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BOOK OF ABSTRACTS

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SUMMARY

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PROGRAMME

WEDNESDAY, MAY 20th

TOPIC 1- **NATURALITY & SUSTAINABILITY : FROM INGREDIENT TO FORMULATION**

CHAIR BY : CÉDRIC PEYROT (LVMH) **& MICHEL GRISEL** (UNIV. LE HAVRE)

09.00 am **Welcome Speech**

09.20 am KEYNOTE SPEECH
Sustainable beauty's paradox: leading the way from non-essential to essential for our planet.
Patrick CHOISY, Associate Steering Director of Upstream Research,
Chloé VAGNIEUX, Sustainability Scoring Manager - **LVMH Recherche** (France)

09.55 am **Colloidal lignin particles as sustainable Pickering stabilizers.**
Giovana COLUCCI, PhD Candidate in Chemical and Biological Engineering - **CIMO** (Portugal)

10.15 am **Sphagnic acid in *Sphagnum palustre* moss for a new bioinspired cosmetic ingredient.**
Coralie BOUTTE, Biotechnology Engineer - **Mibelle AG Biochemistry** (Swiss)

10.35 am **Sustainable bioproduction of next-gen bioactive ingredients.**
Guillaume DÉJEAN, Head of Innovation Solutions & Partnerships - **SWEETECH** (France)

10.55 to11.25 am | **BREAK & POSTERS DISCOVERY**

11.25 am **Extracellular vesicles from microalgae as natural cosmetic actives.**
Paola GARGANO, Cosmetologist - **EVEBiofactory** (Italy)

11.45 am **New amphiphilic structures from vegetable oil for cosmetic uses.**
Cécile JOSEPH, Formulation Head Manager - **ITERG** (France)

12.05 pm **Nature-inspired protection for developing sustainable cosmetics.**
Oihana GORDOBIL, Senior researcher - **University of the Basque Country** (Spain)

12.25 pm **Surface smoothing and film formation of a biodegradable polymer.**
Juliana AMADO, Global Product Manager - **Symrise AG** (France)

12.45 pm **Unlocking the anti-aging potential of anatolian plants.**
Ebru ÖZDEMIR NATH, Associate Professor - **Altınbaş University (**Turkey)

13.05 to 14.35 pm | **LUNCH & POSTERS DISCOVERY**

CHAIR BY : ZORITA DIACONEASA (USAM CLUJ) **& RICHARD DANIELLOU** (AGROPARISTECH)

14.35 pm **From naturality to high performance: a sustainable active ingredient derived from purple pomegranate.**
Lucie COUTURIER, R&D Manager Cosmetic Actives - **Gattefossé SAS** (France)

14.55 pm **From upcycled banana peel to skin longevity.**
Shirley BILLOT, CEO - **SHB** (France)

15.15 pm **Simultaneous identification and quantification of plant metabolites.**
Lauriane LENEN, PhD student - **Natexplore / ICMR** (France)

15.35 pm **Advances in sustainable solid cosmetics through nanogel and microgel systems derived from formulation: perspectives in rheology, cell compatibility, and dissolution**
Laura Daniella SILVA ARIAS, PhD student - **International University of Catalonia** (Spain)

15.55 to 16.25 pm | **BREAK & POSTERS DISCOVERY**

CHAIR BY : LILY MIJOUIN (SHISEIDO) **& NICOLAS HUANG** (UNIV. PARIS-SACLAY)

16.25 pm **Breaking the emulsion paradigm: natural eutectic systems.**
Laura DIVOUX, PhD student - **University of Tours** (France)

16.45 pm **Natural polymers as efficient routes for encapsulation of cosmetic actives by complex coacervation.**
Michel GRISEL, Professor - **University of Le Havre** (France)

17.05 pm **Physicochemical stability and skin-related performance.**
Marie CAFIERO, R&D Engineer - **LVMH Recherche** (France)

17.25 pm **Electromagnetic field–induced structural modulation of formulations.**
Paula OSSOWICZ-RUPNIEWSKA, Professor - **West Pomeranian University of Technology** (Poland)

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THURSDAY, MAY 21st

TOPIC 2 - **DIGITALIZATION & AI**

CHAIR BY : CÉDRIC PEYROT (LVMH) **& MICHEL GRISEL** (UNIV. LE HAVRE)

09.00 am — **Welcome speech**

09.05 am — KEYNOTE LECTURE.
AI & Biomimicry: From nature to the future.
Eliot GRAEFF, PhD & CEO - **Asteria** (France)

09.40 am — **Optical metabolic skin imaging with femtosecond lasers.**
Karsten KOENIG, Head of department of biophotonics and laser technology - **Saarland University** (Germany)

10.00 am — **oloMAP: A multi-omics integration platform for skin research.**
Paolo BONINI, CEO - **Olobion** (Spain)

10.20 to 11.00 am | **BREAK & POSTERS DISCOVERY**

11.00 am — **Learning to feel: AI sensory intelligence for cosmetics.**
Magali BONNIER, PC R&T director - **Croda** (France)

11.20 am — **Serving the skin and the planet: an approach towards automation of ingredient LCA.**
Rachel Westcott, Environmental Data Analyst - **Fairglow** (France)
Yasmine Aïouch Benhida, Senior Science Officer - **Fairglow** (France)

11.40 am to 12.10 pm | **SHORT TALKS**

12.10 to 13.40 pm | **LUNCH & POSTERS DISCOVERY**

TOPIC 3 - **EXPLORING GLOBAL AGEING**

CHAIR BY : LILY MIJOUIN (SHISEIDO) **& NICOLAS HUANG** (UNIV. PARIS-SACLAY)

13.40 pm — KEYNOTE LECTURE
Reprogramming cellular aging to promote skin longevity.
Pr Jean-Marc LEMAÎTRE, Professor, **INSERM** (France)

14.15 pm — **Enhancing the stability and delivery of biomimetic actives.**
Alexandre REEBER, CEO - **Core Biogenesis** (France)

14.35 pm — **Insight on age-related alteration in dermis–epidermis dialogue.**
Laurie VERZÉAUX, Scientific communication manager - **SILAB** (France)

14.55 pm — **Mitochondrion as a pivot organelle to address skin aging.**
Hishda MOHAMED, Senior Marketing Lead | Insights & Innovation - **SEDERMA** (France)

15.15 pm — **Spatiotemporal fluorescence imaging of miR-30a in skin ageing.**
Zoé PFLIGER, Research Engineer - **CNRS** (France)

15.35 to 16.05 pm | **BREAK & POSTERS DISCOVERY**

16.05 pm | **POSTER AWARDS CEREMONY**

16.25 pm — **New findings on keratinocyte pyroptosis and skin aging.**
Yicheng XU, R&D Manager - **Biocosmethic** (France)

16.45 pm — **Co-culture models to explore cosmetic effects on ageing skin.**
Laura BAUCHET, Microbiology Project Manager - **Glycodiag** (France)

17.05 pm — **Modeling ageing and rejuvenation processes in human tissues using advanced ex vivo systems.**
Luigi FORMICOLA, COO & Co-founder - **Exadex-Innov** (France)

Full papers based on the communications will be published in a special issue of International Journal of Cosmetic Science

ABSTRACTS

WEDNESDAY, MAY 20TH

SESSION 1

NATURALITY & SUSTAINABILITY: FROM INGREDIENT TO FORMULATION

MAY 20TH | **9.20 am**

KEYNOTE CONFERENCE

SUSTAINABLE BEAUTY'S PARADOX: LEADING THE WAY FROM NON-ESSENTIAL TO ESSENTIAL FOR OUR PLANET

PATRICK CHOISY[1] & CHLOÉ VAGNIEUX[1]

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Beauty industry has been considered as non essential through its environmental impact compared to energy, transport, food and housing industries. However, as a leading consumer-facing industry, our commitment to sustainability sets a vital precedent. Following the clear shift of consumers expectations starting from 2008 – 2017, we observe a tremendous shift towards naturality at first and then sustainability. This evolution has been structured with normalization such as ISO 16128, Organic standards (COSMOS ORGANIC, COSMOS NATURAL, NATRUE, BDIH) and then Eco Beauty Score based on the European PEF (Product Environmental Footprint) for sustainability.

Different initiatives in sustainability assessment have been developed since in but today, Life Cycle Analysis remains the most powerful methodology to assess the environmental footprint of our products. Traceability has also taken a leap forward with TRASCE initiative which cross enrich sustainability assessment.

The actual momentum is probably less in favour of environment consideration because we have to keep in mind that sustainability relies on three pillars : social, environmental and economics. In a more uncertain economy, competitiveness and performance must be preserved in order for our industry to keep their continuous investment in sustainability.

Our beauty industry, while non essential, is a leading the sustainability quest in fine chemical industries. We have a unique opportunity and responsibility to be exemplary in our sustainability efforts and our investment for long term goal of Planetary Boundaries.

COLLOIDAL LIGNIN PARTICLES AS SUSTAINABLE PICKERING STABILIZERS AND THEIR MULTIFUNCTIONAL ROLE IN COSMETIC EMULSIONS

GIOVANA COLUCCI[1,2], PAULA PLASENCIA[1], TATIANA B. SCHREINER[1], MARIANA MARQUES[3,4], FRANCISCA RODRIGUES[3,4], ALÍRIO E. RODRIGUES[2], M. FILOMENA BARREIRO[1]

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3 - Associate Laboratory i4HB - Institute for Health and Bioeconomy, Faculty of Pharmacy, University of Porto, 4050-313 Porto, Portugal.
4 - UCIBIO - Applied Molecular Biosciences Unit, MedTech-Laboratory of Pharmaceutical Technology, Faculty of Pharmacy, University of Porto, 4050-313 Porto, Portugal.

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OBJECTIVE:

Lignin, a plant-derived aromatic biopolymer, has recently attracted interest in cosmetics due to its biocompatibility, antioxidant, UV-protective, and sustainable properties. As colloidal lignin particles (CLPs), lignin can stabilize Pickering emulsions, providing a sustainable alternative to synthetic emulsifiers associated with health and environmental concerns. From this perspective, this study examines the use of CLPs in the stabilization of cosmetic emulsions, investigating their performance and multifunctional role in formulation.

MATERIALS & METHODS:

CLPs were produced from kraft (KL) and aldehyde-extracted (GA) lignins and subsequently used to produce Pickering emulsions (PE-KL and PE-GA) with Miglyol 812 as the oil phase. The emulsions were tested for stability (freeze-thaw cycles, ISO/TR 18811:2018), UV protection and antioxidant activity, and safety (MTT cytotoxicity assay in keratinocyte and fibroblast cell lines).

