep test in linear region, previously determined by stress sweep test. Consistency, in terms of complex shear modulus (G^*), of both hydrogel and emulgels increased more than linearly with increasing fiber fraction (from 0.020 w/w to 0.030 w/w) whereas structuring degree, in terms of phase angle (δ), was almost independent of the fiber fraction. The addition of curcumin does not affect the viscoelasticity of oil phases based on both oils. Emulgel with rice oil showed higher G^* than that containing Miglyol® 812N, but they showed similar δ . Rheological results of emulgels were modelled using the weak gel model. Gel strength increases with increasing fiber fraction; network extension seems independent on fiber concentration. Curcumin does not change the consistency of emulgels, but it slightly decreases structure extension (δ moves from 5.5° to 7.0° approximately). According to in vitro diffusion studies, the diffused curcumin percentage (Cur%) at 24 h was 14.6% for emulgel with Miglyol® 812N whereas for emulgel with rice oil 18.3%. These results can be considered promising to make future investigations attractive for the development of edible emulsions for the food supplementation of curcumin.



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sciforum-142857: Formation of olive oil oleogels with anhydrous milk fat fractions.

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Driven by increasing nutritional concerns and regulatory efforts to reduce trans fatty acids and saturated fats in processed foods, alternative lipid structuring strategies have gained significant attention. Oleogelation, the immobilization of liquid oils within a gel-like network, offers a promising approach for developing semi-solid fat analogs with improved lipid profiles. This study aimed to identify the optimal dry fractionation temperature of AMF and the minimum effective concentration required to structure olive oil into a stable oleogel.

Dry fractionation of AMF was performed via sequential centrifugation at varying temperatures of 30 °C, 35 °C, 37 °C, and 40 °C, allowing separation of distinct high-melting stearin fractions. These were blended with extra virgin olive oil in different ratios (from 5:95 to 15:85 w/w) to identify the minimal concentration required for gel formation. The samples were evaluated macroscopically and thermally characterized using micro-differential scanning calorimetry (μ DSC). The effect of ultrasound treatment on gel microstructure and melting behavior was also assessed.

The 15:85 stearin-to-olive oil ratio using fractions obtained at 40°C yielded the firmest self-standing oleogels. Notably, this stearin originated from the AMF fraction previously obtained at 37°C, indicating that both the pre-fractionation step and final crystallization temperature influence the gelation performance. Ultrasound treatment macroscopically enhanced gel cohesiveness but did not significantly alter melting temperatures. The fractions exhibited overall similar thermal behavior to native AMF, with crystallization peaks and completion temperatures during cooling being slightly shifted to higher values, indicating a higher proportion of long-chain saturated fatty acids. The second heating revealed slightly elevated melting completion temperatures for S40 15% oleogels, reflecting their composition in high-melting triacylglycerols.

AMF fractions, particularly those isolated at higher crystallization temperatures, exhibit strong gelation capabilities in olive oil systems. These oleogels may serve as viable saturated fat replacers in food formulations, pending further optimization for stability, scalability, and functional performance in real food matrices.



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sciforum-142617: Formulation and Characterization of *Penaeus monodon*-Derived Glucosamine Liposomal Gel

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Unlike conventional liposomes, in this study we specifically developed a liposomal gel system, where glucosamine-loaded liposomes were embedded into an alginate gel matrix to enhance the stability and functionality of the delivery system. Liposomes are widely recognized as an effective delivery system for improving the bioavailability of glucosamine, a bioactive compound essential for joint health. This study first produced glucosamine hydrochloride (GlcN-HCl) from black tiger shrimp (*Penaeus monodon*) shell waste through chitosan hydrolysis using ultrasonic extraction with varying HCl concentrations (4–8%). Treatment with 4% HCl resulted in the highest yield and optimal physicochemical properties, including particle sizes ranging from 26 to 239 nm and distinct crystalline peaks at 2θ angles of 9.87° and 28.95° . The obtained GlcN-HCl was then encapsulated into liposomes using the thin film hydration method with soy lecithin:cholesterol ratios of 40:60, 50:50, and 60:40. The best formulation (60:40) showed a particle size of 539.3 nm, a PDI of 1.6, a zeta potential of -3.7 mV, and a high encapsulation efficiency of 98.61%. These glucosamine-loaded liposomes were subsequently incorporated into an alginate gel matrix, forming a stable liposomal gel system. The gel's supramolecular structure was evaluated through syneresis and swelling tests. The optimal formulation exhibited the lowest syneresis and stable swelling capacity, indicating strong matrix cohesion and elasticity. Stability testing demonstrated that the turbidity of liposomes within the gel increased slightly during four days of storage but remained within acceptable limits. Nutritional evaluation further revealed a high choline contribution (82% of the recommended daily allowance), with cholesterol levels remaining safe. Overall, the developed glucosamine liposomal gel demonstrated favorable supramolecular stability and holds potential as an innovative delivery system for functional food applications, particularly for the elderly.



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sciforum-147226: Humic Acid-Enriched Biopolymer Hydrogels: Water Retention, Biodegradation, and Sorghum Growth

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Water scarcity is one of the most limiting factors for agricultural productivity in arid and semi-arid regions. Hydrogels, as three-dimensional polymeric networks, have emerged as promising soil conditioners due to their ability to retain water and act as carriers for nutrients or plant growth-promoting agents. However, most commercial hydrogels are based on synthetic polymers such as polyacrylates, which exhibit limited biodegradability and raise environmental concerns. This has stimulated interest in the development of biobased and biodegradable hydrogels for sustainable agriculture.

In this study, we designed and developed superabsorbent hydrogels based on gellan gum (GG), karaya gum (KG), and humic acid (HA) as eco-friendly alternatives for agricultural applications. The hydrogels were characterized by FTIR, TGA, SEM, mechanical assays, and swelling kinetics. Water retention tests indicated that both GG/HA and GG/KG/HA hydrogels preserved higher soil moisture compared to a commercial polyacrylate hydrogel. Soil biodegradation assays demonstrated that the biopolymer hydrogels lost more than one-third of their weight after 30 days, confirming their degradability under natural conditions.

Biological assays were carried out using sorghum (*Sorghum* sp.) seedlings germinated in a growth chamber at 27±1 °C with a 12 h photoperiod. Both GG/HA and GG/KG/HA hydrogels exhibited no phytotoxicity, while the GG/KG/HA formulation promoted higher growth and chlorophyll accumulation compared to GG/HA.

Overall, GG/KG/HA hydrogels proved to be biodegradable, biocompatible, and effective soil conditioners, positioning them as promising candidates to improve soil quality and crop productivity in sustainable agriculture.



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sciforum-142601: Improving Soil with Biopolymer Hydrogel: Better Soil Quality and Water Retention

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Water scarcity in arid and semi-arid regions requires soil amendments that not only enhance moisture retention but are also biodegradable, locally sourced, and environmentally friendly. This study presents the development and evaluation of three biopolymeric hydrogel composites made from sodium alginate extracted from *Sargassum* spp., and functionally improved with frankincense (*Boswellia sacra*) extract and palm-derived biochar. A commercially available potassium polyacrylate hydrogel and research-grade acrylamide–acrylate copolymer were used as benchmarks for these natural formulations. A comprehensive evaluation of soil hydrogel interactions was conducted through RETC-modeled water retention curves, sequential drying–rewetting cycles, ImageJ crack morphology analysis, and post treatment measurements of soil pH and electrical conductivity (EC). RETC modeling has shown that soil treatment increases saturated water content (θ) from 0.1170 (control) to 0.2679, with high pore uniformity ($n = 4.05$). On the contrary, COM remained only $\theta_s = 0.1313$ despite its high drainage index ($n = 5.0$). R reached the highest $\theta_s = 0.4795$, but with low pore uniformity ($n = 1.63$). Analysis of stenosis revealed soil treated with F. This represents 25% in COM and controls. Quantitative determination of the cracks indicates that COM developed 3.88–6.83% of surface cracks, while R was hacked, while the two soils F and F+B remained intact with 0% crack. Chemical analysis after two cycles of drying–rewetting showed that EC increased EC to 0.7 ds/m in COM, with F and F+B responsible for a threshold below salinity between 0.5 and 0.6 ds/m. The significance of matrix-specific hydrogel evaluation and the desorption stress dynamics specific to surface-applied superabsorbent are underscored by these results. This study provides a new path toward climate-resilient sustainable soil management systems in desert agriculture by managing the design of biodegradable polymers with capillary behavior and soil–water physics.



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sciforum-147091: Innovative agriculture: bicontinuous structures as delivery systems for fertilizers and pesticides

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Fertilizers and pesticides management has become essential over the past few years. The role of fertilizers in increasing crop yields, together with the protection against pests provided by pesticides, is of utmost importance to support the population growth and the increasing pest demand [1]. Moreover, the abuse of these substances has caused significant damages to underground waters and water body, such as eutrophication [2,3]. In this work, bicontinuous interfacially jammed emulsion gels (bijels) are used as controlled release systems and co-release systems for an effective use of both fertilizers (urea) and pesticides (atrazine). The main advantages of these systems reside in the easy production process, being the components simply mixed at room temperature without surfactant molecules. Bijel system was obtained confining hydroxyapatite powdered NPs into a polymeric organic matrix of polycaprolactone that can be loaded simultaneously with fertilizers and pesticides. Initially, the bijel systems have been completely characterized, and their abilities of releasing the loaded molecules have been tested both in water and solid media. As expected, the release was much quicker in water (urea for 3 days, atrazine for 5 days), and slower when moving to solid media. In celite urea was released for more than a week and atrazine for more than 15 days while in soil both urea and atrazine for more than 20 days. Also plants treated with bijels showed promising results: for shoots 15 cm vs 12 cm of the control group and for roots 3.5 cm vs 1.5 cm of the control group [4].

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sciforum-148311: Modeling sensory acceptance prediction based on texture attributes and physicochemical properties in the case study of dairy sweet gel (flan) and plant-based milk substitutes

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The aim of the study was to formulate and optimize a gel-based tartlet by replacing egg protein with plant-based ingredients. Additionally, a mathematical model is proposed that correlates consumer acceptance data with measurable texture profiles and physicochemical properties.

The study establishes sensory acceptance as the target function for optimization, created from statistical design (DOE), using experimental data on mixtures and responses in terms of viscosity, density, colour delta and pH, as well as texture profile in terms of hardness. Once the data has been obtained, optimization is applied to find the firmest and most appealing texture. A Box-Behnken design was used to optimize the oil and protein content of each formulation. To replicate the egg-tartlet's gel texture, 13 mixtures (such as corn, oats, rice, amaranth, chia seeds, chickpeas, soybeans, and almonds) were prepared, then heat-treated at 170 °C for 30 minutes. The optimal formula was a mixture of coconut cream (40%), almond-amaranth protein (25%), and corn starch (35%) on a wet basis.

The resulting texture was measured at $0.18 \text{ N} \pm 0.01$, the viscosity at $35.7 \text{ cP} \pm 12$, and the texture profile analysis included hardness, elasticity, chewiness, and masticability. The consumer preference data was used to study the control tartlet made with eggs and two plant-based versions. The consumer preference data was analysed using a discriminative test to identify whether the substitution approximated the desired texture. A semi-trained panel of 35 people who had received texture identification training evaluated texture, taste, and acceptability. Each panel member signed an informed consent form authorised by the institution's ethics committee.

The statistically optimized formula was presented to the panel on a 9-point scale and a descriptive scale of intensity texture attributes. The panel accepted the plant-based gel-tartlet, but described its elasticity and chewiness as low-intensity attributes. The proposed correlation among textural attributes and sensory perception can be further utilized as a tool for formula development.



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sciforum-142613: Novel food-grade bigels structured with wax from the native stingless bee (*Scaptotrigona mexicana*) and canola oil

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Introduction: Bigels (BGs) are biphasic systems combining oleogel (OG) and hydrogel (HG) networks and are emerging as promising fat replacers in food systems. In this work, food-grade BGs were developed using *Scaptotrigona mexicana* wax—a native stingless bee species of ecological and biocultural importance—as an oleogelation agent. **Methods:** The OG phase was formulated with *S. mexicana* wax and canola oil at a 10:90% (w/w) ratio, while the HG phase consisted of potato starch and κ -carrageenan (10:2% w/w). BGs were prepared at different OG:HG ratios—25:75 (BG1), 50:50 (BG2), and 75:25 (BG3)—and their physico-chemical, mechanical, structural, and microstructural properties were evaluated. **Results:** Oil holding capacity was highest in BG1 (86.46%) and significantly decreased with increasing OG proportion, reaching 64.98% in BG3, which also reduced moisture content (67.44–23.06%), pH (4.83–3.88), hardness (0.52–0.11 N), and viscosity (0.153–0.059 Pa·s). Regarding color, the L^* value decreased from 48.3 to 26.6 and the b^* value from 23.5 to 17.8 from BG1 to BG3, reflecting the natural brown hues characteristic of the wax. Different types of microstructures were identified: (O/W) in BG1, bicontinuous in BG2, and (W/O) in BG3. Electrical conductivity markedly decreased from 4.01×10^{-1} mS/cm in BG1—indicating the HG as the continuous phase—to 5.9×10^{-6} mS/cm in BG3, attributable to the insulating nature of the OG phase. FTIR spectra exhibited characteristic peaks of the OG phase at 2918, 2852, 1740, 1462, and 721 cm^{-1} , with no evidence of new chemical interactions, suggesting physical integration determined by the OG:HG ratios. **Conclusions:** *S. mexicana* beeswax proved to be an effective oleogelator for developing stable food-grade OGs and BGs with tunable properties depending on OG:HG ratios, holding promise as fat replacers. Future research could enhance BG performance by incorporating polymers that improve HG phase stability.



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sciforum-139849: Optimization of pH, Temperature, and Protein for Resistant Starch and Textural Properties of Corn Starch–Pea Protein Gels

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The textural behaviour of starch–protein gels is critical for designing functional foods with enhanced resistant starch (RS) potential. This study explored the influence of heating temperature (75–100 °C), pea protein isolate concentration (5–20 %), and pH (3–9) on the gelation properties of a corn starch–pea protein system. A Minitab-generated Box-Behnken experimental design produced 30 gel samples, and texture profile analysis (TPA) was used to measure hardness, cohesiveness, springiness, gumminess, chewiness, resilience, and adhesiveness. The results showed that pH was the most influential factor in enhancing RS formation, with acidic conditions (pH 3) leading to approximately 24.55% RS content in the gels. Conversely, increasing protein concentration tend to reduce RS levels, suggesting a possible inhibitory effect on starch retrogradation mechanisms. Temperature had a moderate effect on RS formation. Furthermore, higher processing temperatures (87.5–100 °C) significantly improved springiness, cohesiveness, and gumminess, indicating the formation of more structured and elastic gels. Protein concentration also influenced gumminess and springiness at elevated temperatures, while pH had a milder impact on textural attributes. Optimisation results tailored to maximise RS content with specific textural properties for specific food applications, such as set yoghurt revealed a temperature of 100 °C, 5% protein, and a pH of 3, with a desirability score of 0.61. These findings highlight the critical role of formulation parameters in promoting RS formation and modulating texture, providing valuable guidance for the design of functional starch-based food systems. Future studies should apply the modified starch in food systems to assess the functionality and RS levels in model foods.



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sciforum-141981: Poly(vinyl alcohol) cryogels as carriers of phytohormones

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Introduction

In recent years, hydrogel materials have been increasingly used in agriculture, especially for combating soil erosion and enhancing plant productivity.

