3rd International Conference

CHEMISTRY FOR BEAUTY AND HEALTH

13–15 June 2024, Kraków, Poland
Cracow University of Technology

BOOK OF ABSTRACTS

Cracow University of Technology

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ

Cracow University of Technology

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3rd International Conference

CHEMISTRY FOR BEAUTY AND HEALTH

Book of Abstracts

Kraków 2024

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PREFACE

Dear Sir/Madame

We warmly welcome all participants of the 3rd International Conference „Chemistry for Beauty and Health", which is organized by the Department of Organic Chemistry and Technology, Faculty of Chemical Engineering and Technology, Cracow University of Technology in cooperation with the Nicolaus Copernicus University in Toruń. This year, the conference is organized for the third time, but Cracow University of Technology will host the event participants for the first time. Previous editions were held in Toruń (2018) and Poznań (2021).

The aim of the conference is to spread knowledge and broadly understand the exchange of experiences among scientists, PhD students and students. The conference topics are related to biomaterials, cosmetics chemistry and technology, pharmaceutical chemistry and technology, household chemicals and food chemistry. Among the guests who accepted the invitation and agreed to share their research experience are well-known and respected scientists from France, Spain and the United States. It should be emphasized that the conference topics are extremely topical and multifaceted.

We wish all participants a pleasant stay in Kraków, fruitful deliberations, interesting scientific discussions and establishing new contacts and scientific cooperation.

On behalf of the Organizing and Scientific Committee
Elżbieta Sikora and Alina Sionkowska

3rd International Conference CHEMISTRY FOR BEAUTY AND HEALTH

13–15 June 2024, Kraków

Conference program

13.06.2024	
16:00–18:00	Registration
18:00–19:00	Welcome reception
14.06.2024	
8:00–9:00	Registration
9:00–9:30	**Opening ceremony**
9:30–10:10	**Plenary speaker 1 – Nathalie Giglioli-Guivarc'h**, University of Tours, France University of Tours, France Unlocking biosynthetic pathways in *in vitro* plant cell lines for the production of specific specialized metabolites of interest for cosmetics: concept of cell bio-factory
10:10–10:30	**Zofia Hordyjewicz-Baran:** The use of plant by-products from polish vineyards in cosmetic preparations
10:30–10:50	**Anna Olejnik:** New generation of UV filters based on modified organosilicon compounds
10:50-11:10	**Katarzyna Bialik-Wąs:** Grape berries extract as natural source of bio-crosslinker for preparation of hydrogels
11:10–11:40	COFFEE BREAK
11:40–12:20	**Plenary speaker 2 – Michel Grisel**, University Le Havre Normandie, France Natural Polymers As A Promising Route To Face Challenges In Cosmetics
12:20–12:40	**Tomasz Wasilewski:** Managment of the shampoo formulation with regard to functionality, safety of use and economic aspects
12:40–13:00	**Małgorzata Miastkowska:** Wound and skin care medical devices
13:00–13:20	**Magdalena Malinowska:** Harnessing the anti-aging potential of grape cane extracts in bigel cosmetic formulation
13:30–15:00	LUNCH
15:00–15:40	**Plenary speaker 3 – Ketul C. Popat**, George Mason University, USA Engineering material surfaces for modulation cell adhesion
15:40–16:00	**Martyna Polak:** Polymer diffusion from core to shell in co-axially electrospun fibers and its implication for cel behaviot
16:00–16:20	**Agnieszka Kyzioł:** Multicomponent hybrid materials involving metal nanoparticles and natural compounds
16:20–16:40	**Agnieszka Zielińska:** Application of chitosan-based microencapsulation in cosmetic products

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14.06.2024	
16:40–17.00	**Julia Kulczyńska:** *In vitro* study of the biological effect of multicomponent mixtures containing polyphenols, metal nanoparticles and antibiotics
	COFFEE BREAK
17:00–18:00	**Poster session**
19:00	**Gala dinner**
15.06.2024	
8:00–9:00	Registration
9:00–9:40	**Plenary speaker 4 – María José García-Celma**, University of Barcelona, Spain Innovation from nature: Water-in-water (W/W) emulsions for pharmaceutical and cosmetic applications
9:40–10:00	**Giovana Colucci:** Pickering emulsions stabilized with colloidal lignin particles as multifunctional systems for skincare formulations
10:00–10:20	**Liandra Gracher-Teixeira:** Enhancing food products quality with natural colourants: A double emulsion approach
10:20–10:40	**Ana Carolina Lima:** Biobased inks from β-cyclodextrin/chitosan stabilised hippes for 3D printing
10:40–11:00	COFFEE BREAK
11:00–11:40	**Plenary speaker 5 – Roberta Maia Sabino**, University of Wyoming, USA Antibacterial and hemocompatible biomaterial surfaces using biopolymers from sustainable sources
11:40–12:00	**Marta Sharafan:** Phytochemical profiles and biological activity of callus culture extracts from selected *Vitis vinifera* L. (Grapevine) Cultivars
12:00–12:20	**Mateusz Sochacki:** Separation of Surface-active and inactive biproducts using green technology: foam fraction
12:20–12:40	**Anna Łapeta:** Multifunctional cyclosiloxane as new cosmetic ingredient
12:40–13:00	**Closing ceremony**
13:00–14:30	LUNCH
15:00	Guided tour around Cracow

PLENARY LECTURES

UNLOCKING BIOSYNTHETIC PATHWAYS IN *IN VITRO* PLANT CELL LINES FOR THE PRODUCTION OF SPECIFIC SPECIALIZED METABOLITES OF INTEREST FOR COSMETICS: CONCEPT OF CELL BIO-FACTORY

Adrien Bertin[1], Emeline Marais[1], Shankamala Bose[1], Thibaut Munsch[1], Marianne Unlubayir[1], Johan-Owen de Craene[1], Magdalena Anna Malinowska[2], Christophe Hano[3], Arnaud Lanoue[1], Bilal Haider Abbasi[4], Nathalie Giglioli-Guivarc'h[1]

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Echinacea purpurea (L.) Moench (purple coneflower) is an important medicinal plant from the Asteraceae family appreciated for its effectiveness in cosmetics. *E. purpurea* extracts are particularly used for their anti--inflammatory, antioxidant, anti-aging and soothing properties. They are often included in skin care products to reduce redness and irritation, while promoting the healing of skin imperfections (Oláh et al., 2017). Commonly encountered compounds include lipoproteins, polysaccharides, and betaine as well as sesquiterpenes, polyacetylene, chicoric acid derivatives and alkamides. These compounds can play a crucial role in various biological functions, and their effectiveness depends on the part of the plant used (Coelho et al., 2020). Commercial extracts originated from plants grown in agricultural fields and their compositions vary from one batch to another. In addition, using wild plants often results in phytoconstituent fluctuations due to geographic and/or seasonal constraints. *In vitro* plant tissue culture represents an alternative biotechnological approach to produce valuable plant components, as it eliminates the need to depend on natural flora and provides independence from climatic conditions (Bose et al. 2020). In this study, *E. purpurea* cell lines were developed and cultured under light or dark conditions at three different auxin concentrations. We have observed that the variations of phytohormone concentrations in the culture medium and light significantly influence the metabolic profiles of cells, going as far as the production of a specific specialized metabolite. Interestingly, it now possible, from the same genotype, to produce several cell lines with their own biochemical characteristics and potentially different biological activities. Principal component analyses made it possible to establish first links between the biological activities and the nature of the biochemical composition of the extracts.

Keywords: *E. Purpurea, in vitro* plant cell cultures, antioxidant and antiaging activities

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NATURAL POLYMERS AS A PROMISING ROUTE TO FACE CHALLENGES IN COSMETICS

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Recently, the cosmetics industry has initiated an unprecedented shift towards naturality to meet the high expectations of consumers. They now are demanding products which are safer for health, more environmentally friendly as well as ethically and socially responsible; at the same time they show a distrust of chemical ingredients. The real challenge is to replace the technical and sensory performances of historical synthetic ingredients with new natural ingredients which have at least equivalent performance and quality level.

Therefore, formulating with natural ingredients instead of petroleum-based ingredients while keeping the same performances has gained much interest in the cosmetics industry, and many recent progresses have been made. Within this context, among other bio sourced ingredients, natural polymers (see Figure 1[1]) are very interesting candidates because of their wide variety and their numerous advantages including: large availability, biocompatibility, low cost, biodegradability, non-toxicity and (multi)functional properties[2].

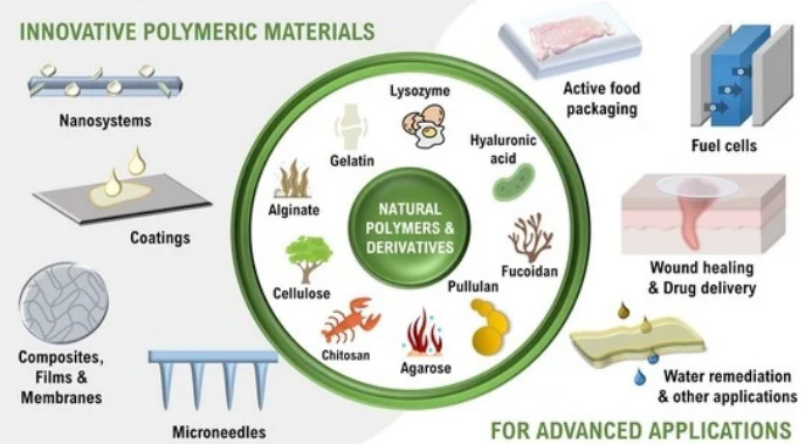

Figure 1. Natural Polymers-Based Materials: A Contribution to a Greener Future [1]

In this context, in order to meet the challenges, many research works are carried out to replace synthetic (e.g. Carbomers®) with natural or artificial polymers respecting the principles of green chemistry.

This presentation offers an overview of recent work highlighting the opportunities and advantages of these natural polymers, often with multifunctional properties; nevertheless, it also illustrates the difficulties and challenges faced by researchers, such as processability or sensory performance, to continue to innovate.

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ENGINEERING MATERIAL SURFACES FOR MODULATING CELL ADHESION

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Surfaces that contain micro- and nanoscale features in a well-controlled and "engineered" manner have been shown to significantly affect cellular adhesion and subcellular function of various biological systems. Our research is focused towards using the tools of micro- and nanotechnology in combination with surface chemistry for applications in biomaterials and tissue engineering. The goal of current research is to design material surfaces that induce controlled, guided, and rapid healing in medical devices such as hip and knee implants, stents, and heart valves. Our work proposes the use of well-controlled nanostructured interfaces with tailored surface chemistry to modulate cell adhesion and enhance implant integration. We have modified nanostructured interfaces to be either superhydrophillic/superhydrophobic, biospecific and nonfoulding depending on the application. For example, to improve cell adhesion and subsequent interaction with the surface, superhydrophillic nanostructures surfaces are desirable (e.g., osteointegration of orthopedic implants). To prevent cell adhesion on the surface, superhydrophobic surfaces are desirable (e.g., preventing blood clotting on stents and heart valves, preventing infection on implant surfaces, etc.). We hypothesize that controlled biomimetic nanoscale architectures can promote cell functionality and enhance short-term and long-term integration of medical devices. Moreover, the ability to create model nano-dimensional constructs that mimics physiological systems can aid in studying complex tissue interactions. By understanding how physical and chemical surface parameters influence cells, we can more effectively design material surfaces that can be used in a clinical setting for different medical devices.

INNOVATION FROM NATURE: WATER-IN-WATER (W/W) EMULSIONS FOR PHARMACEUTICAL AND COSMETIC APPLICATIONS

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Water is the basis of life and one of the most used ingredients in pharmaceutical and cosmetic products. It plays a key role as a solvent in formulas, giving a feeling of freshness when applied to the skin. Aqueous mixtures containing a small percentage of two incompatible polymers can form an aqueous two-phase system at equilibrium in which both phases contain mostly water, but one phase is relatively rich in the first polymer and the other in the second one. Emulsification of such two-phase systems leads to the formation of "water--in-water" (W/W) emulsions. Contrary to conventional O/W and W/O emulsions, W/W emulsions cannot be stabilized by surfactants [1]. A wide range of microstructures can be formed by varying the preparation conditions [2]. They present the compartmentalized features of emulsions without using organic solvents or surfactants. W/W emulsions can be formed using biomimetic components, such as aqueous mixtures of proteins and polysaccharides at room temperature and a great variety of actives can be incorporated. There is currently a great interest in formation and stabilization of fully water-based emulsions, for the development of novel pharmaceuticals and cosmetics based on oil-free emulsions.

The objective of this research is the development of W/W emulsions with natural proteins and polysaccharides and the identification of the critical parameters influencing the formation and stabilization of these emulsions for pharmaceutical and cosmetic applications. The methodology used involves phase diagram determinations; confocal microscopy; *pickering* stabilization; incorporation of actives and release studies and incorporation of eco-friendly preservatives.

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PL 4

ANTIBACTERIAL AND HEMOCOMPATIBLE BIOMATERIAL SURFACES USING BIOPOLYMERS FROM SUSTAINABLE SOURCES

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Thrombus formation and bacterial infections at biomaterial interfaces remain significant challenges in medical device performance. Innovative strategies that offer multifunctional capabilities to combat both issues are critical for advancing biomaterial science [1]. Layer-by-layer (LbL) assembly emerges as a promising approach to modify biomaterial surfaces with polyelectrolyte multilayers (PEMs) to confer desired biological functions [2]. Our study explores the use of naturally derived polysaccharides and polyphenolic compounds, recognized for their biomimetic, biodegradable, and functional properties, to create such multifunctional surfaces [3]. Specifically, we focus on the employment of Tanfloc (TN), a cationic tannin polymer derivative known for its cytocompatibility and zwitterionic characteristics, along with carboxymethyl-kappa-carrageenan (CMKC), a sulfated polysaccharide, and biopolymers derived from beet sugar production by-products, to develop innovative antibacterial and antithrombogenic coatings [4, 5]. These biopolymers exhibit significant antioxidant activity, further enhancing the bioactivity of the developed surfaces. Our findings reveal that PEMs terminated with TN and CMKC demonstrate superior biological properties, including enhanced antibacterial activity, reduced coagulation and platelet adhesion/activation, positioning them as sustainable alternatives to traditional anticoagulants like heparin. This work not only demonstrates the use of PEMs using naturally derived polymers as effective coatings for blood-contacting medical but also represents a significant advancement towards employing more sustainable materials in healthcare systems.

