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INVESTIGAÇÃO BIOMÉDICA E BIOFARMACÊUTICA IBB

Book of Abstracts

About this meeting

InnovDelivery'25 was a one-day international meeting aimed to explore the theme "Nature as inspiration for innovation in Health and Well-being", bringing the insights of leading researchers from the Lusophone worlds of Portugal and Brazil. This event was organized and hosted by CBIOS, the Research Center for Biosciences & Health Technologies of Lusófona University, in Lisbon, Portugal.

The five scientific sessions looked into the future developments in nanotechnology-based delivery systems, topical and transdermal delivery, delivery technologies in cosmetics and consumer products, innovative ingredients and sustainable strategies and advanced models for safety and efficacy assessment.

The meeting was conducted in a hybrid format on February 7, 2025, in the Auditório José Araújo (Lusófona University) and on-line. Scientific communications included 5 keynote speakers, 10 oral communications, 5 flash communications, and 28 posters.

InnovDelivery'25 gathered more than 80 participants from various Portuguese, Brazilian and European universities and research centers, as well as from some pharmaceutical companies. Along with the opportunity to learn and exchange ideas, InnovDelivery'25 aimed to provide all participants with new skills, networking, and new collaborations.

The Organizing Committee

February 2025

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Award Winners

Poster Communication:

- Honorable mention: "Effects of plastic pollution on skin barrier integrity", presented by Beatriz S. Ezequiel (Faculdade de Farmácia, Universidade de Lisboa)

- Best Poster Award: "Can customized delivery systems make antioxidant injections feasible at home?" presented by Renata Basto (LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto)

Flash Communication:

- Honorable mention: "I've got you... under my skin! - Playing a scientific song of many chords in Atopic Dermatitis", presented by Ana Isabel Barbosa (LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto)

- Best Flash Communication: "Transferrin Receptor 1-targeted nanoparticle therapy for Colorectal Cancer", presented by Ariana Pina (GIMM - Gulbenkian Institute of Molecular Medicine)

Oral Communication:

-Honorable mention: "Do you want to redefine precision delivery with a click? HER2", presented by Filipa A. Soares (LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto)

- Best Oral Communication: *Arbutus unedo L*. leaf extracts from Portuguese regions as potential anti-acne ingredients", presented by Ana Sofia Oliveira (Universidade da Beira Interior)

Program

INNOV DELIVERY `25

II LUSOPHONE MEETING ON INNOVATIVE DELIVERY SYSTEMS

Program	
09:00 – 09:30	Opening Session
T1: Nanotechnology-based Delivery Systems	
09:30 – 09:55	**K1:** Snežana Savić Faculty of Pharmacy, University of Belgrade "Lipid-based nanoparticulated systems intended for brain delivery of patented leads/drug candidates acting at GABAA receptors – formulation approach, in vitro and in vivo research platforms"
09:55 – 10:10	**OC1:** Filipa A. Soares LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto "Do you want to redefine precision delivery with a click? HER2"
10:10 – 10:25	**OC2:** Gabrielle Bangay CBIOS, Universidade Lusófona "Abietane Diterpenoids from Plectranthus spp.: Emerging Nanodelivery Strategies for Cancer Therapy"
10:25 – 10:30	**FC1:** Ariana Pina GIMM - Gulbenkian Institute of Molecular Medicine "Transferrin Receptor 1-targeted nanoparticle therapy for Colorectal Cancer"
10:30 – 11:00	Coffee break & Poster Session

Program	
T2: Topical and Transdermal Delivery Systems	
11:00 – 11:25	**K2:** Sara Cordeiro Leicester School of Pharmacy, De Montfort University "Tackling global challenges by overcoming the skin barrier"
11:25 – 11:40	**OC3:** Catarina Faria-Silva iMed, Faculdade de Farmácia, Universidade de Lisboa "Alpha-tomatine foam for inflammatory skin conditions"
11:40 – 11:55	**OC4:** Sara Bom iMed, Faculdade de Farmácia, Universidade de Lisboa "From flowability to extrusion-based 3D Printing: a dual approach based on rheology and texture science"
11:55 – 12:00	**FC2:** Anđela Tošić Faculty of Pharmacy, University of Belgrade "Towards direct transformation of nanoemulsions into nanoemulsion gels: traditional vs. new-generation gelling agents"
12:00 – 13:45	Lunch Break

Program	
T3: Delivery Technologies in Cosmetics and Consumer Products	
13:45 – 14:10	**K3:** André R. Baby Faculdade de Ciências Farmacêuticas, Universidade de São Paulo "Advancing Technologies for Enhanced Sunscreen Efficacy"
14:10 – 14:25	**OC5:** Mariane M. Vergilio UNICAMP, Universidade Estadual de Campinas "Redefining vitamin C in cosmetics: dissolvable microneedles for enhanced stability and target delivery"
14:25 – 14:40	**OC6:** Leticia Kakuda Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo "Advancing Skin and Hair Care with Pequi Oil Liposomal Nanoparticles: Stability and Efficacy"
14:40 – 14:45	**FC3:** Rafaela Zito Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo "Black Soldier Fly larvae oil as an innovative treatment for bleached hair"
14:45 – 15:05	Break

Program	
T4: Innovative Ingredients and Sustainable Strategies	
15:05 – 15:30	**K4:** Patrícia Maia Campos Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo "Application of sustainable raw materials and Brazilian biodiversity in Cosmetics Research & Innovation"
15:30 – 15:45	**OC7:** Ana S. Oliveira Universidade da Beira Interior "*Arbutus unedo* L. leaf extracts from Portuguese regions as potential anti-acne ingredients"
15:45 – 16:00	**OC8:** Aline Caramona iMed, Faculdade de Farmácia, Universidade de Lisboa "Innovative cosmetic ingredients from lupin by-products: unlocking sustainable solutions"
16:00 – 16:05	**FC4:** Ana Júlio CBIOS, Universidade Lusófona "Amino-Acid-Based Ionic Liquids and Lipid-Based Nanoparticles: A Synergistic Approach to Delivery Systems"
16:05 – 16:35	Coffee break & Poster Session

Program	
T5: Advanced Models for Efficacy and Safety Assessment	
16:35 – 17:00	**K5:** Sandra Simões iMed, Faculdade de Farmácia, Universidade de Lisboa "Challenges in assessing efficacy of skin delivery systems entrapping natural bioactive compounds"
17:00 – 17:15	**OC9:** Cariny Polesca CICECO, Universidade de Aveiro "Advances in keratin processing for the development of bioactive 4D-printed materials"
17:15 – 17:30	**OC10:** João Vieira CBIOS, Universidade Lusófona "Rutin-loaded cerosomes: A breakthrough for Xeroderma Pigmentosum patients"
17:30 – 17:35	**FC5:** Ana Isabel Barbosa LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto "I've got you... under my skin! – Playing a scientific song of many chords in Atopic Dermatitis"
17:40 – 18:00	Awards & Closing Session

Poster Session

P1: Grazielly I. Licco
School of Pharmaceutical Sciences of Ribeirão Preto, University of São Paulo

"Efficacy of hair care formulations containing olive leaf extract in the mechanical properties of bleached hair"

P2: Tiago L. Silva
CICECO, Universidade de Aveiro

"Innovative mRNA delivery with sustainable keratin-based materials"

P3: Carolina Santos, Margarida Gingado, Carla Turiel
ECTS, Universidade Lusófona

"Tailored lipid nanoparticles based in larvae biomass for enhanced skin formulations"

P4: Renata Basto
LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto

"Can customized delivery systems make antioxidant injections feasible at home?"