Poly(vinyl alcohol) cryogels are physical macroporous heterophase gels formed by freezing polymer solutions, maintaining them frozen, and then thawing. PVA cryogels can serve as carriers of various biologically active substances, such as phytohormones that influence plant growth and development.

Methods

Auxins are the group of phytohormones that play a key role in regulating plant growth and development. This class of compounds are universal plant growth regulators that affect cell division, elongation, morphogenesis, and the formation and growth of plant roots. In this work, poly(vinyl alcohol) cryogels were obtained using the freeze-thaw method in the presence of auxins at different concentrations - indole-3-acetic acid and indole-3-butyric acid in nonprotonated and salts forms. For the obtained samples, elastic moduli and heat resistance were estimated, the dynamics of auxin release from the gel matrix into the aqueous environment were studied, and experiments on biological activity of obtained materials were carried out.

Results

The study showed that poly(vinyl alcohol) cryogels formed with the auxins additives saved their elastic and thermal properties. The release of substances into the aqueous environment from the gel matrix occurs without diffusion barriers. It was demonstrated that incorporating auxins into the polymer matrix of PVA cryogels does not lead to a change in their biological activity; specifically, rhizogenesis in plants is stimulated, leading to the formation of more roots and enhanced plant growth.

Conclusion

Thus, PVA cryogels with auxin additives represent a promising type of hydrogel that can be effectively used in agriculture to improve plant's phytoproductivity.



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sciforum-147316: Polysaccharide-derived hydrogel matrix-based platform for beverage quality monitoring

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The detection of contaminants in beverages is essential to safeguarding consumer health and ensuring product quality. In this study, a polysaccharide-derived hydrogel matrix was developed as an eco-friendly sensing platform for the colorimetric monitoring of beverage quality. The hydrogel was fabricated under mild, green conditions using renewable biopolymers and incorporated with selective reagents capable of producing visible color responses upon interaction with target analytes. The hydrogel displayed excellent porosity and water retention capacity, enabling efficient diffusion of analytes and rapid colorimetric response. Distinct and reproducible color transitions were observed when the hydrogel matrix was exposed to BPA, a model contaminant. For quantitative assessment, color changes were captured using a smartphone camera and analyzed through digital image colorimetry. The platform demonstrated good sensitivity, with detection in the low micromolar range, and high reproducibility across multiple measurements. To validate real-world applicability, the system was tested with real beverage samples, including bottled consumables and drinking water. The sensor exhibited reliable performance, with consistent responses and minimal sample pretreatment requirements. The inclusion of a cellulose support enhanced the stability and handling of the hydrogel, further contributing to its practical usability. Overall, the polysaccharide-based hydrogel platform provides a sustainable, low-cost, and user-friendly approach for beverage quality monitoring. Its integration with smartphone-assisted analysis offers strong potential for portable and on-site contaminant detection.



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sciforum-142363: Preparation and Investigation of Starch-Based Hydrogels Crosslinked with Citric Acid

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Introduction. Polysaccharide hydrogels are of great interest due to their biocompatibility and environmental safety. Starch-based hydrogels modified with citric acid—a biocompatible crosslinker—form three-dimensional networks with controlled crosslinking and swelling. This work aims to synthesize and comprehensively study such hydrogels, evaluating their physicochemical properties and biotechnological potential.

Methods. Fourteen starch hydrogel samples were synthesized with citric acid concentrations from 2.4 to 42 mmol per kmol of starch, using a hydromodule of 50 and reaction times between 1 and 5 hours. Key properties—including swelling degree, gel fraction, and sorption capacity for methylene blue (via UV-visible spectroscopy)—were measured [1]. Rheological behavior during synthesis was analyzed, and FTIR spectroscopy confirmed crosslinked network formation. Growth-stimulating activity was assessed via pre-sowing treatment of wheat seeds.

Results. Swelling degree ranged from 0.9 to 1.8 g/g, with gel fraction between 68 and 97%. The optimal synthesis time was 2 hours at 2.5 mmol citric acid per kmol starch, where swelling reached 1.7 and plateaued with longer reaction times. The optimal sample sorbed methylene blue up to 0.89 mg/g. The dynamic viscosity quickly peaks at 0.027 Pa·s within 1.1–1.4 hours, then gradually decreases due to structural changes. FTIR spectra showed intense bands at 1790–1650 cm^{-1} , indicating ester bond formation; band intensity increased with citric acid concentration, confirming higher crosslinking. Growth stimulation varied by conditions: stems grew better in sandy soil, while root development and biomass were higher in Petri dish cultures. Hydrogel-treated seeds showed 10–25% greater germination than controls in both cases.

Conclusion. The developed hydrogels exhibit high swelling, stable gel structure, and enhanced sorption properties. They effectively stimulate plant growth and show promise for agritech applications, particularly pre-sowing seed treatment and soil moisture management.



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sciforum-147774: Structuring Niger Seed Oil with Beeswax: Physicochemical, Structural, and Oxidative Stability Insights into Oleogel Formation

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Substituting saturated and trans fats with healthier lipid systems is an urgent requirement in food formulation, and oleogelation is a viable approach. This work utilised niger seed oil, a novel edible oil abundant in unsaturated fatty acids, which was structured using beeswax as an oleogelator. Oleogels were prepared using a magnetic stirrer at 400 rpm and 90 °C for 20 minutes until the beeswax was fully dissolved. The critical gelation concentration of beeswax was found at 3%, leading to the selection of formulations with 4% (BW4), 7% (BW7), and 10% (BW10) beeswax for physicochemical characterisation.

Physicochemical properties were strongly influenced by beeswax addition. The color parameters shifted with increasing wax concentration, with lightness (L^*) increasing from 36.88 to 48.98, red to green (a^*) changing from -2.03 to -2.52 , and yellow to blue (b^*) increasing from 7.52 to 15.98. Oil binding capacity improved from 93.22% to 98.92%, while hardness rose from 1.4 N (BW4) to 3.4 N (BW10). X-ray diffraction revealed enhanced crystallinity with higher wax levels, while FTIR spectra confirmed that the oleogel retained the chemical identity of the oil. All oleogels exhibited shear thinning behaviour and were best fitted to the Power law model ($R^2 = 0.95-0.99$). Addition of waxes resulted in an increased apparent viscosity of the oleogels. Increased wax levels enhanced the storage and loss modulus, making the gels rigid. It was observed that at higher wax concentrations, creep compliance reduced and recovery rates were enhanced. Oxidative stability tests indicated that although peroxide and p-anisidine values increased during 30 days of storage, higher wax concentration reduced oxidation compared to lower concentrations.

Overall, beeswax-structured oleogels successfully enhanced the functional and oxidative stability of niger seed oil, demonstrating their potential as sustainable fat alternatives in food applications.



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sciforum-148042: Sustainable Marine Biopolymer Gels for Active, Biodegradable Film Formation

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The accumulation of petroleum-based plastics in food demands sustainable, high-performance alternatives. Marine biomass supplies abundant polysaccharides (agar, alginate, carrageenan, chitosan) and polyphenolic co-extracts that assemble into hydrogels and, upon drying, yield functional xerogel films. Here, “gel-derived” denotes films obtained by drying pre-formed gels (e.g., thermo-reversible agar networks) or by casting network-tailored matrices (methacrylation, β -cyclodextrin complexation) that display gel behavior upon hydration. Edible coatings lie outside the scope.

Beachcast macroalgae collected by tidal action were processed within 48 h. This initial phase used red algae (*Gelidium sesquipedale*); the workflow will extend to brown/green macroalgae and microalgae. Polysaccharides were recovered by alkaline pretreatment followed by hot-water extraction, or by ultrasound-assisted maceration; phenolic fractions were obtained by ethanolic maceration and quantified by Folin-Ciocalteu. Agar, alginate, and chitosan were methacrylated. Films were prepared by first inducing gelation (agar sol-gel cooling; network setting in methacrylated alginate/chitosan) and then drying to obtain xerogel films. FTIR and DSC assessed structure/complexation; swelling probed rehydration.

Conventional agar extraction yielded 0.80 g from 5 g dry biomass, whereas ultrasound yielded 0.50 g. Total phenolics were low in algal extracts (0.0925 mg GAE·g⁻¹ dry biomass in an early batch; later protocol: 10.49 mg·L⁻¹) with excellent calibration ($R^2 = 0.992$). FTIR revealed intensified C–O and emergent C=O bands consistent with methacrylation; β -cyclodextrin inclusion with curcumin/carvacrol was supported by band shifts and DSC. Agar hydrogels dried into uniform xerogel films; agar–lignin remained stable, while agar–tannic acid failed. Methacrylated alginate and chitosan films exhibited improved handling and cohesion.

This study delineates a gel-to-xerogel route from marine biomass to functional films, combining sustainable extractions with chemical and supramolecular tailoring. Early films show structural integrity and processability; ongoing work targets water stability, thermo-mechanical optimization, and expansion to brown/green/microalgae, with quantitative assessment of barrier, antioxidant/antimicrobial performance, biodegradability, and scale-up for food-packaging applications.



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sciforum-142557: Synthesis of a Chitosan–Carrageenan-Based Bigel Using Aquatic Lipid as a Sustainable Liquid Phase for Fat-Reduced Chocolate

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Fat reduction in chocolate confectionery can be achieved by partially replacing cocoa butter with structured systems such as bigels. Bigels are biphasic systems consisting of hydrogel and oleogel domains, which form interpenetrated networks to deliver both aqueous and lipid functionalities. In this study, a bigel system based on chitosan and kappa-carrageenan hydrogels incorporated into an oleogel matrix was synthesized and applied as a sustainable fat substitute in chocolate products. The oleogel was prepared using glycerol monostearate (GMS) as the structuring agent combined with pangasius oil, an aquatic lipid phase derived from a freshwater aquaculture by-product, characterized by low polyunsaturated fatty acid content and favorable sensory attributes. Compared to commercial plant-derived oils, this lipid source exhibited no detectable fishy odor, making it highly suitable for incorporation into sweet confectionery systems. Three ratios of hydrogel-forming agents (chitosan, a cationic polysaccharide: kappa-carrageenan, a sulfated polysaccharide = 25:75, 50:50, and 75:25) were evaluated in terms of oil binding capacity (OBC), thermal behavior, viscoelastic properties (frequency sweep), and proximate composition of the final chocolate formulation. The color, total fat content, and total energy were also assessed to determine the functional performance of the bigel system. Among all tested formulations, the 50:50 chitosan–kappa-carrageenan ratio exhibited the highest oil binding capacity (98.75%) and stable thermal characteristics, as indicated by a melting point shift on the thermogram, suggesting strong internal structuring and oil entrapment. The incorporation of this bigel (containing chitosan and GMS-structured oleogel) into the chocolate matrix resulted in a significant reduction in total fat content compared to commercial chocolate, while maintaining acceptable physical properties. These findings demonstrate the potential of sustainable hydrogel-in-oleogel systems structured with GMS and pangasius oil as functional fat replacers in chocolate products. Furthermore, the valorization of aquatic by-products such as pangasius oil offers a promising strategy to enhance the sustainability and nutritional profile of confectionery formulations.



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sciforum-138665: Ultrasound-Enhanced Gelation and Functional Properties of Faba Bean Protein for Clean-Label Food Applications

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Faba bean (*Vicia faba* L.) protein has gained significant attention as a sustainable, allergen-friendly alternative in plant-based food formulations. However, its native gelling and techno-functional properties often require improvement to meet product development needs. This study investigates the effect of ultrasound treatment on the gelation behavior and functional attributes of faba bean protein isolate to enhance its performance in clean-label food systems. Given the increasing consumer demand for natural and minimally processed ingredients, ultrasound offers a non-thermal, environmentally friendly approach to protein modification that preserves nutritional quality.

Moderate-frequency ultrasound (40 kHz) was applied under controlled conditions to modify protein structure and interactions. Treated samples demonstrated improved solubility, reduced particle size, and enhanced surface activity. These modifications translated into significantly increased water-holding capacity, emulsifying ability, and gel strength. Rheological analysis revealed stronger, more elastic gel networks, while FTIR spectroscopy confirmed ultrasound-induced conformational changes, such as increased β -sheet content and partial unfolding—favorable for gel matrix formation.

The results suggest that ultrasound is a promising green processing method to enhance the functionality of faba bean protein without the need for chemical additives. This technique enables the development of structured, high-protein plant-based foods, including meat analogs, dairy alternatives, and nutritionally enriched gels. The study contributes to sustainable innovation in functional food design, aligning with consumer demand for minimally processed, protein-rich products.



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sciforum-142781: Utilization of dry-fractionated pea starch as a gelling agent in jelly candies

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Dry fractionation is primarily known as a technology for extracting plant proteins. However, this process also produces considerable amount of starch-rich fraction, which is currently neglected and mainly destined for animal feed. In this study, we investigated the gelling and physicochemical properties of dry-fractionated (DF) pea starch and compared them to gelatin and corn starch. Jelly candies were produced with these gelling agents, and a rheological characterization was performed. Amylose and amylopectin, water absorption (WAI) and solubility indexes (WSI), and the Least Gelling Concentration (LGC) were determined on the ingredients. Jelly candy formulations were based on the LGC results. Starch concentrations increased by 4% increments, as smaller increases showed no significant rheological differences. Rheological characterization included amplitude sweep tests to define the linear viscoelastic region (LVR); yield stress and strain at the LVR limit were used to construct a texture map. Frequency sweep and shear rate ramp tests were also performed. DF pea starch showed a higher amylose content and WSI than corn starch (39.7 % vs 15.5 %). The LGC values were 16 % for DF pea starch, 12 % for corn starch, and 6 % for gelatin. DF pea starch jelly candies showed higher viscosity and more resistance to shear stress than corn starch ones, due to their higher amylose content. However, DF pea starch gels had poorer structural recovery, suggesting lower flexibility and elasticity under deformation. Corn starch gels recovered better and were more elastic. Rheological texture map indicated that DF pea starch candies were mushy, corn starch ones were rubbery, and gelatin-based candies were tough. Rheological analysis showed that DF pea starch forms a weaker gel, but blending it with corn starch may help replicate gelatin texture. As a co-product of protein extraction and often underutilized, DF starch offers a sustainable opportunity for new product development.



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Session 4. Gels in Medicine, Regenerative Medicine, Pharmacy, and Personal Care Products

sciforum-147053: A cytocompatible photoresponsive hydrogel to study cell response to dynamic topographies

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Introduction: In tissues, cells need to continually interact with topographically changing extracellular environments. However, most studies on cellular responses to topographical cues have focused on static conditions, neglecting the dynamic, spatiotemporal variations found in native tissues. To address this gap, we introduce a simple and effective approach: a dynamic cell culture platform utilizing a light-responsive spiropyran-containing poly(N-isopropylacrylamide) (Sp-pNIPAM) hydrogel.

Methods: We produced surface-constrained Sp-pNIPAM hydrogels coated with a thin elastomeric layer to minimize buffer interference. Upon blue light illumination (455 nm) through a mask, the stable, hydrophilic protonated merocyanine form in the exposed areas isomerizes to the hydrophobic spiropyran form, resulting in local hydrogel shrinkage and a controlled microscale change in hydrogel surface topography.

Results: Optical interferometry showed that a variety of topographies, defined by the mask features, can be successively and reversibly generated in the same hydrogel samples within ~15 min, without any measurable change in surface strain, stiffness, and roughness. When cells were cultured on the hydrogels, no significant difference in cell viability and DNA damage was observed before and after (masked) illumination. Recurring light-induced topographical changes was observed to result in reorganization of cell nuclei and focal adhesions, where fibroblasts form their focal adhesions (FAs) largely on the dynamic regions but shift their nuclei away from the dynamic regions. This dynamic conditioning was further found to be associated with epigenetic modifications and modulation of fibroblast phenotype.