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PL 5

ORAL COMMUNICATIONS

THE USE OF PLANT BY-PRODUCTS FROM POLISH VINEYARDS IN COSMETIC PREPARATIONS

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Nowadays, the cosmetics industry is experiencing significant growth, fostering a heightened demand for novel ingredients, particularly those derived from natural sources. The utilization of grapevine buds, cultivated from by-products generated during grapevine cultivation, emerges as a valuable reservoir of phytochemicals for cosmetics formulations. This not only contributes to the industry's expansion but also aligns with principles of environmental and economic sustainability [1].

This study aimed to assess the feasibility of using micellar extraction to isolate valuable compounds from grapevine leaf buds and subsequently use them for the preparation of functional and safe-to-use cosmetic formulations, in particular facial serums. The antioxidant properties and compound characterization of the obtained micellar extract based on grapevine buds were tested and compared. UPLC-MS/MS results showed that the extracts were rich in phenolic and flavonoid compounds, exhibiting antioxidant activity as measured by DPPH and ABTS scavenging capacity.

The demonstrated biological activity of compounds derived from grapevine buds favorably positions them as sources of bioactive phytochemicals for cosmetic applications, providing an effective and environmentally friendly alternative to handling resulting residues.

The extracts were used to prepare model facial serums, which were evaluated based on basic parameters related to functionality (e.g., rheological properties and color). The results showed that facial serums with grapevine bud-based extracts represent safe, natural cosmetics.

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NEW GENERATION OF UV FILTERS BASED ON MODIFIED ORGANOSILICON COMPOUNDS

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It is commonly known that excessive exposure to solar light leads to sunburn, reddening, photo-aging, and in the worst case causes skin cancer [1]. Therefore, to provide protection it is highly recommended to use sunscreen formulations containing UV filters. However, it has been reported so far that some organic sunscreen agents may be photo-unstable causing allergies, penetrate skin layers, and have an adverse effect on the endocrine system [2].

The aim of this study was to obtain and characterize new types of UV filters based on organosilicon compounds (such as spherosilicates) functionalized with hydroxybenzopheone and polyethylene glycol groups. New generation of UV filters have been designed to have a high molecular weight so that they do not penetrate the skin, but remain on its surface. They were obtained in hydrosilylation reaction and characterized by spectroscopic methods. Moreover, their photostability, emulsifier properties as well as hydrophilic–hydrophobic character were assessed. Afterward, the compounds obtained were introduced to the emulsion system. The stability of the sunscreens was assessed using multiple light scattering, and droplet sizes were determined by laser diffraction and optical microscopy. Moreover, the sun protection factor was determined and the permeation studies of UV filters through skin-mimicking membranes by using a Franz diffusional cell were performed. It was proved that modified spherosilicates absorb UV light in the range of 240 to 380 nm, so they can be used as UVA and UVB filters. The new generation of UV filters did not undergo any degradation and remained photostable after 3 h of irradiation. The molar absorption coefficient of modified organosilicon compounds was much higher than that of commercial sunscreen agents such as oxybenzone. Due to the high molecular weight of novel UV filters no permeation through skin-mimicking membrane after 120 min was detected. The results of this study may lead to the development of a novel class of sunscreen agents.

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GRAPE BERRIES EXTRACT AS NATURAL SOURCE OF BIO-CROSSLINKER FOR PREPARATION OF HYDROGELS

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A multifunctional and environmentally friendly hydrogel materials were developed throughout chemically crosslinking reaction of biocompatible polymers and natural crosslinker, which is present in grape extract. This is an interesting approach to the design hydrogels, especially, when it takes into account that many synthetic cross-linking agents, such as N, N'-methylenebisacrylamide, ethylene glycol dimethacrylate, epichlorohydrin, and glutaraldehyde, which are harmful and toxic [1]. It is widely known that grape berries are the source of many beneficial active substances including anthocyanins, flavanols, flavonols, stilbenes and phenolic acids. These active metabolites exhibit particularly beneficial effects on the skin, hence their enormous potential for use as active ingredients in cosmetics and medical devices [2]. The application of the grape extract to obtain hydrogels do not only combines the possibility of chemical cross-linking of polymers, but also provides therapeutic properties to the final matrix. In the case of crosslinking reactions the rheology of polymeric systems is very important, that's why this parameter was analyzed for reaction mixture before synthesis. After that the obtained hydrogels were characterized by conducting Scanning Electron Microscopy (SEM) and Fourier-Transform Infrared Spectroscopy (FT-IR) analysis as well as physicochemical (gel fraction, swelling ability, degradation) and microbiological properties. The release studies of active components from hydrogel materials, were carried out. Additionally, cytotoxicity tests proved that obtained materials do not show cytotoxic effects and they are safe for the skin cells.

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MANAGEMENT OF THE SHAMPOO FORMULATION WITH REGARD TO FUNCTIONALITY, SAFETY OF USE AND ECONOMIC ASPECTS

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Industrial companies producing cosmetics are constantly looking for solutions that will fulfill consumers' expectations as much as possible. Consumers' preferences are constantly changing. In recent years, particular attention has been paid to aspects related to the safety of use, such as low irritant potential, reduced skin drying after the washing process and minimized environmental impact. However, users are invariably seeking for functional and affordable cosmetics.

This paper presents the results of a study in which, correlations between key parameters related to functionality, safety of use and price of the raw material were determined for the developed model shampoos for hair and scalp cleansing.

The various shampoos differed in composition, with a focus on the effect of the content of basic surfactants was analyzed. However, it was assumed that each of the developed cosmetics would have the same viscosity, falling within the acceptable range to consumers. Consequently, the variable content of sodium chloride, used in formulations as a viscosity modifier, was considered. Based on the results obtained, it was shown that increasing the content of the primary active ingredient in shampoo formulations is not synonymous with an improvement in product quality. Empirically, it was shown that for a given type of formulation, there is a certain optimal surfactant content, which guarantees high product quality at a relatively moderate price. Furthermore, the obtained results allow to consciously choose the composition of cosmetics depending on the effects expected by the recipients.

The presented research results and developed correlations can be a valuable source of information for technologists formulating cosmetic compositions, people involved in product development in companies, and even for cosmetics consumers. The results of the work will undoubtedly raise awareness and help answer the question: what specific factors affect the quality of a cosmetic available on the store shelves.

WOUND AND SKIN CARE MEDICAL DEVICES

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Medical devices (MD) are defined as objects or substances that serve the recognition, prevention, monitoring, treatment and alleviation of diseases that achieve this purpose by physical means, not by pharmacological/immunological means or through metabolic effects. Regulatory requirements concerning medical devices are outlined in the Medical Device Regulation (MDR) (EU) 2017/745 [1]. MD classification is a fundamental step in the design and the development of the device, since the class assigned determines the procedure to assess its conformity for CE marking and its entrance into the market [2]. This classification is based on the level of risk associated to the MD in development. The Directive 93/42/EEC defines the MD classes on different parameters such as the degree of invasiveness, the vulnerability of the patient considered, the contact duration, the potential risks associated with the intended use and the MDs intrinsic characteristics, and its dependence on an energy source (active device) [3, 4].

A wound and skin care medical device can be defined as a wound dressing, cotton wool, gauze dressing, bandage, sutures for dermal wound closures and surgical gloves. That type of product include among others: emollients and creams, foams, gels and hydrocolloids dressings. In recent years, topically applied semi-solid formulations certified as medicals devices and not as topical drugs are increasingly used for the treatment of skin diseases.

Intensified placing of medical devices on the dermatological market may be explained by a less complex marketing and authorization process compared to topical drugs. If the requirements are fulfilled to certify a product as a medical device the opportunity will be offered to quickly introduce innovations onto the market [5]. The market analysis of variety wound and skin care medical devices in terms of composition, form and purpose will be the subject of this work.

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HARNESSING THE ANTI-AGING POTENTIAL OF GRAPE EXTRACTS IN BIGEL COSMETIC FORMULATION

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Grapevines are recognized worldwide as a rich source of numerous secondary metabolites that have beneficial effects on human health. This activity includes cosmetic benefits, thanks to the ability of grapevine polyphenols to inhibit skin aging processes [1, 2]. Stilbenoids are particularly interesting because their action includes high antioxidant activity, as well as the ability to inhibit the activity of enzymes responsible for accelerated skin aging processes. Grape canes are a rich source of these compounds and are abundant viticultural byproducts [3]. The use of grape cane extract (GCE) in cosmetics not only offers an intriguing opportunity to utilize these multifunctional active ingredients in effective anti-aging cosmetics but also allows for an interesting way to manage waste generated during grapevine pruning. In recent years, among many cosmetic forms, gels have garnered particular interest. Contrary to emulsions, these cosmetic forms eliminate the need for emulsifiers and offer various benefits. Bigels allow for the incorporation of both polar and non-polar active substances, provide a potent cooling and moisturizing effect, ensure good spreadability, are easy to prepare and wash off after application, enhance the permeability of active ingredients, exhibit high stability, and can be tailored by adjusting the content and structural distribution of individual phases [4]. In our study, we utilized GCE as an active ingredient in the bigel, which we evaluated for quality and its effects on the skin. We determined the physicochemical and organoleptic properties of the obtained gels. The effectiveness of the final formulations was assessed using a skin analyzer test. Research results unequivocally indicate that the use of GCE extract positively influences skin elasticity, smoothness, and moisture, while also reducing pore visibility, minimizing wrinkles, and brightening the skin. The formulations produced are an innovative blend of both the physicochemical structure and the active ingredients, designed for use as highly effective anti-aging formulations.

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POLYMER DIFFUSION FROM CORE TO SHELL IN CO-AXIALLY ELECTROSPUN FIBERS AND ITS IMPLICATIONS FOR CELL BEHAVIOR

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Electrospun polymer scaffolds have great potential in biomedical applications, including tissue engineering, skin patches, and drug delivery [1]. The utilization of core-shell fibers offers an attractive solution, providing the ability to manipulate mechanical properties, flexibility in selecting materials and drugs, efficient encapsulation, robust protection of bioactive drugs in challenging environments, and regulated extended drug release.

This research tackles a significant challenge in the design of core-shell fibers, specifically concerning the blending effect between core and shell polymers during electrospinning. Two polymers, polymethyl methacrylate (PMMA) and polycarbonate (PC), were electrospun to create PC-PMMA core-shell fibers. During co-axial electrospinning, PC diffuses to the PMMA shell, changing the surface chemistry of the produced fibers [2]. Further investigation of surface properties disclosed that the surface potential variation of PC-PMMA fibers affects cellular responses in *in vitro* tests [3–5]. The surface chemistry and potential of scaffolds were verified using X-ray photoelectron spectroscopy (XPS) and Kelvin probe force microscopy (KPFM), respectively. We showed the significant differences between PMMA and PC-PMMA scaffolds, resulting in further investigation using confocal laser scanning microscopy (CLSM) and the AiryScan technique, to verify cell focal adhesion points to fibers [6]. Our study sheds light on the intricacies of core-shell fiber design and underscores the importance of understanding the interplay between fiber properties and cell attachment to scaffolds.

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MULTICOMPONENT HYBRID MATERIALS INVOLVING METAL NANOPARTICLES AND NATURAL COMPOUNDS

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Supramolecular complexation is widespread in Nature and exploits covalent and non-covalent dynamic interactions of simple precursors to assemble complex architectures. Organic/inorganic nanohybrids have currently attracted widespread attention due to their beneficial properties and versatile applications in many biomedical areas. Among different organic components, phenolic compounds and biopolymers offer unique avenues for multifunctional systems with unique properties. In particular, metal–phenolic networks as organic–inorganic multifunctional hybrid systems, have been progressively developed in recent years [1, 2]. However, various types of physical and chemical interactions that arise between different components and how those interactions govern the assembly/disassembly and functionality of the final hybrid systems are still not precisely understood. Polyphenols and other natural compounds can be used as powerful reducing agents of metal ions and at the same time excellent stabilizers of the resulting hybrids, involving covalent interactions [1]. Nevertheless, this bottom-up approach of nanoparticle engineering requires a fine balance between the intrinsic supramolecular forces of assembly and the subsequent interfacial and stabilizing interactions, which has been an ongoing challenge. Thus, mimicking Nature is a promising strategy for the rational design of advanced materials with controlled size, morphology, and functions. For instance, making use of the coordination between catechol based ligands and metal ions such systems have exhibited excellent multifunctional properties such as anti-inflammatory, antioxidant, and antibacterial properties. Furthermore, the versatility of these supramolecular networks, combined with their intrinsic bioactivity (therapeutic) of particular components offers discovery of unknown potential synergy or additive activity.

Herein, I will present various categories of studied in my research group biomaterials based on organic--inorganic systems: *i*) surfaced functionalized metal nanoparticles, *ii*) *1D* polymeric nanofibers decorated with bioagents, and *iii*) films and coatings deposited on medical alloys [3, 4]. Also, recent advances in the antimicrobial applications in biomedical fields (*e.g.*, antibacterial biomaterials, skin repair, bone regeneration, medical devices, *etc.*) will be summarized and highlighted based on the current state-of-art.

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APPLICATION OF CHITOSAN-BASED MICROENCAPSULATION IN COSMETIC PRODUCTS

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Microencapsulation plays a vital role in the cosmetics industry. It involves coating and enclosing particles of an ingredient or mixtures within a protective shell composed of an encapsulating agent. By isolating and safeguarding the active substance, microencapsulation ensures controlled release, resulting in cosmetic products of superior quality and durability [1]. Interest in microencapsulation has surged due to its widespread adoption across various industries, including pharmaceuticals, cosmetics, food, textiles, agriculture, chemicals, biotechnology, and medicine. In cosmetic formulations, where biologically active substances are common, microencapsulation prevents premature degradation caused by factors like temperature, pH, light, and oxidation [2]. It acts as a shield, allowing these compounds to reach their intended target areas within the skin, including the stratum corneum of the epidermis. Coating substances used in microencapsulation can be categorized based on their origin: natural, semi-synthetic, or synthetic. The natural-based group includes polysaccharides (such as alginate and chitosan), proteins (like gelatin and collagen), and lipids. Their advantages lie in their low toxicity and biodegradability [3].

The focus of this presentation is to explore the possibilities and advantages of using microencapsulation, particularly with chitosan, in cosmetic products. The preparation methods and design approaches of chitosan-based microcapsules will be discussed and analyzed. Chitosan, known for its eco-friendliness, biocompatibility, universality, and non-toxicity, stands out as one of the most frequently chosen encapsulating agents. Its broad application scope demonstrates remarkable potential in enhancing cosmetic formulations.