RESULTS:

The PE-KL emulsion presented a homogeneous medium-brown tone (CIELAB color space), pH 6.0, and a mean droplet size of 4.9 ± 0.2 µm with uniformly spherical droplets. The PE-GA emulsion showed a homogeneous white-silk appearance, pH 5.0, and a mean droplet size of 4.2 ± 0.4 µm, also with spherical droplets. Both emulsions remained stable after 12 thermal stress cycles (24 h at 4 and 40 °C), with no detectable changes in organoleptic properties or microstructure. CLPs and emulsions exhibited absorption in the UVA and UVB regions and preserved their absorption profiles after 60 min of UV exposure, indicating high photostability despite low SPF values (circa 1). Additionally, the CLPs revealed antioxidant activity. All samples showed no cytotoxicity in the tested skin cell lines, supporting their suitability for skincare applications.

CONCLUSION:

The findings presented here support the relevance of CLPs as sustainable, highly effective, multifunctional emulsifiers, whose functional properties can be further enhanced by combining them with other active components. Overall, this study contributes to elucidating the role of CLPs in the development of novel and sustainable cosmetic formulations.

LIGNIN, COLLOIDAL LIGNIN PARTICLES, PICKERING EMULSIONS, COSMETICS.

Acknowledgments: This work was supported by national funds through FCT/MCTES (PIDDAC): CIMO UID/00690/2025 (10.54499/UID/00690/2025) and UID/PRR/00690/2025 (10.54499/UID/PRR/00690/2025); SusTEC, LA/P/0007/2020 (DOI: 10.54499/LA/P/0007/2020).
This research was also supported by Fundação para a Ciência e a Tecnologia, I.P./MECI through national funds: LSRE-LCM, UID/50020/2025 (https://doi.org/10.54499/UID/50020/2025); and ALiCE, LA/P/0045/2020 (https://doi.org/10.54499/LA/P/0045/2020). FCT for the Ph.D. research grant of G. Colucci (https://doi.org/10.54499/2021.05215.BD).

SPHAGNIC ACID IN *SPHAGNUM PALUSTRE* MOSS FOR A NEW BIOINSPIRED COSMETIC INGREDIENT

CORALIE BOUTTE[1]; ZHAOJIE WANG[2]; SÉVERINE AMAND[3]; SÉBASTIEN LEBLOND[2]; STÉPHANE POIGNY[1]

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OBJECTIVE:
Sphagnic acid (SA) is a phenolic compound exclusively found in *sphagnum* mosses, who are playing a key role in carbon storage and biodiversity preservation. The purpose of this research is to investigate SA and to explore a sustainable production method of *sphagnum* moss plant material for its potential use in cosmetics.

MATERIAL & METHODS:
SA obtained by chemical synthesis was first analyzed by LC-MS/MS as a standard reference and its stability was determined in different conditions. SA extraction method was then optimized on *sphagnum* mosses collected in a bog and parameters influencing its production in the mosses were investigated. The presence of SA derivatives in an extract of *Sphagnum* palustre (S.palustre) was explored by Feature-Based Molecular Networking. Finally, various approaches were studied to produce S.palustre plant material in a sustainable way for cosmetic application.

RESULTS:
The analysis of trans-SA analytical standard reported the presence of trans and cis SA form, highlighting the molecule isomerization over time and under various conditions. In extracts of collected S.palustre, the chemical reactivity of SA was correlated to the solvent used, to pH, and to temperature values. The SA molecular network analysis enabled the identification of ethyl ester of SA when ethanol was used. Variation of SA concentration was observed along the moss stem, and the highest concentration was found in the capitulum. Finally, the biotechnological approach was selected to produce S. palustre biomass.

CONCLUSION:
Sphagnum mosses are highly interesting plants for a new bioinspired cosmetic ingredient investigation. This study exposed the reactivity of the *sphagnum* mosses key molecule sphagnic acid under different conditions and determined its concentration variation in collected S.palustre mosses. Production of S.palustre by biotechnologies turned out to be the most sustainable way to promote their properties while preserving them in nature. It highlighted how bioinspiration and biotechnologies are key approaches to develop sustainable cosmetic ingredients.

SPHAGNUM PALUSTRE, SPHAGNIC ACID, MOSS, BIOTECHNOLOGY, BIOINSPIRATION

SUSTAINABLE BIOPRODUCTION OF NEXT-GEN BIOACTIVE GLYCANS FOR COSMETICS

GUILLAUME DEJEAN[1], MARWA ZAAROUR[1], JADE FORET[1], MAÏLYS MANENC[1], DANIELE FARIAS[1], MARION DEVILLE GRIS[1], MAXANT VIVIER[1], YANNICK MALBERT[1], GABRIELLE POTOCKI-VERONESE[2], JULIEN DURAND[1]

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OBJECTIVE:
Emerging cosmetic strategies increasingly target cellular metabolism as a central driver of skin firmness, vitality, and age-related functional decline. Oligosaccharides represent a largely underexploited class of bioactives capable of modulating metabolic and immune pathways, yet industrial access to structurally diverse molecules remains limited. This work demonstrates how a proprietary, scalable bioproduction platform unlocks novel oligosaccharide structures and presents their first biological characterization, showing a coordinated metabolic activation loop across key skin cell types for advanced cosmetic applications.

MATERIALS & METHODS:
A synthetic biology platform was developed through metabolic engineering of microbial chassis expressing glycoside phosphorylases, enabling in cellulo synthesis of structurally defined oligosaccharides directly during fermentation and overcoming limitations of chemical synthesis and extraction. Selected oligosaccharides were screened in cosmetic-relevant in vitro models: immunomodulatory effects in human whole blood (IL-6, IFN-□), skin cell metabolism via mitochondrial respiration in keratinocytes and fibroblasts, and adipocyte responses via adipogenesis, beigeing (UCP1), and lipolysis in 2D/3D models. Formulation stability was evaluated over six months in the presence of peptides.

RESULTS:
The platform enabled reproducible production of structurally diverse oligosaccharides previously inaccessible at scale. In adipocytes, specific compounds stimulated lipid turnover, increased lipolysis, and induced beigeing markers, reflecting enhanced energy metabolism. In parallel, these molecules significantly increased mitochondrial respiration in keratinocytes and fibroblasts, reflecting activation of cellular bioenergetics. This metabolic upregulation correlated with biological signatures consistent with improved epidermal vitality and dermal matrix activity. Additionally, certain oligosaccharides modulated inflammatory signaling in human whole blood, supporting a balanced immune environment compatible with tissue homeostasis. Stability studies showed excellent chemical compatibility with peptides, with no discoloration observed.

CONCLUSION:
These results reveal a previously inaccessible class of cosmetic oligosaccharides capable of inducing a coordinated metabolic activation loop across adipocytes, fibroblasts, and keratinocytes. Powered by a proprietary synthetic biology platform, this work provides a sustainable and scalable alternative to extraction and chemical synthesis, unlocking industrial access to structurally complex bioactives for cosmetic innovation targeting skin firmness, anti-aging, and functional vitality.

GLYCOBIOTECHNOLOGY, BIOACTIVE, - SUSTAINABLE BIOPRODUCTION, GLYCANS, ENZYMATIC SYNTHESIS, EXCLUSIVE INGREDIENTS

EXTRACELLULAR VESICLES FROM MICROALGAE AS NATURAL BIOACTIVE AGENTS FOR UVB PROTECTION, ANTI-AGING, AND SKIN DEPIGMENTATION

PAOLA GARGANO[1,2,3], SABRINA PICCIOTTO[1,2], ANGELA PATERNA[2], SAMUELE RACCOSTA[2], ESTELLA RAO[2], DANIELE PAOLO ROMANCINO[1], GIULIA SMERALDI[1], MAURO MANNO[2], MONICA SALAMONE[1], NATASA ZAROVNI[3], GIORGIA ADAMO[1], ANTONELLA BONGIOVANNI[1,3].

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3 - EVEBiofactory at Cell-Tech HUB, National Research Council of Italy (CNR), Palermo 90146, Italy.

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OBJECTIVE :

Microalgae emerged as powerful cosmetic ingredients due to their pigment profile and other bioactive molecules which naturally possess dermo-cosmetic activities (e.g. antioxidant, anti-inflammatory)[1]. Despite these, the production of microalgae extracts, present lots of economic and environmental limitations, considering that, at the end of the extraction protocol, microalgae biomass is discarded as waste. Nanoalgosomes, microalgae-derived extracellular vesicles, represent a patented solution that can be considered as eco-compatible, innovative and multifunctional dermo-cosmetic ingredients, which combine biological efficacy with a solvent-free and sustainable production process. Beyond their role as active ingredients, they also represent an innovative delivery platform for cosmetic actives, improving their bioavailability, efficacy, and penetration while maintaining a natural and sustainable profile.

MATERIAL & METHODS:

Nanoalgosomes are isolated from the marine microalgae Tetraselmis chuii (an edible organism) through Tangential Flow Filtration, a gentle and solvent-free technology that preserves vesicle integrity and microalgae viability. The remaining biomass is reused to start new cultures, ensuring a renewable, low-impact, and economically sustainable production process fully aligned with green chemistry principles.

RESULTS:

Nanoalgosomes demonstrated strong intrinsic antioxidant and anti-inflammatory activities, effectively protecting skin cells from UVB-induced oxidative stress, cellular damage, and senescence. In melanocyte models, they also significantly reduced melanin synthesis, demonstrating a depigmenting effect. Their safety and efficacy were further validated through in vitro skin models: testing on human fibroblast, keratinocytes, melanocytes and on 3D Reconstructed Human Epidermis (RHE), conducted according to OECD 439 guidelines, nanoalgosomes showed no irritation potential, supporting their safety for topical application. These findings were fully corroborated by in vivo 48-hour patch tests on human volunteers, which confirmed the excellent skin compatibility and a non-irritant profile. Moreover, an in vivo anti-irritation test was performed in the forearms of 21 volunteers, using a very low dose of nanoalgosomes for 60 minutes, and results showed a slight anti-irritating effect already 15 minutes after the skin erythema induction through methyl nicotinate.

CONCLUSION:

By combining proven biological efficacy, validated safety on reconstructed skin and on volunteers, and a renewable and solvent-free production process, nanoalgosomes emerge as next-generation, multifunctional dermo-cosmetic ingredients ideally suited for innovative, sustainable, and high-performance cosmetic formulations.