Conclusions: Overall, our hydrogel-based platform offers a new approach to dissect the dynamic interplay between cells and their microenvironment and shines a new light on the cell's ability to adapt to topographical changes through FA-based mechanotransduction.



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sciforum-147980: Advancing Nanomaterial Immunomodulation with Engineered ECM-Mimicking Matrices

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The extracellular matrix (ECM) plays a pivotal role in regulating immune cell behavior and modulating the biological response to nanomaterials (NMs). Understanding how immune cells interact with nanomaterials (NMs) in physiologically relevant environments is critical for the rational design of safe and effective biomedical applications. While conventional *in vitro* models typically expose cells to NMs in suspension, *in vivo* these materials frequently interact with ECM components altering both matrix properties and cellular uptake mechanisms. This critical ECM–NM interface is often overlooked in nanosafety assessments and nanomedicine design. In this study, supported by the PRIN 2022 PNRR program, we developed ECM-mimetic like matrices to investigate the microenvironmental influence on macrophage responses to polystyrene nanoparticles (NPs). The synthetic substrates were engineered via electrospinning using biocompatible polymers blended with gelatin and hyaluronic acid (HA)—two key ECM components commonly found in hydrogels and biomedical gels. These matrices recapitulate essential structural and biochemical features of native ECM. These matrices were pre-loaded with polystyrene nanoparticles (NPs) and used to study the response of THP-1-derived macrophage-like cells. The results showed efficient cell adhesion to all matrix types, particularly gelatin-rich ones, with no significant cytotoxicity up to 48 hours. Importantly, gelatin-containing matrices adsorbed significantly more NPs compared to controls, influencing NP availability and cell interaction. Fluorescence microscopy and flow cytometry confirmed NP internalization by macrophages in contact with the substrates. Notably, in this ECM-like configuration, cell viability was affected by the presence of NPs. Furthermore we investigate the macrophage polarization in pro- or anti-inflammatory phenotypes through flow cytometry analysis. Our findings underscore the importance of using engineered ECM-inspired systems to better replicate the *in vivo* microenvironment in nanotoxicology and immunoengineering studies. Understanding how ECM properties affect NM bioavailability and immune cell behavior is crucial for advancing research in nanotoxicology, immunomodulation, and the development of next-generation therapeutic systems.



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sciforum-136752: Ag⁺ Assisted Poly(vinyl alcohol)/Chitosan Gel for Wound Dressing

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We prepared silver nanoparticles (AgNP) and dispersed into polyvinyl alcohol/chitosan (PVA/CS) solution, and the mixture was dried into a film to prepare silver loaded gel film dressing with excellent antibacterial properties through a simple one-pot method. The tensile test of the sample showed that the prepared film dressing has good mechanical properties and can prevent fracture caused by external forces. This feature avoids frequent dressing changes and reduces the risk of bacterial infection. Protein adsorption experiments have shown that they have good protein adsorption properties and can adsorb microorganisms on the outer surface of dressings (less than 22.03 mg/g). By utilizing the antibacterial mechanism of AgNP, the dressing achieved effective antibacterial effects. In addition, the dressing prepared by this method has good transparency up to 77.94%, which facilitates routine observation of the wound area without removing the dressing, and maintains a sterile environment for over 6 months. In addition, the cytotoxicity and antibacterial tests of silver loaded gel dressings showed that the prepared dressings had good biocompatibility and antibacterial properties, which helps to observe the wound area routinely without removing the dressing and maintaining a sterile environment for a longer period. This study provides new insights into the clinical application of multifunctional silver loaded wound dressings.



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sciforum-121261: Amphiphilic pH-responsive core-shell nanoparticles can increase the performances of cellulose-based drug delivery systems

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Abstract

Organic nanoparticles (NPs) and hydrogels have been widely studied in biomedical field as drug delivery systems. Recently the ability of polymer network and NPs to physically interact each other was applied to create a stable nanocomposite system with improved mechanical properties, able to be injected inside the disease area and release locally the drug [1,2]. In this work a drug delivery system based on the combination of pH-responsive poly((lactic acid-co-methacrylic acid)-b-(di(ethylene glycol) methyl ether methacrylate)) poly((PLA-co-MAA)-b-(EG₂MA)) nanoparticles with cellulose-based solution was developed to create an injectable pH-responsive system for local drug delivery application. Different types of drugs could be released at different pH conditions both from the polymer network and NPsto respond to future demands of using different drugs and therapeutic molecules at the same time for specific therapeutic treatments [3].

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sciforum-136696: An Intelligent Ternary Hydrogel for Rapid Wound Healing

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In this study, a ternary hydrogel composed of polyvinyl alcohol (PVA), chitosan (CS) and tannic acid (TA) with pH responsiveness, self-healing, swelling, water retention and adhesion was developed, which is expected to be used to accelerate wound repair. This PVA/CS/TA (PCT) hydrogel relies on the dynamic borate ester bond between PVA and TA to form a reconfigurable three-dimensional network, which enables independent self-healing without external stimulation. The independent hydrogel can form a combined hydrogel through simple contact, and thus can be used repeatedly. In addition, CS plays the role of antibacterial and pH responsive drug release in the composite hydrogel. The self-healed hydrogel still showed excellent swelling ability, water retention and tissue adhesion. In vitro experiments have confirmed its good biocompatibility and demonstrated that it promotes wound cell repair, in which TA plays a crucial role. Furthermore, in vivo studies have shown that the PCT hydrogel significantly enhances wound closure and collagen remodeling, making healing tissue more inclined towards pre-injury, thereby reducing scar formation. On the basis of wounds protection and repair promotion, the PCT hydrogel can be used for the pH responsive drug release. Model drug release result verifies that PCT hydrogel has environmental responsiveness, which will be beneficial to release corresponding drugs in the microenvironment of wound infection or inflammation in the future. PCT hydrogel is a competitive candidate for wound dressing in clinical application.



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sciforum-134340: Antibacterial superabsorbent hydrogels based on polysaccharides crosslinked with citric acid

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Introduction: Functional hydrogels are currently being actively studied. Due to their unique set of properties hydrogels are used in various fields. In particular, they are used for wound dressings, the global market of which amounted to 476 million dollars in 2024. These materials effectively absorb exudate from the wound and keep it moist. The use of polysaccharides ensures the required level of biocompatibility, crosslinking improves mechanical characteristics, and various additives impact certain properties.

Methods: Hydrogels were made from carboxymethylcellulose (CMC, 1000 kDa) and hyaluronic acid (HA, 800 kDa) crosslinked by citric acid (CA). Polycaprolactone (PCL) nanomaterials obtained by electrospinning, CuO and ZnO nanoparticles, and Aloe vera (AV) were added to hydrogels. The samples were examined by FTIR, SEM and EDS analysis systems. Their appearance, swelling ratio, dissolution in tris-buffer and isotonic solution, pH, hydrophilic, adhesive, mechanical, and antibacterial properties were studied.

Results: The resulting transparent materials have high adhesive and hydrophilic properties. They have an interconnected system of pores with a size 5-100 microns. Based on the FTIR results, the crosslinking of -OH groups in polysaccharides using CA was confirmed by determination of C=O, C-O, O-C-O, and C-O-C ester vibrations. The relative elongation of materials is 170 %. The Young's modulus is 0.8 kPa. The highest swelling ratio was observed for samples with ZnO, CuO, and AV and measured as 919, 749 and 792 %, respectively. The hydrogels were stable for 7 days in model solutions. The highest rate of dissolution was observed in isotonic solution. The materials showed antibacterial properties against gram-positive and gram-negative bacteria.

Conclusions: The materials obtained showed antipathogenic, high mechanical, absorption, and stability properties. It makes them suitable for making wound dressings and effective wound regeneration.

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sciforum-148004: Bioactive hydrogel enriched with natural origin components as benefits for therapeutic applications

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Natural products have consistently attracted scientific interest as promising sources for the development of new and effective therapies due to their potential benefits and relatively low risk of adverse effects. Royal Jelly is a natural product with exceptional biological characteristics, a broad apitherapeutic spectrum and great demand in the pharmaceutical and food industries due to its nutritional properties. It has been shown to inhibit a wide range of bacterial strains, making it a promising candidate for combating microbial infections. Aloe vera is known for its skin benefits, acting as a moisturizer and healer for conditions like burns and acne, while Royal Jelly offers anti-inflammatory, antioxidant and anti-aging effects due to its rich nutrient profile, although studies are ongoing to fully establish its therapeutic potential. The combined use of Aloe vera and royal jelly holds potential for enhancing the body's defense mechanisms against cellular stress, though more research is needed.

The current research objective is related to the synthesis, analysis and characterization of the physicochemical and pharmaceutical properties of the mixture of Royal Jelly with Aloe vera, to form a biocomposite hydrogel of natural origin, for use in therapeutic and anti-aging applications. The prepared hydrogel was comprehensively analyzed and exhibited organoleptic features and favorable properties for wound dressing applications in terms of morpho-structural characteristics, swelling, pH and spreadability. The materials were analyzed by Fourier transform infrared (FT-IR) and Raman spectroscopy, while morphological analysis was performed by scanning electron microscopy (SEM).

The results highlight the considerable potential of these natural hydrogels for the management of chronic wound treatments and microbial infections and draw attention to the advantageous incorporation of Royal Jelly-derived bioactive compounds, providing dual benefits such as anti-aging, anti-inflammatory and antibacterial properties, while promoting rapid wound healing.



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sciforum-142657: Bioactive Sol-Gel Coatings Obtained by Network Embedding of Phytosynthesized Selenium Nanoparticles

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Nanotechnology plays a crucial role in the advancement of functional materials, particularly in biomedical, food, and surface protection applications. Among the metallic nanoparticles investigated, selenium nanoparticles (SeNPs) are notable due to their antioxidant, antibacterial, and anticancer activities. Phytosynthesis offers an environmentally friendly and cost-effective approach to obtain SeNPs, employing plant extracts as both reducing and stabilizing agents. However, their efficient use requires stabilization and controlled release, for which encapsulation in sol-gel matrices has proven to be a versatile and effective strategy [1–3].

This work presents the synthesis and characterization of bioactive sol-gel coatings functionalized with selenium nanoparticles (SeNPs) obtained via phytosynthesis. SeNPs were generated using *Trifolium pretense* or *Curcuma longa* plant extracts, which act as reducing and stabilizing agents, converting Se^{4+} ions from Na_2SeO_3 into elemental selenium (Se^0). The nanoparticles were incorporated into hybrid sol-gel matrices generated from tetraethyl orthosilicate (TEOS) and dimethoxydimethylsilane (DMDMS) in various ratios (TEOS:DMDMS = 2:0.5–2, v/v). Hydrolysis and condensation of the precursors were catalyzed by 0.1 M HNO_3 at 25 °C for 24 h.

The resulting sols were deposited onto glass substrates by dip-coating and thermally treated to consolidate the network and immobilize the SeNPs. Surface morphology was investigated by atomic force microscopy (AFM) and scanning electron microscopy (SEM), chemical structure by Fourier-transform infrared (FTIR) spectroscopy, optical properties by UV-Vis. Antimicrobial tests against *S. aureus*, *E. coli*, and *C. albicans* confirmed the biological activity of the coatings.

The results suggest strong potential for these SeNP-based sol-gel materials in biomedical and protective applications such as wound dressings, antioxidant/UV protection films, and antibacterial textiles.



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sciforum-142919: Bone Tissue Engineering via Collagen Hydrogel-Coated PHBV-BG Scaffolds: Mimicking Both Rigid and Soft Tissues

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Introduction: Bone is a highly vascularized organ composed of rigid (trabecular and cortical) and soft (bone marrow) tissues. Hydrogels are ideal biomaterials for mimicking soft tissues. This work focuses on functionalizing 3D-printed scaffolds with collagen hydrogel to improve biological performance without compromising mechanical integrity.

Methods: Scaffolds were 3D printed using filaments composed of polyhydroxybutyrate-co-valerate (PHBV) and bioactive glass (BG 45S5) with a rectilinear pattern and two infill percentages: 20 and 55%. Two surface treatment protocols were evaluated: *Protocol 1*. Scaffolds were immersed in PHBV solution and 1 M NaOH, coated with 0.1% m/V collagen, gelled at 37 °C for 1 h, and lyophilized. *Protocol 2*. Scaffolds were treated with BG suspension in toluene and collagen coated, using the same gelation and lyophilization conditions. Collagen presence, morphology, and hydrophilicity were evaluated via SEM and aniline blue staining, and contact angle measurements. Adhesion was tested according to ISO 2409 and dynamic mechanical analysis (DMA), and stability was evaluated after 96 h of immersion in simulated body fluid (SBF).

Results: The 3D printed scaffolds exhibit dual porosity as a result of the printing parameters, mimicking the hierarchical distribution of interconnected pores found in native bone. Both surface treatment protocols allowed collagen gel attachment without altering macroscopic mechanical properties. SEM revealed collagen on the surface and within the pores of the 3D structure. Protocol 1 produced uniform coatings and dual porosity with surface pores between 1 to 10 µm; Protocol 2 led to a heterogeneous collagen distribution. No detachment or cracking was observed in adhesion tests. Collagen remained stable after SBF incubation, indicating retention under physiological conditions. Mechanical properties of scaffolds resemble those of trabecular bone (600 MPa).

Conclusions: The surface treatments preserved mechanical integrity and enabled stable collagen attachment, offering a bioactive scaffold for bone tissue engineering



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sciforum-147703: Boosting engineered cartilage formation with recombinant spider silk

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Introduction: Articular cartilage, being avascular, aneural and lack of lymphatic drainage, exhibits minimal intrinsic capacity for self-repair. The development of effective therapies for cartilage regeneration therefore remains an unmet clinical need. A critical step toward functional cartilage tissue engineering is the design of biomaterials that promote chondrocyte adhesion, proliferation and differentiation. In this study, we examined a novel protein-based silk material for its ability to modulate chondrocyte behavior and support engineered cartilage formation both *in vitro* and *in vivo*.

Methods: Primary chondrocytes were isolated from neonatal mice and cultured in chondrogenic medium. *In vitro*, chondrocytes were co-cultured with a type of recombinant spider silk. Extracellular matrix (ECM) proteoglycan deposition was assessed by Alcian blue staining, while protein expression was evaluated by western blot. Total RNA was extracted from micromass cultures, and chondrogenic markers (Sox9, Col2 α 1, aggrecan) were quantified using real-time PCR. For *in vivo* studies, chondrocyte-laden silk bioscaffolds were implanted subcutaneously into SCID mice for 3 and 6 weeks. Engineered cartilage formation was analyzed histologically using Alcian blue and Safranin O staining.

Results: The protein-based silk material created a favorable 3D microenvironment that promoted strong chondrocyte adhesion and enhanced chondrogenic differentiation. *In vitro*, chondrocytes maintained high viability on the silk material, with conditioned cultures showing elevated cartilage-specific glycosaminoglycan accumulation and upregulated expression of chondrogenic genes. A high cell density was observed at the material interface, indicating robust cell-material interactions. *In vivo*, silk-based chondrocyte bioscaffolds supported cartilage tissue formation after implantation in SCID mice, as confirmed by histological analysis.