P5: Zinaida Shakel
LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto

"From nature to nanoparticles: advanced strategies to address skin ageing"

P6: Tânia Moniz
LAQV, REQUIMTE, Universidade do Porto

"Enhancing the delivery of an iron chelator to combat mycobacterial infections"

Poster Session
P7: Mafalda Sarraguça LAQV, REQUIMTE, Faculdade de Farmácia, Universidade do Porto "Nano delivery of isoniazid-based therapeutic deep eutectic systems for enhanced tuberculosis treatment"
P8: Rafaella J. Merli Unicamp, Universidade Estadual de Campinas "Study of rheological behavior through viscosity determination as part of the stability evaluation of cosmetic emulsions containing green propolis oil extract"
P9: Wallace Androm Gomez Junior Faculdade de Ciências Farmacêuticas, Universidade de São Paulo "Ex vivo antilipoperoxidative efficacy of rutin-loaded ethosomes"
P10: Carolina P. Gomes CICS, Universidade da Beira Interior "Mapping Serra da Estrela's endemic flora for sustainable cosmetic applications"
P11: Sarah Daniele M. Lima Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo "Application of vegetable oils from Brazilian biodiversity in cosmetic formulations for curly hair"
P12: Gustavo T. Machado Universidade Federal do Espírito Santo "Development of a natural sunscreen with zinc oxide nanoparticles: photostability and environmental toxicity"

Poster Session
P13: Ana Júlia F. Garcia Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo "Development of a sunscreen containing a fat-soluble derivative of vitamin C and D-panthenol for mature skin: clinical efficacy and sensory properties"
P14: Iuri Machado CICECO, Universidade de Aveiro "Development of keratin-based materials for biomedical applications"
P15: Tijana Stanković Faculty of Pharmacy, University of Belgrade "Design of lipid nanoemulsions loaded with CW-02-79-phospholipid complex for targeted brain delivery: focus on stability in protein-enriched media"
P16: Ana Camila Marques UCIBIO and i4HB, Faculdade de Farmácia, Universidade do Porto "In-situ forming injectable hydrogels containing lipid nanoparticles for local delivery of docetaxel"
P17: Beatriz S. Ezequiel Faculdade de Farmácia, Universidade de Lisboa "Effects of plastic pollution on skin barrier integrity"
P18: Nicole Vidinha CICECO, Universidade de Aveiro "Improving wound healing by controlled release of diclofenac sodium using a keratin-based material"

Poster Session
P19: Marta Martins ECTS, Universidade Lusófona "Caffeic acid loading in TransfersomILs: an alternative method for cutaneous delivery"
P20: Paula Oliveira ECTS, Universidade Lusófona "Nanotechnological advances in cosmetic products: assessment of consumer perception"
P21: Filipa Silva, Madalena Batista, Margarida Caroço, Mariana Rodrigues ECTS, Universidade Lusófona "Enhanced delivery of ferulic acid in SLNs and NLCs through the use of ionic liquids"
P22: Teresa Martinho ECTS, Universidade Lusófona "The impact of choline-based ionic liquids on transfersomes loaded with *p*-coumaric acid"
P23: Ana Patrícia Gomes CBIOS, Universidade Lusófona and SOMAÍ Pharmaceuticals "Pioneering new frontiers in medical cannabis: SOMAÍ's advanced formulations"
P24: Ana Macário-Soares REQUIMTE/LAQV, Faculdade de Farmácia, Universidade de Coimbra "Advanced wound healing therapy using functionalized liposomes encapsulating natural compounds"

Poster Session
P25: José Parreira, Luís Oliveira, Marta Matos, Raquel Mendes ECTS, Universidade Lusófona "Combining solid lipid nanoparticles and semisolid matrices: an exploratory study toward topical delivery"
P26: Ana Patrícia Gomes CBIOS, Universidade Lusófona and SOMAÍ Pharmaceuticals "Advancing cannabinoid therapies: SOMAÍ pharmaceuticals' innovative solutions"
P27: Daniela S. Cabral Escola de Ciências da Saúde, Instituto Politécnico da Guarda "Development of a nanoemulgel containing α-bisabolol for topical application"
P28: Andreia Rosatella CBIOS, Universidade Lusófona and iMed, Universidade de Lisboa "Emerging photoswitchable materials based on ionic liquids"

Keynote Speakers

K1

SNEŽANA SAVIĆ

Department of Pharmaceutical Technology and Cosmetology, Faculty of Pharmacy, University of Belgrade, Serbia

"Lipid-based nanoparticulated systems intended for brain delivery of patented leads/drug candidates acting at GABAA receptors – formulation approach, in vitro and in vivo research platforms"

Snežana SAVIĆ is Professor of Pharmaceutical Technology and Cosmetology at the Faculty of Pharmacy, University of Belgrade, FPUB (Department of Pharmaceutical Technology and Cosmetology), with strong background in the pharmaceutical industry, where she worked for 7 years in the R&D department of the pharmaceutical company Galenika ad in Belgrade. She holds an MSc in Cosmetology, a PhD in Pharmaceutical Technology and a specialization in Pharmaceutical Biotechnology. In the period 2018-2024 she was Vice Dean for Research and International Cooperation (FPUB). Prof. Savić is a lecturer for a number of undergraduate and postgraduate courses: Pharmaceutical Technology 1 and 2, Cosmetology, Introduction to Pharmaceutical Biotechnology. She is the head of specialization in the field of Cosmetology.

Snežana Savić is head of the research group Nanoplatforms for Brain and Skin Drug Delivery. She supervised 17 defended PhD theses, mainly in the field of nanotechnology, and coordinated a number of research projects in this field, both in the area of nanodelivery systems for active pharmaceutical ingredients and cosmetics. She is author or co-author of 153 publications in international peer reviewed journals and a number of oral and poster presentations at national and international conferences. She is co-inventor of two national patents and has long-term collaborations with research groups in Germany, Greece, Slovenia, UK, Ireland, Poland and Switzerland.

She is also the coordinator for the Serbian partner in the Erasmus+ EMJM project: Health and Wellbeing across the Lifespan (HYGIEIA).

K2

SARA CORDEIRO

Leicester School of Pharmacy, De Montfort University, United Kingdom

“Tackling global challenges by overcoming the skin barrier”

Sara Cordeiro is a Senior Lecturer in Pharmaceutical Sciences at the School of Pharmacy at De Montfort University (Leicester, UK). Following a PharmD from the University of Porto (Portugal) and a PhD in Drug Research and Development from the University of Santiago de Compostela (Spain), she worked as a Postdoctoral Research Fellow at Queen's University Belfast (Belfast, UK). Throughout these years, Sara has developed a background in pharmaceutical formulation, drug delivery, nanomedicine, vaccine delivery and microneedles for transdermal drug delivery and diagnostics. Currently, she is establishing her independent research group with a focus on improving and facilitating patients' lives through the development of drug and vaccine delivery systems that are easy to manufacture and scale-up, highly efficient and administered through non-invasive routes.

K3

ANDRÉ R. BABY

Faculdade de Ciências Farmacêuticas, Universidade de São Paulo, Brazil

“Advancing technologies for enhanced sunscreen efficacy”

Pharmacist and Biochemist. PhD in Drugs and Medicines from the Faculty of Pharmaceutical Sciences, University of São Paulo (FCF-USP). Associate Professor at the Department of Pharmacy, Faculty of Pharmaceutical Sciences, University of São Paulo, with experience in the area of Cosmetic Science for over 20 years, involving teaching, research, and scientific publications. Expertise in photoprotection, technologies applied to this class of preparations, cutaneous antioxidant potential "ex vivo", safety and cosmetic efficacy related to sun protection, and development of new protocols.

K4

PATRÍCIA MAIA CAMPOS

Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo, Brazil

“Application of sustainable raw materials and Brazilian biodiversity in cosmetics research & innovation”

Pharmacist, holds a Master's degree and a Doctorate in Pharmaceutical Sciences from the University of São Paulo. Currently, she is a Full Professor at the University of São Paulo. She has over 30 years of experience in research and development of dermocosmetic products: innovation in formulations and evaluation methods. She coordinates the Center of Advanced Studies in Cosmetic Technology (NEATEC) and has extensive experience in the development and clinical efficacy studies of dermocosmetics. She has published more than 100 scientific articles in indexed journals, 400 works reported in scientific events, taught more than 50 lectures and received many awards and honors. She coordinates research projects and has international agreements with Universities and Research Institutes. She is a scientific consultant in the production sector, a member of CATEC/ANVISA and the Technological Council of ABIHPEC.

K5

SANDRA SIMÕES

iMed, Faculdade de Farmácia, Universidade de Lisboa, Portugal

"Challenges in assessing efficacy of skin delivery systems entrapping natural bioactive compounds"

Sandra Simões is a Principal Investigator at the Department of Pharmacy, Pharmacology and Health Technologies and at the Research Institute for Medicines (iMed.ULisboa), Faculty of Pharmacy, Universidade de Lisboa. She is a member of the Animal Welfare Body of the Faculty of Pharmacy, University of Lisbon. Both advanced technologies for drug delivery and pre-clinical assays have motivated her research, which has been focused on design, development and biological evaluation of optimal drug delivery systems for dermal and transdermal delivery, for small and large molecules, with special emphasis on phospholipid-based nanocarriers. Research activity deals with drug-excipient and drug-skin interactions, and development of animal models of acute and chronic inflammation, skin infection and wound-healing. These studies require optimization of techniques for the in vitro, ex vivo and in vivo assessment of dermal and transdermal drug delivery. In the last years, Sandra Simões has been working on the valorisation of food processing industry by-products and the application of extracted bioactives in skin health. More recently, she has been involved in the establishment and optimization of mouse models of breast cancer brain metastasis and glioblastoma for the evaluation of therapeutic efficacy of new drug candidates.

