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PhD Thesis

Biomaterials Based on Bee Products for Dermal Tissue Regeneration

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I. Current state of development

The increasing global burden of skin injuries—whether due to trauma, burns, chronic wounds, or surgical interventions—has intensified the demand for advanced and efficient wound healing strategies. Dermal tissue engineering has become a pivotal area of regenerative healthcare, aiming to develop biocompatible and bioactive materials that can restore skin integrity, prevent infection, and promote rapid tissue regeneration. However, many conventional wound care materials are based on synthetic substances that often lack biocompatibility, pose risks of adverse reactions, or contribute to antibiotic resistance due to overuse of antimicrobial agents [1-3].

In this context, natural biomaterials, particularly those derived from bee products, offer a highly promising alternative.

This issue addressed in this paper thesis centers on developing innovative biomaterials for engineered skin repair, emphasizing the substitution of traditional synthetic active agents with natural bioactive compounds. This approach is driven by growing concerns over the limitations and potential negative effects of synthetic substances commonly used in wound care, including allergic reactions, delayed healing, cytotoxicity, and the rise of antibiotic-resistant bacteria.

In contrast, natural products—especially those derived from bees, are rich in biologically active compounds with well-established therapeutic benefits. These include antimicrobial, anti-inflammatory, antioxidant, and regenerative features that are essential in effective wound healing. Incorporating these substances into biopolymeric matrices like chitosan or other biocompatible carriers enables the creation of composite materials that promote tissue regeneration by reducing the possibility of infection and side effects, thanks to their natural origin and high biocompatibility [4,7].

This thesis proposes that the use of bee products in place of synthetic substances not only supports the principles of green chemistry and sustainable biomaterial development but also improves the therapeutic efficacy of wound dressings. The goal is to create materials that are safer, more effective, and better tolerated by the human body, while still achieving—or surpassing—the performance of existing synthetic alternatives .

Bee-derived substances like honey, royal jelly or propolis are well-known for their therapeutic benefits, which include antioxidant, antimicrobial, anti-inflammatory and tissue-

regenerative effects. These naturally derived compounds present an eco-friendly and biocompatible alternative to the synthetic substances traditionally employed in wound care treatments. Their use in this paper is driven by a growing interest in biologically active materials that align with the principles of green synthesis and restorative therapies.

The research centers on incorporating bee-derived products into biopolymeric matrices—such as collagen, chitosan, and sodium alginate—to develop composite materials tailored for dermal applications. Chitosan, known for its excellent biocompatibility, biodegradability, and wound-healing support, serves as a versatile scaffold that enhances the performance of incorporated bioactive. The resulting materials are designed to possess multifunctional properties: promoting cell proliferation, stimulating collagen and keratinocyte activity, modulating inflammatory responses, and providing effective antibacterial protection [8-10].

Royal jelly, in particular, contributes to wound healing through its content of defensin-1, which stimulates keratinocyte migration and MMP-9 expression—critical for reepithelization. 10-HDA, a prominent fatty acid in royal jelly, possesses wide-ranging antimicrobial activity and influences the activation of genes related to inflammation. Propolis, loaded with flavonoids and phenolic compounds, delivers powerful antimicrobial and antioxidant benefits, while honey supports tissue hydration, suppresses bacterial growth, and promotes autolytic debridement.

Together, these natural agents exhibit synergistic effects, enhancing the regenerative potential of the dressing while minimizing the chance of infection. By harnessing the inherent biological properties of bee products and incorporating them into an advanced biomaterial platform, this study advances the field of natural-product-based biomedical engineering. The findings hold significant promise for improving wound care outcomes, especially for complex skin injuries such as burns, ulcers, and infected wounds. Furthermore, the approach promotes sustainability and aligns with global efforts to reduce reliance on synthetic and antibiotic-based therapies.

The selection of bee products as functional agents in dermal biomaterials aligns with current trends in biomedical research that emphasize sustainability, biocompatibility, and multifunctionality. Moreover, using biopolymeric carriers such as chitosan, gelatin, or collagen to

encapsulate and deliver these compounds further enhances their therapeutic efficacy, mechanical stability, and controlled release in wound environments.

This research offers a significant addition to the literature in regenerative biomaterials by proposing an innovative and holistic strategy to enhance wound healing outcomes by scientifically optimized application of bee products. By integrating traditional wisdom with cutting-edge material science, it seeks to connect natural therapeutics with clinical practice, thereby pushing forward the progress of dermal tissue engineering.

The purpose of the thesis and objectives

This doctoral thesis is motivated by several fundamental considerations. From a medical perspective, there is an urgent need for safer and more effective wound healing materials that support rapid dermal regeneration and minimize infection, particularly in burn victims and patients with chronic wounds. Scientifically, the integration of bee-derived products into advanced biomaterials represents a novel approach that combines traditional apitherapy with modern tissue engineering techniques. At the same time, the use of bee products provides a natural and sustainable strategy, as they are renewable, biodegradable, and biocompatible resources that reduce reliance on synthetic chemicals while aligning with global priorities in environmental protection and human health. Their therapeutic potential is well documented, with a wide range of biological activities—including antioxidant, antimicrobial, anti-inflammatory, and regenerative effects—supporting their application in skin repair. Existing literature validates their efficacy in enhancing reepithelialization, reducing inflammation, and preventing microbial infections. Importantly, the translational relevance of this work lies in the development of natural, biofunctional wound care materials and skin replacements based on bee products, which hold significant potential for clinical use by offering accessible, low-risk, and cost-effective solutions in both human and veterinary medicine [11-14].