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IN VITRO STUDY OF THE BIOLOGICAL EFFECT OF MULTICOMPONENT MIXTURES CONTAINING POLYPHENOLS, METAL NANOPARTICLES AND ANTIBIOTICS

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Antibiotics are a class of drugs whose discovery was a breakthrough in the treatment of bacterial diseases. Unfortunately, despite the broad spectrum of use of these therapeutic compounds and the multiplicity of mechanisms of action on bacterial cells, their efficacy has declined over the years. This is due to the development of resistance mechanisms by microorganisms to antibiotics because of their overuse, use in inappropriate indications or for too long. Facing this problem, one solution is to look for new therapeutic strategies, such as using natural products that exhibit antimicrobial or antiseptic activity while being non-toxic to human cells. Furthermore, these natural products can provide a substrate for the synthesis of metallic nanoparticles, which also show potential for treating bacterial infections.

In the case of this research, rose extracts (*Rosa damascena*, *Rosa rugosa*) and the gold nanoparticles obtained using their application (Au@RD NPs, Au@RR NPs) were characterized in terms of antimicrobial activity both as extract solutions, Au colloids, and as components of chitosan films or fibers. The performed experiments allowed to determine the value of the minimum inhibitory concentration (MIC) and the size of the zone of inhibition using either the direct contact method (chitosan-based films) or the disk-diffusion method in the case of plant extracts. The possibility of potential additive or synergistic effects between rose extracts and antibiotics was also investigated. Such interactions, especially of a synergistic nature, would significantly reduce the dose of the antibiotics. This approach fits in strategies to overcome increasing bacterial resistance [1]. On the other hand, the suggested use of Au nanoparticles as carriers of biologically active compounds included in plant extracts is a new approach and is currently being widely studied [2]. It has been demonstrated that rose extracts and gold nanoparticles exhibit a bacteriostatic effect and low toxicity towards the HaCaT cell line.

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PICKERING EMULSIONS STABILIZED WITH COLLOIDAL LIGNIN PARTICLES AS MULTIFUNCTIONAL SYSTEMS FOR SKINCARE FORMULATIONS

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Lignin, an aromatic biopolymer found in plants, has been recently explored in cosmetic applications due to its remarkable properties, such as biocompatibility, antioxidant, and UV shielding [1]. In the form of colloidal lignin particles (CLPs), lignin can be applied to stabilize Pickering emulsions, resulting in innovative multifunctional formulations. In fact, using bio-based particles in emulsion stabilization is a sustainable approach to replace the conventional synthetic emulsifiers of cosmetic emulsions, which are reported to have adverse effects on health and the environment [2, 3]. From this perspective, this work addresses the emerging use of CLPs as stabilizers in Pickering emulsions. For this, a modified lignin with light color and no smell was selected to produce CLPs using the antisolvent precipitation technique with ethanol. CLPs with distinct characteristics were produced by changing the antisolvent used, i.e., water (CLPs-W) and phosphate-citrate buffer at pH 8 (CLPs-B), and subsequently applied to produce Pickering emulsions with Miglyol 812 oil. The emulsion formulations were optimized for the oil volume fraction (φ) from 0.4 to 0.8, and their droplet size, morphology, and stability were evaluated within 1 month of storage. Finally, optimized formulations were characterized in terms of rheology and antioxidant activity. In summary, CLPs-W had spherical shapes, with sizes around 400 nm, and a more hydrophobic character (three-phase contact angle CA of 107°). In contrast, CLPs-B had smaller sizes (170 nm) with cluster-like shapes and a more hydrophilic character (CA 60°). Both CLPs effectively stabilized oil-in-water Pickering emulsions with excellent long-term stability, yet significant differences in the emulsion's final properties were observed. The use of high φ favored the formation of emulsions with an utterly homogeneous phase, where small oil droplets (7 μm) were produced with CLPs-B even at φ as high as 0.8. The optimized emulsions exhibited shear-thinning and elastic gel-like behavior, which are typical features of cosmetic emulsions. Moreover, the high antioxidant capacity of CLPs was nicely preserved in the Pickering emulsions, these last presenting IC50 values corresponding to a strong level of antioxidant power (70–90 μg/mL). In conclusion, the produced lignin-based Pickering emulsions revealed high potential for designing novel multifunctional delivery systems for skincare formulations.

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ENHANCING FOOD PRODUCTS QUALITY WITH NATURAL COLOURANTS: A DOUBLE EMULSION APPROACH

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Food appearance and colour are tightly associated and may be the most critical factor in attracting consumers. They are increasingly interested in natural products with additional functions due to synthetic colourant constraints associated with health problems. As a result, natural colourants have become a topic of interest for numerous sectors, such as the food, cosmetic and pharmaceutical industries. Natural colourants like carmine (E120) are widely used but may cause allergies and are not vegan. Anthocyanins, natural pigments with bioactive properties, are promising alternatives, but their stability can be compromised by external factors. Encapsulating anthocyanins in double emulsion systems may preserve colour, bioactivity, and control their release. This study aims to replace the carmine colourant used in yoghurts with black carrot (*Daucus carota* L.) extract using a double emulsions (W1/O/W2) system. The primary W1/O emulsion (40/60, v/v) with black carrot colourant in the aqueous phase was dispersed in water (W2) to generate the double emulsion. The W1/O/W2 system remained stable at 30–40ºC and acidic conditions (pH 3–5). A sensory analysis was conducted to check for consumer acceptance.

The use of the double emulsion allowed the yoghurt to keep the colour for 15 days, with ΔE values below 1, indicating imperceptible colour differences to the human eye. For the antioxidant activity, the yoghurt coloured with black carrot double emulsion inhibited DPPH better than other samples. These evidence suggest that the double emulsion system with the black carrot colourant is a promising choice for enhancing food product quality, providing both colour and antioxidant activity. During the sensory analysis, all participants confirmed yoghurt consumption, with 23% preferring sugar-free options, contrasting with 51% favouring sugar-added varieties. Overall, a clear preference for yoghurts with added sugar was observed, with both options (carmine or double emulsion with black carrot extract) emerging as the most preferred choices.

This research introduces novel applications for double emulsion systems in the food industry. This system preserves colour and enriches the product with antioxidant properties. Moreover, the used approach did not influence the yoghurts' acidity and syneresis, keeping them within FDA requirements.

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BIOBASED INKS FROM B-CYCLODEXTRIN/CHITOSAN STABILISED HIPPES FOR 3D PRINTING

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High internal phase oil-in-water Pickering emulsions (HIPPEs) have emerged as versatile platforms for various applications, including food, personal care, pharmaceuticals and tissue engineering. Their superior stability compared to conventional emulsions, reduced dependence on harmful surfactants due to solid particle stabilisation, and the capacity to encapsulate high payloads of active ingredients lead to a growing interest in these systems. HIPPEs, which are characterised by having a high internal phase volume (>74%), form highly viscous systems with shear-thinning behaviour, making them well-suited for three-dimensional (3D) structuring applications. This research area presents exciting opportunities for developing novel functional materials for the food industry, enabling encapsulation, protection, and release of bioactive agents, such as nutraceuticals and vitamins. This study explores the potential of β-cyclodextrin/chitosan (β-CD/CS) complexes as stabilisers for HIPPEs and evaluates their suitability as printable inks for extrusion 3D printing. The HIPPEs composition was systematically varied, considering the β-CD/CS particle concentration (3–4%), the β-CD:CS weight ratio (1:1, 2:1, and 3:1), and the oil type (sunflower or corn oil). Optical microscopy showed a decrease in droplet size with increasing particle concentration. Particularly promising results were obtained with samples containing β-CD:CS weight ratios of 1:1 and 2:1, indicating improved stability due to a greater interfacial area coverage. Rheological analysis confirmed the shear-thinning behaviour, supporting the observations of the printing performance. Flow test revealed increased apparent viscosity with increased particle concentration (3%: 26,868; 4%: 47,712 Pa.s). Furthermore, oscillatory shear and frequency tests supported this result, with storage modulus (G′) values exceeding loss modulus (G″) for all samples (G' ≈ 25,000 Pa.s), indicating a predominant elastic behaviour of the HIPPEs. The oil type subtly affected the HIPPEs-based inks, with samples prepared with sunflower oil showing a more compact printed structure, resembling the intended mesh design. Overall, these findings confirm the use of β-CD/CS complexes as effective stabilisers for HIPPEs in 3D printing applications.

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PHYTOCHEMICAL PROFILES AND BIOLOGICAL ACTIVITY OF CALLUS CULTURE EXTRACTS FROM SELECTED *VITIS VINIFERA* L. (GRAPEVINE) CULTIVARS

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Grapevine (*Vitis vinifera* L.) is a valuable and very popular fruit crop all over the world. Since ancient times grapes have been used for wine production or as the table fruit. The grapevine currently has well established chemical profile with the dominance of phenolic acids, flavonoids, anthocyanins, and stilbenes and is widely used in food, pharmaceutical, and cosmetic industries [1, 2].

The aim of the study was to evaluate the phytochemical composition of *in vitro* callus extracts obtained from different grapevine cultivars (3 red cultivars: Marechal Foch, Regent, Rondo and 3 white cultivars: Hibernal, Chardonnay, Seyval Blanc). The cultures were maintained over 30-day growth cycles on two different media: Murashige and Skoog (MS) and Schenk and Hildebrandt (SH), with various concentration of plant growth regulators: 6-benzylaminopurine (BA), indole-3-butyric acid (IBA) and/or 1-naphthaleneacetic acid (NAA). The extracts were prepared using ultrasound mediated extraction, in 70% ethanol (2 x 30 min). The UPLC-MS/MS analysis was applied for metabolite profiling. The biological activity of obtained extracts was also determined. The antioxidant capacity assessment, by free radical scavenging ability (DPPH method) and ferrous ion-chelating assay, were done. Moreover, the total phenolic content (TPC) was determined using Folin-Ciocalteu method. The skin-brightening activity and anti-aging effectiveness were evaluated using tyrosinase and collagenase inhibition *in vitro* assays, respectively.

The UPLC-MS/MS analysis showed that the most abundant group of compounds in the extracts are polyphenols. That was confirmed also by TPC results. The strong antioxidant activity was indicated by DPPH assay. Moreover, the moderate to high chelating activity was revealed. The results of enzyme assays indicated that extracts could act as tyrosinase and collagenase inhibitors, which confirms their ability to brighten the skin and maintain its protein structure in good condition.

The obtained results proved that grapevine *in vitro* callus culture extracts could be applied as multifunctional raw material for cosmetic preparations.

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O 14

SEPARATION OF SURFACE-ACTIVE AND INACTIVE BIOPRODUCTS USING GREEN TECHNOLOGY: FOAM FRACTIONATION

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Interest in natural products is growing every day, given their many beneficial bioactive properties. Natural materials are used in many commercial products, thought their high-quality is required to meet exorbitant market criteria [1, 2]. The recovery and purification of said materials is slowly progressing towards well-established greener technologies, therefore new sustainable methods are being sought [3, 4]. Foam fractionation belongs to the adsorptive bubble separation methods, which utilize the phenomenon of molecular adsorption on the gas-liquid interface [5]. Foam separation involves selective adsorption of surface-active solutes on the surface of introduced gas bubbles which rise through an aqueous solution [6]. Bubbles emerge from the liquid to form a dispersed system of water and air called foam. In time, the foam becomes relatively enriched in surface-active material, and when recovered enables a separation of targeted species [7]. The foam fractionation method applies to many surface-active and inactive compounds called collectors and colligends, respectively [8]. Bubble-adsorbed collectors function as a grapple binding surface-inactive compounds via chemical or physical interactions, allowing their removal through foam [9]. Foam fractionation is considered a green technology due to simple, economical and ecological separation using aqueous solutions and inert gases [10, 11]. The technology has seen many applications involving recovery of plant and microbial metabolites using numerous surfactants and biosurfactants [12]. The authors wish to introduce the phenomena, basic laws and mechanisms of the technology. Multiple examples of biomaterial separation will be discussed, supported by comprehensive studies. In addition, the authors' current research on the isolation of glycoside biosurfactants, triterpenoid saponins from plant material will be presented. Using a single-stage 3D-printed foam column operated in batch mode, saponins were enriched from 0.1 mg/ml to 3.75 mg/ml with 14.5% total recovery. The study further validated the practical aspect of the foam fractionation technology.

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MULTIFUNCTIONAL CYCLOSILOXANE AS NEW COSMETIC INGREDIENT

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The cosmetics industry is constantly searching for new ingredients that will provide effective protection against the adverse effects of ultraviolet radiation. However, recent studies have shown that certain chemical UV filters may penetrate the deeper layers of the skin affecting the endocrine system [1, 2]. Moreover, they may undergo photodegradation, causing allergies, dermatitis, and toxic reactions [3]. Therefore, the need for a novel UV filter that is both photostable and non-toxic and does not penetrate the epidermis is significant. The objective of this research was to develop a new modified cyclosiloxane that fulfills these criteria and simultaneoesly acts as a UV filter as well as an emulsifying agent in cosmetic formulations. The photostability, hydrophilic–hydrophobic character, and skin permeation ability of cyclosiloxane functionalized with hydroxybenzophenone and polyethylene glycol groups were assessed. Afterwards, the synthesized compound was tested as an emulsifier and the stability of colloidal systems was determined by multiple light scattering at different temperature conditions. The emulsifying properties of functionalized cyclosiloxane were confirmed. Moreover, it was proved that the synthesized compound can protect both against UVB and UVA light and was photostable after 3 hours of irradiation. The sun protection factor of emulsions containing novel UV filter was evaluated. The study performed using Franz cell showed no permeation of novel UV filter through skin mimicking membrane after 2 h. It proves that the modified cyclosiloxane will remain on the skin surface after application. This research might pave the way for the creation of distinctive organic-inorganic hybrids that serve as new classes of emulsifiers and sunscreen agents in cosmetic formulations.

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POSTERS

NEW TRIPEPTIDES – INHIBITORS OF TYROSINASE FOR COSMETIC APPLICATION

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Tyrosinase, also known as polyphenol oxidase, is a copper-containing enzyme. It plays a key role in the biosynthesis of melanin, a dark pigment responsible for protecting the skin against harmful UV radiation and for its characteristic color [1]. However, some people develop tyrosinase overactivity, which leads to a number of unfavorable skin changes, such as freckles or hyperpigmentation spots, which can be prevented by using tyrosinase inhibitors [2]. One of the most active compounds is hydroquinone, which, despite its effectiveness, has irritating and cytotoxic properties, which is why new structures of chemical compounds that would inhibit the activity of tyrosinase are being intensively searched for.