EXTRACELLULAR VESICLES, EXOSOMES, MICROALGAE, PHOTOAGING, PHOTOPROTECTION, UVB-RELATED DAMAGES.

1 - N. Coulombier, T. Jauffrais, N. Lebouvier, Antioxidant compounds from microalgae: a review. Mar. Drugs 19 (2021) 549. https://doi.org/10.3390/ md19100549.

NEW AMPHIPHILIC STRUCTURES FROM VEGETABLE OIL, PROPERTIES EVALUATION AND APPLICATIVE POSITIONING

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OBJECTIVE:

Vegetable oils are starting materials for producing non-ionic amphiphilic structures. To obtain various properties, it is well known that it is possible to play with fatty acid composition (length of carbon chain, saturated or unsaturated functions) or nature of the hydrophilic group. But other parameters such as the structure of the molecule, the synthesis strategy or the presence of minority compounds are as relevant to explore than the hydrophilic and hydrophobic blocks nature and proportions.

MATERIAL & METHODS:

Irrespective of synthesis constraints, the implementation parameters for functional evaluation and positioning require a structured, joint approach. Stability/instability phenomena are complex and depend on the state of aggregation, adsorption and/or repulsion mechanisms between emulsifier and droplet, as well as formulation parameters such as the water/oil/molecule proportions and the emulsification process.

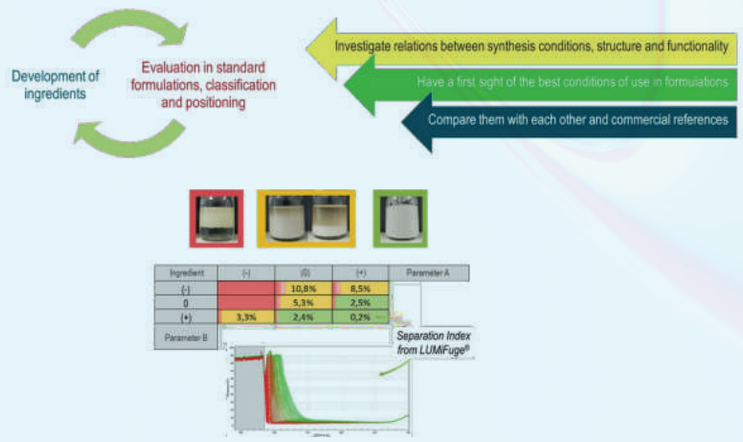
RESULTS:

The aim of recent developments is to evaluate the performance of new amphiphilic molecules in relation to both emulsion chemistry and formulation parameters, using experimental designs in the form of 2-parameter maps. This approach makes it possible to optimize structures and synthesis conditions, position molecules in relation to commercial references and identify the best conditions of use.

CONCLUSION:

The most promising molecules selected thanks to this method were used in simple but representative demo products (pigmented milk, anhydrous balm, cream) to assess their stabilizing, dispersing and emollient properties, based on both physical-chemical and sensory analyses. They demonstrated performance equal to commercial references under similar conditions of use, as well as potential for interesting sensory nuances.

Figure 1. Strategy for the positioning of new polymers in terms of functionality



NATURE-INSPIRED PROTECTION FOR DEVELOPING SUSTAINABLE AND MULTIFUNCTIONAL SKINCARE INGREDIENTS

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OBJECTIVE:
Today, the safety profile of certain chemical ingredients used in skincare and cosmetic products is increasingly questioned due to their detrimental toxicological effects on the ecosystems and human health. Consequently, exploring safe and sustainable natural alternatives is essential for the development of environmentally friendly and health-conscious skincare products. The intrinsic functional and bioactive properties of lignin and tannins, naturally occurred polyphenols, make them highly promising candidates for cosmetic applications. This research integrates nanotechnology with circular economy principles to transform undervalued industrial by-products into a fully biobased alternatives to conventional synthetic ingredients used in skincare formulations. By synergistically combining the protective properties of lignin and tannins, this work aims to engineer a sustainable, safe and multifunctional ingredient with aesthetic compatibility for dermocosmetic formulations able to work as UV-shielding, antioxidant, and antimicrobial agent.

MATERIAL & METHODS:
Lignin-tannin colloidal systems were prepared by combining Kraft lignins with tannins from different origins using a nanoprecipitation method to investigate the influence of polyphenol type and processing conditions on particle self-assembly and properties. The resulting particles were characterized for size, morphology, optical properties, and stability, and evaluated for antioxidant and antimicrobial activity against skin-relevant species, all without animal testing.RESULTS: The lignin-tannin particles (LTPs) exhibited a controlled submicron size range (180-500 nm), tunable UV absorption properties, and good colloidal stability. Compared to lignin-only particles, LTPs showed a reduced brown color improving their aesthetic suitability for cosmetic application. In addition, the particles revealed strong antioxidant activity (IC50: 2-15 µg/mL) and effective antimicrobial activity against skin-relevant bacteria, including Staphylococcus aureus, Streptococcus pyogenes, and Cutibacterium acnes.

CONCLUSION:
This research marks a step forward in the development of fully biobased submicron particles by combining industrially available renewable materials. The combination of lignin and tannin resulted in synergistic protective effects compared to the individual components. Furthermore, the study highlights the potential to fine-tune the physical and functional properties of these biobased particles by adjusting the selection of components and synthesis conditions.

Acknowledgments: O.G. acknowledges the grant RYC-2021-031328-I funded by MICIU/ AEI/ 10.13039/501100011033 and by the European Union NextGeneration EU/PRTR. Financial support from the University of the Basque Country (EHU-N24/07) is also acknowledged.

LIGNIN, TANNINS, COLLOIDAL PARTICLES, BIOBASED INGREDIENTS, MULTIFUNCTIONALITY, CIRCULAR ECONOMY

SURFACE SMOOTHING AND FILM FORMATION OF A BIODEGRADABLE CATIONIC AGENT: PERFORMANCE CHARACTERIZATION OF POLYGLYCERYL-3 BETAINATE CITRATE (PG3 BC) FOR MODERN FORMULATIONS

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OBJECTIVE:
To evaluate the performance and sustainability profile of a novel, 100% naturally derived and readily biodegradable conditioning agent based on a polyglyceryl-3 betainate citrate (PG3 BC) structure, developed as a sustainable alternative to conventional synthetic cationic polymers for hair and skin care applications.

MATERIAL & METHODS:
The deposition behaviour and film-forming properties of the polyglyceryl-3 betainate citrate (PG3 BC) conditioning agent were investigated using Atomic Force Microscopy (AFM). Instrumental and sensory evaluations were conducted to assess wet and dry combability, hair breakage, shine, volume, frizz control, and skin moisturization in rinse-off formulations, and results were benchmarked against conventional polyquaterniums and modified guar gums.RESULTS: The biobased conditioning agent formed a continuous, flexible and lightweight film on hair and skin surfaces, as confirmed by Atomic Force Microscopy, showing uniform coverage and strong surface anchoring. This behaviour is driven by hydrogen bonding from the polyglyceryl-3 backbone and mild electrostatic interactions from the betaine group. Compared to conventional polyquaterniums and modified guar gums, the ingredient delivered equal or superior conditioning performance, significantly improving wet and dry combability, shine, volume and frizz control. In shampoo formulations, hair breakage was reduced by up to 71%, indicating a strong anti-fragmentation effect. On skin, the ingredient increased hydration by up to 16% after 5 minutes and 15% after 2 hours, demonstrating both immediate and sustained moisturization.

CONCLUSION:
The polyglyceryl-3 betainate citrate (PG3 BC) conditioning agent delivers high-performance hair and skin conditioning comparable to or exceeding conventional synthetic polymers, while offering a markedly improved sustainability profile. This combination of efficacy and eco-design makes it a strong candidate for next-generation sustainable personal care formulations.

NATURAL CONDITIONING AGENT, BIODEGRADABLE POLYMERS, HAIR CARE, SKIN MOISTURIZATION, POLYGLYCERYL-3 BETAINATE CITRATE (PG3 BC), SUSTAINABLE COSMETICS

UNLOCKING THE ANTI-AGING POTENTIAL OF ANATOLIAN HELICHRYSUM MILL. SPECIES FOR COSMETIC APPLICATIONS

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OBJECTIVE:

Helichrysum Mill., a member of the Asteraceae family, represented by approximately 656 taxa in the world, 34 of these taxa are naturally found in Türkiye, and 17 taxa are endemic[1]. In ethnobotanical studies conducted in Türkiye, it has been determined that Helichrysum species are widely used, especially for skin problems[2]. Developed in line with Anatolia's rich ethnobotanical knowledge, phytocosmetic formulations contain plant extracts as active ingredients and offer significant advantages in terms of cell regeneration. Increased cellular energy levels enable cells to more effectively carry out proliferation and regeneration processes. This study aims to provide information about the traditional uses of Helichrysum species growing naturally in Anatolia and to describe the phytochemical and biological activity studies conducted on some species in the development of anti-aging cosmetic formulations.

MATERIAL & METHODS:

Selected Helichrysum taxa were gathered from different locations according to their ethnobotanical uses, taxonomically verified, and then ethanolic extracts prepared. The biological activity of these extracts on human skin-related cell lines and enzymes associated with skin aging was subsequently assessed, and their primary bioactive components were identified through phytochemical analysis. Effective and non-toxic doses calculated, and serum formulation developed.

RESULTS:

According to our results, the secondary metabolites from the genus can be categorized into four structural types: flavonoids, phenolic acids, terpenes, and phloroglucinols. Several Anatolian Helichrysum species' ethanolic extracts showed cell-type-specific proliferative effects and enzymatic inhibitions on human keratinocytes, fibroblasts, and endothelial cells without causing cytotoxicity. An anti-aging serum formulation was prepared from the extract that showed the most effectiveness based on biological activity results. These activities emphasize their dermocosmetic and regenerative potential while supporting their conventional uses in skin care.

CONCLUSION:

This multidisciplinary study emphasizes the benefits of fusing contemporary phytochemical and biological methods with ethnobotanical understanding. Through focused extraction and chemical separation, it illustrates the dermocosmetic potential of Anatolian Helichrysum species and provides the foundation for the future formulation of natural anti-aging cosmetic products.