Building on these considerations, this research contributes to the field of regenerative biomaterials by proposing an innovative and holistic strategy to enhance wound healing outcomes through the scientifically optimized application of bee products. By bridging traditional wisdom with cutting-edge material science, the thesis seeks to connect natural therapeutics with clinical practice, thereby advancing the progress of dermal tissue engineering.

The primary aim of this doctoral research was to obtain and characterize novel natural biomaterials with potential applications in dermal tissue engineering, based on biocompatible polymers and natural bioactive compounds, particularly those derived from bee products. The study was structured in multiple stages, each focused on designing and evaluating materials with enhanced biological and functional properties. Specifically, the objectives included: obtaining and characterizing collagen-based sponges enriched with propolis tincture using the freeze-drying (lyophilization) technique to generate porous, biocompatible structures suitable for skin regeneration; formulating and analyzing bioactive films based on chitosan and sodium alginate, incorporating bee-derived products individually or in combination, with the goal of creating flexible, antimicrobial materials for wound healing; synthesizing and incorporating silver nanoparticles into bee product–enriched films via a green synthesis approach using propolis as both reducing and stabilizing agent, thereby enhancing antimicrobial effectiveness in an eco-friendly manner; conducting comprehensive physicochemical and structural characterization of all developed materials through techniques such as SEM, FT-IR, and thermal analysis to investigate component interactions and stability; and evaluating the biological properties of the materials through cytotoxicity assays on relevant cell lines to confirm biocompatibility, alongside antimicrobial testing against common wound pathogens to establish their infection-preventing potential.

Through these objectives, the thesis seeks to advance the creation of sustainable, effective, and multifunctional natural biomaterials capable of supporting dermal tissue regeneration and improving outcomes in wound care management.

Biomaterials are engineered substances created to interact with living systems, including cells, tissues, and organs. They serve a crucial function in medical, pharmaceutical, or biotechnological areas by supporting or improving biological processes, frequently within the human body. Recently, their use in wound healing has advanced, with several products currently in clinical trials. In tissue engineering, biomaterials primarily provide structural support and mechanical load distribution to promote cell attachment, growth, and differentiation, while helping shape and size the regenerated tissue [15-16].

II. Original contributions

1.Collagen based systems with propolis tincture for dermal tissue engineering

The first research direction focused on obtaining systems intended for wound healing, using natural active substances such as collagen and propolis tincture. Collagen was used as a bioactive matrix, playing an important role in epithelial regeneration, while propolis was employed for its antibacterial activity. The systems obtained were analyzed by FT-IR spectroscopy, DSC analysis, Micro CT, UV-VIS spectroscopy, and enzymatic degradation.

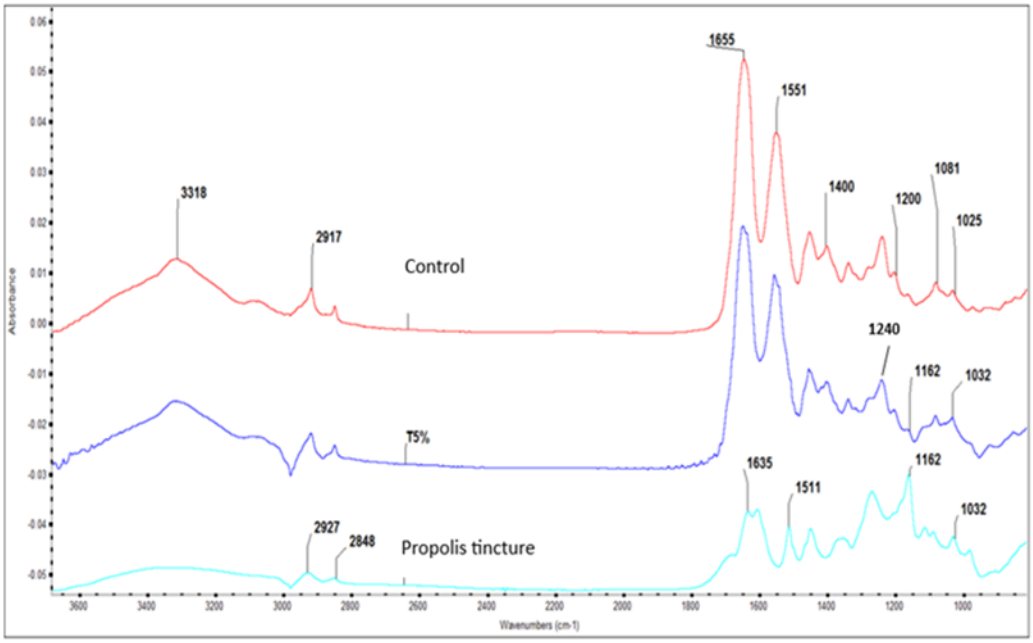


Fig. 1 FTIR spectra of the raw materials (collagen tincture and propolis tincture) and the T 5% sample.

FT-IR and DSC analyses provide compelling evidence regarding the integration of propolis into collagen matrices. The FT-IR spectrum (fig.1) highlights specific bands corresponding to the aromatic rings of flavonoids – essential components of propolis – confirming not only the presence of propolis, but also its structural integration within collagen. Moreover, the DSC curve (fig. 2) indicates an increase in the denaturation temperature in the presence of propolis, suggesting enhanced thermal stability and possible improvements in the mechanical properties of the matrix due to the reinforcing effect provided by propolis.