The aim of the study was to develop novel peptides with tyrosinase inhibition activity. The molecular modeling techniques (Maestro, Schrödinger) was applied to select the peptides with the strongest interactions to mushroom tyrosinase 2Y9X from *Agaricus bisporus*, used as the target protein. The molecular docking studies allowed to select three most active compounds: PEP1, PEP2 and PEP3. Next, the peptides were synthesized in a solid-phase reaction and then purified. Their structure was confirmed using MS, ^{1}H-NMR and UV-Vis techniques. The synthesized compounds were then examined as tyrosinase inhibitors in the *in vitro* test and the cytotoxicity assay of the compounds was also performed.

The obtained results confirmed the tyrosinase inhibitory properties and the safety of the synthesized compounds. The IC50 values for the peptides were: 660 μM, 729 μM and 789 μM, for PEP1, PEP2 and PEP3, respectively. The results indicate that the developed peptides can be used as the active ingredients in whitening cosmetic formulations.

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INNOVATIVE BIOCIDES BASED ON RASPBERRY AND BLACKBERRY LEAVES WITH REDUCED ETHANOL CONTENT

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Plant raw materials with strong antioxidant activity are commonly used to produce cancer drugs. Currently, the industry has focused mainly on the use of plant raw materials for pharmaceuticals, completely ignoring other industries.

On the Polish as well as European market one can observe a deficit of preparations which would have antimicrobial activity, and at the same time were prepared from plant raw materials, readily available both on the market and in the environment. The preparations we propose are characterized by high biocidal properties derived both from ethanol (which is a well-known method to eliminate microorganisms) and from plants with high antioxidant potential, which at the same time enhances antimicrobial activity. In the literature, one can find information about the helpful effect of natural antioxidants in various types of bacterial infections. In addition, human skin is one of the main transmission routes for bacteria colonizing various frequently touched surfaces. Bacteria frequently transmitted by such a route include Enterococcus, Streptococcus, Serratia, Pseudomonas, Bacilius, among others. With the increasing need for antiseptic preparations, in order to potentiate the antimicrobial effect, it is therefore advantageous to combine in preparations applied to the skin ingredients that show antiseptic activity in combination with ingredients with high antioxidant activity.

Performed screening according to EN 13697:2015 for Pseudomonas aeruginosa ATCC 15,442 and for Staphylococcus aureus ATCC 6,538. The screening was conducted by Adimentium.

The full bactericidal activity of MALINA for both reference strains is demonstrated at a dilution of up to 80%. The full bactericidal activity of the preparation JEŻYNA for both reference strains shows at a dilution of up to 60%.

CURCUMIN AND CO-AMORPHISATION – NEW FORMS OF CURCUMIN WITH GALLIC ACID, CAFFEIC ACID AND VANILLIC ACID

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Curcumin is a curcuminoid that is naturally present in the rhizome of turmeric, which is known as Curcuma longa. Turmeric is a versatile plant that is commonly used as a spice, dietary ingredient. Curcumin is reported to possess immunomodulatory, anti-inflammatory, and antioxidant properties. However, curcumin exhibits poor water solubility and low bioavailability. The high amount of scientific research in recent years indicates significant interest in the topic, suggesting the important role they can play, particularly in improving the solubility of curcumin.

We attempted to obtain curcumin co-crystals. However, during the investigation, we discovered that in the presence of curcumin, vanillic, gallic, and caffeic acids change into an amorphous form.

In the study, three phenolic acids were used for the development the method for obtaining curcumin cocrystals. The method involved solvent evaporation and mechanical grinding of curcumin and one of the selected phenolic acids in a mortar, as well as mechanical grinding of one of the selected phenolic acids in a ball mill in a predetermined molar ratio. The structures obtained underwent analysis using X-ray powder diffraction. The curcumin samples obtained were analyzed using differential scanning calorimetry (DSC) and infrared spectroscopy (IR). Subsequently, the dissolution profile of the mixtures in relation to curcumin was determined, and antioxidant tests were conducted using the DPPH and FRAP radicals.

The methods used did not result in obtaining curcumin co-crystals, but co-amorphic forms were obtained. The obtained forms exhibit stronger antioxidant properties compared to crystalline curcumin.

THIAZOLE COMPOUNDS AS INHIBITORS OF PROTEIN TYROSINE PHOSPHATASE 1B (PTP1B): NEW PROSPECT IN THERAPY OF BREAST CANCER

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With increasing understanding of human metabolic pathways, more and more diseases are being associated with protein-tyrosine phosphatase (PTP1B) enzyme overexpression. Among these conditions, some of the more prominent examples include obesity, type 2 diabetes mellitus, as well as vast array of neurodegenerative diseases (such as Alzheimer's disease and Parkinson's disease) [1]. However, arguably the most promising application for the emerging therapeutic group of PTP1B inhibitors, is their implementation in chemotherapy – especially to prevent metastases and to counter the malignant types of breast cancer [2].

The presented work depicts synthesis and efficacy assessment of 17 new drug candidates acting as inhibitors of PTP1B. The activity of all newly developed compounds was compared with the performance of commercially available reference drug – non-competitive allosteric enzyme inhibitor (3(3,5Dibromo-4-hydroxy-benzoyl)--2-ethyl-benzofuran-6-sulfonicacid-(4-(thiazol-2-ylsulfamyl)-phenyl)-amide). The assessment of PTP1B inhibition efficacy of the drugs was conducted with spectrofluorometric method using Agilent BioTek Synergy H1 microplate reader. Analytical method was based on the measurement of enzymatic product, and based on the intrinsic ability of PTP1B to transform nonfluorescent substrate (6,8difluoro-4-methylumbelliferyl phosphate; DiFMUP) into fluorescent product (6,8difluoro4-methylumbelliferone; DiFMU). Measured concentration of the product was corresponding and proportional to the activity of enzyme.

Especially favourable results were observed for four new compounds, three of which were characterised with efficacies comparable to the commercial PTP1B inhibitor (IC50 = 3.234 ± 0.847 μM), while the most promising drug candidate far surpassed the reference and demonstrated six-fold increase of its efficacy (IC50 = 0.508 ± 0.154 μM).

Based on the presented favourable results, and taking into the account the previously outlined clinical significance of the therapeutic group of PTP1B inhibitors – herby demonstrated discovery could prove particularly important in shaping-up future pharmacotherapy of numerous grave diseases including the aggressive types breast cancer.

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P 4

ENHANCING TRANSDERMAL DRUG DELIVERY USING A ROTATING MAGNETIC FIELD: A COMPARATIVE STUDY ON VARIOUS ACTIVE PHARMACEUTICAL INGREDIENTS

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Transdermal drug delivery holds immense promise in modern medicine, offering a no-invasive route for administering medications and avoiding issues associated with oral ingestion or injections [1]. However, the skin's natural barrier, primarily composed of lipids like ceramides and cholesterol, poses a significant challenge to effective drug penetration [2]. This study delves into the innovative approach of utilizing a rotating magnetic field (RMF) to overcome these barriers and enhance transdermal drug delivery.

The research aimed to utilize a rotating magnetic field (RMF) to augment transdermal drug delivery, focusing on the permeability of active pharmaceutical ingredients (APIs) in simple ethanolic solutions. The study used 50 Hz RMF and different APIs such as ibuprofen (IBU), caffeine (CAFF), naproxen (NAP), ketoprofen (KETO), and paracetamol (PAR).

Through a comparative analysis involving various active pharmaceutical ingredients (APIs), the research reveals the substantial impact of RMF on permeability through the skin. Findings indicate that exposure to an RMF significantly augments the permeability of APIs such as ibuprofen, caffeine, naproxen, ketoprofen, and paracetamol. Notably, the degree of enhancement varies depending on the compound, with remarkable increases observed in permeability, as measured by cumulative mass determination after 24 hours of study.

Furthermore, the study demonstrates the consistent efficacy of RMF in reducing delay time across different pharmaceutical formulations. This highlights the versatility of RMF in overcoming transdermal barriers, thereby improving the efficiency and efficacy of drug delivery systems. Overall, the research underscores the promising role of RMF as a novel strategy for enhancing therapeutic outcomes across a diverse range of pharmaceutical agents and formulations.

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REVOLUTIONIZING TRANSDERMAL THERAPIES: ADVANCEMENTS IN ROTATING MAGNETIC FIELD-ASSISTED DRUG DELIVERY

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In the realm of pharmaceutical research, efforts to enhance transdermal drug delivery have spurred innovative strategies aimed at overcoming the skin's natural barrier. One such approach involves the utilization of electromagnetic fields to facilitate the movement of substances through the skin [1, 2]. Previous studies have explored the use of pulsed and constant electromagnetic fields, showcasing their potential to interact with the skin and improve transdermal delivery in a non-invasive and painless manner for patients [3, 4]. Notably, research indicates that pulsed electromagnetic fields have been effective in increasing the permeability of various substances, including 5-aminolevulinic acid [4], naltrexone [1], and dipeptide [2].

This study focuses on utilizing a rotating magnetic field (RMF) to enhance transdermal drug delivery, particularly examining the permeability of ibuprofen (IBU) from different formulations such as gel, cream, and patch. Results reveal a remarkable over-sevenfold increase in ibuprofen permeability when exposed to a 50 Hz RMF compared to control groups without RMF exposure. Additionally, RMF consistently reduces delay time across all semi-solid pharmaceutical formulations, underscoring its efficacy in overcoming transdermal barriers.

The findings of this study provide compelling evidence for the use of RMF in augmenting transdermal drug delivery. By investigating various active pharmaceutical ingredients (APIs) and formulations, the research highlights the significant impact of RMF on enhancing permeability through the skin. Notable increases in permeability are observed not only for ibuprofen but also for compounds such as caffeine, naproxen, ketoprofen, and paracetamol when subjected to RMF exposure.

Moreover, the study underscores the consistent effectiveness of RMF in reducing delay time across different pharmaceutical formulations. These results underscore the potential of RMF to overcome transdermal barriers and enhance the efficiency of drug delivery systems. With its versatile applications and promising outcomes, RMF emerges as a transformative tool in revolutionizing transdermal therapies and improving therapeutic outcomes across a broad spectrum of pharmaceutical agents and formulations.

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TROPINONE-THIAZOLE DERIVATIVES AS ANTICANCER AGENTS

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Tropinone, a typical component of the Solanaceae and Convolvulaceae families, containing the tropane core, is a key intermediate in the synthesis of many alkaloids [1]. Although alkaloids containing a unique tropane core are used on a large scale as anticholinergic drugs in the treatment of neuromuscular disorders, Parkinson's disease, and in poisoning with nerve agents, their antitumor activity has not been widely studied, especially when it comes to tropinone derivatives [2]. Currently, in the literature, we can find only few examples of research on tropinone derivatives as anticancer drugs [3, 4]. In the present study a new series of hybrid compounds containing tropinone and thiazole rings was designed and synthesized as potential anticancer agents. Compounds 3a–3h show high anticancer activity against MDA-MB-231 and B16-F10 cell lines with IC50 values of 1.51–3.03 μM. Moreover, the cytotoxic activity of the investigated compounds against HSF and CCD-18Co cells was 8–70 times lower than against the cancer cells or no toxicity was shown in our tests, with derivative 3a being particularly successful. The mechanism of action of compound 3a in RPMI 8226 cell was shown to be through induction of cell death through apoptosis. The derivatives show ability to inhibit the tyrosinase activity with a mixed mechanism of inhibition. The final molecular docking results showed for IC50 distinct correlation with experiment.

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SPIRO-CYCLOALKYL 2-AMINOTHIAZOL-4(5*H*)-ONE DERIVATIVES AS SELECTIVE 11B-HSD1 INHIBITORS

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Glucocorticoids belong to the group of steroid hormones produced by the adrenal cortex and they are necessary for the proper maintenance of metabolic (including lipid and carbohydrate metabolism) and homeostatic functions of the human body. Glucocorticoid secretion is regulated peripherally by the hypothalamic--pituitary-adrenal (HPA) axis in a double feedback fashion, but also at the tissue level by 11β-hydroxysteroid dehydrogenase type 1 (11β-HSD1) and type 2 (11β-HSD2). 11β-HSD1 is an enzyme that catalyzes the intracellular conversion of biologically inactive cortisone into biologically active cortisol, while 11β-HSD2 catalyzes the reverse reaction. Excess glucocorticoids disrupt the body's metabolic management, which leads to the development of metabolic disorders such as abdominal obesity, insulin resistance or dyslipidemia. The disorders in regulation of the activity of 11β-HSD1, especially that located in visceral adipose tissue, is the pathogenetic basis of diseases such as obesity or type 2 diabetes, which are related and constitute important components of the metabolic syndrome. Therefore, inhibition of 11β-HSD1 represents a promising therapeutic concept for the treatment of diseases associated with metabolic syndrome. Currently, there is significant activity in the academic and pharmaceutical communities towards exploring the role of this enzyme in the pathogenesis of the metabolic syndrome and discovering new chemical compounds as specific 11β-HSD1 inhibitors.

Among the many different groups of organic compounds tested in recent years for the inhibition of 11β-HSD1, 2-aminothiazol-4(5*H*)-one derivatives deserve attention. High inhibitory activity is characterized, among others, by compounds containing the *spiro* rings system of thiazolone and cyclohexane. A number of *spiro*-cyclohexyl- 2-aminothiazol-4(5*H*)-one derivatives with different substituents (methyl, allyl, isopropyl, t-butyl, adamantyl, cyclohexyl, cyclopentyl) in the amino group were synthesized and tested towards 11β-HSD1 activity inhibition. Many of them are characterized by high inhibitory activity, comparable to carbenoxolone, and higher selectivity. The percentage of 11β-HSD1 inhibition at a inhibitor's concentration of 10 μM ranges from 48 to 94% and IC50 up to 40 nM.

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INFLUENCE OF SKIN HYDRATION ON THE PERMEATION OF A MODEL DRUG

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Ex vivo studies using human skin as a permeation membrane is a good approach of *in vivo* percutaneous studies [1]. Nevertheless, the availability of human skin requires approval from ethical committees, which varies depending on the country, and in some cases, involves a high economic cost. The use of skin that closely resembles human skin, and predicts well in humans, represents a tool of great interest for the pharmaceutical and cosmetic industries when developing formulations for skin application. The objective of this study was to investigate the cutaneous permeability of a model compound (KTP) with suitable physicochemical properties (log P octanol/water = 3.12 [2]; MW = 254.28 g/mol) in two types of membranes: porcine skin (which exhibits significant similarity to human skin) [3] and human skin, under two conditions: non-hydrated and hydrated. The main results are shown in table 1.