Oral Communications

INNOV DELIVERY `25

II LUSOPHONE MEETING ON INNOVATIVE DELIVERY SYSTEMS

OC1

Do you want to redefine precision delivery with a click? HER2

Filipa A. Soares[1], Adrián Margüello[2], Maria Jesús Serramía[2], Gonzalo Villaverde[3], Jorge Rubio-Retama[3], Salette Reis[1], Cláudia Nunes[1], Beatriz Salinas[2,4]

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Abietane diterpenoids from *Plectranthus* spp.: emerging nanodelivery strategies for cancer therapy

Gabrielle Bangay[1,2#], Vera M.S. Isca[1#], João Morais[3], Jennifer Fernández Alarcón[4], Ana S. Viana5, Catarina P. Reis[6], Catarina Pereira-Leite[1], Ana M. Díaz-Lanza[2], Lucília Saraiva[3], Cristina Fornaguera[4]*, Patrícia Rijo[1,6]*

[1] CBIOS – Universidade Lusófona's Research Center for Biosciences & Health Technologies, Lisbon, Portugal
[2] Universidad de Alcalá de Henares. Facultad de Farmacia, Departamento de Ciencias Biomédicas (Área de Farmacología; Nuevos agentes antitumorales, Acción tóxica sobre células leucémicas. Alcalá de Henares, Madrid, España
[3] LAQV/REQUIMTE, Laboratório de Microbiologia, Departamento de Ciências Biológicas, Faculdade de Farmácia, Universidade do Porto, Portugal
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[5] Centro de Química Estrutural, Faculdade de Ciências da Universidade de Lisboa, Portugal
[6] Research Institute for Medicines (iMED.Ulisboa), Faculdade de Farmácia, Universidade de Lisboa, Portugal

#Shared 1st authorship, *shared senior authorship. **Email:** patricia.rijo@ulusofona.pt

Nanoparticles (NPs) enhance drug delivery systems by improving bioavailability and targeted release of therapeutic agents, particularly when combined with natural products, enabling more effective treatments with reduced side effects. Nanoparticles loaded with natural products improve drug encapsulation, control release, extend circulation, and reduce toxicity for more effective therapy. Metal-based NPs, especially gold nanoparticles (AuNPs), are favored for their easy synthesis, handling, and unique properties, making them ideal for drug and gene delivery, particularly in cancer therapy. Abietane diterpenoids like 7α-acetoxy-6β-hydroxyroyleanone (Roy, **1**) isolated from *Plectranthus* species display cytotoxic properties, though their therapeutic use is limited by poor water solubility and low bioavailability. To address these limitations, Roy (**1**) and an ester derivative were incorporated into gold nanoparticle (AuNP) nanosystems. These nanoformulation were characterized in terms of particle size, polydispersity index (PDI), zeta potential, and encapsulation efficiency. Antitumour studies using breast cancer cell lines (MDA-MB-231, 4T1, and MCF7) revealed that Roy-functionalized AuNPs produced stronger cytotoxic effects compared to either functionalized Roy or plain AuNPs, demonstrating the enhanced efficacy of the nanoformulated compounds. Additionally, the Roy-AuNPs exhibited a selective antitumour activity toward cancer cells over healthy human fibroblast (HDF) cells, suggesting that these diterpenoid-based nanosystems may offer promise for cancer treatment applications.

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1. Gulla S *et al.* In: Gurtler V, Ball AS, Soni SBTM in M, eds. Nanotechnology. Vol 46. Academic Press; 2019:255-293.

Alpha-tomatine foam for inflammatory skin conditions

Catarina Faria-Silva[1,2], Denise Scavone[3], Joana Marto[1], Pedro Simões[2], Manuela Carvalheiro[1] and Sandra Simões[1]

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Green tomatoes, a by-product of the agrifood industry, are rich in glycoalkaloids, particularly alpha-tomatine. This glycoalkaloid has several health-promoting properties, including anti-inflammatory, anti-carcinogenic, and fungicidal effects. As a subgroup of saponins, glycoalkaloids also have surfactant properties, making them ideal for use in foam formulations. Foams are convenient for topical application and are perfect to formulate compounds with surface-active properties.

The aim of this work was to extract tomatine from green tomatoes using an environmentally friendly technique, and to formulate it into a foam for treating inflammatory skin diseases. In this formulation, tomatine acts both as the active ingredient and a surfactant.

The extract was analyzed for its content of phenolic compounds, carbohydrates and total saponins. Antioxidant activity was evaluated using DPPH (2,2-diphenyl-1-picrylhydrazyl radical) and CUPRAC (Cupric Reduction Antioxidant Capacity) assays. Anti-inflammatory properties were assessed *in vitro* using the NO production assay in RAW264.5 cells, while cell viability was evaluated in HaCaT human keratinocyte cell line. The tomatine-containing foam was formulated using only sustainable ingredients. The foam was characterized for its rheological properties, including viscosity, oscillation behavior, adhesiveness and texture. Foam stability was also studied. *In vivo* tests were conducted to confirm the anti-inflammatory efficacy. The extract characterization proved its antioxidant and anti-inflammatory activity. The formulation presented a gel-like appearance and the foam obtained by a foam pump dispenser was macroscopically homogeneous. In rheological terms, the formulation behaves like a non-Newtonian fluid with elastic properties. An adhesive force value of 0.469 N.s was obtained for a peak normal force of -0.109 N.

Acknowledgements: This work was supported by the project PTDC/SAU-SER/30197/2017-LISBOA-010141-FEDER-030197 and PhD fellowship 2022.11984.BD from FCT. Research Institute for Medicines - iMed.ULisboa is funded by FCT through projects UID/DTP/04138/2020 and UIDP/04138/2020. LAQV-REQUIMTE is funded by FCT through projects UIDB/50006/2020 and UIDP/50006/2020.

From flowability to extrusion-based 3D Printing: a dual approach based on rheology and texture science

Sara Bom[1], Matilde Carvalho[1], Pedro Prazeres[2], Pedro C. Pinto[1,3], Helena M. Ribeiro[1] and Joana Marto[1]

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3D printing (3DP) is increasingly seen as a pioneering technology that enables the personalization of pharmaceutical and cosmetic products, blending innovation with versatility. However, further progress is needed, along with investments in new methodologies to optimize the 3DP process (1). Therefore, this work aimed to characterize one of the key parameters in hydrogel's printing - flow behavior - and optimize the related-3DP settings through a dual approach based on rheology and texture.

A gelatin-based ink containing 40% (w/w) of gelatin type B (Acofarma, Spain) was developed and analyzed using a Kinexus Lab+ Rheometer (NETZSCH, Germany). Gelation temperature and viscosity at the cross-over (f = 1 Hz; T= 55-25˚C) were defined and the flowability was characterized by a 3-steps personalized sequence mimicking the 3DP process (shear rate: 0.1-100 s-1). For texture analysis (Texture Analyser, Stable Micro Systems, UK), an in-house-built set-up was used to predict the inks' extrudability across different gauge (G) nozzles: 25G, 27G, and 30G.

Linear rheological analysis was used to define the ideal 3DP temperature, with viscosity showing the highest impact on this selection: 43°C (η = 247.9 Pa.s). In addition, it was possible to validate the 3DP performance, with the 3-steps analysis showing a drop in viscosity at the higher shear rate step - good indicator of extrudability, followed by a quick recover after deposition - predicting high printability. While rheology has been useful in assessing the inks' flowability, it is also of interest to explore how various G nozzles influence extrudability. The texture assay indicated the force required to extrude: 16.9 N (25G), 34.8 N (27G) and 53.4 N (30G).

This dual approach, which is based on a material-process perspective, will assist in optimizing flow-related 3DP settings - temperature and pressure, and nozzle G.