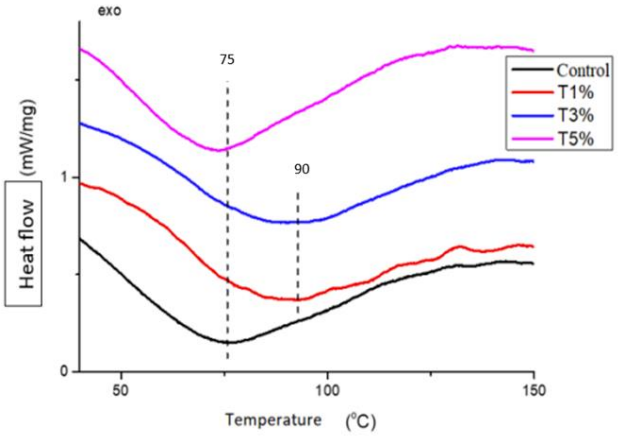


Fig. 2 DSC Curve for Control, T 1%, T 3%, and T 5% samples

In addition to spectroscopic analyses, Micro CT images (fig.3) show that all samples contain pores, predominantly with open porosity. Open pores facilitate gas exchange and nutrient diffusion, which are essential aspects for tissue regeneration. The negligible amount of closed porosity suggests that the system is well-structured to support cell infiltration and migration, thereby enhancing its applicability in the dermal field.

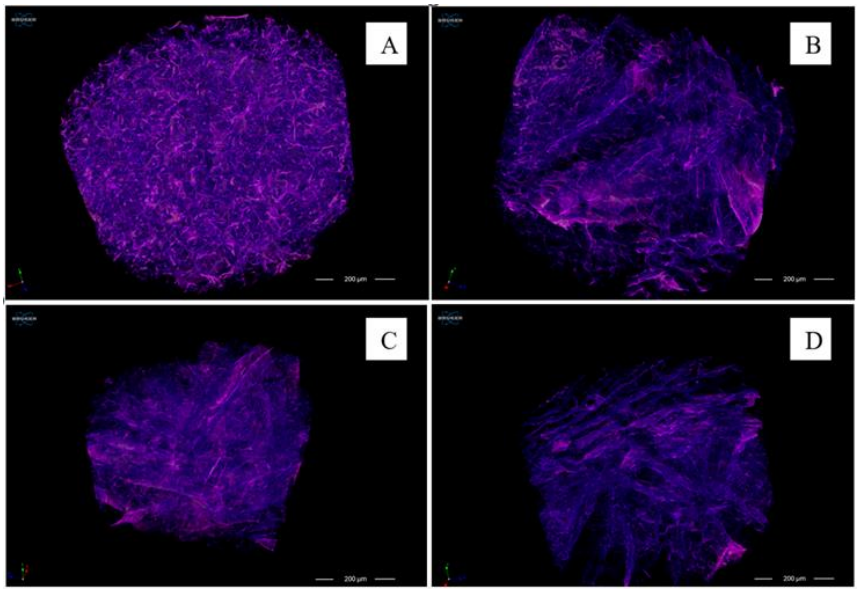


Fig. 3 Micro CT Images of Control Sample (A), T 1% (B), T 3% (C), and T 5% (D).

UV-VIS analysis was performed to determine the release profile of the active substance (propolis) from the polymeric matrix. According to the graph (Fig 4), a significant release of propolis occurs within the first 24 hours.

The analysis of the release profiles of the collagen–propolis tincture samples reveals interesting aspects regarding their behavior. The sample with the lowest concentration of propolis tincture (1%) shows the highest amount of propolis released. This observation suggests that lower concentrations may facilitate a more efficient release mechanism, possibly due to reduced obstruction within the polymeric matrix.

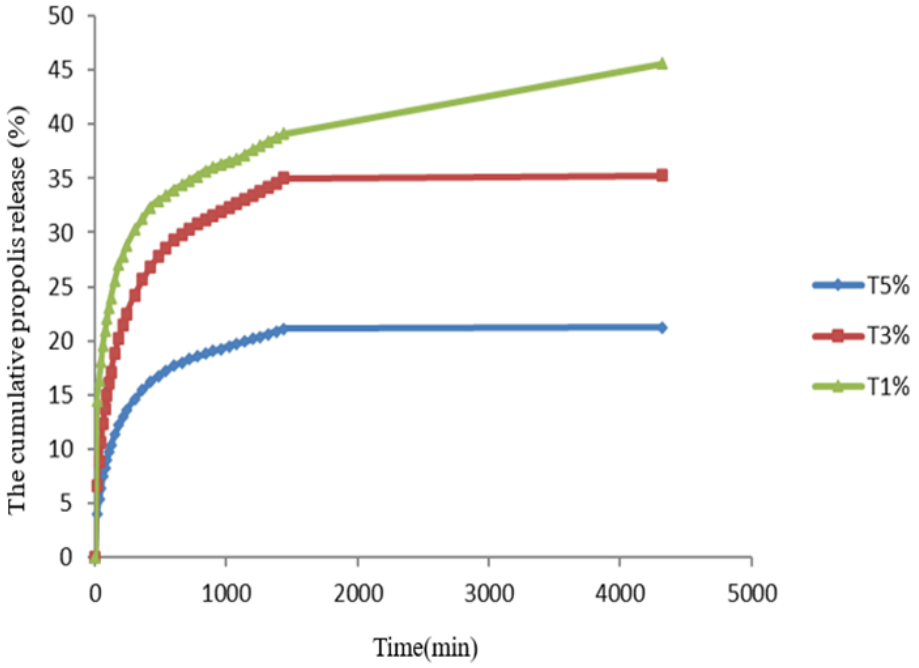


Fig. 4. Release Profiles of T 1%, T 3%, and T 5% Samples in Phosphate Buffer pH

UV-VIS analyses highlight a critical correlation between the concentration of propolis tincture and pore interconnectivity.