Table 1. Median (range) of permeated amount at 24 h, steady-state flux, permeability coefficient and amount retained in the skin, in hydrated skin

Hydrated skin	Q_{24} (µg)	J_{ss} (µg/h/cm2)	Kp.103 (cm/h)	Skin retained (µg/g)
Porcine	27.69* (25.03–35.63)	1.91* (1.87–2.16)	11.11* (9.62–17.45)	122.30 (117.01–136.13)
Human	165.73 (159.33–173.87)	5.11 (5.02–5.14)	25.20 (24.73–25.33)	122.98 (27.36–126.15)

*p<0.05 (Kruscal-Wallis One-Way ANOVA on Ranks)

The porcine skin (flank) is less permeable than human skin. These differences are accentuated when considering hydrated skin (human skin 2.27 times higher in terms of Kp).

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EFFECT OF RESVERATROL ON MACROPHAGE AND FIBROBLAST VIABILITY – *IN VITRO* STUDIES

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Introduction: Resveratrol is a plant-derived polyphenol that has received much attention in recent years. Previous studies have shown that resveratrol has high bioactivity, with anti-cancer, anti-obesity and neuroprotective effects. Positive effects of resveratrol have also been shown in skin wound healing, scarring and photoaging [1]. It has also been shown that the anti-aging mechanisms of resveratrol mainly involve regulation of cell viability, proliferation and migration, regulation of oxidative stress, and improvement of mitochondrial function and mitigation of inflammatory processes [2].

Aim: The aim of this study was to evaluate the effects of different concentrations of resveratrol on the adhesion/viability of macrophages and fibroblasts under *in vitro* culture conditions.

Materials and Methods: Two cell lines were used for the study: macrophages RAW 264.7 (ATCC, USA) and fibroblasts L-929 (ATCC, USA). Cells at $1x10^4$/ml were cultured in 24-well plates with different concentrations of resveratrol per ml of medium: 2 mg of resveratrol (R2 group), 6 mg (R6 group), or 10 mg (R10 group). The control group consisted of cells cultured in culture medium without resveratrol (CTR group). The cells were cultured in an incubator at 37°C and in an atmosphere of 5% CO2. On days 3 and 7 of culture, the adhesion/viability of macrophages and fibroblasts was assessed using a colorimetric assay with crystal violet (CV).

Results: On day 3 of culture, regardless of the dose of resveratrol used, there was a statistically significant decrease in macrophage adhesion/viability (R2 group, R6 group and R10 group) compared to the control group (CTR group). Further 7-day culture of macrophages in the presence of resveratrol resulted in an increase in cell adhesion/viability, but only in the group of cells grown with 2 mg of resveratrol (R2 group). In the case of fibroblasts, there was an increase in the adhesion/viability of cells cultured with 6 mg of resveratrol (R6 group) on both days 3 and 7 of culture, and a decrease in fibroblast adhesion on day 7 of culture, in the group of cells cultured with 2 mg of resveratrol (R2 group) compared to the control (CTR).

Conclusions: The level of cell adhesion/viability depends on the type of cell line, the dose of resveratrol and the time of cell culture.

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TOPICAL FORMULATIONS FOR ATOPIC DERMATISIS

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Atopic dermatitis (AD) is a chronic inflammatory skin disease characterized by bothersome itching and eczematous lesions [1]. It manifests as dryness and redness of the skin, mainly in areas of flexion, such as under the knees and in the groin. The disease follows cyclic periods of aggravation and remission, with the possibility of episodic recurrences. Treatment often requires periodic breaks [1, 2].

Various forms of cosmetics are used to eliminate the symptoms of AD. The most popular are creams, lotions and gels, which work fastest on local skin lesions. They contain ceramides, hyaluronic acid, vitamin E, glycerin and allantoin, which relieve itching and moisturize the skin [2]. For medical products, lotions, foams and emulsions are often used. Medicinal preparations are mainly pills and capsules, which promote healing. They can also come in the form of foams, ointments and creams, containing active ingredients such as levocetirizine, betamethasone, calcipotriol and corticosteroid. In addition, special silk garments are being created for people with AD to improve the condition of the skin [2, 3].

Above all, atopic skin requires adequate hydration and reduction of inflammation, with a noticeable dry epidermis. In this regard, the plant *Kalanchoe Daigremontiana* can be used in preparations. It is characterized by high anti-inflammatory and antioxidant activity. It contains flavonoids and polyphenols in its chemical structure. In addition, it is quickly absorbed and leaves the skin nourished [4].

The aim of this paper was to analyze the market for a variety of cosmetics, medical devices and drugs for the prevention of atopic dermatitis, guided by the appropriate choice of product form, composition, active ingredients and exact purpose.

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EMULGELS WITH *BOSWELLIA* SPECIES AS TOPICAL FORMULATION DESIGNED FOR POST-RADIOTHERAPY SKIN CARE

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It is estimated that even 95% of patients subjected to radiation treatment experience radiodermatitis including: erythema, dry and moist desquamation. Observed post-radiation skin reactions and their complications have a severe impact on a patient's organism, and may cause countless complications including treatment delay, lowering of the quality of life (physical and psychological pain) or esthetic effects. The use of herbal extracts as the source of antioxidant substances capable of neutralizing free radicals and providing protection from ionizing radiation appears to be an alternative therapy for radiodermatitis. Due to presence of boswelic acid one of the most promising herb is *Boswellia*.

In order to assess the applicability of emulgels as oncocosmetics, their stability, physicochemical properties, rheological properties and antioxidant capacity were determined.

Obtained emulgels exhibited desirable physicochemical properties, stability, and pH. They were non-Newtonian fluids, diluted through shearing with yield stress. Sensory analysis confirmed consistency suitable for sensitive skin, good spreadability, and quick absorption. The most promising preparation was the emulgel containing the Soxhlet extract and essential oil (Em_SO), due to its high antioxidant properties compared to other preparations (% inhibition of 11.69) and polyphenol content (3.63 mg/dm^3). Additionally, probands positively assessed all its features, including consistency (4.00), absorption (4.43) and hydration (4.71).

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SELECTED PLANT EXTRACTS OF THE LAMIACEAE FAMILY AS A SOURCE OF ANTI-ACNE ACTIVE MOLECULES

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Skin changes in the form of acne vulgaris are one of the most common skin diseases among people during teenage years. The active ingredients of plants have the ability to reduce acne lesions and the accompanying redness of the skin. Acne-supporting cosmetics, which can be found on drugstore shelves, extremely often contain natural plant extracts. These raw materials, as additives to cosmetic products, act synergistically with therapeutic agents, and additionally support the care of acne-prone skin [1]. The supportive effect of plant extracts in the treatment of acne-prone skin is related to their high content of natural biologically active substances, which, when in contact with the skin, carry a lower risk of irritation and side effects [2, 3]. There is a huge variety of plants that contain plant metabolites that show beneficial effects on acne reduction: saponins, mucilages, flavonoids, tannins and terpene compounds. All these groups of compounds are important in the cleansing and regeneration of acne-affected skin [4].

In this paper, a comparative study of the antioxidant activity of selected extracts from the Lamiaceae family was carried out using methods with the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical, FRAP (Ferric Reducing Antioxidant Power) and with the ABTS (2,2'-azobis(3-ethylbenzothiazoline-6-sulfonate) cation radical and chelating properties. The Folin-Ciocalteu method was used to determine the total flavonoid content. In addition, the ability of the extracts to inhibit tyrosinase, collagenase and elastase was tested, and microbiological activity against selected strains of bacteria responsible for the formation of papules, pimples and reddened inflammation was determined, as well as the cytotoxicity of selected extracts.

The results of the study confirmed that, due to their significant activity, the studied extracts of the Lamiaceae plant can find application, as active substances in cosmetics for acne-prone skin, as well as support the treatment of skin lesions that acne causes.

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THE COSMETIC POTENTIAL OF KOMBUCHA – ANTIOXIDANT ACTIVITY AND *EX VIVO* SKIN PERMEATION STUDY

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Over recent years, there has been a growing interest in cosmetic preparations whose recipes are based on natural raw materials. Kombucha, thanks to its health-promoting properties, seems to be an interesting active ingredient in cosmetics. Kombucha is a non-alcoholic fermented tea-based drink originating from East Asia. These beverages are the source of many biologically active compounds, including: organic acids, vitamins, minerals, amino acids and polyphenolic compounds. Polyphenols are one of the largest groups of antioxidants of plant origin, which can be a valuable active ingredient of cosmetics.

The aim of the study was to assess the antioxidant potential and total polyphenol content (TPC) in two types of kombucha – prepared from black tea (BK) and green tea (GK). The content of selected phenolic acids and caffeine in both types of kombucha was examined using HPLC. The ability of the identified compounds to accumulate and permeate through pig skin was tested using a Franz diffusion cell.

GK was characterized by higher antioxidant activity assessed by the ABTS and FRAP methods than BK. TPC and antioxidant potential assessed using the DPPH method did not differ statistically significantly between the tested kombuchas. Both types of kombucha were characterized by high content of caffeine, gallic acid, and caffeic acid. BK had a higher content of these compounds. These compounds had the ability to permeate and accumulate in the skin. Caffeine from BK permeated and accumulated in the skin in higher concentrations than from GK. The ability to accumulate gallic acid in the skin in the case of both kombuchas did not differ statistically significantly, however, a higher concentration of this compound was found in the acceptor fluid after BK permeation. A higher accumulation of caffeic acid in the skin was observed in the case of GK, however, no statistically significant differences in the permeation of this compound through the skin were found between GK and BK.

The *in vitro* analyzes of antioxidant potential and *ex vivo* skin permeation study confirm the cosmetic potential of kombucha. However, the use of kombucha in a specific cosmetic preparation should be preceded by an in-depth analysis in terms of the expected cosmetic effects., because other ingredients in the preparation, such as vehicles, excipients or other active ingredients, may significantly affect on its action, release, and ability to permeate and accumulate in the skin.

THE ANTI-INFLAMMATORY, ANTI-AGING AND WOUND HEALING PROPERTIES AND POSSIBLE USE ON THE SKIN OF HYDROGELS CONTAINING *EPILOBIUM ANGUSTIFOLIUM* L. EXTRACTS

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Nowadays, there is growing interest in the search for novel, effective, and safe dermatological preparations containing active ingredients with multiple effects. One of the potential sources of biologically active substances used in the treatment of various skin diseases are plants. *Epilobium angustifolium* L. is an ethnomedicinal plant known as a medicinal plant in many regions of the world, among others, in various skin diseases. Despite the great interest in this plant, there are still few reports of biological activity of ready-made dermatological or cosmetical preparations containing the *E. angustifolium* extracts. In this study, an attempt to evaluate the possibility of using this plant in preparations for the care of skin was made. The hydrogels (HEa) were made based on plant dry extracts prepared using three solvents: 70% (v/v) ethanol, 70% (v/v) isopropanol and water. The anti-ageing and anti-inflammatory properties, wound healing and skin permeation of topical hydrogels containing *E. angustifolium* extracts was assessed. In *E. angustifolium* extracts The following phenolic acids were found: gallic acid; 3,4-dihydroxybenzoic acid; 3-hydroxybenzoic acid and 4-hydroxybenzoic acid. All the HEas showed a reduction in the activity of lipoxygenase enzymes, proteases, and inhibition of protein denaturation. Additionally, in vitro penetration studies were performed using the Franz diffusion cells. All *E. angustifolium* extracts incorporated in hydrogels permeated the pigskin into the acceptor phase solutions. These studies showed that the active ingredients contained in *E. angustifolium* penetrate through human skin and accumulate in it. This plant may be an interesting plant material to be applied as a component of cosmetic and dermatological preparations with anti-aging and anti-inflammatory properties.

EFFECT OF MASSAGE IN COMBINATION WITH WHEAT GERM OIL ON SELECTED SKIN INDICES

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Introduction: Skin ageing is a natural process involving a decrease in the biological activity of cells and a slowdown in the regenerative processes in each layer of the skin. Among the most commonly recommended anti-ageing treatments are various types of massage. The additional use of lipid substances during a massage can improve the function of the skin's protective hydrolipidic film.

Aim: The purpose of this study was to evaluate the simultaneous effects of dermostimulating massage and wheat germ oil on microcirculation, transepidermal water loss, firmness and elasticity of facial skin.

Material and methods: the study was carried out on a group of 30 women aged 21–24 years, who, in a subjective evaluation, struggled with dryness and lack of elasticity of facial skin. The study women were randomly assigned to three groups: group M (massage treatment), group O (evening 3-day facial skin care with wheat germ oil), group MO (massage treatment combined with wheat germ oil). The following were measured: skin temperature (T), transepidermal water loss (TEWL), skin viscoelasticity (R0-firmness and R2-elasticity). The control was the measurement of skin indices before the treatments.

Results: Compared to the state of the skin before the treatments, there was an increase in facial skin temperature in the M and MO groups, and an increase in the TEWL index in the O group. A decrease in the firmness index (R0) and an increase in the elasticity index (R2) of the skin were observed in all groups (M, O, MO) compared to the pre-treatment control. Massage combined with wheat germ oil (MO group) was shown to result in an increase in facial skin temperature, compared to the group that received massage (M group) or applied oil to the skin (O group). There was also an increase in transepidermal water loss in the MO group, compared to the group that received massage (M group). There were no differences in skin firmness between the study groups, but there was an increase in skin elasticity in the MO group compared to the M and O groups.

Conclusion: regular repetition of massage treatment with wheat germ oil has a beneficial effect on skin indices relevant to the prevention of facial skin aging.

EXTRACTION AND CHARACTERIZATION OF FISH COLLAGEN HYDROGEL FROM NORTHERN PIKE (*ESOX LUCIUS*) WITH POTENTIAL APPLICATION IN SKIN WOUND HEALING

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Many different raw materials can be used for wound dressing biomaterials manufacturing, including collagen. In all animals, collagen is the most abundant protein and it is responsible for the structural integrity of many tissues [1]. Collagen obtained from fish is required from some religious and ethnic groups, thus indirectly increasing demands for fish collagen for biomedical applications.

Hydrogel materials have become ideal in wound biomaterial research due to their high water content, good biocompatibility, and physico-chemical properties. Compared to traditional dressings such as gauze, hydrogel dressings can provide a moist environment for wound healing. By loading active substances and modifying the composition and structure of hydrogels, hydrogel dressings can be endowed with excellent tissue adhesion functions, antibacterial and antioxidant properties, and modulation of inflammatory factor expression; thus, they have a promising future in dressing applications [2].