ETHNOBOTANY, HELICHRYSUM, PHYTOCOSMETICS, PHYTOCHEMISTRY, ANTI-AGING

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FROM NATURALITY TO HIGH PERFORMANCE: A SUSTAINABLE ACTIVE INGREDIENT DERIVED FROM PURPLE POMEGRANATE

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OBJECTIVE:
Pomegranate is renowned for its antioxidant richness and benefits on skin aging, inflammation, and oily skin. Traditionally, cosmetics rely on the Red Pomegranate (Punica granatum var. Wonderful), widely cultivated in Mediterranean regions and exploited in food and nutraceutical industries. We identified an unconventional, ornamental and non-food grade variety: the Purple Pomegranate (Punica granatum var. Cybèle), cultivated in the south of France under sustainable practices. This variety does not compete with the food sector and offers two major advantages: a phyto-chemical profile significantly richer in antioxidant compounds than conventional varieties, and remarkably strong intrinsic preservation properties. The objective of the presentation is to highlight the phytochemical uniqueness and demonstrate the superior biological performance of extracts compared to the Red Pomegranate ones leveraging their genetic distinctiveness and optimized extraction processes.

MATERIAL & METHODS:
A comprehensive analysis was conducted, including genomic profiling to confirm varietal uniqueness and phytochemical characterization focused on antioxidant compounds. A frugal process was designed using sustainable solvents and resource-efficient principles. Biological activities were assessed through antioxidant and anti-inflammatory assays in monolayer cultures of normal human keratinocytes, seboregulation tests on a 3D sebocyte spheroid model, and an in-vitro microbiome assay modeling oily-skin condition. Advanced technologies such as live-cell imaging and microtissue models were employed.RESULTS: Purple Pomegranate extracts exhibited a significantly higher concentration of antioxidants than Red Pomegranate, including flavonoids and ellagitannins. This enriched composition delivered superior efficacy: early and pronounced oxidative stress reduction (live-cell imaging), strong sebogenesis inhibition in 3D sebocyte spheroids, confirmed by reduced lipid droplet synthesis, and selective inhibition of S. aureus while preserving C. acnes diversity and S. epidermidis integrity. These results highlight a multi-targeted approach for oily and acne-prone skin, combining antioxidant, anti-inflammatory, and microbiome-balancing benefits.

CONCLUSION:
Through a sustainable value chain and ecodesigned manufacturing process, Purple Pomegranate emerges as a new source of cosmetic active offering high performance and naturality. Its unique phytochemical profile and advanced biological benefits position it as a promising solution for skin aging, and oily skin.

PURPLE POMEGRANATE, SUSTAINABLE ACTIVE, ANTIOXIDANT, SEBOREGULATION, MICROBIOME, OILY SKIN

FROM UPCYCLED BANANA PEEL TO SKIN LONGEVITY: A 100% NATURAL AND SUSTAINABLE LIPIDIC INGREDIENT TARGETING INFLAMMAGING

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OBJECTIVE:

Chronic low-grade inflammation, known as inflammaging, is a key biological driver of skin ageing, contributing to extracellular matrix degradation, barrier impairment and reduced skin resilience. In parallel, cosmetic innovation must address growing demands for natural, sustainable and socially responsible ingredients. The objective was to develop a COSMOS-certified, 100% natural lipidic ingredient derived from upcycled banana, targeting inflammaging through an integrated approach combining biobased sourcing, eco-designed processes, life-cycle thinking and social responsibility. All banana growers are shareholders.

MATERIAL & METHODS:

Yellow banana peel (Musa acuminata) was selected for its richness in phytosterols and lipidic bioactive compounds relevant to skin homeostasis. The raw material was sourced at plantation level in Martinique by valorizing upstream food loss, with GLOBALG.A.P.- certified growers ensuring traceability and compliance with European social standards. A controlled pre-treatment combined with eco-extraction technologies was implemented to preserve thermosensitive lipidic and phenolic fractions. The resulting lipidic extract was characterized for its bioactive composition. Biological activity was evaluated using in vitro models relevant to skin ageing and inflammation, focusing on inflammatory mediators and extracellular matrix-related biomarkers.

RESULTS:

The lipidic extract obtained from upcycled banana peel was naturally enriched in phytosterols and bioactive lipids involved in skin barrier organization and inflammaging regulation. In vitro evaluations demonstrated modulation of key biomarkers associated with chronic inflammation, including reduced pro-inflammatory mediators and matrix-degrading enzymes, together with stimulation of extracellular matrix components (collagens, elastin). From a life cycle perspective, locally sourced food loss and eco-designed processes contributed to reduced raw material waste and overall environmental impact. Social sustainability was reinforced through a fully traceable supply chain relying on certified growers operating under European labor regulations.

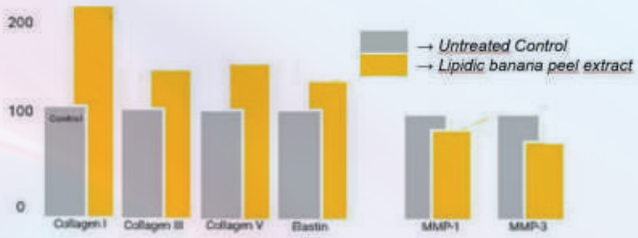

Figure 1. Effect of a lipidic extract derived from yellow banana peel on extracellular matrix markers in human dermal fibroblasts. Results are expressed as percentage relative to untreated control (100%). The extract increased collagen I, III and V and elastin expression, while reducing matrix metalloproteinases MMP-1 and MMP-3.

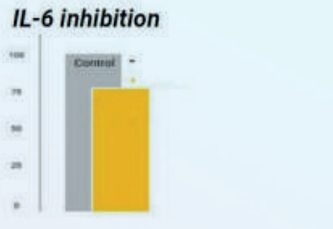

Figure 2. Modulation of the pro-inflammatory cytokine IL-6 in human skin cells treated with a lipidic extract derived from yellow banana peel. Results are expressed as percentage relative to untreated control (100%).

CONCLUSION:

This work demonstrates that 100% natural and COSMOS-certified ingredients can achieve high biological relevance when sustainability is integrated from sourcing to process design. The valorization of food loss-derived banana peel provides a robust strategy to target inflammaging while supporting skin longevity and responsible cosmetic innovation.

INFLAMMAGING, SKIN LONGEVITY, 100% NATURAL INGREDIENT, COSMOS, FOOD LOSS VALORIZATION, PHYTOSTEROLS

SIMULTANEOUS IDENTIFICATION AND QUANTIFICATION OF ACTIVE METABOLITES IN NATURAL INGREDIENTS USING QUANTITATIVE 2D 1H-13C HSQC NMR: A NEW APPROACH APPLIED TO A PICEA ABIES EXTRACT

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OBJECTIVE:

Quantifying metabolites in natural ingredients is often limited by the lack of authentic standards, especially for newly discovered, non-commercial, or costly compounds. Traditional analytical workflows depend on multiple non-universal and frequently destructive techniques. Compared to standard 1D NMR, quantitative HSQC NMR[1-3] (qHSQC) distributes correlations across two dimensions, reducing signal overlap and making it especially suitable for analysing natural ingredients. This study investigated qHSQC as a single, versatile, and non-destructive method enabling simultaneous identification and absolute quantification of metabolites in natural extracts.

MATERIAL & METHODS:

A methanolic extract of Picea abies was chemically profiled using NMR combined with chemometric tools and a natural metabolite database, leading to the identification of various simple sugars, stilbenes, flavonoids, phenolic acids, and diterpenes. Quantification was carried out using an NMR workflow: well-resolved, non-overlapping cross-peaks of target metabolites (E-astringin, E-piceid, and (+)-catechin, key chemical markers) were selected, integrated, and compared to signals from a dedicated experimental qHSQC database, using structurally related compounds as proxies when authentic standards were unavailable. Peak volumes were proportional to metabolite concentrations, enabling absolute quantification in natural ingredients.

RESULTS:

The NMR approach enabled the absolute quantification of E-astringin, E-piceid, and (+)- catechin in the dry crude extract. When using authentic standards, the concentration values (195.3±4.4, 6.4±0.6, and 9.6±0.1 mg/g of dry extract, respectively) differed from mass spectrometry measurements by less than 1%, demonstrating excellent agreement. Using proxy standards, quantification values differed by 5-10%, showing that the workflow remained robust even in the absence of authentic standards.

CONCLUSION:

This new NMR workflow extends absolute quantification to natural ingredients using a limited set of standards. It enables simultaneous identification and quantification of metabolites in a single, non-destructive experiment, providing complementary quantitative information to LC- HRMS, even without compound-specific standards. Thus, for cosmetic formulations, this innovative approach ensures reliable chemical profiling of extracts, guarantees batch uniformity, and delivers accurate quantification of bioactive compounds, thereby elevating product performance, reliability, and consumer trust.

QUANTITATIVE NMR, ABSOLUTE QUANTIFICATION, NATURAL INGREDIENTS, PICEA ABIES, LC-HRMS

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ADVANCES IN SUSTAINABLE SOLID COSMETICS THROUGH NANOGEL AND MICROGEL SYSTEMS DERIVED FROM FORMULATION: PERSPECTIVES IN RHEOLOGY, CELL COMPATIBILITY, AND DISSOLUTION

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OBJECTIVE:

The transition to solid cosmetics with low water content requires materials that combine performance, stability, and sustainability. This study explores Nanogel and Microgel systems, evaluating how differences in the composition and concentration of cryoprotectants affect their structures and behaviors in both the solid and rehydrated states [1,2].

MATERIAL & METHODS:

Both gels were designed from a standard base, incorporating specific modifications to various ingredients in the hydrogel structure and varying the concentration of gluconolactone as a cryoprotectant to generate different micro- and nanoscale network organizations. The samples were subjected to standard freeze-drying conditions. Characterization before and after freeze-drying included oscillatory rheology, dissolution kinetics under controlled hydration, cell viability assays in human dermal fibroblasts, and sensory evaluation of the product.

RESULTS:

Freeze-drying resulted in distinct solid matrices determined by formulation architecture. Nanogel produced an elastic, rapidly rehydrating network characterized by quick dissolution and a smooth glide. In contrast, Microgel generated a denser, cohesive structure with slower breakdown and a cushion-like tactile sensation. Both systems exhibited cell compatibility comparable to the negative control (cells cultured in medium), supporting their suitability for topical application. Rheological analysis confirmed that post-drying reinforcement was dependent on polymer organization, underscoring the role of composition in controlling solid cosmetic behavior.

CONCLUSION:

This work demonstrates that innovative nanogels and microgels can become promising sustainable platforms for the development of next-generation solid cosmetics, regardless of access to advanced drying process optimization. The findings reinforce the importance of formulative engineering as a key pathway to expanding the landscape of environmentally conscious solid cosmetic technologies.