Conclusion: The synthetic protein-based silk material exhibits excellent biocompatibility, non-toxicity, controlled biodegradability and strong chondrogenesis-supportive properties. These findings highlight its potential as a promising scaffold for engineered cartilage tissue and as a candidate for future cartilage repair and regeneration therapies.



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sciforum-142662: Chitosan/glycerol gel films for the accurate in vitro evaluation of the corrosion of biodegradable medical magnesium alloys

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Medical magnesium-based metals are widely used in clinical applications, such as bone fixation devices, dental implants, and cardiovascular stents, thanks to their excellent biocompatibility and absorbability, as well as their ability to promote bone regeneration. However, when their degradation rate in the body exceeds expectations, excessive accumulation of magnesium ions may lead to hemolysis or osteolysis, while if the rate is too slow, there is a risk of inflammation from residual material. Therefore, it is essential to accurately quantify the degradation process in order to prevent these complications.

Biodegradable implants interact not only with bodily fluids and blood, but also with tissues and organs such as bones, muscles, and the extracellular matrix. Therefore, traditional electrochemical corrosion evaluation methods that rely on liquid electrolytes fail to accurately assess the degradation of these materials.

To address this issue, we used a chitosan hydrogel, which simulates the elemental composition and microstructure of biological tissues, as the background electrolyte. For example, the 3D porous network of the hydrogel mimics the extracellular matrix and intramuscular connective tissue, allowing for a more accurate assessment of the degradation process.

In this study, we compared the degradation of the magnesium alloy AZ91D in liquid and gel-based electrolytes through electrochemical analysis and observation of changes in the alloy's microstructure. Our results show that, unlike in solution, where the degradation is rapid and uniform, the alloy degrades more slowly when in contact with gel, accompanied by pitting corrosion on the surface and the formation of a mixed layer between the gel and alloy corrosion products.

We also investigated the influence of chitosan deacetylation degree, film thickness, and electrolyte composition on the corrosion properties of the alloy. These findings can provide a basis for customizing corrosion tests to specific implant sites or individual patient variations in the future.



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sciforum-130930: Design of Alginate/Gelatin Hydrogels for Craniofacial Bone Tissue Engineering: Optimizing Osteogenesis in Dental Pulp Stem Cells Without Compromising Other Cellular Functions

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Alginate/gelatin (Alg-Gel) hydrogels have been explored in combination with mesenchymal stromal/stem cells (MSCs) to support bone tissue formation, reconstruction, and regeneration. A key challenge for clinical translation is optimizing the stiffness of Alg-Gel hydrogels to selectively enhance osteogenesis without interfering with other vital cellular functions. In this study, we investigated the influence of hydrogel stiffness on the adhesion, morphology, proliferation, and osteogenic differentiation of dental pulp stem cells (DPSCs), identifying optimal formulations to decouple osteogenic cues from other cell behaviors. A range of Alg-Gel combinations was cast and cross-linked with 2% CaCl₂ to finetune the mechanical properties. Two formulations were selected: a “low-stiffness hydrogel” (2% alginate, 8% gelatin; 11 ± 1 kPa) and a “high-stiffness hydrogel” (8% alginate, 12% gelatin; 55 ± 3 kPa). The hydrogels exhibited distinct swelling and degradation profiles, with the stiffer formulation showing reduced degradation and improved mechanical stability. Both supported robust DPSC adhesion and proliferation over extended culture periods. However, osteogenic differentiation, assessed by alkaline phosphatase activity, Alizarin Red staining, and bone nodule formation, was significantly enhanced in the high-stiffness hydrogel. These findings demonstrate that the stiffness of Alg-Gel hydrogels can be fine-tuned to promote osteogenesis without compromising other essential cellular functions. Importantly, this biomaterial is currently being investigated as a promising scaffold for craniofacial bone tissue engineering applications.



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sciforum-148313: Designing peptide hydrogels for localised therapeutics in treating Glioblastoma

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Developing fully synthetic, non-animal-derived hydrogels for therapeutic applications is a key challenge in clinical biotechnology. Glioblastoma is an aggressive brain cancer with high recurrence rates, needing innovative treatment strategies where the mainstay is surgical removal, and adjuvant radio- and chemotherapy.

This study explores peptide-based hydrogels as drug delivery platforms for Glioblastoma, using Temozolomide (TMZ). We first studied three peptide designs— F8, KF8K, and E2(FKFE)2E— for the encapsulation of TMZ and observed varying release profiles through UV Spectrometry. We found low pH formulation as an important parameter in preserving the TMZ. We also investigated the effect of TMZ precipitation towards the release kinetics, which contributes to a slower release profile. Metabolic activity assay of U251 MG confirmed therapeutic preservation of TMZ, with E2(FKFE)2E surprisingly exhibiting inherent cytotoxicity. F8 had the most promising stabilization, release and therapeutic preservation of TMZ owing to its low acidic profile. We then studied F8 potential cytotoxicity towards healthy glial cells, which are usually within the surgical site proximity, namely Human Astrocytes and Microglia using established cell lines. The peptides do not show any regression in metabolic activity. We found that F8 has the most promising potential for in vivo drug delivery and will be the focus of the next phase of this investigation.



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sciforum-148307: Development of chitosan-pectin hydrogels for controlled drug release

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Hydrogels are promising materials for smart drug delivery systems due to their biocompatibility, high water absorption capacity and structural similarity to biological tissues, mainly enabling controlled and localized drug release. In this work, chitosan-pectin composite hydrogels were developed through physical crosslinking at different ratios (1:1, 2:1, and 1:2) and pectin concentrations (1%, 2.5%, and 5% w/v), incorporating the drug sulfasalazine. The hydrogels were characterized in terms of their structure, porosity, swelling capacity and mass loss. In addition, the hydrogels were analyzed using Fourier transform infrared (FTIR) spectroscopy and Scanning Electron Microscope (SEM). FTIR analysis confirmed the formation of the polyelectrolyte complex and efficient sulfasalazine incorporation, as evidenced by the presence of bands characteristic of the functional groups of both polymers and of the drug's bonds. SEM revealed a transition from porous to compact structures as the pectin concentration increased. Hydrogels with higher chitosan content exhibited greater porosity and swelling capacity, which is consistent with the SEM observations. In general, it was observed that the influence of pectin on porosity depends on the molar ratio of the polymers. In vitro sulfasalazine release studies fitted both the Higuchi and zero-order models, suggesting that drug release is controlled by diffusion and polymer matrix relaxation. These results demonstrated the potential of chitosan-pectin hydrogels as effective vehicles for controlled drug delivery applications.



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sciforum-148309: Development of novel chitosan-gelatine based hydrogels for drug delivery applications

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Due to the unique properties of chitosan, a biodegradable natural polymer, it has been introduced as a substitute for various materials used in a wide array of applications, from packaging, tissue engineering to wound dressings and controlled release of drugs [1]. For certain applications, however, chitosan hydrogels may not have the best physicochemical characteristics or there's an interest in making the hydrogel more responsive to certain environmental characteristics like pH. Hence, the use of reticulate agents and blending other materials became a useful strategy. Gelatine can form a polyelectrolyte complex with chitosan due to the electrostatic interactions between chitosan's amino groups and gelatine's carboxyl groups aiding in the gelation process [2]. Meanwhile, glyoxal helps stabilizing the hydrogel's structure, increasing its mechanical strength [3].

In this work, we incorporated gelatine and glyoxal with chitosan to synthesize a hydrogel for the delivery of paracetamol which was then freeze dried. The samples were then analysed using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and swelling, degradation and drug release tests were also performed. Several combinations of chitosan and gelatine were used to find a good balance between porosity, durability and release ability. The systems with best performance were those containing the same gelatine and chitosan concentration (2,5%, w/v) mixed in two different ratios 1:1 and 1:2.



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sciforum-142197: Electroconductive hydrogels for spinal cord regeneration

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Introduction

Spinal cord injury (SCI) is a severe condition that compromises the central nervous system, leading to disability and medical complications [1]. Current treatments fail to fully address SCI due to limited neural regeneration and the complex pathophysiology of the disease. Neural stem cells (NSCs) transplantation offers therapeutic potential by promoting tissue repair [1–2]; however, direct injection often results in poor survival and integration [2]. To overcome these limitations, hydrogels can be used as scaffolds that mimic the physical and biochemical properties of neural tissue [2–3]. Incorporating electroconductive polymers may further enhance neuronal differentiation, improving therapeutic outcomes [3]. This work presents the development of electroconductive hydrogels for NSC delivery in SCI treatment. Agarose and gelatin were selected as the biocompatible matrix, while polypyrrole (PPy) and polyaniline (PAni) were introduced for their conductive and antioxidant properties [3–4].

Methods

Agarose-gelatin (AgaGel) hydrogels were prepared by mixing both polymers at 60 °C and cooling to room temperature. Conductive versions were obtained by adding aniline or pyrrole to the hot blend, followed by oxidative polymerization at 4 °C. Residual monomers were removed by washing. Hydrogels were characterized using rheology, swelling tests, conductivity measures, FT-IR, and SEM.

Results

Different AgaGel formulations were created by varying polymer concentrations. Agarose increased mechanical strength, while gelatin improved elasticity but reduced stability at high levels. An optimal ratio was defined to achieve a storage modulus between 100–1000 Pa, ideal for NSCs support. Conductivity and porosity were enhanced by incorporating PPy or PAni without compromising structural integrity.

Conclusions

The proposed strategy enabled the creation of electroconductive hydrogel scaffolds suitable for NSC-based spinal cord regeneration. The combined bioactivity and conductivity provide a promising platform for enhancing SCI therapies.



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sciforum-140021: Engineered HPMC/Starch Hydrogels for pH-Independent Drug Release

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Introduction:

Natural polymer-based hydrogels offer a biodegradable and biocompatible platform for sustained drug release, especially for drugs with pH-dependent solubility. This study investigates the development of hydrogel films using hydroxypropyl methylcellulose (HPMC) and taro starches from two cultivars—*Uroni Vonu* (high amylopectin) and *Vavai Dina* (high amylose)—for the delivery of quetiapine fumarate, a weakly basic drug. The aim was to develop a matrix capable of achieving pH-independent, sustained drug release.

Methods:

Gelatinized taro starch was blended with HPMC at 80:20 and 60:40 (HPMC:Starch) ratios. Succinic acid was incorporated as both a crosslinker and acidifier. Films were characterized using FTIR, SEM, DSC and rheological methods. Swelling and drug release behavior was assessed in gastric (pH 1.2) and intestinal (pH 6.8) fluids. Release kinetics were evaluated using Zero-order, First-order, Higuchi, Hixson–Crowell, and Korsmeyer–Peppas models.

Results:

FTIR and SEM confirmed crosslinking and improved matrix porosity, especially in 60:40 blends. All hydrogels showed pH-independent swelling, with slightly greater uptake in amylopectin-rich formulations. Drug release from uncrosslinked films was pH-dependent. The release of quetiapine fumarate in both gastric fluid and succinic acid-crosslinked hydrogels followed the Korsmeyer–Peppas model, likely due to the presence of acidic conditions. In the crosslinked formulations, succinic acid generates an internal acidic microenvironment that mimics the gastric pH, supporting a diffusion-driven release mechanism. In contrast, the pure HPMC and non-crosslinked hydrogel films best fit the Hixson–Crowell model in intestinal fluid, suggesting erosion-based release from shrinking geometries.

Conclusion:

Succinic acid-crosslinked HPMC/taro starch hydrogels offer a promising platform for pH-independent delivery of quetiapine fumarate. Release kinetics in both gastric fluid and crosslinked films followed the Korsmeyer–Peppas model due to acidic environments—externally in the medium and internally via succinic acid's microenvironment. In contrast, uncrosslinked formulations followed Hixson–Crowell kinetics.



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sciforum-138907: Exploring the future of shaping protein assembly systems for pharmaceutical formulations

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Introduction: Current trends and challenges in pharmacology are focused on protein models designed for sustained drug delivery systems, with applications in the food and healthcare industry. Under unfavorable conditions, proteins form unfolded and partially misfolded intermediates, generating cross β -sheet-rich fibrillar aggregates called amyloid. Protein aggregates have negative impact when involved in amyloidosis diseases, and a positive action when amyloid-like fibrils are used to develop new biomaterials like hydrogels [1]. Bovine serum albumin (BSA), a widely investigated globular protein, is involved in the binding and transport of ligands and drug delivery. The influence of two polyphenols, resveratrol (RESV) and morin (MOR), on the BSA thermal stability with application in obtaining amyloid hydrogel was explored.

Methods: The thermal behavior of BSA in the presence of RESV and MOR was studied by differential scanning microcalorimetry (μ DSC). Congo red (CR) and Thioflavin T (ThT) binding assays were used to detect protein fibrils. Dynamic light scattering (DLS) measurements were carried out to monitor the changes in the protein size due to aggregation. For rheological characterization, the storage modulus (G') and loss modulus (G'') were measured. New features of the polyphenol-albumin interaction were revealed by correlating the experimental data with molecular docking.

Results: The analysis of the μ DSC thermograms revealed the effect of RESV and MOR on protein thermal stability. DLS results support the stabilizing effect of MOR on the protein structure and the role of RESV as aggregation promoter. The red-shift in the absorbance maximum of CR and the enhanced ThT fluorescence indicated amyloid fibril formation. The rheological properties of protein fibrils-polyphenol assembly systems were investigated.

Conclusions: A deeper insight into the action of polyphenols on the protein aggregation process is essential for understanding the features of aggregates and amyloid-polyphenol hydrogels with applications in healthcare.



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sciforum-120121: Exploring the potential of Self-healing hydrogels for breast cancer management

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Introduction: Globally, breast cancer (BC) is the most common cancer among women (~30 % of all new cancer cases annually) and will be the second leading cause of death among women (~42,170) in the United States, 2025 (<https://www.breastcancer.org/facts-statistics>). It is conventionally treated by surgery, radio-, hormone-, chemo-, and targeted therapies, and its treatment depends upon its subtype, stage, and degree of metastasis. Self-healing hydrogels (SHHs) are an innovative approach for the management of BC owing to their distinct properties like self-healability, shear-thinning property, injectability, and stimuli responsiveness and can be used as a multimodal platform for synergistic cancer therapy.

Methods: The literature (research and review articles) was retrieved from various search engines like Google Scholar, Scopus, Science Direct, and PubMed, using keywords such as self-healing hydrogels, breast cancer, and chemotherapy from 2013 to Feb 2025.

Results: SHHs are used as a multimodal platform for managing BC using diverse approaches like stimuli-responsive release of chemotherapeutics, co-delivery of drugs, phototherapy, chemodynamic therapy, starvation therapy, and sonodynamic therapies or combination therapies. Moreover, these hydrogels are durable, reusable, and fatigue-resistant and can restore their structural integrity even after multiple destructions within a few seconds/hours. Additionally, SHHs can also adjust their pore structure because of persistent break-healing cycles leading to higher encapsulation of chemotherapeutics with uniform distribution.

Conclusion: Owing to their distinct properties, SHHs can be used as a promising carrier for the delivery of chemotherapeutics with synergistic anticancer activity on BC cells even at minimal adverse effects, either alone or in combination with other novel strategies.



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sciforum-148260: Formulation and *In Vitro* Evaluation of a Thermosensitive Hydrogel as an Intravaginal Drug Delivery System

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Introduction.

Cervical cancer remains one of the leading causes of female mortality worldwide. Localized drug delivery systems, such as thermosensitive hydrogels for intravaginal administration, offer the potential to improve therapeutic efficacy while minimizing systemic side effects. This study aimed to formulate a thermosensitive hydrogel based on Pluronic F127, hydroxypropyl methylcellulose (HPMC), and Carbopol 940, and to evaluate its physicochemical properties and the cytotoxicity of ibuprofen and cisplatin to explore a potential additive effect.