In this context, the aim of this study was to obtain and characterize fish collagen hydrogels from Northern Pike (*Esox Lucius*). The fish collagen hydrogels were obtain by a serial of process that included acid treatments for removing flesh, scales; alkaline treatment to remove non-collagen proteins; alcohol treatment for fat removal. The characterization was made by physical-chemical measurements (determination of dry matter content; determination of ash content; determination of total nitrogen content; determination of the protein substance; determination of pH), dicroism circular and FT-IR analysis. Further tests will be performed to demonstrate the wound healing potential of hydrogels.

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OPTIMIZATION OF EXTRACTION CONDITIONS OF TOTAL PHENOL COMPOUNDS AND ANTIOXIDANT ACTIVITY IN THE APPLE POMACE

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Recently, the consumption of fruit and vegetables as juices and smoothies is increasing [1]. This process is associated with the formation of pomace. The recycling of pomace is a significant problem in food processing [2]. Due to the fact that an apple pomace are a source of many valuable phenolic compounds, which have antioxidant, antibacterial, antiviral, anti-inflammatory, antiallergic and anticancer properties, the popularity of their use in many industries is growing [3–4]. The concentration of polyphenols in the apple pomace is influenced by many factors, e.g. genetic, environmental and technological [5]. Extraction process is the most important step in the production of bioactive compounds from plant material and by-products [6]. The aim of this study was to select the most optimal conditions for the ultrasound assisted extraction of total phenolic compounds and antioxidant activity of the apple pomace. The process of the extraction were optimized with mathematical methods of experiment planning (Statistica R ver. 13, StatSoft, Poland). In order to obtain extracts using the statistical method of experimental design (DOE), the central-composition design $3^{(K-p)}$ was used, where p always takes the value 1 and K is the number of variables. In all cases, the statistical significance level was assumed to be $p < 0.05$. The group of input (independent variables) parameters included: temperature, and extraction time, concentration of solvent, ratio of mass raw material to solvent, whereas the output (dependent variables) were: total content of phenol compounds, and the antioxidant activity of the extracts. The total phenolic content was determined according to the Folin–Ciocalteau method, and the antioxidant activity was determined using DPPH method.

The ranges of the variability of the process input variables are listed in Table 1.

Table 1. The variability ranges of independent parameters

Independent variable	The ranges of variability
Temperature [°C]	25, 35, 45
Extraction time [min]	30, 60, 90
Concentration of solvent [%]	50, 75, 100
Raw material/solvent ratio [g]	2, 5, 8

The comparison of the results obtained in twenty eight various variants of the experiment can the assumption that the most effective parameters of the apple pomace extraction process are: temperature 45°C, extraction time 90 minutes, 50% concentration of ethanol, and the ratio of raw material/solvent equal to 8 g.

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ALKYL POLYGLUCOSIDES AS A MEDIUM IN MICELLAR-MEDIATED EXTRACTION FROM *O. BASILICUM* – EXPERIMENTAL AND THEORETICAL RESEARCH

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Micellar-mediated extraction methods, based on green chemistry principles, appear to be an interesting alternative for extracting cosmetic raw materials, compared to classical extraction with organic solvents. *Ocimum basilicum L.* is widely used throughout the world. It contains essential oil and many compounds with antioxidant, antimicrobial, anti-inflammatory, and anticancer properties. For this reason, basil can be used as a raw material in the cosmetic industry [1–5].

In the present study, micellar extracts of *Ocimum basilicum L.* were obtained using aqueous solutions of alkyl polyglucosides (APGs) with different carbon chain lengths, i.e. capryl glucoside, lauryl glucoside, and cocoyl glucoside. Extraction was assisted by ultrasounds (UAE). Extracts properties, such as antioxidant activity, total phenolic, and flavonoid contents, were measured using spectrophotometric and chromatographic methods.

Generally, the determined concentration of antioxidants was higher for extracts obtained in the ultrasounds field. The total content of polyphenols and flavonoids was the greatest when the coconut glucoside was used. However, the extracts obtained with caprylic/caprylic glucoside provided optimal antioxidant properties.

Alkyl polyglucosides can be successfully used to obtain plant extracts. APG micelles improve the efficiency of the extraction process. They are non-ionic, biodegradable surfactants that are safe and mild to the skin, so these extracts can find a wide range of cosmetic applications.

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COSMETIC COMPOSITIONS CONTAINING NATURAL SAPONIN DERIVATIVES

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The skin is the largest organ of the human body. Its diseases often constitute not only a health or aesthetic problem but also a social one, making interpersonal contact difficult. Dermocosmetics are products designed to support problematic skin conditions, rather than cure. They function as a supportive treatment alongside pharmacological therapy, by offering a range of soothing, antioxidant, and anti-inflammatory ingredients in the form of gels, creams, or ointments. These ingredients can alleviate a range of undesirable symptoms, improving skin hydration and reducing inflammation. The search for new active ingredients for use in preparations that soothe skin lesions is a current global research trend. Many cosmetic firms are interested in natural saponins or their aglycons. Compositions containing diosgenin and dioscin have been demonstrated to stimulate collagen synthesis, inhibit collagenase activity, enhance fibroblast proliferation, and enhance skin elasticity without inducing skin irritation [1] or protecting the skin from intrinsic ageing [2]. From our library of natural compounds, we selected diosgenin and tigogenin derivatives that exhibit no toxic effects on normal cells. These compounds have been observed to stimulate the expression of anti-inflammatory cytokines or exhibit antioxidant activity [3, 4]. Subsequently, a multigram scale laboratory technology was developed for selected compounds. Our approach, which eliminates unfavourable chromatographic purification processes and reduces the number of single extractions, resulted in the obtaining of pure active natural saponin derivatives for cosmetic compositions. Further formulation studies indicated that the use of a well-defined single synthetic derivative of natural origin as the active ingredient could enhance the effectiveness of a model dermocosmetic composition.

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ANTIOXIDANT BIOPOLYMER FILMS WITH RESVERATROL AND SYRINGIC ACID FOR POTENTIAL SKIN APPLICATIONS

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The grape (*Vitis vinifera* L.) is one of the oldest crop plants and is widely used in many industries. The food industry accounts for the largest share of the use of grapes and grape-derived products. Both wine and fresh grape fruits are products that are exported and imported worldwide in the millions of tonnes [1]. Grapes and wine are used in cosmetology in many skin care treatments and the raw materials extracted from the different parts of this plant are rich in substances with antioxidant, antimicrobial, and anti-inflammatory activity and are therefore the basis of many cosmetic formulations [2, 3]. In addition, grape extract or individual compounds from this plant are of increasing importance in medicine and pharmacy due to their hepatoprotective, cardioprotective, neuroprotective, and anticancer properties [2, 4].

Resveratrol is a polyphenolic compound, a stilbene derivative, one of the most abundant compounds found in grapes, mainly in their peels. This natural compound has high therapeutic and preventive potential due to its antioxidant, anticancer and anti-inflammatory activities [5]. Resveratrol is also a whitening ingredient due to its activity as a tyrosinase inhibitor [2]. The use of this compound is limited by its poor water solubility and high UV sensitivity. Another valuable component with antioxidant potential is syringic acid, a derivative of gallic acid [6]. This acid is formed, among other things, by the degradation of the 3-O-glucoside of malvidin present in young red wine.

In medicine and cosmetology, new solutions and formulations are being sought to respond to current needs and problems. In recent decades, there has been a growing interest in biopolymers, which can be used, among others, in skin applications. A matrix based on natural polymers has several advantages: biodegradability, biocompatibility, non-toxicity.

This study proposes the preparation of biopolymer films for topical skin applications with the addition of active substances occurring directly or indirectly in the grapevine, namely resveratrol and syringic acid. These compounds were chosen for the research because of their high antioxidant potential. Two concentrations of each compound were used and the synergistic effect of these substances was evaluated. A blend of chitosan and glucomannan was used as a polymer matrice. The obtained films were characterized in terms of physicochemical, antioxidant, and surface properties, as well as swelling and degradation analysis was performed.

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LIPID-BASED NANOSYSTEMS AS CARRIERS INCREASING THE POTENTIAL OF POLYPHENOLS IN NUTRITIONAL THERAPY

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The aim of the study was to obtain stable systems of lipid-based nanocarriers (SLN, NLC, HA-NLC, liposomes) with a selected polyphenol – quercetin as an active ingredient showing potential activity in nutritional therapy.

Lipid-based nanosystems were obtained by ultrasonification technique (HPH). The stability was assessed by macro- and microscopic observation and viscosity measurements. The physicochemical properties of both incorporated and non-incorporated carriers were examined. In vitro release studies of quercetin (QC) were performed at the 37°C, using cellulose membrane and the mixture of PBS/ethanol as a receptor solution. The concentration of the actives in the receptor medium was analyzed by UV-Vis (Marcherey-Nagel).

Release study of quercetin from optimal lipid-based nanocarriers indicated its prolonged and controlled release profile. On this basis, a mathematical model that best describes the kinetics of the active substance release from the tested carriers were fitted.

The conducted research gave promising results allowing to conclude that the obtained lipid-based nanosystems may be a potential carrier of quercetin which possess the therapeutic effect in nutritional therapy.

CHARACTERIZATION OF COSMETIC FORMULATIONS BASED ON CHITOSAN AND ITS DERIVATIVES

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Biopolymers are extensively utilized in the cosmetic industry as raw materials and exhibit significant potential for biomedical applications due to their natural origin, controlled bioactivity, biocompatibility, antibacterial, antifungal properties, and film-forming ability [1–3]. Among the wide array of biopolymers, polysaccharides such as hyaluronic acid, cellulose derivatives, and chitosan are extensively employed in cosmetic preparations. Chitosan, a cationic polysaccharide derived from partial deacetylation of chitin in an alkaline medium holds particular prominence.

When chitosan and its derivatives are combined with active ingredients such as flavonoids, phenolic acids, vitamins, antioxidants, antibacterial agents, and other biologically active compounds, it becomes feasible to create materials with tailored properties [3, 4]. This includes enhancing processability to produce innovative gels, films, emulsions, and other formulations suitable for cosmetic products.

In this study, we characterized cosmetic formulations comprising chitosan or carboxymethyl chitosan along with varying additions of aloe extract and hyaluronic acid. The cosmetic formulations were assessed for their rheological, sensory, and application properties using a corneometer. Analysis of the results obtained indicates that the appropriate addition of polymers and extracts, along with the homogenization conditions of the emulsion, influence the increase in emulsion viscosity. Furthermore, the inclusion of aloe and hyaluronic acid noticeably affects the level of hydration and the sensory evaluation of the emulsion. All formulated emulsions demonstrated stability, maintaining uniformity.

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MORPHOLOGY AND SURFACE PROPERTIES OF CHITOSAN FILMS MODIFIED USING CAFFEIC ACID, B-CHITIN DISPERSION AND A NEUTRALIZATION PROCESS

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Chitin, recognized as the second most abundant polysaccharide in nature following cellulose, boasts an estimated annual production ranging from approximately 10^{10} to 10^{11} tons [1–2]. It is predominantly present in the exoskeletons of crustaceans and insects, as well as in the cell walls of certain fungi and microorganisms. Given its ubiquity and renewable nature, chitin holds significant importance as a resource. It bears the potential to substantially contribute to the advancement of sustainable processing methods for bioactive and biodegradable materials. However, despite its abundance, chitin's intrinsic insolubility poses challenges for subsequent processing.

The properties of chitin can be altered through appropriate processing techniques. Chitosan, the foremost derivative of chitin, is obtained through the chemical treatment of chitin. It exhibits considerably improved solubility compared to chitin, albeit at the expense of its mechanical and thermal properties [3, 4]. Consequently, chitosan is frequently subjected to further modifications, or complex systems are derived from it, wherein various types of additives such as organic compounds, inorganic compounds, or nanoparticles are dispersed within the polymer matrix [2, 3, 5].

The study presented herein will focus on elucidating the rheological properties of chitosan composites incorporating a water dispersion of α-chitin and a solution of caffeic acid. Additionally, as part of this investigation, composite films were prepared and subjected to characterization through infrared analysis, AFM microscopic tests, and swelling tests. The results obtained indicate notable alterations in the morphology and roughness of the resulting films upon the introduction of chitin whiskers into the chitosan matrix in the form of a water dispersion. Furthermore, these modifications extend to the swelling properties of the tested systems. Consequently, the materials characterized in this study hold promise for potential applications in both cosmetic and biomedical fields.

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P 24

PREFORMULATION STUDIES OF INSULIN HYDROGELS BASED ON POLOXAMER AND POLOXAMER/CHITOSAN FOR TOPICAL APPLICATION

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Introduction: Insulin (INS) is a hormone that regulates blood glucose and lipid concentrations. Recent studies confirm its high therapeutic potential in the treatment of dermatological diseases, with a low risk of systemic adverse effects. It regulates inflammatory processes in the skin and promotes wound healing. It stimulates the growth of M2 macrophages and increases IL-10 levels. It stimulates the proliferation of endothelial cells, keratinocytes, and fibroblasts via the PI3K-Akt-Rac1 pathway. It influences collagen maturation processes, and granulation tissue formation [1, 2]. It plays an important role in every stage of wound healing, although the mechanism of its action within the lesional skin is not known. The aim of our study was to develop a hydrogel preparation containing insulin for topical application. To our knowledge, there is currently no ready-made semi-solid insulin preparation in the pharmacy market.

Methods: Hydrogel matrices were prepared based on Poloxamer 407 (PLX) and Poloxamer 407 with chitosan (CHI). The concentration of insulin (Insulatard®Penfill®) in the polymer matrix was 1 mg/g hydrogel. The pharmaceutical availability of insulin was assessed in vitro. An ERWEKA DT 600 paddle apparatus (Husenstamm, Germany) was used. The diffusion capacity of INS from the substrate was assessed using the Strat-M® membrane, which provides a high correlation with human skin. The rheological parameters of the formulations developed (PLX/INS-F1; PLX/CHI/INS-F2) were investigated using a Lamy RM 200 Touch laboratory rheometer (Lamy Rheology Instruments, Champagne au Mont d'Or, France).

Results: After a time of 10.5 h, 23.5% of insulin was released from hydrogel F1, whereas 21.5% was released from hydrogel F2. Insulin release from both formulations occurred in a prolonged manner, providing a prolonged effect of the hormone over time. Rheological studies confirmed that the hydrogels have the character of non-Newtonian shear-thinning fluids with a flow limit and exhibit thixotropy.