SOLID COSMETICS, SUSTAINABILITY, NANOGELS, MICROGELS, RHEOLOGY, DISSOLUTION.

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BREAKING THE EMULSION PARADIGM: NATURAL EUTECTIC SOLVENTS BASED SYSTEMS FOR PERFORMANCE AND RESPONSIBILITY

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OBJECTIVE:

Natural Eutectic Solvents (NES), prepared by mixing plant cellular constituents such as sugars, polyols, or amino acids and mimicking the vegetal intracellular milieu, are emerging as a promising green alternative for producing innovative cosmetic ingredients from biomass[1]. After demonstrating that small amounts of these solvents can be successfully incorporated into emulsions and creams, providing stability and sensory benefits, the present study aims to take a pioneering step toward exploiting the full potential of these solvents as key formulation ingredients. New types of emulsions where NES replace the traditional solvents of the aqueous and/or oily phases were prepared, redefining cosmetic emulsions with new physicochemical and sensory properties. Innovative waterless hydrophobic NES in hydrophilic NES emulsions (HNES/NES emulsions) will be more specifically described.

MATERIAL & METHODS:

To develop this new kind of emulsions, a smart design approach was implemented, aligned with Safe and Sustainable by Design (SSbD) principles defined by the European Commission.[4] NES were selected based on their physicochemical, sensory and extraction properties, as well as life cycle and regulatory considerations. Safety evaluations were also performed. To ensure straightforward industrial transfer, cold process relying on standard homogenization was used to prepare emulsions. Formulation was explored using a Design-of-Experiments approach to understand the impact of concentrations, process parameters, and NES properties on emulsions performances.

RESULTS:

Translucent emulsions with submicron droplet sizes and stable at least one month at 40°C/75% RH were obtained. They present a novel sensory profile positioned between a cream and a serum, improving gloss while maintaining a non-sticky finish and leaving a hydrophilic residual film on the skin. Penetration studies using 1% retinyl palmitate as a model active ingredient demonstrated significantly enhanced dermal delivery, at least three-fold higher than reported values for conventional oil-in-water emulsions. Finally, end-of-life impact was assessed via ecotoxicity testing. The formulations exhibited median effective concentration for Daphnia immobilization values above 100mg/L, meeting OECD recommendations guidelines[4].

CONCLUSION:

NES emerge as multifunctional key ingredients, enabling innovative and sustainable cosmetic emulsions produced using standard processes and easily transferred to industry. This work shows how formulation science can reshape products to unite performance with environmental responsibility.

NATURAL EUTECTIC SOLVENTS, EMULSION, FORMULATION, DESIGN OF EXPERIMENTS, SKIN PENETRATION ENHANCEMENT, ECOTOXICITY

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NATURAL POLYMERS AS EFFICIENT ROUTES FOR ENCAPSULATION OF COSMETIC ACTIVES BY COMPLEX COACERVATION

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OBJECTIVE:

Natural active compounds are commonly used in topical delivery systems due to their diverse qualities, including antioxidant, anti-ageing, regenerative, and anti-inflammatory effects[1,2]. However, many limitations (e.g. low solubility, restricted skin penetration, sensitivity to environmental, chemical instability etc.) often impact their efficacity, thereby reducing efficiency. Encapsulation techniques offer interesting potential to face these problems. For the present study, among different encapsulation techniques available, spray drying was selected as a popular and efficient method, cost effective, easy to operate and suitable for large-scale production[3]. In addition, complex coacervation, a physicochemical method of encapsulation involving two polymers of opposite charges self-assembling through electrostatic interactions, was investigated. Among other advantages, it represents an excellent approach to improve the oxidative stability and controlled release behavior of biologically active compounds[4]. Both technologies were investigated with lonely using natural polymer.

MATERIAL & METHODS:

This study focusses on the potential of a series of natural polymers, namely fungal chitosan, arabic gum and starch derivative as promising candidates for fully vegetal encapsulation of biologically active ingredients. Both spraying drying microencapsulation and complex coacervation technologies were envisaged. A wide variety of analysis was used to characterize the different systems (FTIR, DSC, TGA, rheology, microscopies, …), actives encapsulation rate and release (LC-MS, UV) and, finally, thermal complexes and actives stability.

RESULTS:

Results allow revealing efficient encapsulation and stability improvement of actives with using both spray drying and coacervation techniques, with possibilities to tune control size, structure and stability of polymer complexes by modulating the experimental conditions of complexes preparation. In addition to encapsulation performance, the natural polysaccharides studied herein may bring multifunctional properties such as antimicrobial, anti-inflammatory, and wound healing properties which can further enhance efficacy of topical delivery systems [5].

CONCLUSION:

This work based on fully vegetal polymers for efficient encapsulation of sensitive actives brings sustainable and eco-friendly options for encapsulation in cosmetic formulations[6]. Both technologies studied, either spray drying and coacervation, are undoubtedly promising for household products and materials where sensitive ingredients could be integrated into formulations and released when used by the consumer or over time throughout their whole lifespan[7,8].

ENCAPSULATION, NATURAL POLYMERS, ACTIVES, SPRAY DRYING, COACERVATION, FORMULATION

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PHYSICOCHEMICAL STABILITY AND SKIN-RELATED PERFORMANCES OF VEGETAL PARTICLE-STABILISED EMULSIONS

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OBJECTIVE:
The growing demand for clean label and sustainable products calls for innovative approaches to emulsion design, which are typically diluted systems stabilised with surfactants. This work introduces a novel emulsion scaffold solely stabilised with orange by-product microparticles, upcycled from agri-food industry. To further highlight the clean label dimension, we focused on lipid-concentrated emulsions (>50% w/w) as a way to reduce water content and increase the proportion of bioactive material in the formulation. By comparing orange-stabilised emulsions with their classical surfactant-stabilised counterparts, this study investigates their physicochemical stability as well as their biological performance of realistic cosmetic formula.

MATERIAL & METHODS:
Physical properties were monitored under different storage conditions using size distribution and backscattering profile. Chemical stability was assessed on the same samples through oxidation markers, ranging from global pO2 measurements (fluorescent probe) to specific aldehydes (p-anisidine) and tocopherols (LC-DAD-Fluorimetry) quantifications. Phenolic profile of orange pomace microparticles was also characterized (LC-MS). Biological performance was evaluated on human skin explants, targeting key anti-ageing biomarkers semi-quantitatively across the epidermal and dermal layers.

RESULTS:
Orange-stabilised emulsions exhibited significantly higher physical stability, compared to surfactant-based systems. Their structure resists coalescence and creaming, whereas surfactants are more prone to these instabilities (particularly creaming). Orange-stabilised emulsions also tended to be more stable with regard to lipid oxidation. LC-MS analysis revealed the presence of endogenous polyphenols at high contents in orange microparticles, which may provide additional antioxidant protection. Ex vivo studies demonstrated superior bioactivity, with more activated anti-ageing biomarkers across deeper skin layers.

CONCLUSION:
Both structurally and chemically, orange microparticles outperformed conventional surfactants in a realistic cosmetic model, highlighting their potential to drive innovation in next-generation emulsion design. Beyond replacing surfactants, these upcycled particles enhance the activation of anti-aging biomarkers and can provide intrinsic antioxidant properties. Strategic interfacial design with clean label bioactive material enables multifunctional high-performance emulsions that deliver both cosmetic efficacy and sustainability.microparticles, bioactive emulsion, clean label, physicochemical stability, skin biology

ELECTROMAGNETIC FIELD–INDUCED STRUCTURAL MODULATION OF ACTIVE COMPOUNDS FOR ENHANCED TRANSDERMAL DELIVERY

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OBJECTIVE:

The effectiveness of transdermal delivery is limited by both the barrier function of the skin and the solid-state organization of active compounds. The objective of this study was to evaluate whether low-frequency electromagnetic fields can be used as a non-invasive tool to induce controlled structural modifications of selected active substances and thereby influence their transdermal transport and skin accumulation.

MATERIAL & METHODS:

Model nonsteroidal anti-inflammatory compounds differing in molecular structure and lipophilicity were exposed to static, pulsed, oscillating, and rotating magnetic fields under defined laboratory conditions. Structural and physicochemical changes were assessed using spectroscopic and thermal techniques to identify modifications in crystal packing, intermolecular interactions, and molecular mobility while verifying chemical stability. Ex vivo permeation experiments were performed using Franz diffusion cells and porcine skin as a predictive membrane model, in accordance with non-interventionary study requirements.

RESULTS:

Exposure to electromagnetic fields induced subtle, reversible supramolecular rearrangements in the active compounds without altering their chemical identity. These structural modifications were associated with changes in solubility, transdermal flux, and skin retention profiles. Pulsed and rotating magnetic fields produced the most pronounced enhancement of transdermal permeation, whereas selected static field configurations favoured increased local accumulation within the skin. The magnitude and direction of the observed effects were dependent on the applied field parameters and the molecular characteristics of the active substances.

CONCLUSION:

Low-frequency electromagnetic fields enable controllable, nondestructive modulation of the structural organization of active compounds, thereby enabling tunable transdermal transport and skin accumulation. This approach provides new insight into the use of physical fields to optimize transdermal delivery systems without chemical penetration enhancers.

Acknowledgment:This study was supported by the National Science Center, Poland [OPUS 25, Project No. UMO-2023/49/B/ST8/00605].

ELECTROMAGNETIC FIELD, TRANSDERMAL TRANSPORT, STRUCTURAL MODULATION, SKIN PERMEABILITY, SKIN ACCUMULATION

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4 - Măgeruşan S., Hancu G., Rusu A., Molecules, 2023, 28: 7219.
This research was supported by the National Science Centre (Poland) under the OPUS 25 grant no. UMO-2023/49/B/ST8/00605.

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ABSTRACTS

THURSDAY, MAY 21ST

SESSION 2

DIGITALIZATION & IA

SESSION 3

EXPLORING GLOBAL AGEING

MAY 21ST | **9.05 am**

KEYNOTE CONFERENCE

AI & BIOMIMICRY: FROM NATURE TO THE FUTURE

ELIOT GRAEFF[1], NIKOLAY TCHAKAROV[1], LEO HEMAMOU[1], FELIX GUEGUEN[1], NICOLAS MORAND[1]

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While biomimicry has gained significant traction in the scientific community, its translation into industrial practice remains hindered by systemic barriers. Among other key challenges, R&D practitioners remain highly pressured by resources and time constraints, biomimicry requires the integration of new expertise, as well as access to highly dispersed biological data that is often hard to translate into concrete results, leading to high investments with uncertain returns[1].
Numerous studies have underlined how numerical tools could solve part of these limitations[2], and the current development of AI-based methodological frameworks opens the door to entirely new ways to structure an accelerated research transfer path, both for technological and methodological findings, supporting the spread of biomimicry and its industrial integration. Using a dataset of articles and patents, we have been able to structure a database[3] and associated knowledge graph dedicated to biomimicry practice. These numerical data structures were then combined with a suite of AI agents based on a biomimetic process of reference to formalize a new biomimetic tool assisting practitioners[4].