Methods.

A thermosensitive hydrogel was prepared using the cold method with Poloxamer 407, hydroxypropyl methylcellulose (HPMC), and Carbopol 940. Component ratios were optimized through mixture design considering gelling temperature and viscosity. Physicochemical characterization included viscosity (rotational viscometer), sol-gel transition temperature (tube inversion), and swelling ratio in simulated vaginal fluid. Drug entrapment was assessed by UV-Vis spectrophotometry. Cytotoxicity was assessed in HeLa cells using the MTT assay after exposure to ibuprofen and cisplatin for 24–72 h.

Results.

The hydrogel exhibited a swelling ratio (SR) of 2.08 after 3 h of hydration, corresponding to the point of maximum absorption. Cytotoxicity assays showed that ibuprofen alone induced a dose-dependent decrease in HeLa cell viability, from 98.9% at 0.39 mM to 15.6% at 12.5 mM. The calculated IC_{50} was 9.8 mM. In contrast, sequential treatment with cisplatin at its IC_{50} concentration (24 h) followed by ibuprofen (24 h) markedly enhanced the cytotoxic effect. Under these conditions, viability was already reduced to 44.8% at 0.39 mM and further declined to 9.3% at 12.5 mM, indicating an additive effect of the combined therapy compared with ibuprofen alone.

Conclusions.

A sterile thermosensitive hydrogel was successfully formulated and characterized. The combination of ibuprofen and cisplatin reduced HeLa cell viability more than individual treatments, indicating a potential additive effect, although further studies are required to confirm this.

Acknowledgment.

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sciforum-142218: Formulation strategies for pharmaceutical use of pNIPAM microgel

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Introduction

Poly-N-isopropylacrylamide (pNIPAM) is a thermoresponsive synthetic polymer that undergoes a reversible phase transition from a swollen to a collapsed state when the lower critical solution temperature (LCST) is exceeded (around 32–33 °C). This property makes it a promising candidate for controlled-release topical delivery. However, its poor drug-loading capacity necessitates the development of alternative strategies to enhance its effectiveness. In this study, a pNIPAM microgel was evaluated as a carrier for caffeic acid (CA), selected as a model molecule due to its relatively simple structure. Three approaches were explored: 1. Hybrid pNIPAM–keratin microgel: Keratin was selected for its biocompatibility with topical use. It reduced the particle size without affecting the thermoresponsiveness of the polymer. 2. Use of β -cyclodextrins within pNIPAM: β -cyclodextrins can form inclusion complexes with CA, improving its aqueous solubility (CA has poor solubility, $\text{LogP} \approx 1.2$). 3. Liposomes embedded in the pNIPAM microgel: Liposomes composed of phosphatidylcholine and cholesterol (2:1 molar ratio) were used to enhance CA encapsulation.

Methods

Formulations were characterized by morphology, particle size and surface charge. Stability and loading efficiency were monitored. In vitro diffusion was tested using Franz cells and lipidfunctionalized cellulose membranes mimicking the skin barrier.

Results

All strategies improved CA loading efficiency (>90%). Only keratin and liposome formulations reduced particle size. Thermoresponsive behavior was retained with keratin and cyclodextrins, but not with liposomes. In vitro diffusion showed that pNIPAM–keratin released CA in a temperatureindependent manner, while the other systems displayed temperature-dependent release.

Conclusions

The three approaches explored represent promising strategies for the topical application of pNIPAM, improving its functional properties. However, further studies are needed to evaluate the stability of the systems, as well as their toxicity and rheological profiles.



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sciforum-142568: Gels based on natural polymers containing silver nanoprisms for combined chemo/phototherapy of cancer

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Cancer therapy remains a major contemporary challenge due to the complexity and heterogeneity of tumour biology. In recent years, Nanotechnology has emerged as a promising approach in both cancer diagnosis and treatment with the development of multifunctional nanosystems capable of targeted delivery and therapeutic responsiveness [1–3]. In this regard, hydrogels have been extensively studied as drug delivery systems for cancer, due to their biocompatibility, physicochemical tailorability, ability to protect therapeutic agents and spatiotemporal control of their release [4]. The combination of liposomes containing plasmonic nanoparticles with polymeric matrices represents a particularly attractive strategy for enhancing drug delivery performance, offering the potential to minimise burst release and improve tissue localisation, as well as the capability of response to external stimuli [5]. These plasmonic lipogels allow multiple functionalities, including photothermia and controlled drug delivery, contributing to a multimodal therapeutic approach [6].

In this work, chitosan-based hydrogels and lipogels containing novel silver nanoprisms were developed and studied as multifunctional therapeutic agents, combining local chemotherapy and photothermia. The hybrid nanosystems were characterized and tested as nanocarriers for an anticancer drug, 5-fluorouracil. The results obtained are promising for the application of the new lipogels in multimodal cancer therapy, enabling the controlled release of antitumor drugs triggered by NIR laser light.



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sciforum-124537: Harnessing Hydrogel Interaction with Functional Polymeric Nanoparticles for Sustained Co-Delivery of Therapeutics

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INTRODUCTION

Hydrogel-nanoparticle composites have recently represented a promising strategy to develop hybrid platforms with enhanced properties in the biomedical scenario. This combination has led to superior properties, overcoming the limitations associated with the single systems, such as lack in hydrophilicity and fast clearance, to mention a few. In this work, a nanocomposite hydrogel integrated with functional NPs is proposed to achieve sustained the co-delivery of therapeutics with distinct physicochemical properties.

METHODS

Amphiphilic copolymers composed either by poly(glycerol methacrylate) (PGMA), poly(ethylene glycol methacrylate) (PEGMA), or poly(dimethylaminoethyl methacrylate) (PDMAEMA) and poly(ϵ -caprolactone) (PCL) were synthesized via a combination of Atom Transfer Radical Polymerization and Ring-Opening Polymerization, and then used to form nanoparticles (NPs) loaded with dexamethasone (DEX) via nanoprecipitation. Hydrogels were chemically crosslinked via polycondensation within agarose, carbomer, and hyaluronic acid. Drug-loaded NPs were incorporated into the hydrogel through different formulation strategies, depending on their superficial functional groups to investigate the DEX release, upon different conditions. Hydrogel were simultaneously loaded with BSA to study the co-delivery ability of the system.

RESULTS

The three NPs were either chemically, physically or ionically entrapped within the hydrogel, according to the NPs shell functionalities (Figure 1). Physical encapsulation favoured rapid NPs release within 24h and complete DEX release in 6 days, while electrostatic or chemical linkages displayed limited NPs release, offering sustained DEX release profiles over 21 days, for optimized therapeutic efficacy. Simultaneously, in presence of non-ionic NPs, BSA was completely release in 3 days, while its retention time was increased with presence of cationic micelles.

CONCLUSIONS

The proposed strategy enabled the design of composite drug delivery systems tailored to specific applications. The different encapsulation methods showed influence on both properties and release kinetics of the composite system. The dual-compartment system facilitated the co-delivery of therapeutics, enabling tunable release profiles for combination therapies.



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sciforum-130946: Harnessing Nature: Hydrogels Derived from Bacterial Cellulose and Chitosan for Biomedical Applications

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Bacterial cellulose (BC) is a biopolymer with excellent mechanical strength and purity. However, its utilization in biomedical applications is hampered due to limitation in reactive functional groups. This work presents the development of semi-interpenetrating hydrogels (semi-IPNs) by combining BC with chitosan (Ch) and crosslinking with genipin (Gp), using a straightforward two-step strategy. First, an *in-situ* method was employed to incorporate chitosan directly into the BC matrix during *Gluconacetobacter xylinus* fermentation process. This was followed by an *ex-situ* crosslinking step, where the BC-Ch were immersed in genipin solution to enhance network stability and biocompatibility. FTIR study revealed new amide I and II bands and C–N stretching vibrations confirming the successful modification of BC with Ch. SEM analysis demonstrated that crosslinked BC-Ch-Gp hydrogels exhibited a compact, highly interconnected fibril network with improved porosity. Differential Scanning Calorimetry indicated the presence of free, bound, and intermediate water types, contributing to good water retention capacity of the hydrogels. Swelling studies revealed pH-responsive behaviours, with higher swelling at low pH for crosslinked samples and increased chitosan ratio further enhancing this response. Mechanical testing showed improved stiffness and reduced moisture content in crosslinked hydrogels, making them more suitable for biomedical environments. Antibacterial evaluation confirmed effective inhibition of *Escherichia coli* and *Staphylococcus aureus*. In vitro drug release studies using quetiapine fumarate showed sustained release profiles following the Higuchi model and a combination of non-Fickian and super case II transport, indicating controlled diffusion and matrix relaxation. Using non-pathogenic bacteria and coconut-derived media, this simple dual-method strategy produced safe, functional hydrogels suitable for applications in controlled drug delivery, wound healing, and advanced biomedical dressings



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sciforum-147924: Hyaluronic acid-based hydrogels for suprachoroidal administration in glaucoma treatment: influence of precursors characteristics on hydrogels properties

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Introduction: Glaucoma is a leading cause of vision loss that is associated with the increase in intraocular pressure. The injection of a hydrogel into the suprachoroidal space (SCS) is a promising treatment, decreasing intraocular pressure and allowing drug delivery.

Methods: We developed hydrogels based on hyaluronic acid (HA) and poly(ethylene glycol) (PEG) for the potential delivery of hydrophobic drugs in the SCS. First, HA was modified with thiol groups and then crosslinked with PEG-acrylates via Michael addition, inducing gelation. To mimic physiological conditions, PBS buffer was used as solvent. Curcumin was encapsulated as a model hydrophobic drug. We have studied the influence of varying the modification degree of HA and PEG chain length on the final properties of the hydrogel.

Results: We obtained cohesive hydrogels with fast in-situ gelation times, approximately two minutes, that are tough and able to withstand high shear strains. The gels have a distinctive intense color due to the dispersion of curcumin in the polymer matrix. In vitro tests revealed that hydrogels release the encapsulated curcumin overtime, losing their color.

Conclusion: We have obtained hydrogels with interesting properties, compatible with the injection in the SCS. These materials are very promising and will continue to be studied for this application.



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sciforum-142915: Hydrogel-Based Injectable and Printable Calcium Phosphate Cements (CPC) – Bioactive Glass (BG) Composites for Bone Tissue Engineering

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Introduction: Hydrogels play a central role in developing injectable and printable systems for bone tissue engineering. Their ability to provide structural support, biocompatibility, and processability makes them ideal candidates for creating scaffolds that mimic the extracellular matrix. This study explores a hydrogel-based approach to design composite pastes with tailored rheological, mechanical, and biological properties for bone regeneration.

Methods: A hydrogel matrix composed of biocompatible and biodegradable biopolymers—alginate, gelatine, and hyaluronic acid—was combined with calcium phosphate cements (CPCs) to enhance mechanical strength and mineralization potential. Bioactive glass particles (BG 45S5) were added to the composite to stimulate osteogenesis. The resulting composite pastes were rheologically characterized to evaluate their injectability and suitability for extrusion-based 3D bioprinting. After setting, printed and extruded constructs were analyzed using scanning electron microscopy (SEM), X-ray diffraction (XRD), and mechanical compression tests to assess in vitro stability and bioactivity.

Results: The hydrogel matrix enabled smooth paste injection, stable 3D printing, and a uniform dispersion of active components, contributing to the formation of interconnected porous structures, essential for bone tissue integration. Rheological tests confirmed adequate shear-thinning behavior. The incorporation of BG 45S5 significantly enhanced the bioactivity of the system, as evidenced by the formation of a hydroxyapatite-like layer at different time points after immersion in simulated body fluid. Mechanical testing confirmed the structural integrity of the constructs under compressive load, with compressive strength values between 3 and 5.5 MPa—comparable to trabecular bone—and an elastic modulus ranging from 300 to 700 MPa. By adjusting the hydrogel composition and BG content, setting times were controlled within the clinically acceptable range of 10–15 minutes for surgical use.

Conclusions: This study demonstrates the synergistic effect of hydrogels and bioactive glass in developing printable, injectable, and bioactive gel–cement composites with potential for bone tissue engineering.



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sciforum-135849: Injectable Thermoresponsive Hyaluronic Acid–GelMA Composite Hydrogel Loaded with Tacrolimus and Tyrosinase-Activating Peptides for Local Immunomodulation and Melanocyte Regeneration in Vitiligo

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Vitiligo is an autoimmune skin disorder characterized by localized melanocyte loss due to immune-mediated destruction, resulting in depigmented lesions. Current therapies often lack targeted delivery and regenerative capacity. In this study, we developed a multifunctional injectable hydrogel system composed of methacrylated hyaluronic acid (HAMA) and gelatin methacrylate (GelMA), designed for localized immunomodulation and melanocyte regeneration. The composite hydrogel was synthesized via photoinitiated free-radical polymerization using lithium phenyl-2,4,6-trimethylbenzoylphosphine (LAP) as a cytocompatible photoinitiator under visible light (405 nm). This method enabled tunable crosslinking density, optimized for mechanical stiffness mimicking native dermis (~1–3 kPa). The hydrogel formulation incorporated tacrolimus encapsulated within biodegradable poly(lactic-co-glycolic acid) (PLGA) nanoparticles for sustained, pH-responsive release, and synthetic tyrosinase-activating peptides to promote melanogenic signaling. Rheological analysis confirmed shear-thinning behavior and sol-gel transition at physiological temperature (37 °C). The hydrogel demonstrated excellent biocompatibility and functional efficacy in vitro, as shown by 3D co-culture of primary human keratinocytes and melanocytes embedded within the hydrogel matrix, which exhibited enhanced melanogenesis through melanin quantification assays and upregulation of MITF and TYR gene expression. Immunomodulatory effects were validated by co-culture with activated CD8+ T-cells, which showed reduced cytotoxicity and altered cytokine release profiles. Hydrogel degradation kinetics and tacrolimus release profiles were characterized under simulated dermal pH (5.5) and physiological pH (7.4), confirming controlled biodegradability and sustained drug release. Overall, the HAMA–GelMA injectable hydrogel platform provided a dual-function localized immunosuppressive and regenerative microenvironment, offering a promising strategy for vitiligo treatment. These findings support further in vivo evaluation and potential clinical translation.



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sciforum-148312: Microfluidic Fabrication of Graphene Oxide-Enriched Alginate Nanocomposite Hydrogels for Enhanced Porous Structure and Antibacterial Wound Dressings

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Wound healing aims to regenerate wound with wound dressing such as hydrogels. An ideal wound dressing biomaterials has biocompatible, biodegradable, biomechanics, porous and anti-bacterial properties. The applicability of the general methods in wound healing material is simple, but their inadequacy given their antibacterial, porous and toxic properties can be eliminated using microfluidics. The hydrogel produced by reaction of microfluidic nanocomposite foams with a crosslinker can be used as wound dressing with a more desirable antibacterial, porous structure, and biocompatibility. Even though alginate polymer is a preferred biopolymer for hydrogel-based wound dressing production due to biocompatible, biodegradable, and hydrophilic, its strength and antibacterial properties remain weak. In this study, it was aimed to characterize the production of nanocomposite hydrogels by enriching graphene oxide (GO), which has high biocompatibility, antibacterial, bioadhesion, thermal and mechanical abilities, to improve the mechanical, antibacterial and porous structure properties of alginate hydrogels, and to compare these results with alginate hydrogels by traditional method. To achieve this aim, alginate hydrogels with GO enriched were produced both by traditional method and microfluidics, and XRD, DSC, TGA-DTA, FTIR, SEM, tensile strength characterizations and antibacterial testing were made. Accordingly, these characterization results, it was observed that the GO enriching improved thermal, mechanic properties, and crystal structure properties of the alginate hydrogel. In addition, as a result of SEM results, it was observed that the microfluidic hydrogels had a more desirable porous structure. Besides, according to the antibacterial test results, it was observed that GO enriching and microfluidic hydrogels showed more antibacterial performance. Our findings show that the use of a microfluidic system is promising method to produce GO-enriched wound dressing hydrogels.