In conclusion, the detailed analysis of collagen-based dressings incorporating propolis tincture illustrates the potential of this system as a biomaterial for wound treatment. Future research could focus on refining the formulation to maximize therapeutic efficacy, while ensuring the preservation of structural integrity and long-term functionality.

2. Biomaterials based on bee products and their effectiveness in soft tissue regeneration

With the efficiency of propolis in the collagen matrix confirmed, the next step was to explore the combined effects of honey, propolis, and royal jelly.

The samples were prepared using acacia honey, propolis tincture, and pure royal jelly. To obtain the mixture, 20 mL of propolis tincture, 5 g of royal jelly, and 35 g of honey were used. The resulting mixture was homogenized in a water bath for 20 minutes and then stored in a dark place in tightly sealed containers.

For the preparation of sodium alginate–chitosan films, sodium alginate layers were first prepared by dissolving the honey/propolis tincture/royal jelly or the mixture in 50 mL of distilled water, together with 1 g of sodium alginate and 0.1 g of glycerin.

Based on reports from the literature [20,21] and our own exploratory experiments, the following ratios were selected to obtain five samples (Figure 1): A — control, AH (3.5 g honey), AP (2 mL propolis tincture), ARj (0.5 g royal jelly), AM (5 mL mixture).

The samples were cast into Petri dishes and dried under vacuum at 35 °C for 24 hours.

Subsequently, the chitosan solution was prepared by dissolving 2 g of chitosan in 50 mL of 1% acetic acid. Ten milliliters of this solution was poured over each sodium alginate layer and dried under vacuum at 35 °C for 24 hours.

SEM analysis of the sodium alginate–chitosan composites revealed distinct morphological differences among the studied formulations. The control sample (A) exhibited a relatively smooth and compact structure, indicative of a well-formed polymeric matrix. The addition of honey (AH) slightly altered the surface, resulting in a smoother texture with minor porosity, likely due to the incorporation of organic components. The propolis-containing sample (AP) displayed a rougher surface with visible granular structures (Fig. 5), suggesting phase separation or aggregation of resinous particles.

The royal jelly formulation (ARj) showed a fibrous, layered appearance with areas of increased roughness, probably due to interactions between royal jelly proteins and the polymeric matrix.

In the case of the composite containing the mixture of honey, propolis, and royal jelly (AM), the morphology was highly heterogeneous, characterized by varied textures and potential phase interactions among the multiple bioactive agents (Fig. 5).

Overall, SEM images highlight the significant influence of bee products on the morphological characteristics of sodium alginate–chitosan composites, with varying degrees of roughness, porosity, and structural modifications across all formulations.

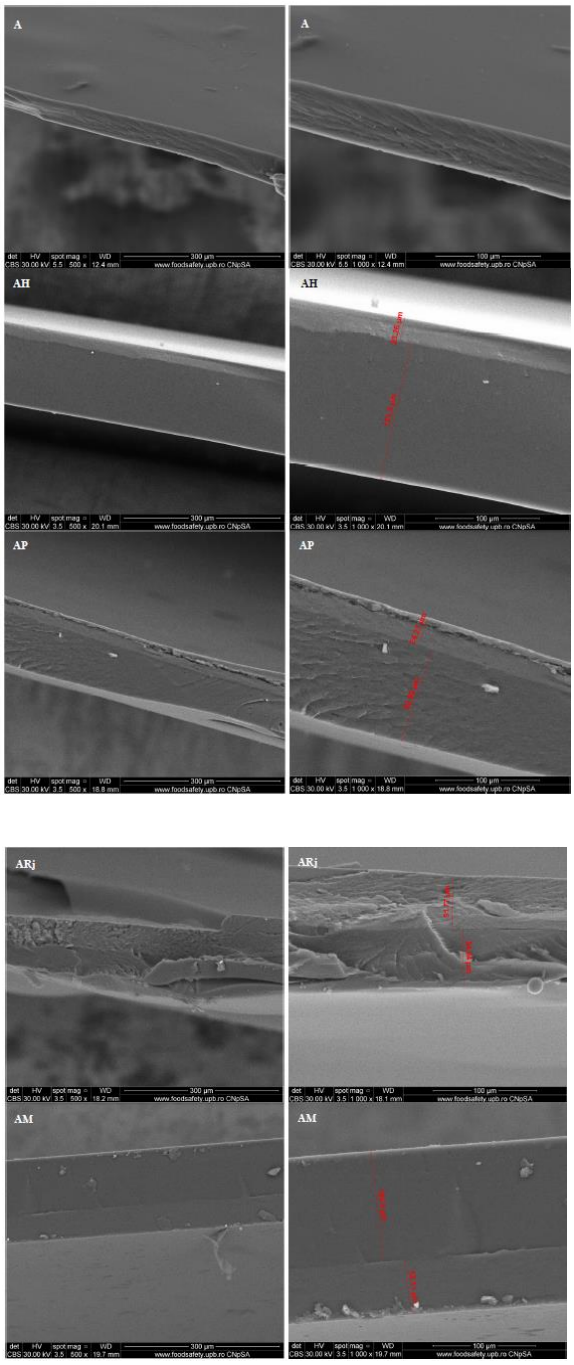


Fig. 5 SEM images for composite films A; AH; AP; ARj; and AM.