We then tested this tool with industrial practitioners regarding its ability to improve the innovation process based on three main factors linked to industrial constraints on resource allocation (time and expertise) and creativity level (functional reasoning, novelty). Results were gathered via surveys and usage data.
Results showed a significant increase across all categories, underlining AI's ability to:
1 - allow the autonomous practice of biomimicry,
2 - make biological data actionable by non-biologists for biomimetic purposes, and
3 - reduce biomimetic process duration.

Our study underlines how engineering design research might have found in AI its most promising path toward concrete impact. Whereas training engineers in a new method takes a few generations, adjusting AI agents and tools takes hours.
These findings open three main questions:
1 - Are tools, rather than mindsets, the most credible levers to support our transition?
2 - Can we infuse biomimetic reasoning into the adaptation of these AI agents to their specific contexts in order to make them more efficient?
3 - Finally, can biological principles, characterized by their coherence with life on Earth, provide the essential ethical guardrails for the next generation of generative AI?

BIOMIMICRY, ARTIFICIAL INTELLIGENCE, BIOINSPIRED INNOVATION, RESEARCH TRANSFER

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OPTICAL METABOLIC SKIN IMAGING WITH FEMTOSECOND LASER

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OBJECTIVE:
To introduce a new nonlinear digital skin imaging method to visualize the cellular metabolism in the living epidermis based on the detection of the reduced coenzyme NAD(P)H. Materials and Methods. High-resolution label-free non-invasive in vivo skin imaging based on two-photon excited and time-correlated blue/green NAD(P)H fluorescence[1] with an infrared femtosecond fiber laser at 780 nanometers is presented. In particular, the ratio of free to bound NAD(P)H in the living epidermis as well as the mean autofluorescence lifetime is calculated and depicted as false-colored image within seconds for 512x512 pixels optical skin sections with superior 300 nanometer lateral resolution covering a field of view of about 0.2x0.2 mm2. The mean laser of 20 mW and the beam dwell time of a few microseconds per pixel of the 80 MHz laser beam are safe for in vivo human skin imaging.

RESULTS:
The NAD(P)H coenzyme ratio and mean fluorescence lifetime of the intratissue mitochondria serve as optical parameters of the cellular metabolism. Typically, the free form of the reduced coenzyme NAD(P)H is dominant in the human epidermis with a percentage of about 85% and a mean fluorescence lifetime of about 0.2 ns compared with the protein-bound form of 15% and 2 ns lifetime. Oxygen supply, inflammation, cosmetics, and ageing effects change these parameters. Conclusion: Optical metabolic imaging (OMI) of human skin cells in their native in vivo 3D microenvironment can be performed with high subcellular spatial resolution as well as superior picosecond time-resolution based on highly focused near infrared femtosecond laser radiation and used for diagnosis and personalized treatment of skin diseases such as inflammation as well as to study the cosmetics-cells-interactions including exogenous oxygen supply.

FEMTOSECOND LASER, FLUORESCENCE LIFETIME IMAGING, NADH, OPTICAL METABOLIC IMAGING

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OLOMAP: A MULTI-OMICS INTEGRATION PLATFORM FOR SYSTEMS-LEVEL SKIN ANALYSIS

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The complexity of skin biology arises from tightly interconnected lipid, protein, and metabolite networks that collectively govern barrier integrity, hydration, inflammation, and metabolic homeostasis. Capturing these interactions requires integrated multi-omics approaches combined with advanced bioinformatic frameworks capable of translating large-scale molecular data into actionable cosmetic insights. The oloMAP software platform was developed to enable holistic integration of skin lipidomics, proteomics, and metabolomics, facilitating pathway-level interpretation, biomarker discovery, and efficacy assessment for cosmetic and nutricosmetic research. oloMAP integrates heterogeneous omics datasets through unified normalization, annotation, and network-based analyses, allowing the simultaneous exploration of lipid classes, protein pathways, and metabolic signatures within the same biological context. This systems-level approach enables the identification of coordinated molecular shifts rather than isolated biomarkers, supporting mechanism-driven product development and substantiation of cosmetic claims. The integrated multi-omic analysis enabled the identification of 794 lipid species, 720 proteins, and 377 metabolites, providing a comprehensive and physiologically relevant view of skin health and its dynamic responses to environmental and physiological factors and possible stressors. This approach also captures systemic-to-cutaneous metabolic crosstalk Hu et al. (2019), with the convergent lipid, protein, and metabolite signatures representing testable biomarkers relevant to inflammation, aging, and skin microbiota research. This work demonstrates how multi-omics integration using oloMAP transforms complex skin datasets into clearer, more intuitive, and user-friendly representations, enabling mechanistic insights and opening new avenues for discovery relevant to cosmetic innovation. By linking lipid, protein, and metabolite dynamics within a unified analytical framework, oloMAP supports evidence-based development, optimization, and substantiation of cosmetic and nutricosmetic products focused on skin barrier performance and metabolic balance.

SKIN MULTI-OMICS, LIPIDOMICS, PROTEOMICS, METABOLOMICS, SKIN BARRIER, BIOMARKER DISCOVERY, COSMETIC RESEARCH, OLOMAP

1 - Hu, Y. et al. Metabolic Syndrome and Skin Diseases. Front. Endocrinol. 10, (2019)

LEARNING TO FEEL - AI SENSORY INTELLIGENCE FOR SKINCARE FORMULATIONS

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OBJECTIVE:

Tactile perception of skincare formulations arises from complex, time-dependent interactions between composition, skin surface, and application dynamics. Quantifying this perceived response remains challenging due to the multisensory nature of parameters such as friction, vibration, pressure, and shear which activate mechanoreceptors. This work aims to develop an AI-driven framework capable of predicting sensory attributes such as spreadability, thickness, and stickiness directly from instrumental measurements, enabling formulation assessment without relying solely on in-vivo sensory testing. The objective is to provide a digital approach that supports formulation design and accelerates innovation cycles.

MATERIALS & METHODS:

Sixteen formulations were selected to span a broad sensory space, including aqueous gels, oils, petrolatum-based materials, and both oil-in-water and water-in-oil emulsions. Each sample was characterized using complementary instrumental methods capturing mechanical, rheological, vibrational, and tribological behaviours. Measurements include flow and LAOS protocols, compression and stickiness tests, friction curves, and multidirectional force–vibration signals collected during application. Multiple machine learning algorithms were evaluated on cross-validated datasets, and models were trained using 63 combinations of instrumental inputs to reflect realistic laboratory constraints as formulators may not have the equipment or time to perform every measurement.

RESULTS:

Gaussian Process Regression deliver the most consistent predictive performance, achieving mean absolute errors below 10 for spreadability, thickness, and stickiness. The probabilistic nature of the model allows direct estimation of uncertainty, which is a key advantage for decision-making in formulation screening. Despite the diversity of input configurations, accurate predictions were achievable using reduced or single-instrument datasets, demonstrating the robustness and versatility of the approach. External validation on seven independent water-in-oil formulations—designed with similar sensory profiles—confirm that the model accurately captured fine sensory attributes differences.

CONCLUSION:

This study establishes a digital framework linking instrumental signatures to sensory perception in skincare formulations. Its novelty lies in (i) the flexibility to generate reliable predictions from varied instrumental datasets, and (ii) the integration of these models into an interactive AI interface enabling immediate sensory prediction with associated confidence levels. This approach provides formulators with a practical, scalable digital tool and contributes to the broader transition toward data-driven, predictive formulation design.

SENSORY PREDICTION, MACHINE LEARNING, TACTILE PERCEPTION, RHEOLOGY, TRIBOLOGY, DIGITAL FORMULATION

SERVING THE SKIN AND THE PLANET: AN APPROACH TOWARDS AUTOMATION OF INGREDIENT LCA

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OBJECTIVE:

Assessing environmental impact is essential for transitioning to a sustainable future in the cosmetics industry, which contributes 0.5%-1.5% of global greenhouse gas emissions[1]. However, reliable environmental data is severely lacking; analysis of 30,000 cosmetic ingredients (INCI) reveals that less than 1% are covered by standard databases[2].

This data gap, often due to supply chain opacity, forces formulators to rely on generic proxies.

This study presents a novel methodology capable of generating precise Life Cycle Assessments (LCAs) for all 30,000 known cosmetic ingredients.

METHODS:

Leveraging computational modeling and process-based intelligence, an algorithm was developed to derive environmental characterization factors through retrosynthesis, or reconstruction of an ingredient's complete life cycle. For synthetic and biotechnology materials, the methodology models unique chemical pathways (e.g. hydrolysis, fermentation), accounting for specific catalysts, solvents, and energy inputs. For plant-based ingredients, the algorithm incorporates detailed data on raw material extraction, farming practices, and harvesting. This allows for precise environmental modeling even when specific supplier data is missing.

RESULTS:

This research has expanded Life Cycle Inventory (LCI) coverage by modelling 99% of the most common INCI by mass, from over 170 reactions and process templates. A preliminary validation study conducted on 130 modeled INCI showed a <20% deviation between the model's results and high-effort manual LCAs conducted by a French ingredient manufacturers. This study proves that algorithmic intelligence can deliver the precision required to make impactful decisions.

The database now encompasses over 10,000 detailed INCI models, enabling the eco-design ofingredient life cycles, personalization based on supplier-specific data, and comparative simulations of diverse origins and manufacturing routes.

CONCLUSION:

This innovative algorithm bridges the gap between skin health and planetary health. By providing a scalable, ISO-aligned tool to quantify 16 standardized environmental impacts, from climate change to water use, it empowers the industry to move beyond guesswork. It paves the way for a sustainable future where every formulation decision is informed by the true environmental cost of its ingredients.