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Redefining vitamin C in cosmetics: dissolvable microneedles for enhanced stability and target delivery

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Ascorbic acid (AA) has been widely used and studied in recent decades due to its antioxidant potential and other essential roles for the skin. AA is a water-soluble vitamin, and its rapid degradation in aqueous environments presents a challenge for its incorporation into cosmetic formulations. To overcome this issue, some stabilization strategies have been applied, such as using large amounts of silicones or utilizing AA derivatives within formulations. However, AA derivatives often need to be used at higher concentrations due to their lower efficacy compared to the original molecule. In this study, we propose the repositioning of AA by using delivery systems based on dissolvable microneedles (DMNs). Since DMNs contain low water content, this system could prevent AA degradation. Additionally, DMNs can promote efficient delivery of AA by facilitating the diffusion of molecules into deeper layers of the skin through minimal and temporary disruption of the stratum corneum (1). This study aimed to develop a DMNs array for efficient delivery of AA to skin, focusing on the fabrication and characterisation of the array. The DMNs were produced by incorporating AA in a matrix of hyaluronic acid (HA) and a backing layer of polyvinylpyrrolidone (PVP) (Fig. 1). The fabrication method used was micro-moulding. DMN characterization including stereomicroscopy, and others *ex vivo* assays were employed to assess the physical attributes of the DMN arrays and skin penetration depth. The findings demonstrate the potential of DMN arrays as a promising tool for efficient, targeted, and controlled intradermal delivery of AA for cosmetic applications.

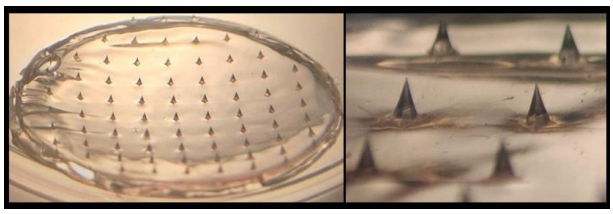

Figure 1 – Geometry of AA-loaded HA DMN array by stereomicroscopy.

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Advancing skin and hair care with pequi oil liposomal nanoparticles: stability and efficacy

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Pequi oil (*Caryocar Brasiliense* Cambess), a natural Brazilian resource rich in fatty acids and bioactive compounds, holds high potential for cosmetic applications due to its antioxidant, moisturizing, and emollient properties. In this context, this study aimed to develop a stable delivery system by incorporating pequi oil (PO) into liposomes and stabilizing them through freeze-drying, enhancing its efficacy in formulations for skin and hair care. Liposomes, empty (L1) and containing 1% PO (L2), were prepared and freeze-dried with sucrose as a cryoprotectant. Characterization included dynamic light scattering, zeta potential, and encapsulation efficiency (EE), confirming high stability over 49 days and EE of 93.8% compared to the liquid formulation. The dried liposomes were added to a rinse-off hair conditioner and a gel formulation. Hair tests were performed on standardized virgin and bleached tresses, evaluating tensile strength, combability, softness, and cuticle alignment by Reflectance Confocal Microscopy. For skin care, clinical studies were performed using biophysical and imaging techniques. The measurements were carried out in 10 study participants before and 2 hours after the application of the formulations in terms of skin hydration, transepidermal water loss, sebum content, and skin microrelief. The liposome PdI showed minimal variation, particle size in the nanometric scale and with constant zeta potential. The treatment with liposomes containing PO improved cuticle alignment, providing deep nourishment and strengthening the hair structure. The emollient properties of PO lubricated the hair shaft and coated flaky or dry hair fibers. The small size of the liposomes facilitated PO penetration into the hair cuticles, showing a tendency to increase hair strength. In addition, the gel containing L2 improved skin hydration, barrier function, and microrelief, demonstrating the dual benefits of PO properties. In conclusion, this innovative approach combines advanced encapsulation and freeze-drying technologies, enhancing the functional performance of pequi oil in cosmetics. These findings support the development of high-value natural formulations, emphasizing the importance of Brazilian biodiversity in advancing sustainable and effective cosmetic products.

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Arbutus unedo L. leaf extracts from Portuguese regions as potential anti-acne ingredients

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Acne vulgaris is a multifactorial disease of the pilosebaceous unit that affects millions worldwide and plant-based anti-acne alternatives have been increasingly searched by consumers. The strawberry tree (*Arbutus unedo* L.) has gained popularity in scientific literature for its bioactive properties. While the fruit is well-known, the leaves are often considered a waste product. This work aimed to evaluate the anti-acne potential of *A. unedo* L. leaves collected in three different regions from mainland Portugal. Extracts were obtained by aqueous infusion of the leaves collected in Proença-a-Nova, Gouveia, and Odemira and phytochemically characterized by UHPLC-PDA-MS/MS and GC-MS. The antimicrobial activity was tested against *Cutibacterium acnes*, *Staphylococcus aureus* and *Staphylococcus epidermidis* using the broth microdilution assay. Cell biocompatibility was assessed in keratinocytes, fibroblasts and macrophages using the MTT assay. Antiinflammatory potential was evaluated through nitric oxide production, and anti-lipase activity was evaluated with Ellman reagent. The three extracts were qualitatively similar and were characterized by the presence of phenolic compounds, organic acids and sugars. *Cutibacterium acnes* demonstrated higher susceptibility, with a minimum inhibitory concentration of 0.5 mg/mL for all extracts. This concentration did not affect the growth of *S. epidermidis*, a skin commensal, with two of the three extracts. This effective concentration was also proven biocompatible with all tested cell lines. The Gouveia extract exhibited the strongest anti-inflammatory properties, and all extracts showed antilipase activity, with the Odemira extract being the most effective. *Arbutus unedo* L. leaf extracts demonstrated promising anti-acne activity through several mechanisms, with selective action against *C. acnes* and biocompatibility with skin cells. As a sustainable byproduct of the fruit production, the leaves present potential for eco-friendly applications in acne management.

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Innovative cosmetic ingredients from lupin by-products: unlocking sustainable solutions

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The cosmetic industry is increasingly prioritizing sustainability in response to consumer awareness of environmental issues. This evolving landscape drives the need to explore alternative sources for cosmetic ingredients. Simultaneously, the food industry creates substantial waste, which provides opportunities to use by-products. Lupin, rich in bioactive compounds with antioxidant, anti-inflammatory, anti-ageing, and photoprotective properties, presents a suitable option for cosmetic applications. This study explores the potential of extracting health-promoting compounds from Portuguese lupin by-products (hulls and cotyledons) to revolutionize the cosmetic industry. Subcritical water (SBW) extraction was applied as a sustainable method that uses water as a solvent under high pressure and temperature. The extracts were evaluated for phenolic content and tested on HaCaT cells for cytotoxicity, antioxidant capacity (H2O2 and UVB light), and enzymatic inhibition (elastase, hyaluronidase, and tyrosinase). The lupin extracts showed high phenolic content (>0.6 g gallic acid/100 g dry mass) and demonstrated low cytotoxicity and strong antioxidant capacity, with notable ROS inhibition (>70%) and elastase inhibition (>90%). These results suggest that lupin extracts may protect skin cells from oxidative damage and improve skin elasticity. Particularly, lupin hull extracts had exceptional ROS inhibition in response to UVB light exposure, making them ideal for sunscreen formulations. Their inclusion could significantly enhance sunscreen efficacy and establish a new standard for sustainable cosmetic innovation. This study emphasizes the potential of lupin extracts as valuable cosmetic ingredients through SBW extraction. The cosmetic industry can use these sustainable ingredients to develop eco-friendly solutions that meet both consumer demands and environmental needs. The use of lupin by-products highlights the value of waste, offering a compelling model for the future of sustainable cosmetics.

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Advances in keratin processing for the development of bioactive 4D-printed materials

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Chicken feathers are composed predominantly of keratin, a fibrous protein with potential for biomedical applications due to its antioxidant and anti-inflammatory effects and the ability to promote cellular activities. However, keratin has low solubility in water and conventional organic solvents, which makes its processing a challenge. To address this, we developed an innovative and sustainable approach using acetate-based ionic liquids for feather dissolution, enabling the direct production of three-dimensional (3D) structures via 3D printing. The developed materials revealed excellent structural integrity and shape fidelity. Comprehensive characterisation of the materials covered rheological and mechanical properties, along with degradation behaviour. Additionally, the developed materials demonstrated outstanding biocompatibility and exhibited dynamic shape-changing over time, driven by cellular traction forces, showcasing their potential for 4D printing applications. Overall, this study offers a sustainable approach for feather waste valorisation, presenting an innovative method to produce keratin-based materials for advanced tissue engineering.