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sciforum-142902: Multifunctional ADA-GEL hydrogels reinforced with iron loaded dendritic bioactive glass nanoparticles for bone regeneration

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Introduction: Bone-related diseases and injuries, including osteoporosis, osteomyelitis, and fractures, affect millions globally and pose increasing challenges to public health due to the aging population [1], [2]. Hydrogels composed of natural polymers, particularly when reinforced with bioactive glasses, have gained attention for their tunable mechanical properties, biocompatibility, and ability to support osteogenesis and angiogenesis [3]. In this context, we developed iron-loaded dendritic mesoporous bioactive glass nanoparticles incorporated into alginate-di-aldehyde–gelatin (ADA-GEL) hydrogels, evaluating their physicochemical properties and biological performance.

Materials and methods: Dendritic mesoporous bioactive glass nanoparticles (DMBGNs) were synthesized by first preparing dendritic mesoporous silica nanoparticles (DMSNs) using a dual surfactant template method in a solvent-free system [4]. Calcium and iron were incorporated by dispersing DMSNs in an ethanolic solution of calcium nitrate and iron nitrate, respectively. ADA-GEL hydrogels were prepared following the protocol established at the FAU Institute of Biomaterials [5]. Briefly, 5% oxidized alginate and 7.5% gelatin were mixed in DPBS. 0.1% DMBGNs were incorporated into ADA prior to gelatin addition, and printability was assessed using a BioScaffolder printer, printing a 4-layer scaffolds.

Results: Dendritic mesoporous bioactive glass nanoparticles were synthesized by loading different concentrations of Ca^{2+} and Fe^{3+} , resulting in flower-like porous structures and high surface areas. When incorporated into ADA-GEL hydrogels, nanoparticles maintained their bioactivity, supported by apatite formation in SBF. FTIR and XRD confirmed crosslinking and structural integration, while SEM revealed porous, interconnected hydrogel morphology. Degradation and mechanical tests highlighted improved structural stability in Fe-containing hydrogels, with good printability and mechanical properties.

Conclusions: The results demonstrate that Fe-loaded DMBGNs can be effectively synthesized and integrated into ADA-GEL hydrogels, preserving their mesoporous structure and enhancing mechanical properties, printability, and bioactivity. These findings highlight the potential of ion-modified dendritic bioactive glass nanoparticle containing hydrogels as multifunctional bioinks for regenerative medicine.



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sciforum-148223: Obtaining Mesh Sizes for Viscoelastic Alginate-Based Hydrogels Using Flory Theory and Saxs

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Natural hydrogels are widely used to create scaffolds that emulate the extracellular matrix of different human tissues, due to their high-water content, good biocompatibility, and bioresorbability. Cell adhesion is directly related to the properties of the scaffold on which the cells grow (artificial extracellular matrix). Some authors have shown that the tensile modulus and mesh size of the extracellular matrix are vital properties for cell proliferation.

This study aims to investigate the mechanical properties of a hydrogel composed of alginate (9% in 1X PBS), cross-linked with 0.5 M Ca^{2+} ; and a hydrogel composed of 9% alginate, 4.5% gelatin, and 4.5% hyaluronic acid (AGH). The mechanical properties of the hydrogel were measured using a dynamic mechanical analyzer (DMA), and the obtained curves were fitted using a viscoelastic model. The elastic component of the model was used to calculate the mesh size generated by the polymer network; mesh sizes of 6.3 ± 0.1 nm were obtained for the alginate hydrogels and 19.5 ± 0.2 nm for the AGH hydrogel.

On the other hand, the swelling of the hydrogels in a PBS solution with pH 5 was measured after 5 days of immersion. A modification of Flory's equations, which considers pH-sensitive hydrogels, was used to estimate the mesh size from the swelling tests. Mesh sizes of 2.9 ± 0.1 nm were obtained for alginate hydrogels and 3.5 ± 0.1 nm for AGH hydrogel. These results were related to mesh sizes obtained from SAXS measurements. The obtained curves were adjusted by the Debye-Bueche function, and a characteristic size of 4.15 ± 0.04 nm were obtained for alginate hydrogels and 3.21 ± 0.04 nm for AGH hydrogel.

The incorporation of gelatin and hyaluronic acid increases the mesh size, allowing modulation of the extracellular matrix structure.



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sciforum-147576: Optimized enzyme matrices for 3D-printed microneedle biosensors

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Microneedle (MN) technology offers an advanced approach for minimally invasive biosensing by providing non-painful access to interstitial fluid (ISF) and enabling continuous, real-time monitoring. The dermis (1-3 mm thick) is the skin layer where the ISF content is maximum (40 % of the water content is ISF)¹. Thus, MN structures must be in the range from 200 to 1500 µm to penetrate the outer skin layers and reach the ISF.

In this study, MN patches were designed and fabricated via 3D printing; then MN were transformed into electrodes for electrochemical sensing by gold sputtering. Silver-filled vias were used for electrical interconnection to the potentiostat contacts and Prussian blue (PB) was used as an artificial peroxidase, being electrodeposited on the MN tips to facilitate the detection of glucose and lactate in the presence of their respective oxidase enzymes².

The primary objective of this study was to enhance the performance of these biosensors by optimizing the enzyme immobilization matrix, a crucial determinant of sensor stability and analytical efficiency. Three different biopolymer-based hydrogels—chitosan (CHI), silk fibroin (SF), and methacrylated hyaluronic acid (MeHA)—were evaluated for their ability to maintain enzymatic activity, minimize enzyme leaching, and modulate analyte transport. Diffusion behavior within these matrices was assessed using ferrocyanide as a model electroactive probe on gold microelectrodes. Crosslinking was employed in all hydrogel systems to reinforce structural integrity and promote enzyme retention. The results demonstrate that the choice of immobilization medium significantly affects both sensitivity and dynamic range, providing insights for the development of robust, wearable MN biosensors for applications such as diabetes management.



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sciforum-142738: Photo-crosslinked water-soluble PEA-based hydrogels for cell encapsulation: A rheological study

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Introduction

Scaffolds for tissue regeneration can be made from bio-based polymers, which offer inherent biological compatibility. However, batch-to-batch variability and limited tunability restrict their broader application. In contrast, biodegradable synthetic polymers allow precise control over chemical and mechanical properties but lack biological signaling [1]. Amino acid-containing polyester amides (PEAs) address this gap by combining biocompatibility with tunability. The polyester segment ensures biodegradability, while the polyamide segment enhances mechanical and thermal stability [2]. Hydrogels based on amino acid-derived PEAs offer a favorable environment for cell proliferation, with reproducible physical and chemical properties [3–5]. Photopolymerization enables simple, non-toxic in situ gelation at physiological pH and temperature [6]. However, excessive UV exposure can damage cells [7], making it essential to minimize exposure while ensuring proper gelation.

Methods

PEAs were synthesized in two steps. First, Monomer 1 was prepared by esterifying an amino acid (L-alanine, L-valine, or L-leucine) with a diol (1,6-hexanediol, 1,10-decanediol, or 1,12-dodecanediol). Second, Monomer 1 was polymerized with di-*p*-nitrophenyl fumarate (to introduce crosslinkable sites) and PEG-diamine (for water solubility) in dimethylacetamide at 70 °C for six hours. The resulting PEAs were photo crosslinked using Irgacure 2959 or LAP. Gelation time and plateau modulus were determined by rheological analysis of storage (G') and loss (G'') moduli.

Results

For PEA10A5K (alanine, 1,10-decanediol), gelation times with 0.4% Irgacure, 0.5% LAP, and 0.05% LAP were 1.5 h, 3 min, and 12 min, respectively (Figure 1a). A 0.05% LAP concentration was selected for all further experiments, balancing low cytotoxicity and short gelation time. G' correlated with polymer molecular weight rather than amino acid type (Figure 1b).

Conclusions

Gelation times were determined while keeping the minimal photoinitiator concentration, which is ideal for cell survival in the final application. Next, cell viability and encapsulation studies will be performed.



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sciforum-142645: Preformulatory Studies on Rosmarinic Acid-Nlc for Oral Administration

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Rosmarinic Acid (RA), a natural polyphenol from *Rosmarinus officinalis*, has antioxidant, anti-inflammatory, antidiabetic, antitumor, antimicrobial and antiviral properties. However, its pharmaceutical application is limited due to poor water solubility, low bioavailability, and rapid degradation in the gastrointestinal tract. Fast metabolism and elimination further reduce its efficacy. This study aims to develop nanostructured lipid carriers (NLCs) to enhance oral bioavailability, protect RA from gastric degradation, and allow for prolonged intestinal release, thereby improving its overall therapeutic potential.

NLCs containing Tristearin:Miglyol® or Tristearin:Vitamin E (2:1 w/w) and 2.5% Poloxamer were produced by hot homogenization and ultrasonication. RA was dispersed in the molten lipid phase, at different concentrations (0.5, 1, 2 mg/ml). Formulations were characterized by encapsulation efficiency, loading capacity, size distribution, morphological and charge properties by mean of different techniques including HPLC, Transmission Electron Microscopy (TEM), PCS and zeta potential.

The preformulation study selected TM-RA1 and TV-RA1 (1 mg/ml RA) that remained stable up to 90 days post-production in terms of encapsulated RA (80%) and size, without significant variations in size distribution and polydispersity. Antioxidant activity, assessed by photochemiluminescence (PCL), was preserved. *In vitro* release study by equilibrium dialysis showed a controlled, time-dependent release of RA, following second-order kinetics consistent with the Higuchi model. Permeability tests using the PermeaPad® Plate revealed a five-fold reduction in RA diffusion compared to aqueous suspension, supporting sustained release. Static *in vitro* digestion confirmed that NLCs protect RA from gastric degradation, enabling intact delivery to the intestinal environment and promoting absorption. To improve mucosal adhesion, further studies will be conducted including NLC in gel-based systems.



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sciforum-140215: Preliminary *in vitro* evaluation of a e-beam cross-linked doxorubicin loaded hybrid hydrogel as a potential therapy strategy for melanoma

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Polymeric drug delivery systems have gained attention, with hydrogels emerging as promising candidates due to their tunable properties, controllable degradation, and ability to stabilize labile drugs [1]. Literature suggests that hybrid hydrogels, combining synthetic and natural polymers, offer optimal chemical and mechanical properties for medical use [2]. Among crosslinking strategies, electron beam (e-beam) radiation stands out [3], providing precise network control and inherent sterilization without toxic reagents [4]. In this context, hybrid hydrogels of bovine collagen and sodium carboxymethylcellulose (natural) with poly(vinylpyrrolidone) and poly(ethylene oxide) (synthetic) were obtained via e-beam (25 kGy), with doxorubicin loaded before or after irradiation.

The cytotoxic and anti-proliferative effects of these hydrogels, designed to release doxorubicin at its IC₅₀ concentration (10 ng/mL), were evaluated on A375 melanoma cells. The anti-tumour efficiency was assessed via indirect contact studies, using the extraction method (ISO 10993-5 standards), in terms of cell viability (Live/Dead test), proliferation (CCK-8 assay) and morphology (actin staining with Alexa Flour 488 – phalloidin).

The results revealed significant differences in cell proliferation among the tested hydrogels, with the lowest OD values observed for the cells grown in the extraction media from the PD81'DOX*/PD81'DOX** samples, and closely followed by the cells maintained in the extraction media from the PD81' and PD81'DOX samples. This observation, combined with the absence of the red stained cells, indicates either a suppression of metabolic activity or a restriction in cell proliferation. Similarly, cytoskeleton examination showed a decrease in cell density and a more spread-out morphology in cells grown in the PD81'DOX* and PD81'DOX** extraction media, further highlighting the anti-proliferative effect of these hydrogel formulations.

In conclusion, the doxorubicin-loaded hybrid hydrogels exhibit promising anti-tumour potential and could serve as effective drug delivery platforms in melanoma therapy.

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sciforum-142913: Prospects for Rapid Delivery of Active Pharmaceutical Ingredients to the Brain for Neuroprotective Action: Examples of Nasal Gel Formulations

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Neurological disorders, including cerebrovascular and neurodegenerative diseases, represent one of the most urgent challenges in modern medicine. Despite progress in neuropharmacology, many available drugs exhibit limited clinical efficacy, often due to poor penetration across the blood-brain barrier (BBB) and suboptimal bioavailability. Intranasal drug delivery has emerged as a promising route for non-invasive, rapid CNS targeting. Of special interest are intranasal gel dosage forms, which offer prolonged mucosal contact, improved drug retention, and increasing therapeutic effectiveness. The aim of this study was to develop and preclinically evaluate novel intranasal gel formulations of neuroprotective agents, using in silico modeling and machine learning tools to optimize composition and predict efficacy and safety.

Methods: We have created a new information technology for in silico substantiation of rational formulations of intranasal dosage forms with neuroprotective effect and developed the expert system “ExpSys Nasalia”. We have created models for machine learning of binary classification to predict the penetration of APIs through the BBB and to prevent the occurrence of pharmaceutical incompatibilities in the composition of the formulation. Three intranasal gels were formulated with neuroprotective agents: Angiolin, IL-1 receptor antagonist (IL-1ra), and Compound K (a triazoloquinazoline derivative).

Results: The resulting formulations demonstrated high safety in toxicological studies, with no observed local irritation or allergenicity. IL-1ra gel showed superior neuroprotective efficacy compared to citicoline in ischemia and multiple sclerosis models. Angiolin gel improved survival and cognitive outcomes in neonatal rats following prenatal hypoxia. Compound K gel reduced anxiety, improved memory, and exerted antioxidant and anti-apoptotic effects after ketamine anesthesia.

Conclusions: This study demonstrates a successful framework for developing intranasal neuroprotective drugs using information technologies and machine learning. The three novel gels exhibited favorable safety profiles and significant neuroprotective potential in preclinical models, supporting their further development as novel therapeutic options for brain disorders.



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sciforum-147899: Quantum-Programmed Nanogels for Ultra-Precise Cancer Therapy

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Abstract

Introduction:

Cancer therapy still encounters major hurdles, including drug resistance, systemic side effects, and the inability of many treatments to adapt to the highly variable tumor microenvironment. Nanogels are attractive candidates for targeted delivery because of their biocompatibility, high drug-loading ability, and responsiveness to biological stimuli. However, traditional nanogels are limited by pre-set designs that do not respond to the dynamic nature of tumor biology. To overcome this limitation, we describe the development of **advanced smart nanogels programmed with adaptive algorithms**, designed to regulate drug release in real time and enable more effective, personalized therapy.

Methods:

The nanogels were engineered to incorporate molecular sensors that respond to environmental cues such as pH, enzymatic activity, oxidative stress, and hypoxia. Data-driven models were used to predict tumor behavior and guide adaptive release patterns. Computational simulations examined nanogel-tumor interactions, drug diffusion dynamics, and responsiveness to microenvironmental fluctuations. A comparative framework was applied to evaluate the performance of adaptive nanogels against conventional, non-programmed systems.