LIFE CYCLE ASSESSMENT, COSMETIC INGREDIENTS, ARTIFICIAL INTELLIGENCE, ENVIRONMENTAL IMPACT, CARBON FOOTPRINT, SUSTAINABILITY

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Cycle Assessment, [Online] 21(9), pp.1218–1230. vailable: http://link.springer.com/10.1007/s11367-016-1087-8.

ENHANCING THE STABILITY AND DELIVERY OF BIOMIMETIC GROWTH FACTORS VIA PLANT-DERIVED OLEOSOME FUSIONS: APPLICATIONS IN SKINCARE AND HAIRCARE

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OBJECTIVE:
Biomimetic growth factors are of growing interest in cosmetic science due to their role in skin regeneration and tissue homeostasis. However, their broader application has been limited by poor protein stability and inefficient delivery across the stratum corneum. This work evaluates a plant-produced oleosome–growth factor fusion technology designed to improve protein stability and bioavailability in skincare formulations and explores its extension into scalp and haircare applications. In parallel, the sustainability performance of this plant-based production system is assessed.

MATERIAL & METHODS:
Human-identical epidermal growth factor (EGF) and fibroblast growth factor-2 (FGF-2) were expressed in Camelina sativa seeds as fusions with native oleosome structures. Oleosome–protein complexes were isolated using aqueous, low-energy processing without organic solvents. Protein stability was evaluated under accelerated storage conditions. Independent clinical studies in human subjects were conducted using topical formulations containing oleosome–growth factor fusions. Skincare studies assessed wrinkles, firmness, pigmentation, and barrier-related parameters over 14 days, including comparative evaluation versus retinol. A separate clinical study evaluated an oleosome–FGF-2 fusion in haircare applications, measuring scalp condition and hair parameters. Sustainability performance was assessed using third-party environmental, social, and governance (ESG) rating frameworks, including EcoVadis.

RESULTS:
Oleosome–growth factor fusions demonstrated markedly improved protein stability compared to non-fused growth factors. In skincare applications, clinical results showed visible improvements in wrinkles, firmness, pigmentation, and barrier-related parameters within 14 days, with performance comparable to or exceeding retinol-based formulations and good tolerability. In haircare applications, treatment with an oleosome–FGF-2 fusion resulted in measurable increases in hair density, hair shaft thickness, and parameters associated with the hair growth cycle. Independent ESG assessment ranked the production system among the highest-performing globally, reflecting strong environmental, social, and governance performance.

CONCLUSION:
Plant-derived oleosome–growth factor fusion technology represents an effective strategy for improving the stability and delivery of biomimetic proteins in cosmetic applications. By combining clinically relevant performance with low-impact, plant-based production validated through independent sustainability assessment, this approach supports established efficacy in skincare and demonstrates promising potential for extension into scalp and haircare applications.

PLANT-DERIVED OLEOSOME–GROWTH FACTOR FUSION TECHNOLOGY ENHANCED STABILITY AND BIOAVAILABILITY OF BIOMIMETIC PROTEINS TOPICAL DELIVERY OF EGF AND FGF-2 IN SKINCARE, CLINICALLY VALIDATED ANTI-AGING AND BARRIER BENEFITS, SCALP AND HAIR GROWTH SUPPORT VIA GROWTH FACTOR DELIVERY, SUSTAINABLE, LOW-IMPACT PLANT-BASED BIOPRODUCTION (ESG-VALIDATED)

INSIGHT ON AGE-RELATED ALTERATION IN DERMIS-EPIDERMIS COMMUNICATION

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OBJECTIVE:

The aim of this *in vitro* modeling study was to investigate how the dermal compartment communicates with the epidermis and affects its aging.

MATERIALS & METHODS:

First, a proteomic study has been conducted to determine the impact of aging on intercellular communication. To this end, a model of aged fibroblasts was developed and the content of their secretome was analyzed. This research has also been extended to their extracellular vesicles (including exosomes) to study their role in molecular transport, particularly miRNAs. Extracellular vesicles were isolated, and the expression of 9 miRNAs known to inhibit key epidermal functions (proliferation, differentiation/barrier function, and regeneration) was analyzed by quantitative PCR. Then, to determine the impact of the age-induced communication shortfall of the dermal compartment on epidermal functions, keratinocytes from old donors (> 60 years old) were submitted to the secretome of aged fibroblasts. Ki-67 proliferation marker was then examined by immunocytofluorescence. Markers of epidermal differentiation, cell cohesion, hydration and epidermis to dermis anchoring were investigated by quantitative PCR.

RESULTS:

Mapping the secretome of young fibroblasts enabled the detection of 335 proteins, 128 of which are involved in a communication function. Four major biological pathways involved in communication originating from the dermis were identified, including IGF-1 regulation, inflammation signaling, growth factors signaling and cell interactions. The results reveal that, compared to the secretome of young fibroblasts, the secretome from aged fibroblasts is characterized by a deregulation of more than half of these proteins. Moreover, miRNAs analysis reveals a significant increase in their expression with aging, suggesting a communication shortfall that could induce an alteration in epidermal biological functions.

To corroborate this hypothesis, old keratinocytes were exposed to aged fibroblasts secretome. It highlighted that the expression or synthesis of epidermal markers related to cell proliferation, differentiation, cohesion, hydration and anchoring to dermal-epidermal junction are significantly altered by the secretome from aged fibroblasts. Hence, results obtained demonstrate that the alteration of dermis to epidermis communication appearing during aging has a significant impact on the biological functions of keratinocytes.

CONCLUSION:

This novel study highlights the role of dermis to epidermis communication in epidermal behavior during aging.

CELL COMMUNICATION, PROTEOMICS, EXTRACELLULAR VESICLES, EXOSOMES, EPIGENETICS, SKIN AGING.

MITOCHONDRION AS A PIVOT ORGANELLE TO ADDRESS GLOBAL SKIN AGEING IN MULTI-STRESS ENVIRONMENTS

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OBJECTIVE:

Skin ageing is no longer a purely aesthetic concern. It reflects progressive skin health deterioration driven by a systemic, multi-stress process combining intrinsic biological decline and extrinsic aggressions such as psychological stress and environmental pollution. These stressors converge on mitochondrion[1,2], redefining this organelle beyond its classical role as a cellular powerhouse into a stress-sensing, defence and circadian-integrating hub; the "CEO" of the cells[3]. This work aimed to investigate mitochondria-centred cosmetic strategies addressing skin ageing by targeting two complementary stress axes: chronic stress-induced circadian disruption and pollution-driven hypoxic stress.

MATERIAL & METHODS:

Two biomimetic actives obtained by precision fermentation were evaluated using human keratinocytes, fibroblasts, cell co-cultures, reconstructed human epidermis and skin explants. Mitochondrial function was assessed through membrane potential, oxygen consumption, NAD^+ and ATP synthesis. Circadian regulation, stress mediators, longevity and skin biomarkers were analysed using biochemical, gene expression and immunohistological methods. Clinical investigations were conducted under controlled cosmetic use conditions on adult volunteers.

RESULTS:

The first strategy addressed stress-ageing by restoring mitochondrial-linked circadian signalling. It increased circadian-controlled NAD^+ availability and improved NAD-dependent sirtuin 1 and ATP synthesis, resulting in reinforced skin barrier and extracellular matrix regeneration, with smoother, firmer and more resilient skin. The second strategy targeted hypoxiageing™ by preserving mitochondrial homeostasis under pollution stress. It increased mitomembrane potential, oxygen uptake and ATP production, sustained Nrf2-dependent antioxidant defence and reinforced skin layer integrity, leading to improved skin radiance.

CONCLUSION:

These findings position mitochondria as a unifying biological target for global skin ageing. By acting as a convergence point for psychological and environmental stress, mitochondrial-centric strategies support a longevity-driven shift beyond conventional anti-ageing toward adaptive, resilient and long-term skin health.

MITOCHONDRIA, SKIN AGEING, CIRCADIAN RHYTHM, OXIDATIVE STRESS, POLLUTION, LONGEVITY.

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SPATIOTEMPORAL FLUORESCENCE IMAGING OF MIR-30A ACTIVITY IN A 3D AGED HUMAN EPIDERMIS MODEL UNCOVERS A NOTCH-DEPENDENT MECHANISM RELEVANT TO SKIN AGING AND COSMETICS

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OBJECTIVE:

Skin aging is characterized by epidermal atrophy, barrier dysfunction and delayed wound healing. Growing evidences highlights the role of microRNA (miRNA) in skin aging. MiRNAs are short non-coding RNAs that play essential roles in fine-tuning specific genetic networks and are considered as innovative target for skin biology in the field of cosmetic.

MATERIAL & METHODS:

Previously we developed an inducible molecular probe, called RILES (RNAi-Inducible Luciferase Expression system) in which luciferase reporter gene is controlled by a miRNA of interest[1]. Once the RILES probe is transferred in cells, the activity of the miRNA of interest induces emission of an optical signal detectable using standard bioluminescence equipment. The RILES system was placed under control of the TGF-ß1/miRNA-21 pathway in keratinocytes to screen a library of 53 crude plant extracts for application in skin re-epithelialization[3]. Silymarin (SM) was identified as a modulator of miRNA-21 that induces three distinct transcriptomic signatures associated with keratinocyte differentiation, cell cycle regulation, and lipid metabolism, as demonstrated by RNA-Seq analysis. We further showed that SM blocks cell cycle progression, inhibits keratinocyte differentiation via Notch3, stimulates lipid synthesis via PPARγ and inhibits inflammatory responses by NF-kB regulation.

RESULTS:

Here we developed a RIFES system, an optimized RILES system to visualize the spatial expression of miRNA-30a-5p and miRNA-30a-3p by fluorescence imaging in a 3D cultures of human primary keratinocytes in a skin aging context[4]. These miRNAs were identified by our collaborators[5] as repressors of the BNIP3L mitophagy receptor and were shown to regulate mitophagy, thereby contributing to altered mitochondrial metabolism during aging. We successfully imaged the expression of miRNA-30a-5p and -30a-3p in the suprabasal layers of reconstructed epidermis and demonstrated that inhibition of the Notch-1 pathway induced fluorescent signal expression in the basal layers of engineered 3D RIFES epidermis. Furthermore miRNA-30a overexpression was found to downregulate Notch-1 suggesting a negative feedback loop between miRNA-30a and Notch pathway that was confirmed in aged epidermis biopsies.

CONCLUSION:

Our RIFES system is an innovative tool that enables visualization of miRNA activity in 3D epidermis that can be used to 1) uncover downstream signaling pathways in skin aging and 2) as probe to screen novel anti-aging compounds.