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Rutin-loaded cerosomes: a breakthrough for Xeroderma Pigmentosum patients

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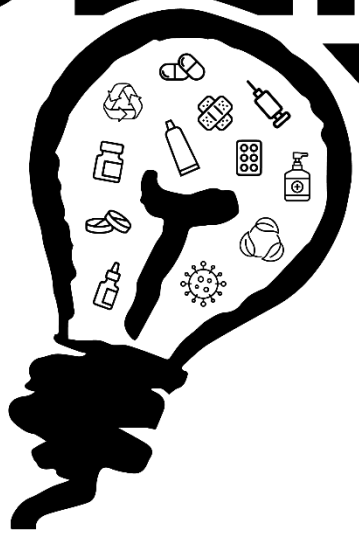

II LUSOPHONE MEETING ON INNOVATIVE DELIVERY SYSTEMS

Transferrin receptor 1-targeted nanoparticle therapy for colorectal cancer

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Colorectal cancer poses a significant global health challenge, ranking among the most prevalent and standing as the second leading cause of cancer-related mortality (1). Its formidable nature is attributed to difficulties in both early detection and a lack of effective and targeted treatments (2). In response to this limitation, we propose using the Transferrin receptor 1 (TfR1) as a target for drug delivery systems in colorectal cancer, owing to its discernible overexpression in tumours (3). To achieve this goal, we characterized human colorectal cancer cell lines such as SW480, HT-29, HCT116, a healthy human intestinal cell line (hIEC), and a murine colorectal cancer cell line, MC38, focusing on assessing the expression of TfR1s through flow cytometry and immunocytochemistry assays. We developed poly(ethylene glycol) (PEG) and poly(lactic acid) (PLA)-based nanoparticles functionalized with the T7 peptide (HAIYPRH) to specifically target TfR1. The targeting efficacy of these nanoparticles was evaluated across various cell lines using flow cytometry. After identifying the most effective formulation, we encapsulated doxorubicin (Dox), an anti-cancer drug, within the nanoparticles to assess its therapeutic efficacy. Both in vitro and in vivo studies demonstrated that the Dox-loaded nanoparticles efficiently targeted tumour cells while reducing cytotoxicity in the healthy cell line. In a murine colorectal model, the Dox-loaded nanoparticles significantly improved survival rates compared to free doxorubicin treatment, highlighting the potential of TfR1-targeted nanoparticles in advancing more precise and effective treatments for colorectal cancer.

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Towards direct transformation of nanoemulsions into nanoemulsion gels: traditional vs. new-generation gelling agents

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Nanoemulsion gels are innovative delivery systems with very complex structure in which nanoemulsions' droplets are dispersed in a gel matrix. Nanoemulgels successfully combine the favorable characteristics of nanoemulsions and hydrophilic gels, while overcoming the disadvantages of both, thus providing modern carriers with the potential for improved delivery of drugs and cosmetics [1].The aim: The aim of this study is to investigate the possibility of direct gellation of fragile carriers, such as low-energy nanoemulsions with traditional and new-generation gelling agents. Carbomer 980 and xanthan gum were used in this study as represenatives of traditionally used gelling agents in hydrophilic gels, while polyacrylate-crosspolymer 6 was selected as a novel gelling agent. Nanoemulsions with ibuprofen as the model active were first prepared via the phase inversion emulsification (EPI) method and then directly transformed to nanoemulsion gels with the addition of 1% of a selected gelling agent. Both nanoemulsions and nanoemulgels were monitored by dynamic light scattering in order to confirm the preservation of nanodroplets in the gel matrix during transformation. Complex interactions between pure nanoemulsions and the gel matrix were investigated by Fourier-transform infrared (FTIR) spectroscopy. All nanoemulsion gels was sucessfuly prepared by direct gellation of nanoemulsion. The mean particle sizes ranged from 60.12 to 62.12 nm for all three formulations, which corresponded to the size of the droplets initially found in the nanoemulsions. Expectedly, transformation of the liquid to semi-solid state has slightly increased the PDI values; from 0.093 for the nanoemulsion to around 0.166 for the nanoemulgel. The zeta potential value was two times higher for the carbomer and xanthan gum gels and three times higher for the polyacrylate-crosspolymer 6 gel compared to nanoemulsion, indicating additional stabilization of the nanoemulsion during transformation. This is in line with the pH values increase (5.12 for the nanoemulsion; 6.28, 6.50 and 6.27 for carbomer 980, xanthan gum and polyacrylate-crosspolymer 6, respectively). FTIR analysis showed that nanoemulsions completely preserved their structure in the formed nanoemulgels, not showing quenching or reduction of characteristic peaks originating from the nanoemulsion.

It was shown that direct gelation of the nanoemulsion with different gelling agents successfully produced nanoemulgels in which the nanodroplet structure was fully preserved, as confirmed by droplet size measurements and FTIR analysis. The zeta potential was highest in the nanogel with polyacrylate-crosspolymer 6, indicating its potential to further stabilize the nanodroplets and thus extend the stability of the nanosystem.

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Black soldier fly larvae oil as an innovative treatment for bleached hair

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Amino-acid-based ionic liquids and lipid-based nanoparticles: a synergistic approach to delivery systems

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Ionic Liquids (ILs) have emerged as promising ingredients in the pharmaceutical and cosmetic fields (1), due to their capacity to incorporate sparingly water-soluble compounds in different delivery systems and increase colloidal stability (1,2). Their combination with lipid-based nanoparticles can be an interesting approach since these hybrid nanosystems are biocompatible, biodegradable, and capable of incorporating hydrophilic and lipophilic compounds (1). So, we aimed to explore the potential of amino-acid-based ILs – (2-hydroxyethyl)–trimethylammonium-L-phenylalaninate [Cho][Phe] and (2-hydroxyethyl)–trimethylammonium glycinate [Cho][Gly] – by the evaluation of the physiochemical properties of the developed nanosystems (transfersomes, solid lipid nanoparticles and nanostructured lipid carriers) and their performance, using hydroxycinnamic acids as model compounds for topical application. Results showed that IL-containing nanoparticles were suitable for topical administration, due to their physicochemical properties and colloidal stability. Furthermore, the presence of [Cho][Gly] seems to contribute to a higher AE and LC. Moreover, ILs also demonstrated to increase the total amount of compounds released and to allow a higher permeation flux through silastic membranes and human skin. Overall, this project showed the potential of amino acid-based ILs to act as multifunctional green ingredients to boost the performance of lipid-based nanosystems. Further studies are awaited to verify their safety and efficacy when incorporated into innovative delivery systems.

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"I've got you…under my skin!" – Playing a scientific song of many chords in atopic dermatitis

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Skin is a complex orchestra of many instruments that performs a harmonious melody when every key player is in tune. However, when this harmony fails to exist, skin diseases can occur, affecting nearly one-third of the world's population and being the fourth most common class of all human disease. Barrier disruption and inflammation occur as an 'out of tune' characteristic in many skin diseases, particularly in Atopic Dermatitis (AD).

AD is a common skin condition affecting all ages, with significant barrier dysfunction and allergic inflammation, which considerably impact their quality of life. While emollients are still a treatment' cornerstone, severe AD requires potent therapies with limitations and high costs, justifying the need for more personalized medicine approaches and different topical vehicles to ensure accessible treatments for all disease manifestations (1, 2).

To tackle these great challenges of AD, harmonized three classes of key instruments: Nanotechnology, to create composite systems of hydrogels with lipid nanoparticles, capable to deliver the anti-inflammatory betamethasone in target tissues; Biophysics, to unravel the impact of the composite formulations in skin barrier recovery in the outermost skin layers; and Biotechnology, to develop healthy and AD-mimetic human skin models to observe the AD-phenotypic reversion upon treatment with the designed formulations. Our results show that many chords could be tuned for this AD therapeutic option, particularly a high retention of drug, cytocompatibility, anti-inflammatory potential, improved order in skin lipid barrier, and AD characteristics' reversion.