Results:

Simulation outcomes indicated that adaptive nanogels achieved more controlled and sustained release profiles, with improved drug retention at the tumor site and reduced premature leakage. Compared to conventional systems, adaptive nanogels demonstrated enhanced therapeutic index, showing up to 40% higher bioavailability in modeled tumor environments. The approach also revealed potential for patient-specific adjustments, where unique tumor signatures could be used to fine-tune release kinetics and improve treatment outcomes.

Conclusions:

This study introduces a novel class of adaptive nanogels that combine smart biomaterial design with predictive programming. By responding dynamically to tumor conditions, these nanogels offer a self-regulating platform for cancer therapy that may minimize systemic toxicity while maximizing therapeutic efficacy. The concept represents a forward step toward precision medicine, with strong potential for translation into clinical oncology.



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sciforum-140587: Redox-Responsive Boronic Acid-Based Hydrogel for Controlled Drug Delivery and Theranostic Applications

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Introduction

Redox-responsive biomaterials are gaining traction in drug delivery and theranostics due to their ability to respond to oxidative stress in pathological environments like cancer. Phenylboronic acid (PBA) derivatives are particularly attractive because of their biocompatibility and selective reactivity toward hydrogen peroxide (H₂O₂). We report a novel PBA-based polymer, poly(2-hydroxyethyl methacrylamide-co-phenylboronic acid methyl methacrylamide) (PHMPAMM), which forms injectable hydrogels with polyvinyl alcohol (PVA) for controlled drug release and imaging applications.

Methods

PHMPAMM was synthesized via radical polymerization and characterized by nuclear magnetic resonance. Biocompatibility was evaluated using glioma cell cultures. Hydrogels were prepared by blending PHMPAMM with PVA at optimized ratios and assessed for morphology, viscoelastic properties and redox responsiveness using scanning electron microscopy (SEM), rheology, and 1 mM H₂O₂, respectively. Degradation and drug release studies employed albumin (large molecule), indocyanine green (small molecule), and nanoparticle-based contrast agents.

Results

PHMPAMM exhibited excellent cytocompatibility and formed instant gels when in contact with PVA, suitable for injection via dual-syringe systems. SEM and rheology studies demonstrated excellent structural and injectable properties. Furthermore, the hydrogels degraded significantly faster in oxidative conditions compared to PBS, demonstrating strong redox sensitivity. Lastly, controlled release experiments confirmed efficient encapsulation and sustained release of both large and small therapeutic agents, as well as nanoparticle retention.

Conclusions

PHMPAMM-based hydrogels represent a promising platform for redox-responsive drug delivery and theranostics, particularly in cancer therapy. Their biocompatibility, injectability, and ability to encapsulate and release diverse therapeutic and imaging agents in a controlled manner highlight their potential for clinical translation.



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sciforum-145307: Surface-Localised Photosensitizer Nanocomposite Hydrogels for Photodynamic Inactivation

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An escalation in antimicrobial drug resistance among pathogens has driven the need to develop alternative treatment methods. Photodynamic inactivation (PDI) is a promising antibiotic-free antimicrobial strategy. Hydrogels have proven their effectiveness as delivery systems for photosensitizers (PS) in antimicrobial PDI. Despite increasing interest, PS-loaded hydrogels encounter several challenges, including limited light penetration, issues with solubility, stability, and bioactivity of many PS under physiological conditions [1]. Moreover, achieving a uniform distribution of photosensitizer (PS) molecules within hydrogels remains a significant challenge during fabrication. Smectites are low-cost, eco-friendly inorganic hosts that have proven to be effective for many photosensitizers (PS) molecules, preserving their fluorescence and photoactivity, improving dye stability, and reducing photodegradation [2]. This study intercalated the photosensitizer phloxine B (PhB) into organically modified synthetic saponite (Sap) with different surfactants as the primary host material. Thin films with a thickness in the micrometre range were subsequently prepared using vacuum filtration. The hydrogel precursor, composed of dissolved poly(vinyl alcohol) (PVA) and glycerol as a crosslinker, was cast onto the freshly prepared film placed in a mould to partially penetrate and swell the organoclay layer. A thin nanocomposite film on the surface of the hydrogel was formed during the crosslinking process, forming surface-functionalised hydrogel [3]. This approach offers greater precision in PS loading and distribution than bulk incorporation, concentrating the active substance at the surface. Absorption and luminescence spectroscopy revealed a direct relationship between PhB loading and absorbance, and an inverse relationship with fluorescence intensity, indicating concentration quenching and molecular aggregation. X-ray diffraction confirmed structural changes upon PhB intercalation and nanocomposite formation, while infrared spectroscopy verified the presence of the components in the composites without significant chemical alteration. This novel approach involving surface-modified hydrogels enables controlled PS loading and distribution through a simple fabrication process, potentially advancing the therapeutic effectiveness of PDI-based hydrogels.



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sciforum-148246: The Creation of A Docetaxel-Loaded Hydrogel Nanosponge for the Treatment of Malignant Melanoma

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Introduction: Second most prevalent non-melanoma skin cancer in the world, squamous cell carcinoma, is mostly brought on by exposure to UV light. Surgery, radiation, and chemotherapy are examples of current therapeutic modalities; these methods frequently have drawbacks in terms of toxicity and patient compliance. Poor solubility and absorption make topical administration of curcumin, a natural substance with proven anticancer effects. The purpose of this work was to describe a curcumin-loaded nanoemulsion gel technology for improved topical administration in the treatment of SCC.

Methods: The spontaneous emulsification process was used to create curcumin nanoemulsions. Surfactant and co-surfactant screening found appropriate emulsifying agents, solubility tests were used to choose the best oil phase. Different ratios of oil-to-surfactant/co-surfactant were assessed. Particle size analysis, zeta potential measurement, thermodynamic stability testing, and polydispersity index calculation were performed on the chosen formulations. The carbopol gel matrix was filled with optimized nanoemulsions, which were then assessed for cytotoxicity using the MTT assay, in-vitro drug release using Franz diffusion cells, drug content, entrapment efficiency, and physical properties.

Results: Capmul CMC was chosen as the oil phase since it showed the maximum curcumin solubility (90±0.18 mg/mL). The surfactant was Tween 20, the co-surfactant was PEG 400. F6 (oil:SCOS 1:6) and F8 (oil:SCOS 1:8) were two formulations that underwent optimization. With a globule size of 125.3 nm, a zeta potential of -18.3 mV, and a PDI of 0.310, F8 demonstrated exceptional qualities. For the F8 formulation, the nanoemulsion gel demonstrated 99% entrapment efficiency. According to in-vitro release experiments, F8 released 59.41% more medication over a 24-hour period than F6, which released 66.11%. According to cytotoxicity testing, the F8 formulation's IC₅₀ values were 59.63 µg/ml.

Conclusion: When compared to traditional therapies, the proposed curcumin nanoemulsion gel method effectively improved drug solubility and offered sustained release features appropriate for topical SCC treatment, including decreased systemic toxicity and improved patient compliance.



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Session 5. Gels in Electro-magneto-mechanical Devices, 3D Printing, and Manufacturing

sciforum-148019: Optimization of Cross-Linked PVA Functionalized with PANI: In Situ Strategies to Design Electro-Conductive Fibrous Platforms for Brain Applications

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Polyelectrolyte hydrogels such as Polyvinyl alcohol (PVA) can be combined with conductive polymers to create bioactive and electrically responsive materials for biomedical use. In this study, we prepared PVA hydrogel in the form of electrospun nanofibrous mats containing two different forms of polyaniline (PANI)—emeraldine base (EB-PANI) and PANI nano short fibers (PANI-NF)—and evaluated their morphology, electrical behavior, and biological response. Citric acid was used as a crosslinker to improve water stability and structural integrity of the electrospun mats.

Electrospinning was carried out using PVA/PANI blends, followed by a short thermal treatment to activate crosslinking. The obtained fibers were analyzed by SEM, which showed uniform morphologies. Pure PVA fibers had an average diameter of about 0.53 μm , while the addition of PANI slightly increased the fiber size (0.65 μm for EB-PANI and 0.72 μm for PANI-NF). Electrical tests indicated conductivity values between 10^{-8} and 10^{-7} S/cm. Non-crosslinked samples showed generally higher conductivity, while crosslinking affected EB-PANI and PANI-NF differently: EB-PANI maintained stable values, whereas PANI-NF displayed reduced conductivity, probably linked to their different protonation and charge transport mechanisms. In vitro experiments with SH-SY5Y neuroblastoma cells confirmed that all scaffolds were cytocompatible and supported cell adhesion and proliferation up to 14 days, with no signs of toxicity.

These results show that PVA/PANI hydrogel-based nanofibers can be considered as conductive and biocompatible scaffolds, suitable for applications in the brain field. The comparison between EB-PANI and PANI-NF highlights the role of PANI structure on conductivity and provides useful information for optimizing electro conductive platforms



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sciforum-142869: 3D printed hierarchical hydrogel–nanogel scaffolds for controlled delivery of nonsteroidal anti-inflammatory drugs

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Introduction

3D bioprinting offers promising opportunities for developing advanced drug delivery systems with tailored architectures. Hydrogels are widely used due to their high biocompatibility, porosity, and tunable swelling behavior. However, due to the 3D printing process, they often show limited mechanical properties and poor modulation of drug release when drugs are simply embedded within their mesh. To address these limitations, nanogels (NGs) can be incorporated into the hydrogel matrix to create a hierarchical structure with improved control over diffusion and release. In this work, we developed a formulation based on methacrylated NGs embedded within a gelatin methacrylate (GelMA) matrix. Using extrusion-based 3D printing followed by UV crosslinking, we produced composite scaffolds in which the NGs remain covalently bound within the matrix, preventing uncontrolled release and enabling localized, sustained drug delivery.

Methods

NGs were synthesized from hyaluronic acid and polyethylene glycol, functionalized with methacrylate groups, and dispersed into a GelMA-based ink. Porous scaffolds were fabricated via extrusion printing and UV crosslinked. Physicochemical and mechanical characterizations were performed via NMR, FTIR, rheology, swelling/degradation tests, and printability. Diclofenac was used as model drug to assess release via HPLC. Biocompatibility of the 3D printed constructs was confirmed in accordance with ISO standards.

Results

NGs showed ~30% methacrylation and integrated well into the GelMA network without compromising printability. Rheological data indicated a moderate decrease in G' and G'' but enhanced critical strain. Optimal printing parameters were identified via printability maps. The hierarchical scaffold exhibited sustained drug release (~37% in 7 days), while hydrogel systems alone released ~62%. Structural integrity was maintained over time, highlighting the composite potential for applications such as patches or implantable drug depots.

Conclusion

The developed 3D printed hierarchical scaffolds offer a stable, biocompatible, and reproducible platform for controlled drug delivery, with strong potential for personalized therapeutic applications.



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sciforum-133354: Antifreeze, Conductive and Flexible Ternary PVA/PVP/SA Hydrogels

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Polyvinylpyrrolidone (PVP) has excellent water solubility, biocompatibility and surface activity, which has been widely used in medicine, biomedical engineering, cosmetics and food. PVP and its monomers are water-soluble, while cross-linked PVP or its copolymers are insoluble in water, but can absorb water and form hydrogels. PVP hydrogels are widely used in medical and biomedical engineering because of their excellent biocompatibility. The current work combined PVP with polyvinyl alcohol/sodium alginate (PVA/SA) to form a ternary antifreeze conductive hydrogel by repeated freezing-thawing method and ion cross-linking method. During cross-linking process, the pyrrolidone group was introduced to improve the conductivity. The PVA crystallization network and SA ion cross-linking network are interpenetrated, which increases the mechanical properties of the hydrogel network and makes the hydrogel have both frost resistance and conductivity. Thus, the PVA/PVP/SA hydrogels showed good mechanical and electrical properties, with further modification of ethylene glycol (EG) as a bridging agent, the hydrogels exhibited certain low temperature resistance while maintained good mechanical and electrical properties at low temperature. A supercapacitor was constructed by utilizing the ternary PVA/PVP/SA hydrogel as electrolyte, which revealed a specific capacitance of 7 mF cm^{-2} at the current density of 0.5 mA cm^{-2} , indicating a good prospect in the field of flexible energy storage.



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sciforum-140428: Microstructural, textural and rheological properties of edible bigels designed for 3D food printing

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Three-dimensional (3D) food printing is an emerging technology in food processing, offering high flexibility and customization to meet the growing demand for personalized nutrition and innovative product designs. Bigels, semi-solid systems composed of a hydrogel and an oleogel, present a promising approach as edible inks for extrusion-based 3D food printing due to their structural and functional properties.

This study aimed to develop and characterize edible bigel inks with optimized properties for 3D food printing applications. Bigels were prepared by blending beeswax (6%)–monoglycerides (4%) sunflower oil oleogels with gelatin (4%)–guar gum (1%) hydrogels at varying ratios (0–50%). Their microstructural, textural, and rheological characteristics were evaluated to assess printability and structural integrity.

Polarized light microscopy revealed distinct microstructures with increasing oleogel content, shifting from oleogel-in-hydrogel systems to bicontinuous networks. Textural analysis using a forward extrusion test demonstrated that oleogel content significantly influenced firmness and extrusion force, key parameters for 3D printing performance. Rheological analyses, including flow curve assessments, amplitude and frequency sweep tests, confirmed that all formulations exhibited pronounced shear-thinning behavior and predominantly elastic properties ($G' > G''$). These features are critical for smooth extrusion and maintaining structural stability post-printing. Furthermore, the 3-Interval Thixotropy Test (3ITT) evaluated structural recovery under shear, showing improved recovery percentages at higher oleogel concentrations.

These findings highlight the potential of bigels as functional and customizable inks for 3D food printing, enabling the development of novel food products with tailored textural and nutritional attributes.



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sciforum-134186: Sulfidation-MnO₂ Dual-Modified Cu-Co-MOFs for Flexible Supercapacitors with Hydrogel Electrolyte

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Metal-organic frameworks (MOFs) have garnered significant attention as advanced energy storage materials owing to their exceptional specific surface area and structurally tailorable properties. Nevertheless, practical implementation faces critical limitations including intrinsic poor electrical conductivity and inadequate structural stability. To address these challenges, this study proposes an innovative dual-modification strategy integrating controlled sulfidation with conformal MnO₂ coating. Initially, bimetallic Cu-Co-MOF nanoarchitectures were hydrothermally synthesized on nickel foam substrates. Subsequent sulfidation treatment transformed the precursor into Cu-Co-S ternary compounds, effectively optimizing electronic band structures and achieving a 3.8-fold conductivity enhancement. Through rapid electrochemical deposition, ultrathin MnO₂ nanosheets were uniformly constructed on Cu-Co-S surfaces, forming hierarchical heterojunctions. This dual-engineering: (1) substantially reinforced mechanical stability via protective coating, (2) established built-in interfacial electric fields accelerating electron transfer kinetics (charge transfer resistance reduced by 67%), and (3) provided abundant electroactive sites for ion adsorption. The optimized Cu-Co-S@MnO₂ electrode delivered outstanding electrochemical performance, including a high specific capacitance of 1,842 F g⁻¹ at 1 A g⁻¹ and 91.3% capacitance retention after 10,000 cycles. When configured into a flexible asymmetric supercapacitor (FASC) employing polyvinyl alcohol (PVA)/KOH hydrogel electrolyte, the device achieved remarkable energy density of 68.4 Wh kg⁻¹ at 850 W kg⁻¹ power density, along with 88.7% capacity retention over 15,000 bending cycles. These results validate the dual-modification strategy's efficacy in developing mechanically robust, high-performance flexible energy storage systems for next-generation wearable electronics.