Conclusions: The proposed hydrogel formulations of insulin show good application properties. The amounts of released hormone from the F1 and F2 formulations are consistent with literature reports on the bioavailability of protein-peptide substances after topical administration [3]. The developed hydrogels are a promising direction for insulin carrier development.

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INTERACTIONS OF SAPONINS AT THE WATER-AIR AND WATER-OIL INTERFACES WITH CHEMICAL COMPOUNDS AS DONORS OR ACCEPTORS OF HYDROGEN BONDS AND THEIR ROLE IN EMULSION STABILIZATION

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The aim of our research is to check the possibility of modulating the surface adsorption and emulsification properties of saponin by adding compounds that can combine with it in solution via hydrogen bonds or electrostatic interactions. The chemical compounds mentioned above include urea, thiourea, glycerol, choline chloride, betaine, and nicotinic acid. The tests are carried out in an emulsion system where the aqueous phase is the medium-chain triglyceride oil Miglyol 812N.

Saponin is a natural surfactant compound that readily undergoes biodegradation. Due to their properties, saponins find applications in various fields as surfactants or emulsifiers. Given the complexity of the chemical structure of these biosurfactant mixtures, they have become the subject of current research.

The impact of the aforementioned additives on saponin adsorption at the water-air and water-oil interfaces was investigated. Additionally, the long-term stability of the emulsions was examined. Building upon the studies presented in references [1–3], the correlation between the properties of adsorptive layers and the properties of corresponding emulsions was explored, with particular emphasis on how additives of selected chemical compounds affect the destabilization mechanisms of the resulting oil-in-water emulsions. The formed emulsions were analyzed from their inception and throughout their evolution.

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HEXOSOME DISPERSIONS WITH DIGLYCEROL BASED SURFACTANT AS LIPOPHILIC DRUG DELIVERY VEHICLES

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Hexagonal lyotropic liquid crystals (LLC) consist of nano-scaled hydrophilic and hydrophobic domains, which are separated by surfactant self-assembled nanostructures. Hexosomes are aqueous dispersions of reverse hexagonal liquid crystals, composed by amphiphiles such as glyceryl monooleate or phytantriol and stabilized by surfactants [1, 2]. In recent years, hexagonal liquid crystal-based formulations have been used to solubilize hydrophilic, lipophilic, and amphiphilic molecules, and to encapsulate biomolecules as proteins, peptides, DNAs, and siRNAs [3, 4]. In this work, hexosomes based on diglyceryl mono-isostearate [5], and stabilized by F127, were used as delivery vehicles for ketoprofen (KP), a model lipophilic drug. A reverse hexagonal liquid crystal formulation (C41V HII phase) containing KP was developed. C41V HII phase near its maximum swelling capacity (65% C41V) and hexosomes were used for the encapsulation of 0.5 wt% KP. The DLS analysis revealed that hexosomes showed an average size of 92.5 ± 2.5 nm and were stable for at least one month after preparation at room temperature. Drug release tests showed that KP release was faster from hexosomes (>90% released after 6 h), while a strong delay in drug release was observed from the hexagonal liquid crystal formulation (10–15% released after 6 h).

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FORMULATION OF LIQUID CRYSTAL EMULSION WITH RETINOL AND DIPOTASSIUM GLYCYRRHIZINATE FOR PSORIATIC SKIN – PROSPECTS AND POTENTIAL USE OF TRANSFEROSOMES AS NANOCARRIERS FOR ACTIVE INGRIDIENTS

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Psoriasis is a chronic hyperproliferative inflammatory disease that affects 2–3% of the population [1–3]. The liquid crystals formed in emulsion with suitable emulsifiers exhibit a molecular structure similar to lipid systems in the stratum corneum. That kind of emulsion reduces transepidermal water loss without solubilizing proteins and lipids naturally contained in the skin [4]. Psoriatic skin has a disrupted epidermal barrier, which exacerbates inflammation [5]. Interesting substances that could potentially benefit skin with psoriasis are glycyrrhizin and retinol [6, 7]. For the above reasons, skin care with liquid crystal emulsion containing retinol and dipotassium glycyrhizzinate may be recommended. Nanocarriers are used to maximize the effects of active ingredients. Transfersomes have appeared as promising nanosystems because of their deformability and unique characteristic [8].

The aim of the study was to produce a liquid crystal emulsion for skin with psoriasis. The goal was also to explore the potential and prospects of using transferosomes as nanocarriers for retinol and dipotassium glycyrrhizinate.

Based on the accepted principles of cosmetic formulation and using basic laboratory equipment, liquid crystal emulsion was developed. Hydrogenated lecithin, Cetearyl Olivate and Sorbitan Olivate (Olivem 1000) were responsible for the structure of the emulsion. For the attempts of transferosomes' production, lecithin, cholesterol, ethanol, water, and dipotassium glycyrrhizinate as an edge activator were used. They were made using the principles of the thin-film hydration method. The transferosomes were evaluated microscopically. Visible, spherical structures with a lipid bilayer were formed.

The produced transferosomes could be a potential carrier containing both retinol and dipotassium glycyrrhizinate. In such a combination, retinol will influence the regulation of keratinocyte hyperproliferation, while dipotassium glycyrrhizinate will alleviate inflammation and potentially reduce the irritating effects of retinol. The liquid crystal emulsion would influence the stabilization of these active substances, as well as improve the hydration and tightness of the skin barrier through its very structure.

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POSS-INDUCED SELF ORGANIZATION IN POLYURETHANE SCAFFOLDS

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As a result of the ease of their properties modification, polyurethane materials (PU) are increasingly being used as biomaterials in medicine. Their structure shows a tendency toward self-organization, resulting in phase separation that provides thermoplastic properties [1]. Scaffolds are used as drug delivery systems and in tissue engineering, mimicking the function of the body's natural tissues and promoting their regeneration. Their three-dimensional, porous structure provides suitable conditions for cell proliferation [2].

Aliphatic PU, synthesized from hexamethylene diisocyanate and poly(tetramethylene ether) glycol and 1,4-butanediol were modified by 1,2-propanediolisobutyl POSS as a pendant comonomer. In our previous proceedings, the obtained materials were characterized by lack of toxicity, biocompatibility, and osteoinductivity due to the self-organization of the POSS segments [1, 3].

To observe the influence of POSS self-organization on pore structure, we made scaffolds of materials containing 0% and 10% POSS using a porogen-leaching procedure. The dissolution of 10% by weight material was carried out at 100°C in dimethylsulfoxide (DMSO) for two hours, then small amounts of nonsolvent were added followed by NaCl in a grain size of 150–250 μm. After being cooled to 4 or 23°C, the porogen and solvent were leached with amounts of water to obtain the porous structure. The samples containing POSS showed increased pore wall porosity. The presence of additional smaller pores, rungs, and bridges of sizes between 200–800 nm, can result in better adhesion of hydroxyapatite and living tissue to the biomaterial surface [1].

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LAWSONE AS A PROMISING AGENT MODIFYING PROPERTIES OF CHITOSAN-BASED MATERIALS

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Chitosan with its wound healing, antimicrobial and antioxidant properties is commonly prepared in the form of films, scaffolds or gels to create novel material for tissue engineering, skin regeneration, wound dressing as well as skin and hair care products [1]. Its biodegradability, biocompatibility and susceptibility to modification made it a desirable biopolymer in pharmacy, agriculture or textile industry [2]. Following sustainable development, there is a growing interest in both the health and beauty aspects of chemistry science to use renewable, natural raw materials that can easily improve the properties of biopolymer products making them useful in biomedical or cosmetic applications. As some of quinone dyes, found in plants, possess antimicrobial and wound healing activity they can be promising agents modifying biopolymer materials properties. Among naphthoquinones, lawsone can be distinguished. This henna-derived pigment is characterized by antifungal and antibacterial activity. Henna belongs to *Lythraceae* family and has been used for ages for cosmetic and therapeutic purposes [3]. The acceleration of the wound healing process of henna extract was confirmed by numerous studies [4].

The study aimed to prepare and characterize chitosan films incorporated with lawsone. Chitosan was dissolved in acetic acid, and subsequently to appropriate amount of solution lawsone in two selected concentrations was applied. The solution casting method was used to obtain the films, for which FTIR spectra were registered and mechanical properties were investigated. Moreover, contact angle analysis, colorimetric measurements, and swelling analysis were performed. SEM and AFM images were collected. Prepared films were smooth and homogenous. It was observed that lawsone addition to chitosan films influenced their mechanical properties, samples were characterized by higher values of Young modulus, tensile strength, and elongation at break parameters. Modification of chitosan films resulted in a slight decrease in surface free energy and hydrophilicity of tested samples. However, the swelling degree was higher for lawsone enriched samples than for pure chitosan films and the disintegration of modified samples occurred faster. Films with additives presented increased surface roughness. The addition of lawsone also affected the color of the chitosan material. Chitosan and lawsone combination is a promising solution with a potential application in wound dressing and cosmetics.

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SYMBIOTIC MICROSPHERES FOR COSMETIC APPLICATION

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In recent years, the cosmetic industry has focused on skin microbiome friendly products. Apart from encapsulation process, using the combination of probiotic and prebiotics (symbiotic products) improves the survival of bacteria in unfavourable conditions of the cosmetic formulation [1]. Alginate microcapsules are biocompatible, biodegradable and non-toxic delivery systems for active substances, also for alive microorganisms [2–7].

The aim of the work was to obtain high-quality microspheres in the emulsification process and to assess the impact of encapsulation of *L. casei* bacteria on the viability of probiotic microorganisms in alginate-tapioca starch microspheres. Tapioca starch was used as a prebiotic substance. In order to optimize and obtain the most desired values, the statistical design of experiments (DOE) method was used for subsequent encapsulation of probiotic bacteria in optimal microspheres. Batches of microspheres were prepared using a $3^{(K-p)}$ fractional plan. The group of input parameters included: emulsifier, prebiotic and alginate concentrations, and the mass ratio of alginate to prebiotic. The statistical analysis was carried out based on one-way analysis of variance (ANOVA), approximation profiles and saddle plots were developed, and then the influence of the microparticle composition on the physicochemical properties and viability of probiotic bacteria during internship was examined.

The obtained results showed that the addition of a prebiotic and the coating of microcapsules with biopolymers significantly affect the survival and viability of the probiotic strain during long-term storage.

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PHYSICOCHEMICAL TESTS OF ARGAN OIL FROM VARIOUS SOURCES

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Vegetable oils play an important role in the food, pharmaceutical and cosmetic industries. They are not only a source of nutrients, but can also serve as a carrier of bioactive substances in creams, emulsions and other cosmetic preparations. Argan oil is a plant raw material obtained from the seeds of the argan tree (Argania spinosa), which is endemic and grows only in the southwestern part of Morocco. It has unique nutritional, regenerative and antioxidant properties. Argan oil is of interest to many consumers from various economic sectors (pharmaceutical, cosmetics and food). Due to its high demand and high price, it may be subject to many adulterations, e.g. using cheaper, more easily available oils. In order to quickly and easily assess its quality, it is necessary to know the full composition of argan oil, which is also determined by storage conditions, method of extraction and place of origin.

When checking oil quality, oil parameters such as acid value, peroxide value and iodine value are also assessed. Gas chromatography (GC) is standardly used to assess the fatty acid profile of argan oil. Another effective method for identifying the composition of argan oil is ^{1}H NMR.

The aim of the research was to determine the composition of argan oil, which is an indicator of the quality of the cosmetic raw material, using selected analytical methods.

Seven samples of cosmetic raw materials from various sources (Morocco) were selected for analysis. ^{1}H NMR was used to determine the profile of fatty acids (omega3:omega6), and these results were then correlated with those obtained from GC chromatography. The tocopherol content was also determined using HPLC.

The quality of argan oil was determined by the quantitative ratio of omega 3 to omega 6 acids and the content of tocopherols.

Argan oil is a unique pharmaceutical and cosmetic formula. We have shown that the composition of argan oil indicates health applications. ^{1}H NMR spectra quickly and effectively determines the authenticity of argan oil without the need for special sample preparation. The obtained results correlate well with the results obtained with the standardly used GC method.

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QUALITATIVE AND QUANTITATIVE ANALYSIS OF ANTI-AGING COSMETICS CONTAINING BAKUCHIOL

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Bakuchiol is an anti-aging and antioxidant compound rapidly gaining popularity in cosmetic formulations under name of 'phytoretinol' or 'plant-derived retinol'. Due to limited control of cosmetic (or 'cosmeceutical') products, the question of their quality is raised.

Four methods of both qualitative and quantitative analytical methods (UV-Vis and NMR spectroscopy, HPLC) were applied to examine declared bakuchiol content in five cosmetic samples varying in price and composition.

All methods were compared and found usable in such analysis with spectroscopic methods being the most promising for future applications as they provided convergent results with HPLC in shorter time of analysis.

Obtained results allow to conclude quality falsification in one sample and quantity falsification in the other.

COMPARATIVE STUDY OF DIFFERENT EXTRACTS OF LAVENDER AND LAVANDIN CULTIVARS USING HPLC-DAD AND ^{1}H NMR ANALYSIS

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Lavender (*Lavandula angustifolia* Mill.) and lavandin (*Lavandula* x *intermedia* Emeric ex Loisel.) are cultivated mainly for essential oil, but they also contain polyphenolic compounds. Their level in the plant extract depends on the species, cultivars and the extraction method.

The aim of this study was to compare the polyphenolic profile, antioxidant and anti-inflammatory activity of methanolic, aqueous and supercritical CO_2 extracts of lavender and lavandin cultivars. The inflorescences of 4 cultivars of lavender (Betty's Blue, Elizabeth, Hidcote, Blue Mountain White) and 3 cultivars of lavandin (Alba, Grosso, Gros Bleu) were used. Phytochemical profile was determined using high performance liquid chromatography with diode array detector (HPLC-DAD) and nuclear magnetic resonance (^{1}H NMR). DPPH free radical scavenging assay (DPPH-EPR) and ferric reducing antioxidant power assay (FRAP) were performed to measure the antioxidant activity of plant extracts. The anti-inflammatory activity (COX-2 inhibition) of the extracts was determined using the spectrofluorimetric method.