In the FTIR analysis of the samples, we observe –OH and –NH vibrations between 3260 and 3280 cm^{-1}, which highlight the hydrogen bonds supporting the polymeric structure. The peaks at 2923 and 2880 cm^{-1} reflect the presence of $–CH_2$ groups, while the bands between 1594 and 1603 cm^{-1} indicate C=O and C=C bonds from polysaccharides (fig. 6).

The addition of bee products generates new bands between 1619 and 1638 cm^{-1}, associated with C=O vibrations from sugars and proteins, while the peak at 1542 cm^{-1} highlights the amide II band. Other bands, such as the one at 1408 cm^{-1}, correspond to carbohydrates and amino acids, showing the molecular interactions within the samples.

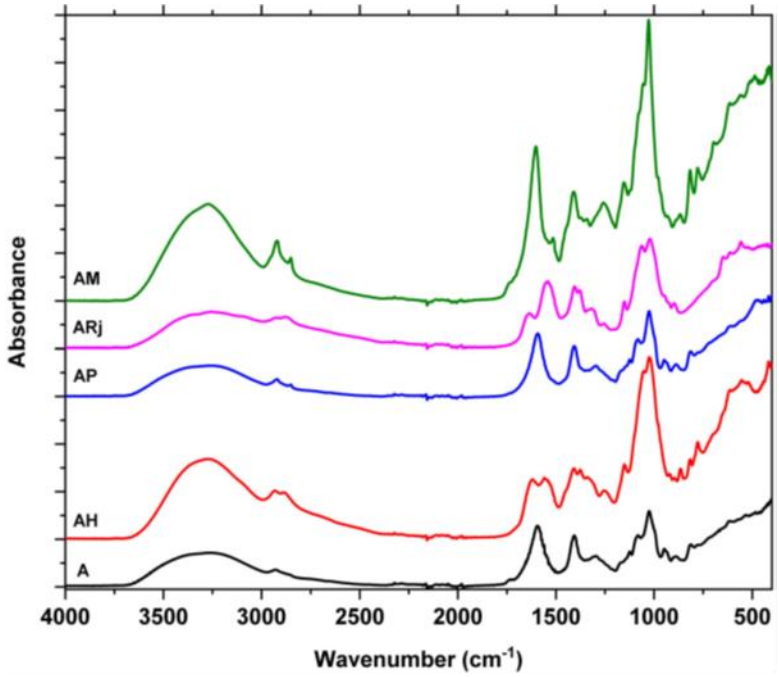


Fig. 6 FTIR spectra for the composite films A; AH; AP; ARj; and AM

Thermogravimetric analysis shows that mass loss begins at ~115 °C, continues between 115 and 460 °C through dehydration and partial oxidation, then between 460 and 720 °C polymer chain fragmentation occurs. After 720 °C, the material undergoes complete oxidation, which confirms the thermal stability and chemical behavior of the biomaterials (fig. 7).

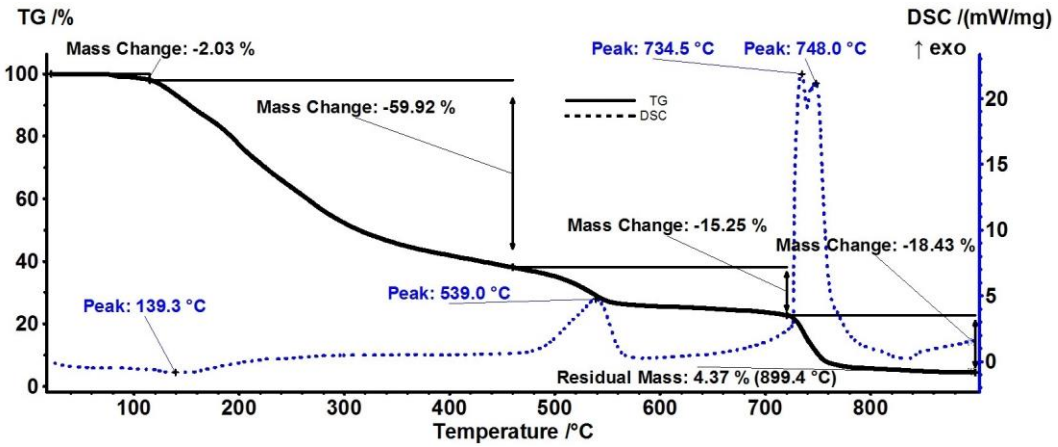


Fig. 7 Thermal analysis (TG and DSC curves) for the AM sample

Regarding antibacterial activity, the alginate–chitosan films exhibited a significant inhibitory effect against all tested Gram-positive bacteria (fig. 8).

The samples enriched with propolis (AP) and the mixture of bee products (AM) showed the largest inhibition zones, demonstrating a synergistic effect.

For Gram-negative bacteria, the samples with propolis tincture and the mixture of bee products displayed significantly higher activity than the control sample (fig. 9).

Pure honey did not generate significant inhibition zones, but when incorporated into the film (AH), it exhibited good antibacterial activity, particularly against P. aeruginosa and E. coli.

This effect is attributed to the controlled release of bioactive compounds from the film matrix, their protection, and the improved contact with bacterial cells.

The results confirm that polymer film–based delivery systems can significantly enhance the antimicrobial activity of natural products, creating a synergistic effect between the matrix and the bioactive compounds.