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sciforum-147771: Tunable Hydrogel Platforms to Mimic Breast Cancer Microenvironments via 3D Bioprinting

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Breast cancer remains a leading cause of mortality among women, yet conventional preclinical models often fail to replicate the structural and biomechanical features of native tumor tissue. Flat, two-dimensional cultures lack the three-dimensional cellular interactions necessary for accurate studies, while animal models frequently exhibit poor translational predictability. To overcome these limitations, we designed and optimized bioprintable hydrogel systems capable of mimicking the physical and structural properties of breast tumor microenvironments.

Sodium alginate (ALG) and gelatin (GEL) blends were formulated at varying concentrations and ionically crosslinked with calcium chloride to generate hydrogels with tunable stiffness in the range of pathological breast tissue. Their physical stability, pH behavior, and controlled degradation were systematically evaluated over a period of three weeks. Structural and chemical integrity were investigated through scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR), confirming the preservation of the alginate backbone and the successful integration of gelatin. Rheological studies provided insight into viscoelasticity and shear-thinning properties relevant to extrusion-based bioprinting, while printability assessments identified formulations suitable for the fabrication of stable constructs.

The resulting scaffolds exhibited interconnected porous networks, a storage modulus of approximating 10 kPa, and adequate viscosity profiles to sustain both print fidelity and cell viability. Together, these findings highlight ALG–GEL hydrogels as versatile platforms for recapitulating tumor-specific mechanical cues, supporting nutrient transport, and enabling the fabrication of reproducible, physiologically relevant three-dimensional breast cancer models. Future work integrating cancer cell lines will further validate their potential as advanced tools for oncological research and therapeutic testing.



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Session 6. Gels in Chemical Processing, Energy, and Environment

sciforum-142810: Cellulose-coated emulsion microparticles with a unique inner hydrogel shell: structure and function as micro-reactors for enzymatic transformations

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Cellulose is an abundant and renewable resource for sustainable chemicals and fuels. We developed cellulose-coated emulsion microparticles fabricated by high-pressure homogenization of the oil with an aqueous suspension containing cellulose hydrogel particles. The cellulose hydrogel is regenerated from aqueous alkali solution by coagulation with water and further washing. The inner structure of these micro-particles was revealed by imaging using cryogenic scanning electron microscopy and quantified by small-angle x-ray scattering: a unique multi-layer structure in which an inner oil core is surrounded by a shell composed of a porous cellulose hydrogel, which is encapsulated by an external cellulose shell. The outer coating appears to be homogeneous without evidence of particulate matter, indicating that the emulsion is not of the “Pickering” type. The inner shell is determined to be a porous cellulose hydrogel which is inhomogeneous. It consists of pores, the size of which is a few tens of nanometers, embedded in a denser highly branched hydrogel with an apparent fractal structure. The fractal dimension (~2.5) is suggestive of the aggregation process that occurs during regeneration.

Our objective is to convert cellulose from pretreated biomass directly to bioethanol and biodiesel in a one-pot process using these microparticles as bio-reactors for a cascade of biochemical processes. We show that enzymes can be spontaneously incorporated with these microparticle: cellulytic enzymes attach to the outer layer while lipases spontaneously penetrate the inner shell to reside at the inner oil-hydrogel interface. Moreover, the cellulose-coated emulsion microparticles spontaneously hybridize with yeast cells (*S. cerevisiae*). We show that this integrated structure is effective in simultaneous cellulose saccharification and fermentation to ethanol. Furthermore, we recently demonstrated the full “one-pot” transformation of cellulose to fatty-acid ethanol ester (“biodiesel”) by enzymatic cellulose hydrolysis, yeast fermentation and lipase-catalyzed trans-esterification of triacyl-glyceride in the microparticles’ core, in a single emulsion-based consolidated bioprocess.



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sciforum-123451: Bi₂O₄/ Polyaniline Thin Films Doped with Magnesia for Multipurpose Uses: Synthesis and Applications

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One of the most difficult problems the world is currently experiencing is climate change. The long-term, localized effects of global warming are clear in the domains of politics, science, society, ethics, and economics. Renewable energy sources and energy storage devices are potential solutions for this problem. The current work highlights the role that metal oxide supercapacitors play in the creation of sustainable energy sources. This aligns with many of the Sustainable Development Goals (SDGs), such as Goal 13 (Climate Action) and Goal 7 (Affordable and Clean Energy). Metal oxide thin film is a useful tool for scientists due to its many uses in electrical device performance, environmental remediation, materials development, and transdisciplinary research. The Sol gel dip-coating method was used to create magnesium-doped bismuth oxide (Bi₂O₄) thin films for the study. The monoclinic Bi₂O₄ phase was confirmed to be present in all thin films using X-ray diffraction spectra. Using Fourier transform infrared spectroscopy; the functional bonds of bismuth oxide were verified in the range of around 460 to 580 cm⁻¹. The bandgap of undoped and Magnesia-doped Bi₂O₄ films was found to be between 2.2 and 1.97 eV. For the Magnesia: Bi₂O₄ films to be used as window layers in solar cells, this range was needed. Magnesia-doped Bi₂O₄ performs better photocatalytically than undoped Bi₂O₄, most likely as a result of better charge separation and transfer. Exposure to visible light accelerates the breakdown of organic contaminants. More investigation is needed to find the best doping concentration and investigate various approaches to improve the photocatalytic capabilities of Bi₂O₄. According to the study's findings, Magnesia-doped Bi₂O₄ has a lot of potential uses in water purification and environmental remediation. This substance contributes to the achievement of sustainable development goals by offering a useful and affordable method of water treatment.



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sciforum-120046: From Ionotropic Gelation of Chitosan to Reusable Magnetic Sorbents for Wastewater Treatment

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Chitosan, a bio-based polymer derived from chitin, has attracted significant interest as a sustainable platform for advanced sorbent materials. Ionotropic gelation using sodium tripolyphosphate (TPP) was employed to produce chitosan-based beads with controlled morphology, porosity, and stability in aqueous environments. This mild, water-based method enables the rapid formation of hydrogel-like structures through electrostatic interactions between the protonated amino groups of chitosan and the phosphate groups of TPP, eliminating the need for toxic cross-linkers and preserving the biocompatibility of the system.

To further enhance functional performance, novel engineered spinel ferrite nanoparticles were incorporated into the chitosan matrix during gelation, generating magnetic responsiveness. The resulting hybrid beads were systematically characterized in terms of structural integrity, porosity, and magnetic behavior. Optimization of the gelation parameters—particularly the chitosan/TPP ratio and the influence of surfactants—proved essential for tailoring the beads' textural properties, surface area, and adsorption capacity.

Adsorption experiments using representative organic pollutants (synthetic dyes) confirmed that the porous, magnetically responsive beads act as efficient sorbents, combining high removal efficiency with easy recovery from aqueous medium. Regeneration studies further demonstrated reusability over multiple adsorption-desorption cycles without significant loss of performance.

Overall, the results emphasize ionotropic gelation as a versatile, sustainable, and scalable strategy for developing functional chitosan-based gels. By integrating magnetic nanoparticles, this approach enables the recovery and reuse of the sorbents, contributing to circular and environmentally friendly solutions for wastewater treatment.



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sciforum-148291: Polysaccharide-based decontamination gels for the radioactive decontamination of metal parts within radioactive waste management

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Within the nuclear industry, the issue of radioactive waste management is of vital importance. Therefore, it is necessary to have methods and tools that allow for the treatment of contaminated materials without compromising worker health and that are economically viable. This work focuses on the synthesis of gels based on natural polysaccharides, which could form easily removable polymeric films and can decontaminate metal surfaces contaminated with radionuclides. Decontamination aims to remove or reduce contaminants (sometimes in combination with other hazardous materials) present on the surfaces of pipes, tools, glove boxes, radioactive cells, structures, and equipment such as rotors, motors, centrifuges, pumps, pump heads, columns, etc.

The use of polysaccharide-based decontamination gels is one of the currently available chemical decontamination treatment methods. They offer several advantages, such as lower operating costs during decontamination processes, lower risk for occupationally exposed personnel, no need to install a sealed system, and the gels are biodegradable. The use and development of decontamination gels contribute to reducing radioactive waste management costs and improving treatment.

Gels composed of different polysaccharides were tested to evaluate their decontamination properties on stainless steel surfaces and were evaluated by obtaining decontamination factors (DF). Gels containing 2.8% chitosan, 6% sodium alginate, 1% guar gum + 3% hydroxyethyl-cellulose, and 3% pectin were synthesized.

Decontamination tests on stainless steel specimens were positive, with high DF values obtained for various radionuclides, demonstrating the gels' ability to decontaminate metal surfaces and the high efficiency of the decontamination process. Radionuclides such as Nd-147 on stainless steel stood out, with very high Fd values. Similarly, high Fd values were obtained for Co-58 and Hf-181. The DF values in the decontamination process depend on the type of gel applied, the contaminating radionuclide, and the surface to be decontaminated.



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sciforum-142867: Recent Advancements in Gel Materials for Green Chemical Processes, Clean Energy, and Environmental Solutions.

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Gel-based materials have recently emerged as versatile platforms for addressing challenges in green chemical processes, clean energy, and environmental remediation. Their three-dimensional polymeric networks, high liquid-holding capacity, and tunable physicochemical properties make them adaptable to multiple sustainable applications.

In our work, we focused on the design and functionalization of gels derived from bio-based polymers and ionic liquids to create eco-friendly alternatives for chemical processing. Our experimental results demonstrated that ionogels not only improved catalyst retention but also enhanced reaction selectivity, leading to reduced solvent usage and lower waste generation. Similarly, organogel-supported catalytic systems were successfully tested in esterification reactions, achieving higher yields under mild conditions compared to conventional methods.

In the energy domain, we developed gel polymer electrolytes with optimized porosity and surface functionality. Electrochemical studies revealed improved ionic conductivity and thermal stability, which translated into better cycling performance of prototype lithium-ion cells. Notably, the gels retained flexibility and stability even after multiple charge–discharge cycles, with only a minor decrease in conductivity.

For environmental applications, we fabricated bio-inspired hydrogels functionalized with natural additives. Adsorption experiments confirmed their efficiency in removing heavy metals and organic dyes from water, with recyclability over several cycles showing only a slight decline in adsorption capacity.

This integrated investigation underscores the potential of gel-based materials as sustainable, multifunctional systems that bridge green chemistry, clean energy, and environmental solutions.



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sciforum-142886: Synergistic Stabilization and Rheology of Sodium Alginate Gel Foams for Subsurface Carbon Storage and Enhanced Oil Recovery

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Sodium alginate (SA) gel foams are gaining attention as high-performance fluids for subsurface applications, including geological carbon storage and enhanced oil recovery (EOR). In this study, we systematically investigate the synergistic stabilization and rheological behavior of sodium alginate gel foams with eco-friendly foaming agents. A series of gel foams were prepared by varying surfactant and SA concentration, and the type of crosslinking agents. The foam stability and rheological properties were evaluated under different salinity and temperature conditions to simulate reservoir environments. Foam drainage time and coarsening behaviours were used to estimate stability, while oscillatory and steady-state rheological tests were conducted to characterise viscoelasticity and flow behaviour. The results reveal that both the concentration of SA and the type of crosslinker significantly influence the gel network structure and foam stability. The rheological measurements show that the optimised gel foams exhibit Non-Newtonian behaviour and high elasticity, which are essential for controlling mobility in porous media. These findings provide fundamental insights into the design of stable, biodegradable gel foams tailored for harsh subsurface conditions. The study also highlights the potential of combining natural polymers with green surfactants to develop environmentally friendly formulations with tunable properties, offering new strategies for sustainable reservoir engineering and fluid control technologies.



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sciforum-147782: Synthesis of advanced Biopolymers through Chemo-selective Approach for Enhanced Oil Recovery from Non-producing Reservoirs

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The production of crude oil must be increased to meet the growing global energy demand. As crude oil will remain a dominant energy source for the next ~30 years, enhanced oil recovery (EOR) has become essential to maximize output from existing reservoirs, which is more economical than drilling new wells. Conventional recovery methods are inefficient, leaving behind nearly 50% of the original oil. Within EOR, biopolymers are emerging as sustainable alternatives due to their accessibility, cost-effectiveness, viscoelastic behaviour, and biodegradability. Natural polymers such as guar gum, xanthan gum, welan gum, scleroglucan, schizophyllan, and gum tragacanth are increasingly investigated to replace synthetic polymers. However, microbial deterioration, shear-stress instability, and sensitivity to reservoir conditions (temperature, salinity, concentration, and functional groups) restrict their widespread application. This study introduces a novel chemically tailored biopolymer for EOR from non-producing reservoirs. While conventional polymers like polyacrylamide and xanthan gum typically achieve only 4–5% incremental recovery, our preliminary results demonstrate up to 10% additional recovery. The polymer is structurally modified through graft copolymerization, gel modification, esterification, crosslinking, and nanocomposite functionalization, ensuring higher viscosity, stability, and reservoir compatibility. The formulations will be developed using single or modified polymers along with oilfield adjuvants after validation under simulated reservoir conditions. Even a 1–2% incremental recovery can translate into millions of additional barrels of oil, highlighting scalability, and economic relevance of this approach. Recently, chemo-selectively modified and thermo-viscosifying polymers further support enhanced sweep efficiency under harsh conditions through viscosity increment, wettability alteration, and emulsification. These polymers have been successfully investigated in both laboratory experiments and field trials, highlighting their strong potential for large-scale EOR applications.

“Towards Sustainable Oil Recovery: Biopolymer Solutions for Energy Efficiency”



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sciforum-142647: Zein-Derived Polymer Gels: Design of Crosslinked Networks for Sustainable Soft Materials

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In the context of the transition towards a circular and climate-conscious materials economy, there is a growing interest in the development of gel-based materials derived from renewable feedstocks [1,2]. Proteins, as abundant natural macromolecules that are frequently available as byproducts of agro-industrial processes, offer a sustainable yet underutilised platform for the design of advanced soft materials [1,2]. However, protein-derived systems characteristically exhibit fragility and suboptimal processability, thereby constraining their functional application as gels and flexible films [2].

The present study explores the transformation of zein, a protein derived from maize that is devoid of nutritional value, into polymer gels via chemical functionalization and radical crosslinking. The acrylation of Zein was carried out to varying degrees in order to introduce polymerizable groups. It was then co-polymerized with an acrylic monomer, resulting in the formation of solid thermosetting gels with a flexible film morphology. These crosslinked networks exhibit characteristics typical of bio-polymer gels, namely a stable 3D architecture, a solvent-free formulation, and mechanical resilience.

Resulting zein-based gels demonstrated the capacity to preserve the intrinsic strength and thermal stability of the protein, while exhibiting significant enhancements in elongation, flexibility, and toughness. It is noteworthy that lower acrylation degrees resulted in enhanced mechanical properties, indicating that mild, non-invasive chemical modifications can optimise gel performance. The influence of biobased crosslinkers was also evaluated in order to further tailor network properties.

These thermoset protein gels demonstrate considerable promise in a range of applications, including sustainable coatings, packaging, and flexible electronics. The design of these materials demonstrates a promising route for the conversion of agricultural residues into robust, solvent-free gel materials that support the broader goals of circular economy and sustainable materials science.

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