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Poster Communications

INNOV DELIVERY `25

II LUSOPHONE MEETING ON INNOVATIVE DELIVERY SYSTEMS

P1

Efficacy of hair care formulations containing olive leaf extract in the mechanical properties of bleached hair

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Innovative mRNA delivery with sustainable keratin-based materials

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Messenger RNA (mRNA)-based therapies have gained significant attention in recent years due to their potential in treating infectious diseases, immunological disorders, cancer, and genetic conditions. These therapies can enable the expression of specific genes and promote the production of proteins that can induce target immune responses. However, delivering mRNA effectively remains a challenge due to its large molecular size, limited stability, and susceptibility to immune reactions. To overcome these challenges, polymer-based delivery systems have been investigated and are gaining attention for their versatility and biocompatibility. Keratin, a protein with high antioxidant and anti-inflammatory properties, holds promise in this field and can be recovered from various sources, including sheep wool. In this study, a sustainable approach was developed using aqueous solutions of ionic liquids (ILs) to dissolve brown sheep wool and recover keratin. Following ILs screening, 1-ethyl-3-methylimidazolium acetate ($[C_2C_1im][C_1CO_2]$) was identified as one of the most effective solvents, with a protein recovery yield of (71 ± 3) wt%, under optimal conditions. The recovered keratin was characterized and used to develop keratin-based materials for advanced mRNA delivery applications. This study offers a sustainable approach for wool waste valorization while developing keratin-based materials for mRNA delivery.

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P3

Tailored lipid nanoparticles based in larvae biomass for enhanced skin formulations

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INNOV DELIVERY `25
II LUSOPHONE MEETING ON INNOVATIVE DELIVERY SYSTEMS

Can customized delivery systems make antioxidant injections feasible at home?

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Resveratrol (RES), a potent antioxidant, has garnered attention for its extensive therapeutic potential. However, its clinical utility is hindered by significant limitations, including poor aqueous solubility, rapid photodegradation, and minimal skin permeation due to its small molecular size (1). These challenges necessitate innovative delivery systems to ensure its stability and bioavailability. To address these issues, we developed poly (lactic-co-glycolic acid) (PLGA) nanoparticles (NPs) encapsulating RES with an efficiency of approximately 87.3 ± 2.6 % and a loading capacity of 10.0 ± 0.8 %. These nanoparticles exhibit a negative zeta potential, ensuring colloidal stability and preventing aggregation, as well as storage stability of about two months. Encapsulation effectively shields RES from UV-induced degradation while enabling controlled drug release, thereby enhancing its therapeutic applicability. To further optimize RES delivery, 3D-printed hollow microneedles (MNs) equipped with a chamber for a 1 mL plunger syringe were designed. These microneedles serve as a hybrid between traditional injections and dermal systems, enabling the administration of nanoparticles in liquid form. Engineered for durability and sharpness, the MNs demonstrated mechanical robustness, reusability, and structural integrity during application. Two MN lengths, 1 mm and 1.5 mm, were fabricated, both exhibiting a safety index greater than 1, indicating their safe and reliable performance for clinical application. The efficacy of these microneedles was validated through penetration studies using histological and confocal microscopy techniques. These studies confirmed that the 1.5 mm MNs delivered RES-loaded NPs to the dermis-hypodermis interface, while the 1 mm MNs effectively targeted the upper dermis. This precision allows for tailored delivery based on therapeutic requirements, according to the condition being treated. *Ex vivo* permeation assays using pig abdominal skin demonstrated that the loaded RES-loaded NPs passing through the hollow MNs enhanced RES delivery compared to the free compound, achieving deeper penetration and improved permeation across the skin layers. This adaptability makes the system suitable for treating a range of skin and systemic conditions. Delivery to the upper dermis could target oxidative stress-related conditions like photoaging, or melasmas, while deeper delivery to the dermis-hypodermis interface may address the management of keloid scars (2-5). This dual delivery system combines nanoparticle technology with advanced microneedles, overcoming barriers to RES application. Its safety, adaptability, and precision suggest potential for at-home use, revolutionizing antioxidant therapies and advancing personalized medicine.

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P5

From nature to nanoparticles: advanced strategies to address skin ageing

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Skin ageing is a major concern in modern society, driven by increasing life expectancy and a growing demand for effective anti-ageing solutions (1). Hyaluronic acid (HA) is a key molecule in maintaining skin health, promoting moisture retention, elasticity, and nutrient exchange (2,3). However, HA levels naturally drop with age, contributing to visible signs of ageing such as wrinkles and loss of firmness (4). Addressing this challenge, our study explores nature-inspired innovations to boost HA production in skin cells using β-carotene, a powerful antioxidant with anti-ageing properties (5), delivered via solid lipid nanoparticles (SLNs).

The β-carotene-loaded SLNs were formulated using Glycerol Monostearate (Imwitor 900K) and cacao butter, stabilised with a surfactant. Characterisation included particle size, polydispersity index, zeta potential, stability at 4°C, encapsulation efficiency, and loading capacity. Biological assays in human dermal fibroblasts and HaCaT cells assessed their impact on metabolic activity, HA production, reactive oxygen species evaluation, and apoptosis.

The optimised SLNs showed high encapsulation efficiency and moderate stability, effectively delivering β-carotene to skin cells. Treatment with these nanoparticles significantly enhanced HA production, demonstrating their potential for skin health and counteracting ageing processes.

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Enhancing the delivery of an iron chelator to combat mycobacterial infections

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Antimicrobial resistance poses a critical challenge to global health, with bacterial resistance contributing to over a million annual deaths. Amongst the explored strategies to address this problem, an Iron Deprivation approach has emerged as a promising alternative to traditional antibiotics, exploiting bacteria's dependence on Fe for survival.

Although the human body naturally limits bacterial access to Fe during infection, pathogens have developed mechanisms to overcome these limitations, namely by the production of siderophores, leading to a competitive struggle for available iron sources. Exploiting this competition for Fe, the use of hexadentate chelators based on 3,4-hydroxypyridinones has been shown to be effective in inhibiting bacterial proliferation. Previous studies pointed out the relevance of rhodamine on the chelator framework to improve the targeting to the infection site [1]. Herein, we report the strategies to improve the delivery of 3,4-HPO to compete with bacterial siderophores and inhibit bacterial growth within macrophages. Our present investigation focused on the encapsulation of the hexadentate iron chelators, CP256 and MRHT [2], using poly(lactic-co-glycolic acid) (PLGA) nanoparticles (NPs) to enhance their targeted delivery and efficacy against macrophage intracellular infections. The study demonstrates that the chelators were efficiently encapsulated into PLGA nanoparticles, which were then internalised by macrophages. These findings highlight the potential of drug delivery systems in the development of new strategies to address bacterial infections, particularly those involving intracellular pathogens resistant to conventional therapies.

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Nano delivery of isoniazid-based therapeutic deep eutectic systems for enhanced tuberculosis treatment

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Study of rheological behavior through viscosity determination as part of the stability evaluation of cosmetic emulsions containing green propolis oil extract

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The study of rheological properties evaluates the influence of applying forces on the flow and deformation of a material. One way to perform this evaluation is through viscosity analysis, especially in the context of cosmetic and topical formulations, as it expresses the fluid's resistance to flow, so the higher the viscosity, the greater the resistance1. Understanding this behaviour is important not only in product development but also as a parameter for quality control and stability, enabling the assessment of effects caused by time, storage conditions, and the incorporation of active substances1. In this context, this study aimed to evaluate the organoleptic characteristics, pH, and viscosity of formulations stored at room temperature (25 ± 2 °C), oven (40 ± 2 °C), and refrigerator (5 ± 2 °C) for 90 days, performing tests at the initial time (T0) and every 30 days. The formulations included 10%(m/v) green propolis oil extract (GPOE), derived from *Baccharis dracunculifolia*, a typical Brazilian plant composed of flavonoids and phenolic substances2, and 10%(m/v) sunflower oil (SO), which served as the control without functional active ingredients. Viscosity analyses were performed in duplicate using the VOLS-1 system (volume limited spindle) coupled to the IKA ROTAVISC me-vi rotational viscometer with a VOL-SP-6.7 spindle, at a temperature of 22 ± 1 °C, at speeds of 0.5 rpm, 0.8 rpm, and 1.0 rpm in an ascending sequence followed by descending return, maintaining 120 seconds at each speed, in order to also characterize the type of flow and thixotropy. Results from T0, conducted 48 hours after preparing the formulations, showed that the one containing GPOE (26880 cP / shear rate γ of 1.32 s^{-1}) was already less viscous than SO (31328 cP / shear rate γ of 1.32 s^{-1}). Both compositions exhibited non-Newtonian fluid properties, as viscosity values decreased with increasing shear rates, indicating pseudoplastic behaviour. Regarding thixotropy, the formulations showed thixotropic characteristics, with small variations in graphical pattern considering each storage conditions. Furthermore, over time, a decrease in viscosity values was observed, as expected for emulsion type formulations, although the desired sensorial properties were maintained. The incorporation of GPOE resulted in lower viscosity and pH values compared to SO but did not significantly alter the rheological behaviour.