Polyphenols, including phenolic acids, flavonoids and coumarins were found in all extracts. HPLC analysis showed the presence of the caffeic acid, ferulic acid glucoside, rosmarinic acid, morin, coumarin and herniarin. Much higher content of coumarins was found in supercritical CO_2 extracts, while phenolic acids and flavonoids were observed in methanolic and aqueous extracts. Moreover, the content of phenolic acids and flavonoids was higher in lavender, while the content of coumarins was higher in lavandin in all types of extracts. Methanolic and aqueous extracts rich in polyphenolic compounds were found to show stronger antioxidant and anti-inflammatory activity than supercritical CO_2 extracts. The obtained results showed that the cultivar and the extraction method play a key role in the final bioactive constituents content and potential healing properties.

METABOLIC PROFILING AND NON-TARGET LC-MS/MS APPROACH TO ASSESS EXPOSURE TO SELECTED NATURAL AND SYNTHETIC PESTICIDES IN CEREALS

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The escalating utilization of artificial pesticides within agricultural sectors has elicited concerns regarding their environmental repercussions and detrimental impacts on non-target entities, notably affecting the physiological and metabolic effects of cereal crops – critical components of global food production [1]. Integrating allelopathy, a naturally occurring ecological phenomenon, into a comprehensive pest management strategy can substantially diminish the dependency on chemical pesticides. Allelopathy is considered a multi-dimensional phenomenon in which one organism produces biochemicals that influence the growth, survival, development, and reproduction of other organisms [2]. This investigation delves into the comparative analysis of natural alternatives of pesticides with allelopathic potential, namely umbelliferone and scopoletin, against synthetic pesticides, specifically tebuconazole and 2,4-D, focusing on their influence on the modulation of metabolic processes in wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*). Metabolomic profiling and fingerprinting techniques were used to assess the effects of both synthetic and natural compounds on metabolic processes, focusing particularly on the shikimate pathway. Pesticide and allelochemicals metabolites were identified using LC-HRMS, while a non-targeted analysis using LC-ESI-MS/MS in the ion trap scanning mode was used to compare the overall changes in the metabolism of the crops exposed during the 4-week growth period. PLS-DA models were developed to visualize differences in wheat and barley metabolic profiles induced by exposure to a pesticide or allelochemicals, based on the chromatographic and spectral data. The results provide evidence for the ability of allelopathic compounds to alter plant metabolism in a different way to conventional pesticides, with a clear distinction between the metabolic responses of wheat and barley induced by synthetic and natural pesticide treatments. This research augments the comprehension of plant metabolic dynamics in response to pesticide exposure and accentuates the potential of allelochemicals as sustainable alternatives to conventional pesticides, thereby advocating for environmentally benign agricultural practices that harmonize effective pest management with the imperatives of environmental preservation and food safety and consumers of health.

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DIETARY SUPPLEMENTS WITH PIPERINE AS A BIOENHANCER – SOLID STATE ANALYSIS USING SSNMR SUPPORTED BY THEORETICAL CALCULATIONS

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The primary alkaloid present in black pepper fruits is piperine. It promotes the absorption and bioavailability of other Active Pharmaceutical Ingredients (APIs). As a result, it can be used as an additive in solid forms of dietary supplements to increase bioavailability.

Solid-state forms are the most popular for both drugs and food supplements. Therefore, it is crucial to analyze the solid-state structure of pharmaceutical ingredients. The study focused on the solid state of piperine standard and solid dietary supplements with the addition of piperine as an absorption promoter.

The solid-state structure and conformation were obtained through ^{13}C CP MAS NMR analysis. Spectra were recorded using variable contact time and dipolar dephasing experiments. Additionally, cross-polarization kinetics parameters were analyzed. Our research enabled us to create a database of NMR parameters that can identify three polymorphic forms based on the analysis of ^{13}C CP MAS NMR spectra and theoretical calculations. We then used the ^{13}C CP MAS NMR technique to confirm the authenticity and presence of curcumin in dietary supplements containing curcumin, with the addition of piperine. The presence of piperine was confirmed even when its mass content was 70 times lower than that of curcumin. This method can be used to test the quality of dietary supplements that contain piperine as an absorption promoter.

SUSTAINABLE DEVELOPMENT IN THE DETERGENT INDUSTRY

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The sustainable development (SD) strategy in the detergent industry includes initiatives supporting the circular economy and reducing the environmental footprint of cleaning and laundry products, taking into account all phases of the product life cycle [1]. The goal of SD can be achieved by focusing not only on highly biodegradable raw materials, but also on the selection of appropriate packaging and the design of innovative forms of the detergent products. The concept of the detergent products concentration, as an element of sustainable development leads to environmentally friendly formulas, in smaller packages and with lower water content [2, 3]. As a result, it also remains consistent with the "water less" trend. The dynamic development of washing agents in the measured doses form, in packed in polyvinyl alcohol (-PVOH) foil [4] gives the possibility of rational use of the product, limiting the overdosing of the detergent. A review of the patent literature shows that among biodegradable materials PVOH film is an interesting alternative to plastics made of HEDP and PET [5–6]. The mechanical properties [7] and biodegradability of the PVOH film [8–10] make it possible to expand its use in the process of designing sustainable detergent products.

The presentation discusses the possibility of limiting the negative impact of detergents on the natural environment and reducing the amount of plastic introduced thanks to the concentration of detergent products and the use of PVOH film as a packaging material.

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AUTOMATIC DISHWASHING DETERGENTS WITH BIOSURFACTANTS

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Surface active agents (SAAs), commonly called surfactants, are a large group of substances whose specific properties result from their chemical structure. SAAs molecules are characterized by an amphiphilic structure, they consist of two fragments with different properties in relation to water: a hydrophilic part and a hydrophobic part.

Surfactants are used in many industrial products and processes. In this presentation, based on available literature, the physico-chemical properities and possibilities of use environmental sustainable biosurfactants in automatic dishwashing detergents are discussed.

In the coming years, the use of surfactants based on non-renewable raw materials, which may be a source of environmental pollution, will be limited. Therefore, it is necessary to look for cleaning products that will maintain environmental balance. Biosurfactants are an example of environmental friendly SAAs. The benefits of their use include: high biodegradability, low toxicity and great availability of raw materials for their production. The main obstacles to their dissemination include: low productivity and high cost of commercially available solutions.

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UPCYCLED COSMETICS – FORMULATIONS WITH APPLE POMACE EXTRACT AS A PROOF OF A CONCEPT

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Background: Modern skincare trends prioritize natural ingredients due to consumer demand for eco-conscious products [1, 2]. There is also increasing interest in cosmetics derived from recycled materials, including fruit and vegetable waste, which are abundant sources of bioactive compounds such as polyphenols and carotenoids [3]. An illustrative example of such cosmetic ingredients is apple pomace. A byproduct of apple processing contains these bioactive compounds along with fiber, pectins, and essential minerals, making it a valuable ingredient for cosmetics [4].

Aims: The aim of this study was to evaluate the effect on skin parameters of 3-step series of cosmetics with apple pomace extract designed and formulated by the authors: cleansing gel, serum, and facial cream. Parameters such as skin moisturizing and trans-epidermal water loss were evaluated.

Methods: Apple pomace extract was incorporated into three cosmetic formulations and underwent in-vivo evaluation. To evaluate skin parameters (such as skin moisturizing and transepidermal water loss) noninvasive instrumental methods *Courage + Khazaka electronic GmbH* were used along with a survey. The study involved 25 healthy women between 25 and 55 year of age. Volunteers have been used 3-step cosmetic series for six weeks. Skin parameters were measured before use, after first application and after 6 weeks use. The survey was conducted after the end of the cosmetic use period to gather subjective opinions about parameters such as rheological and organoleptic properties of the formulations.

Results: After applying three formulations containing 1–3% of apple pomace extract the skin parameters improved. Survey respondents rated the tested products very good and good and did not indicate the occurrence of any adverse skin reaction or other circumstances requiring the discontinuation of cosmetics use.

Conclusion: This study highlights that cosmetics with apple pomace extract as its active ingredient have a potential as interesting and innovative cosmetic products that meets hat meets with a positive reception by potential consumers. Such products are proof of the possibility of using post-production waste as a very effective and safe cosmetic active ingredient.

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PHYTOCHEMICAL ANALYSIS OF VERBENA (*VERBENA OFFICINALIS*) HERB EXTRACT FOR USE IN COSMETIC PRODUCTS

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Cosmetic products containing ingredients of natural origin are becoming more and more popular on the cosmetics market, hence cosmetic producers introduce such products to the market. The plant extracts contained in them contain many valuable ingredients, such as polyphenol compounds and vitamins. Plant additives make a given cosmetic have good properties that delay the skin aging process, nourish, regenerate, and moisturize [1].

Verbena, which is the subject of the research, is a perennial plant rich in active substances, including verbascoside and its esters, which belong to polyphenolic compounds, iridoid glycosides, such as verbenaline and verbena, as well as oils [2–4].

The research aimed to determine flavonoids and polyphenols in common verbena extracts and to examine their antioxidant activity. In addition, the effect of the obtained extracts on the skin was also examined.

After the research, it was found that the average content of flavonoids expressed as quercetin in the verbena herb extract was much higher and amounted to 202.25 mg/100 g. The total content of phenolic compounds determined by the Folin-Ciocalteau method in the verbena herb extract was 199.38 mg/100g, calculated as caffeic acid. Antioxidant activity determined by the CUPRAC method expressed as caffeic acid equivalent, was 236.38 mg/100 ml.

After testing using a corneometer, it was found that verbena herb extract containing 1.0001 g of the herb in 50 ml of water had the best moisturizing properties. The hydration level was higher than the control field and remained approximately the same. However, solutions containing a larger amount of dry verbena herb extract (2.0012 g and 3.0016 g in 50 ml of water) had values lower than the control field and skin hydration decreased.

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BIOLOGICAL ACTIVITY OF RAW 264.7 MACROPHAGES CULTURED WITH BAMBOO LEAF EXTRACT – *IN VITRO* STUDIES

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Introduction: Plant preparations have been used as modifiers of the immune response since the dawn of time. In recent years, particular attention has been paid to the properties of bamboo leaf extract. Among other things, it has been shown to have high biological and pharmacological efficacy promoting antioxidant, antioxidant, antiapoptotic, anticancer and anti-inflammatory effects [1].

Aim: The aim of this study was to evaluate the effect of different concentrations of bamboo extract on the biological activity of macrophages under in vitro culture conditions.

Materials and Methods: The RAW 264.7 macrophage cell line was used for the study. To study the effect of bamboo leaf extract on macrophages, cells at 1 x 104/ml were cultured in 24-well plates with different concentrations of bamboo extract, 3 ml (BEX3) or 10 ml (BEX10) per 1 ml of medium. The control group consisted of macrophages cultured in culture medium without the addition of the extract (CTR).

Results and conclusions: The viability of macrophages cultured with 3 ml bamboo extract (BEX3) did not differ from that of control cells (CTR). At the same time, this group (BEX3), compared to the control, showed an increase in AK release and a decrease in protein secretion by the cells. Macrophages cultured with a higher dose of bamboo extract (BEX10) showed an increase in cell viability, an increase in NO release and a decrease in protein secretion compared to control macrophages (CTR). In conclusion, the addition of bamboo extract at a dose of 10 ml seems to have had a more beneficial effect on macrophages, which resulted in an increase in cell viability/proliferation. However, there was a decrease in protein secretion in both groups tested (BEX3 and BEX10).

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BIOLOGICAL RESEARCH ON NANOHYDROXYAPATITE COATINGS CONTAINING GENTAMICIN AND SILVER NANOPARTICLES

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All medical procedures involve the risk of infection, and the implantation of a foreign body such as an implant is particularly dangerous. Despite continuous work to improve the biocompatibility of materials, postoperative inflammation and infections still occur. That is why drugs are widely used. Antibiotics are administered to minimize the risk of infection, but unfortunately bacteria are increasingly becoming resistant to commonly used medicinal substances, which forces scientists to invent new ways to fight microorganisms. Nanomedicine revolutionized many field of science, giving us a number of opportunities. Nanometals are often used due to their unique properties, including antimicrobial and anti-inflammatory ones, for example silver or copper [1–3].

Microcirculation plays an important role in the immune system's defence response and antibiotics delivery. Therefore, if bacterial adhesion occurs before tissue regeneration, the host's immune system is often unable to prevent the colonization of microorganisms producing a biofilm matrix. The inhibition of microbial adhesion is essential to prevent postoperative infections [1, 4].

The aim of the research was to propose a material with antibacterial properties that would act locally. Nanohydroxyapatite coatings were deposited on the Ti-13Zr-13Nb alloy using the electrophoretic deposition method. Then samples were immersed in an antibiotic solution (gentamicin; concentrations 1 mg/ml and 0.5 mg/ml) and silver nanoparticles. The obtained coatings were placed in a bacterial solution for 30 days. The coatings were examined using scanning electron microscopy before and after contact with bacteria. Additionally, the silver and antibiotic release into the solution of simulated body fluids were analyzed.

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ENHANCING STABILITY: CO-AMORPHOUS PHARMACEUTICAL SOLID DISPERSIONS OF ANTIHYPERTENSIVE SARTANS AND ASCORBIC ACID FOR CARDIOPROTECTION

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Co-amorphization emerges as a strategic approach to enhance the solubility and bioavailability of APIs, and when coupled with a judiciously chosen nutraceutical co-former, it reveals the potential for dual-acting pharmaceutical products. This study focuses on synthesizing co-amorphous pharmaceutical solid dispersions of poorly soluble antihypertensive drugs – sartans (angiotensin II receptor blockers), including valsartan (VAL), telmisartan (TEL), and losartan (LOS-K), in conjunction with vitamin C (VitC) as a co-former. VitC is a known nutraceutical substance that has a beneficial effect on the human body in various respects This substance was chosen as a co-former in our study due to its protective effects on vascular endothelial functions and its ability to reduce the risk of coronary heart disease and improve the lipid profile [1, 2]. In addition to its biological effect, the factor determining the selection of this compound as a co-former was its high solubility in water, approximately 245 mg/mL, which is over a thousand times higher than solubility of sartans.

While the co-amorphization of VAL presents fewer challenges, more difficulties are encountered with TEL and VitC. Only limited studies have explored the co-amorphization of TEL, with even fewer regarding VitC. In this research, we describe the synthesis of co-amorphous solid dispersions and their characterization using XRPD, FT-IR and DSC techniques. Additionally, DFT and QTAIM calculations are employed to elucidate the interactions within the solid dispersions.

In vitro release profiles of the synthesized products reveal significant improvements, particularly in the case of TEL, where the release profile was enhanced by up to 8 times. Remarkably, the resulting solid dispersions exhibit resistance to recrystallization, maintaining stability for extended periods, even up to a year.

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