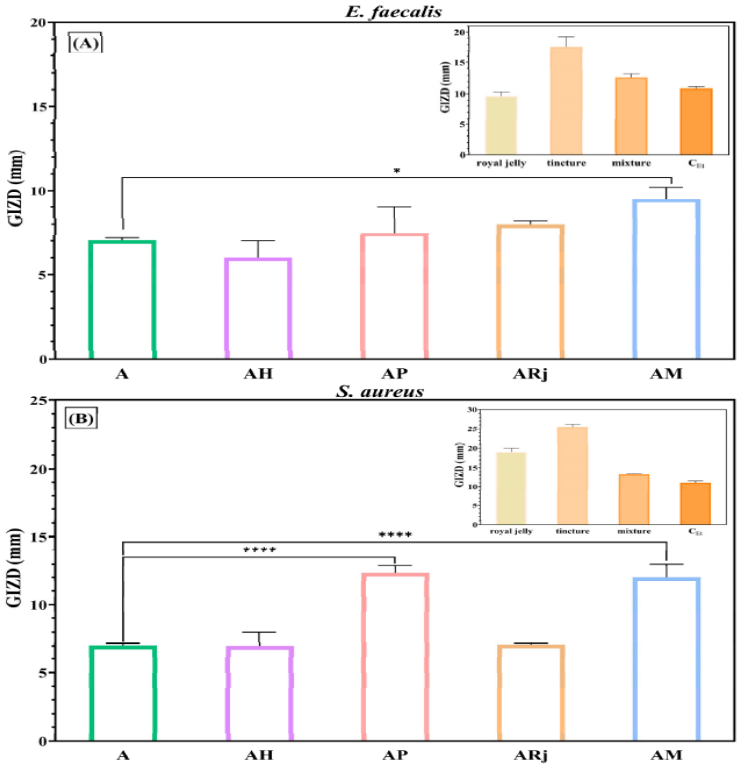


Fig. 8 Antibacterial profiles of composite films against Gram-positive bacteria

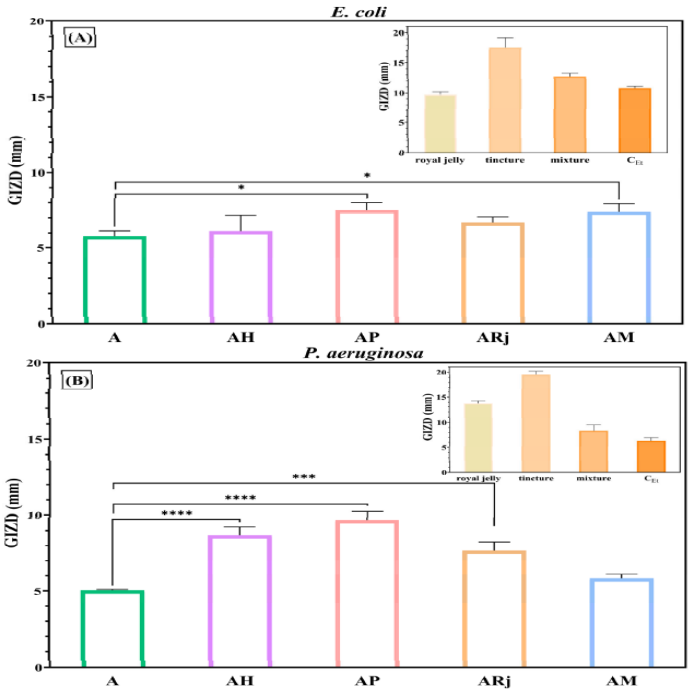
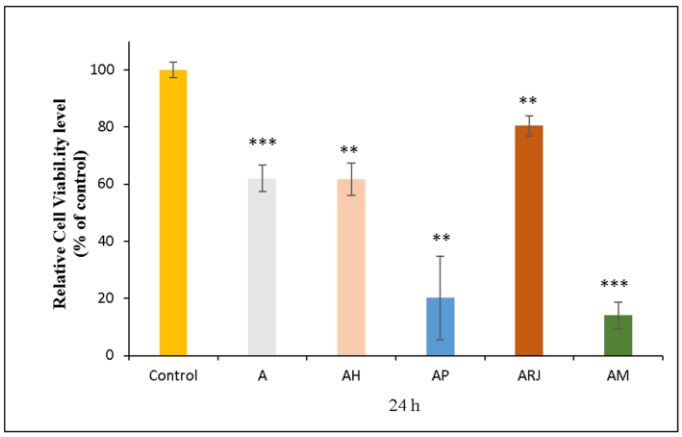
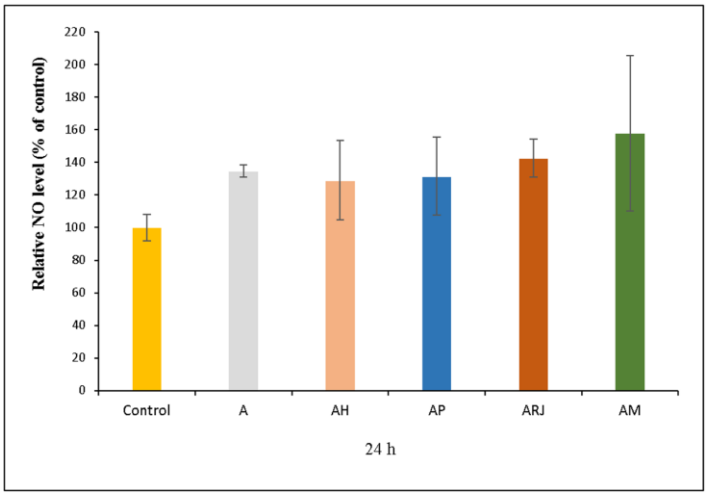


Fig. 9 Antibacterial profiles of composite films against Gram-negative bacteria

Regarding the cytotoxicity tests, the results can be seen in Figure 10.The MTT assay evaluates cell viability by measuring metabolic activity. High values indicate survival and proliferation, while low values suggest cytotoxicity. In our samples, the control maintained ~100% viability. The honey-containing film (AH) preserved moderate viability of ~65%, propolis (AP) significantly reduced viability to ~20%, indicating high cytotoxicity, while royal jelly (ARj) showed the highest viability at ~80%, being the most biocompatible. The combined formulation (AM) displayed reduced viability of ~10%, highlighting the need to optimize concentrations in order to balance antimicrobial efficacy with cellular safety.