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Ex vivo antilipoperoxidative efficacy of rutin-loaded ethosomes

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The imbalance between the generation and exposure to free radicals and their detoxification mechanisms, collectively referred to as oxidative stress, results in cellular damage and accelerates premature skin aging. The development of cosmetic formulations incorporating antioxidants to mitigate these effects represents a significant focus area within the industry. However, a critical challenge lies in the low permeability of these bioactive molecules through the stratum corneum, as effective cutaneous delivery necessitates specific molecular properties such as an optimal hydrophilic-lipophilic balance, small molecular size, and neutral charge. In this context, nanocarriers such as ethosomes have emerged as promising vehicles to enhance the penetration of active ingredients through the stratum corneum. The objective of our study was to develop and characterize ethosomes encapsulating rutin, employing the following methodologies: preparation of the nanostructured suspension via the rotary evaporation method, characterization of particle size, polydispersity index (PDI), and zeta potential through dynamic light scattering (DLS), determination of encapsulation efficiency using high-performance liquid chromatography (HPLC), formulation of a gel containing the suspension for *ex vivo* evaluation, *in vivo* assessment of the cutaneous penetration/permeation of the active ingredient using the tape-stripping technique coupled with HPLC quantification, and *ex vivo* evaluation of the antioxidant efficacy of rutin-ethosome complexes using the HPLC-TBARS-EVSC protocol. The modified production method successfully yielded ethosomes with appropriate size, PDI, and zeta potential, suitable for the intended application. Tape-stripping penetration/permeation studies indicated that the nanostructure impeded rutin's passage through the stratum corneum compared to its free form. However, antioxidant activity assessments using the HPLC-TBARS-EVSC protocol suggested that neither the nanostructured ethosomal formulation nor free rutin significantly reduced lipoperoxidation under the experimental conditions employed.

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Mapping Serra da Estrela's endemic flora for sustainable cosmetic applications

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Application of vegetable oils from Brazilian biodiversity in cosmetic formulations for curly hair

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Studies have shown that the Brazil hair care segment is the second largest in the world and that around 70% of Brazilians have wavy, curly or coily hair. Studies demonstrate that these curls have a distinct angular curl, vary in amino acid composition and contain different amounts of sulphur atoms, contributing to a different structure (1), which generates demand through their specific needs, and the beauty industry is an important precursor in this process to introduce new products for curly hair, with the development of innovative and sustainable products (2). In this context, the aim of this study was to develop and evaluate hair formulations based on vegetable oils from Brazilian biodiversity in a specific blend for curly hair. Thus, this blend was developed containing Pequi oil (*Caryocar brasiliense*), Buriti oil (*Mauritia flexuosa*), and Babaçu oil (*Attalea speciosa*) and the oils were applied separately on the standardized curly locks of hair to analyze their efficacy. In the study, five strands were evaluated before and after treatment: control tresses (M1), tresses treated with pequi oil (M2), tresses treated with buriti oil (M3), tresses treated with babassu oil (M4) and tresses treated with the blend of biodiversity vegetable oils (M5). The measurements were made in terms of gloss, softness, combability and tensile strength. The results showed that there was a significant increase ($p<0.05$) in the shine of the tresses treated with the oils alone or in combination. In relation to the same tresses, there was a significant reduction ($p<0.05$) in the force needed to comb the hair. As for the tensile strength, there was a significant increase ($p<0.05$) in strands M2, M3 and M5. Finally, there was no significant change in softness. In conclusion, the isolated vegetable oils showed similar results to the blend of oils in improving the physical and mechanical properties of curly hair.

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P12

Development of a natural sunscreen with zinc oxide nanoparticles: photostability and environmental toxicity

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The increasing demand for natural and sustainable cosmetic formulations has driven research on eco-friendly sunscreen products. This study aims to develop a natural sunscreen formulation incorporating zinc oxide (ZnO) nanoparticles synthesized via a green, eco-friendly method. The primary objectives were to evaluate the photoprotective efficacy, photostability, and environmental toxicity of the resulting formulation.

ZnO nanoparticles were synthesized through a precipitation method using zinc acetate and thiourea, yielding star-shaped nanoparticles. The particles were characterized for their structural and functional properties and incorporated into emulsions based on natural emulsifiers, Polyglyceryl-4 Oleate (and) Polyglyceryl-6 Oleate (and) Polyhydroxystearic Acid, and Polyglyceryl-6 Polyhydroxystearate (and) Polyglyceryl-6 Polyricinoleate. The formulations were tested for preliminary stability, photostability, and in vitro sun protection factor (SPF) using diffuse reflectance spectrophotometry.

The ZnO-based sunscreen exhibited SPF values above 30, with a critical wavelength (λc) over 370 nm, confirming broad-spectrum UV protection. Both formulations demonstrated excellent photostability, retaining over 93% of their initial SPF after UV exposure. Environmental toxicity was assessed using Artemia sp. bioassays, revealing low toxicity even at higher nanoparticle concentrations, with mortality rates below 30%.

These findings highlight the potential of ZnO nanoparticles as effective physical UV filters in natural sunscreen formulations. The study underscores the importance of integrating environmentally safe nanomaterials into cosmetic products to meet consumer demand for sustainable and biocompatible options while ensuring high photoprotective performance.

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P13

Development of a sunscreen containing a fat-soluble derivative of vitamin C and D-panthenol for mature skin: clinical efficacy and sensory properties

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Development of keratin-based materials for biomedical applications

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Keratin, a fibrous protein present in feathers, wool, and human hair, is known for its remarkable biological properties, including anti-inflammatory and antioxidant effects and the ability to promote cellular migration. These properties make keratin a promising candidate for the development of biomaterials (e.g. hydrogels, films, and scaffolds) for biomedical applications. In this study, keratin was recovered from chicken feather waste using cholinium acetate (80 wt% in water), an ionic liquid with low toxicity and high biocompatibility (1). The recovered keratin was used for the development of hydrogels and films, pure or combined with tannins, in order to improve material properties. Condensed and hydrolysable tannins were used as additives due to their antioxidant properties, resulting in improved biomaterials' performance. All biomaterials were physically and chemically characterized, and the addition of tannins resulted in exceptional UV-blocking capability (up to 99%) and enhanced antioxidant activity. Overall, our findings underscore the high-performance of keratin-based biomaterials for biomedical applications, such as dermal drug delivery films or injectable drug-loaded hydrogels.

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P15

Design of lipid nanoemulsions loaded with CW-02-79-phospholipid complex for targeted brain delivery: focus on stability in protein-enriched media

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The use of intravenous nanoemulsions for the delivery of poorly soluble drugs to the brain could be hampered by rapid opsonization and clearance by the reticuloendothelial system (1). Therefore, we aimed to develop lipid nanoemulsions (NEs) as carriers for the phospholipid complex of CW-02-79 (novel ligand with high affinity for σ2 receptors in the brain) with improved stability in the biological, protein-enriched matrix and brain targetability, by modifying the surface of nanodroplets with various PEGylated phospholipids. NEs were prepared using high pressure homogenization method, by varying the steric stabilizers (DSPE-PEG2000 with/without DSPE-PEG-mannose). The obtained formulations were characterized in terms of droplet size (Z-ave), polydispersity index (PDI), morphology, zeta potential (ZP), pH value, electrical conductivity (EC) and osmolality. In order to gain an insight into the stability in the biological media, developed NEs were incubated with bovine serum albumin and fetal bovine serum in phosphate buffer saline (pH 7.4) at 37˚C for 24 hours. Z-ave and PDI analysis were conducted at the beginning and after 0.5 h, 1 h, 2 h, 4 h, 8 h and 24 h. The values of all monitored physicochemical parameters (Z-ave, PDI, ZP, pH, EC and osmolality) of the developed NEs, with and without surface functionalization, proved their suitability for intravenous administration. Evaluation of protein binding interactions revealed that the undecorated NEs interacted most strongly with the proteins, while the PEGylated NEs showed less noticeable interactions, especially when 0.2% DSPE-PEG2000 and 0.1% DSPE-PEG-mannose were combined. This study showed that the addition of DSPE-PEG-mannose reduced protein binding to the nanodroplets, thus improving the NEs stability in protein-enriched media. Considering that mannose can bind glucose transporter-1 (GLUT-1), which is abundant in the blood–brain barrier, NE prepared with DSPE-PEG-mannose is promising formulation worth exploring further for brain targeting.