AGING, EPIDERMIS, MIRNA, RILES

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NEW FINDINGS ON KERATINOCYTE PYROPTOSIS: THE SELF-PORTRAIT OF SKIN METAFLAMMAGING

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OBJECTIVE:

The aging process is often linked to the emergence of chronic low-grade inflammation, the chronic inflammation may be related to metabolic disorders, leading to the new concern of "Metaflammaging". But the mechanism of this novel aging process on skin remains unclear. Pyroptosis, a gasdermin-mediated inflammatory cell death, is marked by pore formation, cell swelling, membrane rupture, and the release of intracellular contents. The purpose of this study was to understand how metaflammaging affects skin aging through pyroptosis pathways.

MATERIAL & METHODS:

Human primary keratinocytes (NHEKs) were obtained from a mature female donor. After the pre-incubation step of 24 hours in absence or in presence of a Mushroom-Based Skin Protectant (MBSP) or a Flower-Based Skin Protectant (FBSP), cells were then incubated again with or without LPS or UV for 24 hours. At the end of the incubation period, p-STAT3, NLRP3 inflammasome, interleukins, caspases and gasdermin D and E intracellular protein levels were measured in cell lysates.

RESULTS:

In NHEKs, the expression of target proteins involved in distinct gasdermin D–mediated pyroptosis pathways was significantly increased following LPS treatment and was markedly attenuated by the JAK2 antagonist MBSP. Interestingly, UV exposure induced activation of both gasdermin D– and gasdermin E–mediated pyroptosis pathways, whereas the aquaporin booster FBSP effectively mitigated these impacts.

CONCLUSION:

Metaflammaging is the result of the interaction between metaflammation and inflammaging. JAK2 inhibition reduces STAT3 phosphorylation, decreases the activation of NLRP3 inflammasome, thereby inhibiting gasdermin-D cleavage and downregulating interleukin expression. This caspase-1-dependent pyroptosis constitutes one of the key mechanisms involved in metaflammaging. We found that not only canonical pyroptotic mechanisms but also noncanonical pyroptosis may be targeted during LPS- or UV-induced epidermal metaflammation. This is the first time that metaflammation-type aging process has been observed in skin through keratinocyte pyroptosis pathways. Targeting metaflammaging may therefore represent a novel strategy for promoting healthy aging and holistic skin care.

METAFLAMMAGING; PYROPTOSIS; INFLAMMASOME; METABOLIC HOMEOSTASIS; HEALTHY AGING

CO-CULTURE MODELS TO EXPLORE EFFECT OF COSMETIC PRODUCTS ON SKIN MICROBIOTA

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The cutaneous microbiota is composed of various populations of microorganisms that are distributed in well-defined balance which depends on the environment and localization on the skin[1,2]. The symbiosis of microorganisms with skin cells is the key for ensuring functionality of biological skin barrier, preventing pathogen colonization, maintaining microbiota equilibrium, and triggering appropriate immune response to ensure skin homeostasis. Thus, during the last decade, cosmetics industry has increasing their interest in developing new ingredients in this field. In our laboratory, we have developed various in vitro models of skin microbiota, composed of 2 to 5 **wild-type strains of bacteria and/or yeast**, isolated from healthy skin volunteers. Microorganisms are mixed together at specific ratios, in the same conditions, and can mimic skin environment such as dry, moist, sebaceous or skin hair. All of them co-culture models aim to explore the activity of new cosmetic ingredients or formulations on the metabolism of co-living strains.

Our co-culture models allow the screening of ingredients or formulation activities either on microbiota dysbiosis found in several skin disorders or on microbiota eubiosis state found on normal skin. Regarding to dysbiosis, we found this state in several skin conditions such as:
(1) **Dandruff** by the ratio of *Staphylococcus*, *Cutibacterium* and *Malassezia species*,
(2) **Atopic dermatitis** with the balance study between *Staphylococcus aureus* and *Staphylococcus epidermidis*,
(3) **Acne** with a model composed of *Cutibacterium* acnes phylotypes (IA1 and II).

For eubiosis, we have developed a model with five bacterial signatures of the **facial microbiota**[3] : *C. acnes, C. xerosis, S. epidermidis, S. mitis and M. luteus*. A **score measuring the impact** of ingredients have been established, based on the logarithmic reduction of the five species present. This methodology makes it possible to correctly differentiate substances that have no impact on the microbiota from bactericidal substances such as phenoxyethanol or parabens. Reliably and accurately, the data obtained in each co-culture model allow us to explore the cosmetic ingredient's potential on skin microbiota: bactericidal, prebiotic or if it keeps the bacterial population in equilibrium. Complementary methods also allow the exploration of the microbiota secretome.

SKIN MICROBIOTA, IN VITRO, CO-CULTURE MODELS, DYSBIOSIS

1 - Kong, H., H., Segre, J. A., J. Invest. Dermatol., 2012, 132, 933-939.
2 - Eisenstein, M., Nature, 2020, 588, S209-S211.
3 - Pécastaings, S. et al, Journal of Cosmetic Science, 2024, 75.6, 565-580.

MODELING AGEING AND REJUVENATION PROCESSES IN HUMAN TISSUES USING ADVANCED EX VIVO SYSTEMS

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OBJECTIVE:

Ex vivo tissue models closely mimicking human physiology are crucial for identifying new cosmetic strategies that target the complex mechanisms involved in ageing, for which conventional in vitro models lack relevance. We used a donor-derived ex vivo tissue model that preserves multiple structural and functional compartments to study age-related changes in facial skin and associated deep tissue, and to explore how cosmetic actives, including those developed in the context of "botox-like" smoothing strategies or collagen-restoring approaches, modulate these processes in a controlled and reproducible ex vivo setting.

MATERIAL & METHODS:

Vascularized ex vivo tissue models were generated from donor subcutaneous tissues from the facial area of elderly donors (>50 years old) using a patented process that preserves the native extracellular matrix (ECM), cellular diversity (fibroblasts, stem cells, neuronal elements, etc.) and 3D vascularization. These models were then treated with active ingredients, as well as botox as a reference. Transcriptomic, proteomic, and secretomic analyses were performed.

RESULTS:

The tissue models were able to reproduce key phenomena associated with skin ageing, displaying specific ageing hallmarks (e.g. inflammaging, limited ECM and fibroblast remodelling, reduced mitochondrial activity). We then selected several key biomarkers associated with longevity and tissue regeneration, measured them in our tissue models and compared them to age-matched reference datasets in order to develop a longevity score. In tissue models derived from elderly donors, botox showed a profound impact on tissue homeostasis, reducing cell proliferation and myofibroblast presence, mitochondrial function, as well as vascular and lymphatic flow, suggesting a fine modulation of cellular pathways beyond its canonical action underlying its anti-wrinkle effect. Different cosmetic reference actives were then assessed for their ability to elicit botox-like and anti-ageing cosmetic outcomes, compensating the negative effects of botox on tissues, including caffeine, which stimulated metabolic activity, and enoxolone, which promoted collagen I expression.

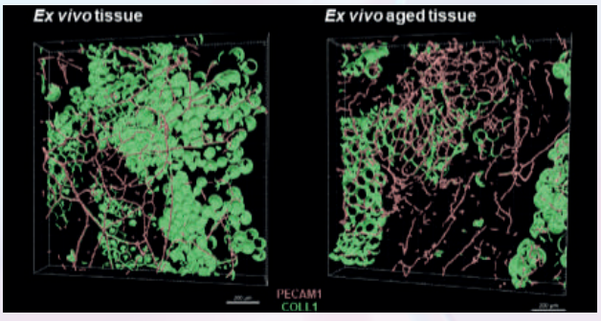

Figure. Development of ageing relevant ex vivo tissue model, marked by collagen depletion. Images acquired with Confocal LSM880 microscope after tissue clearing; collagen I (green), PECAM1 (red).

CONCLUSION:

The ex vivo tissue model described here provides a physiologically relevant platform for the development of cosmetic strategies targeting skin ageing. It enables multi-parametric evaluation to substantiate cosmetic claims related to age-related loss of facial firmness and tissue integrity, to go beyond anti-aging effects towards a stimulation of tissue rejuvenation and regeneration.

EX VIVO MODEL; SKIN AGEING; STEM CELLS; COLLAGEN; BOTOX-LIKE

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BEATING HEART OF THE WORLD COSMETICS INDUSTRY

COSMETIC VALLEY is the organization that brings together, coordinates and supports companies, research centers, universities and schools in the French perfumery-cosmetics sector.

As a major player in economic development, COSMETIC VALLEY, in partnership with local authorities, promotes growth and innovation in the sector and contributes to the international influence of the French cosmetics industry.

COSMETIC VALLEY carries the voice of a network of more than 6,300 establishments of all sizes (85% VSE/SME/ETI, and all world leaders), representing nearly 226,000 jobs for a turnover of €71 billion.

COSMETIC VALLEY represents, on behalf of the industry, the values of Universal utility, Human well-being, Responsibility towards the living, Freedom and Scientific progress. These values, pillars of Made in France, are united around the signature FRANCE CARES FOR YOUR SKIN, place the sector in a promise of a mission of general interest, enhancing the entire industry.

The Centre Val de Loire Region has placed research and innovation in cosmetics at the heart of its Regional Innovation Strategy. As a leader in the sector, it is home to more than 150 cosmetics companies in its territory, supported the creation of the Cosmetic Valley competitiveness cluster, the world's leading network of manufacturers in the sector, and, together with Lombardy, supports the Go4Cosmetics European platform on the digital and ecological transition.

In 2015, it launched the Ambition Research Development Cosmetosciences program led by the University of Orléans in partnership with the University of Tours, the CNRS, Cosmetic Valley and Studium, which brings together laboratories and research teams with recognized expertise in the fields of plant and biotechnological sourcing, development of eco-processes for extraction, characterization of plant extracts, formulation and encapsulation of active ingredients, skin biology and the use of new technologies to assess the activity and control the safety of cosmetic ingredients.

The program aims to stimulate collaborative research and innovation in cosmetics between academic and industrial laboratories to support the development of the cosmetics industry, with a unique positioning at the European level on the entire value chain, from plant material to finished products.

Combining economic dynamism and scientific excellence, Orléans is the regional capital of the Centre Val de Loire région. Its fully restored city centre makes Orléans a modern, pleasant, and dynamic city. The Loire, a UNESCO World Heritage Site, runs through Orléans contributing to the identity of the area. A City of Art and History, particularly with the history of Joan of Arc, it is located at the gateway to the famous "Châteaux de La Loire".

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