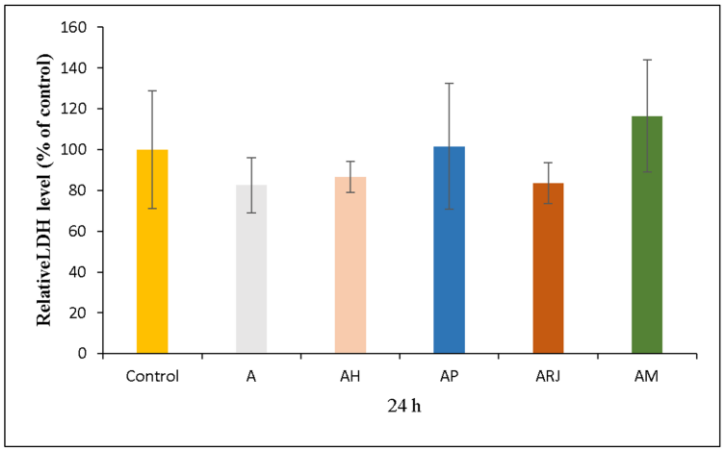


Fig. 10 Citotoxicity assays – MTT, LDH, NO

The NO test provides insights into the immunomodulatory potential of the biomaterials. The AH, AP, and ARj samples stimulated moderate nitric oxide production, between 130 and 140%, supporting immune activation without the risk of excessive inflammation. This suggests that the bioactive formulations may promote healing and infection control.

The LDH test evaluates cell membrane integrity. The low LDH levels for AH and ARj confirm biocompatibility, while AM shows higher values, indicating increased cytotoxicity.

In conclusion, these tests highlight that honey and royal jelly incorporated into alginate–chitosan films are promising candidates for regenerative applications, while propolis requires adjustments to maintain a safe biocompatibility profile.

3. Antimicrobial composite films based on alginate–chitosan with honey, propolis, royal jelly and green-synthesized silver nanoparticle

The results obtained with bee product–based biomaterials inspired us to develop an antimicrobial variant by adding silver nanoparticles and using an alginate–chitosan matrix. Thus, the next research direction focused on creating multifunctional composite films with both regenerative and protective roles against infections. Considering the lack of studies on their synergistic effects, the goal was to provide new perspectives for enhancing the therapeutic potential of bee product–based formulations. This was achieved through the incorporation of AgNPs and examination of their impact on the overall efficacy of these natural compounds .

We prepared bilayer films from alginate and chitosan, incorporating various natural bioactive compounds and, in some cases, silver nanoparticles synthesized via a green method. To

improve the biological properties, silver nanoparticles (AgNPs) were synthesized through green chemistry, using propolis tincture as both a reducing and stabilizing agent. $AgNO_3$ was dissolved in distilled water, the pH was adjusted to 9.6, and propolis was then added; the formation of AgNPs was monitored by the color change of the solution.