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In-situ forming injectable hydrogels containing lipid nanoparticles for local delivery of docetaxel

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Nanostructured lipid carriers (NLCs) can enhance the bioavailability of docetaxel (DTX) while reducing its associated side effects. However, it has been reported that intravenously administered nanoparticles fail to accumulate effectively in solid tumours (1, 2). Therefore, this study aimed to combine NLCs with in-situ forming hydrogels to facilitate local administration and improve drug retention at the tumour site. DTX-loaded NLC (NLC-DTX) dispersions were prepared by sonication and subsequently gelled with the thermoresponsive polymer poloxamer 407 (15%, w/w) using the cold method. The resulting NLC-DTX were monodisperse, with an average particle size of 161 nm, a zeta potential close to -30 mV, and high entrapment efficiency (~98%). The nanocomposite hydrogels containing NLC-DTX (HG-NLC-DTX) were assessed for their gelation and injectability properties. Rheological measurements indicated that HG-NLC-DTX remained in a sol state at room temperature and gelled at 34.3°C, undergoing rapid transformation into gel at body temperature. Furthermore, extrusion through 18G and 21G needles required injection forces within acceptable limits for clinical use (< 20 N). The in vitro release profile of DTX from HG-NLC-DTX demonstrated sustained release over time, following the Korsmeyer–Peppas model. A slight delay in drug release due to gelation was noted, but the total DTX released from HG-NLC-DTX after 56 hours (17.4%) was comparable to that from NLC-DTX. Although the benefits of the developed nanocomposite hydrogels may not be clear from the release data alone, gelation is still expected to be crucial for retaining NLC-DTX at the tumour site.

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Effects of plastic pollution on skin barrier integrity

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Plastics, including polystyrene and its degradation products, are considered a global environmental threat (1). The human stratum corneum (SC) is a complex biological system that offers impermeability and protection from its surroundings, therefore, small variations on this structure can compromise its functions. This study focused on understanding how styrene oligomers affect human SC model lipid membranes.

SC model lipid membranes were prepared with varying styrene oligomers concentrations. Membranes were analysed using X-ray diffraction (X-RD) to determine changes in lipid structure. Permeability was conducted in Franz diffusion cells and accessed through electrical impedance (EI), transepidermal water loss (TEWL), and indomethacin (IND) permeability tests.

X-RD analysis revealed that the addition of styrene oligomers, particularly styrene trimers (ST), caused significant increases in lamellar periodicity. TEWL measurements showed a concentration dependent increase in water permeability, while EI measurements and IND permeability do not reveal significant compromised skin barrier function.

These findings suggest that styrene oligomers have an impact in the lamellar orientation of the SC lipids, highlighting the need for further investigation into the health implications of plastic-derived pollutants.

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Improving wound healing by controlled release of diclofenac sodium using a keratin-based material

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Wound healing is a complex physiological process that involves four distinct phases: hemostasis, inflammation, proliferation, and remodeling. Disruptions in these stages, particularly prolonged inflammation, can delay the wound healing process, leading to chronic wounds. To address this challenges, biocompatible wound dressing materials have garnered significant attention in recent years. These materials provide a physical barrier against microorganisms while permitting gas exchange to maintain hydration. Protein-based materials, with their inherent ability to provide controlled drug release, have demonstrated a high potential for wound treatment, offering stability to incorporate drugs and ensuring their continuous release at therapeutic levels over time. In this study, keratin – a fibrous protein with remarkable biological properties, such as antioxidant and anti-inflammatory effects - was recovered from chicken feather waste using cholinium acetate, an ionic liquid with low toxicity and high biocompatibility. This sustainable keratin recovery process yielded a high protein recovery while aligning with green chemistry principles. The recovered protein was used to produce films loaded with diclofenac sodium, a nonsteroidal anti-inflammatory drug commonly used for the treatment of pain and inflammation. Our results underscore the promise of keratin-based materials in biomedical applications, particularly in promoting effective and sustainable drug delivery for wound treatment.

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Caffeic acid loading in TransfersomILs: an alternative method for cutaneous delivery

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Nanotechnological advances in cosmetic products: assessment of consumer perception

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Enhanced delivery of ferulic acid in SLNs and NLCs through the use of ionic liquids

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The impact of choline-based ionic liquids on transfersomes loaded with *p*-coumaric acid

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Pioneering new frontiers in medical Cannabis: SOMAÍ's advanced formulations

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Advanced wound healing therapy using functionalized liposomes encapsulating natural compounds

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Combining solid lipid nanoparticles and semisolid matrices: an exploratory study toward topical delivery

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Advancing cannabinoid therapies: SOMAÍ Pharmaceuticals' innovative solutions

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Development of a nanoemulgel containing α-bisabolol for topical application

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Atopic dermatitis (AD) is a recurrent inflammatory skin disease that causes functional, psychological and social morbidity. Formulations for cutaneous drug application have evolved due to nanotechnology and nanocarrier systems, notably nanoemulsions (NEs) and nanoemulgels (NGs), have shown to be promising options in topical AD therapy (1,2). α-bisabolol has anti-inflammatory, antimicrobial, and antipruritic properties, which makes it a promising candidate for the treatment of AD (3).

The aim of the work was the development of an NG with α-bisabolol that allows its topical application as an alternative or adjuvant treatment for AD.

A formulation of NE with α-bisabolol was developed and optimised for subsequent loading into a Xanthan Gum (GX) gel to form α-bisabolol NG. NEs with different concentrations of α-bisabolol were successfully formulated. They presented sizes below 200 nm, PdI below 0.3 AU, high zeta potential and negative charge and pH between 6.0 and 6.5, and stability over 28 days. The entrapment efficiency was approximately 81%. Thereafter the NE were converted into NG through gelation with 1% GX gel, which was subjected to accelerated stability and stability assays during 3 months, which demonstrated to be suitable for skin application.

Due to the developed NG's characteristics and the results achieved, the NG demonstrated the potential to be explored as an alternative anti-inflammatory treatment or adjuvant for topical application in AD.

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Emerging photoswitchable materials based on ionic liquids

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Ionic Liquids (ILs) are a unique class of versatile and "greener" solvents, compared with classic organic solvents, with customizable properties, including polarity. Due to the variety of combinations between anions and cations it can show high capacity for dissolving a variety of polar and non-polar compounds (1). Deep Eutectic Solvents (DES) considered also as green solvents, similar to IL, result from a mixture characterized by a melting point depression, due to the formation of robust hydrogen bonds between the hydrogen bond donors (HBDs) and acceptors (HBAs). Compared to ILs, DES have the advantage of being cheaper and readily available from nature . Molecular photoswitches are small molecules capable of reversible isomerization under light exposure, altering their physicochemical properties . These compounds have attracted significant interest due to their applications in light-mediated catalysis, photoresponsive materials, molecular electronics, and controlled drug delivery (2). Common photoswitches include azobenzenes, stilbenes, spiropyrans, and diarylethenes, which typically undergo either electrocyclization or cis–trans isomerization . However, many conventional photoswitches require UV light for activation, limiting their use in biological applications (3). Donor-acceptor Stenhouse adducts (DASA) have emerged as a promising alternative, displaying photochromism under visible light, which enhances their applicability in biological systems (3). Their switching mechanism involves a reversible Nazarov-type 4π electrocyclization, further distinguishing them from other photoswitches (3). Given the potential benefits for their use in smart applications, a study was conducted to understand the stability of molecular photoswitches in different ILs. The aim was to evaluate the behaviour of the equilibrium between the two isomers in different ILs and DES, using UV-Vis analysis. The results indicate that ILs and DES are effective media for the photoisomerization adducts. The conversion of DASA isomers under visible light was successfully achieved in all the solvents tested. In particular, the percentage of the triene form was quantified in Aliquat Cl, providing insights into its stability within the IL. Additionally, choline chloride/oxalic acid demonstrated the ability to stabilize the cyclopentenone form of DASA in the absence of light exposure. Further studies are ongoing to quantify the isomers, assess their stability under heat conditions, and evaluate their reversibility. These findings have potential applications in drug delivery, particularly in the controlled release of pharmaceuticals using photoresponsive systems.

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