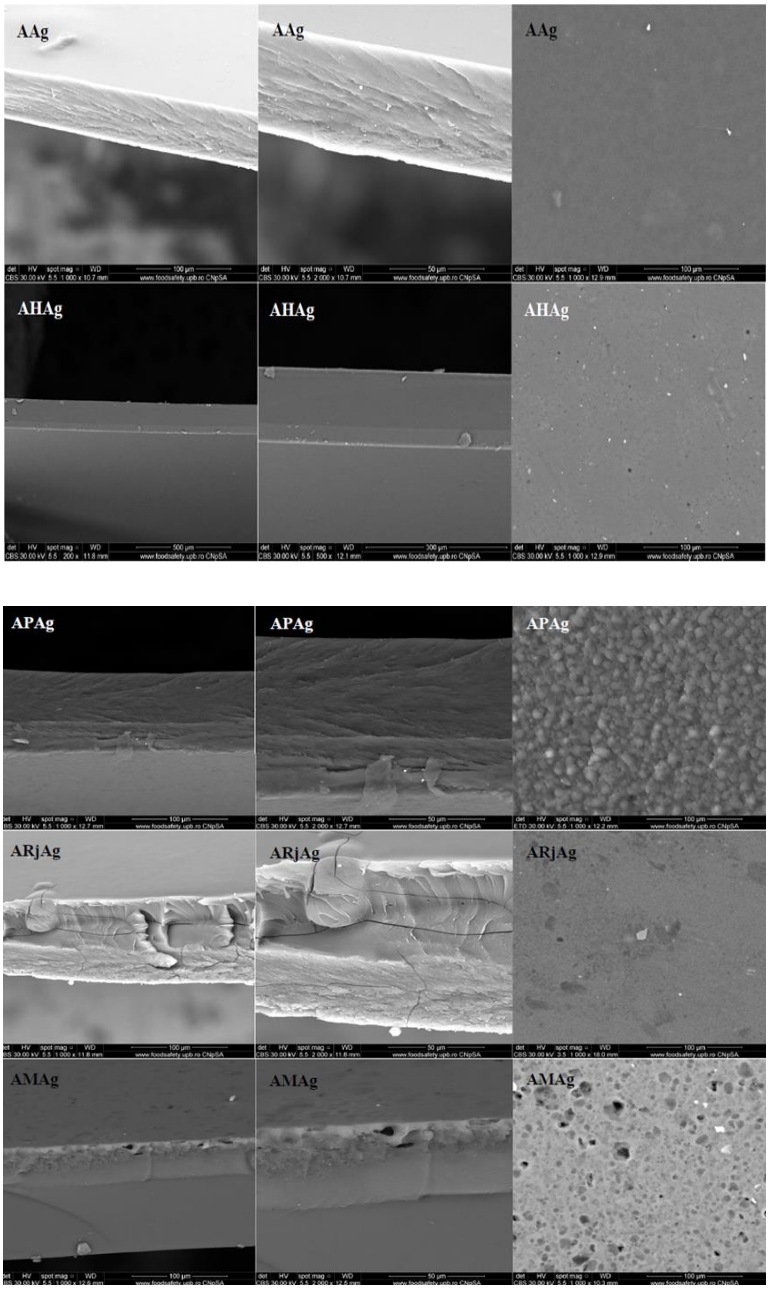


Fig. 11 SEM micrographs SEM micrographs for the samples A, AHAg, APAg, ARjAg, and AMAg.

SEM analysis of the alginate–chitosan composites reveals significant morphological differences between formulations (fig. 11). The AHAg sample exhibits dispersed bright spots, indicating the presence of nanoparticles, with uniform distribution across the film. APAg shows an irregular texture, with nanoparticles interacting with bioactive compounds, increasing structural complexity.

The ARjAg film displays a layered, fibrous appearance, with good nanoparticle dispersion contributing to porosity and textural variations. AMAg presents a porous surface and complex structure, highlighting the synergy between compounds. The simple matrix with AgNPs, AAg, shows a uniform structure, with well-dispersed nanoparticles, maintaining the integrity of the polymeric network.

Thus, the inclusion of bee products and AgNPs modifies the morphology of the films, affecting roughness, porosity, and structural characteristics, which may influence the biological and functional properties of the biomaterials.

The FTIR spectrum of the honey-containing sample shows characteristic signals of functional groups from chitosan, alginate, and bee products. The peak at 3277 cm^{-1} corresponds to N–H and O–H stretching, C–H bands between 3000–2800 cm^{-1} indicate carbohydrates and amino acids, and amide bands at 1624 and 1552 cm^{-1} highlight the proteins. Additionally, the bands at 1024 and 885 cm^{-1} confirm the presence of polysaccharides and the chitosan structure. These FTIR data are essential for compositional and structural characterization of the film (fig. 12).

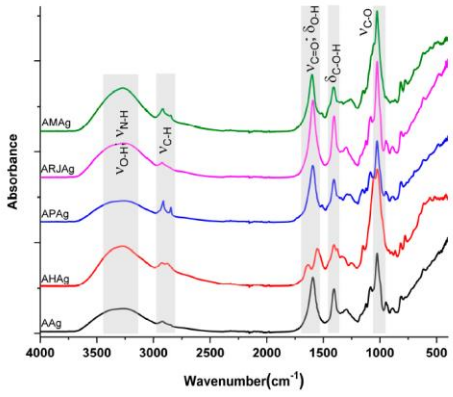


Fig. 12 FTIR spectra for AAg; AHAg; APAg; ARjAg; AMAg samples

The UV-Vis spectra (fig. 13) clearly show interactions between silver nanoparticles and the bioactive compounds. In the propolis and royal jelly samples, AgNPs cause shifts and increases in absorption, indicating specific interactions. In honey and the multicomponent mixture, broader bands and higher intensity are observed, demonstrating the synergy between AgNPs and bee products, as well as how these interactions influence the structure and properties of the composite film.

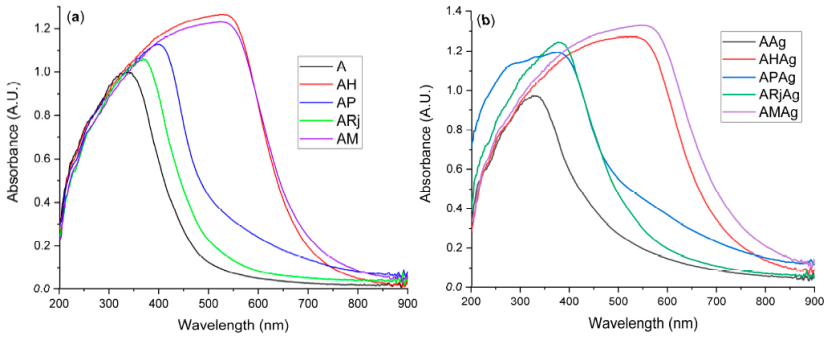


Fig. 13 The UV-Vis spectra for the samples without AgNPs (a) and with AgNPs (b).

Thermogravimetric analysis shows that AMAg loses residual solvent up to ~115 °C, while carbon dioxide from oxidation reactions appears later compared to AM (fig. 14). The main degradation range between 115 and 460 °C includes polysaccharide dehydration, protein degradation, and polymer backbone fragmentation, along with oxidation of smaller fragments. This highlights the thermal stability and complex degradation behavior of the sample.

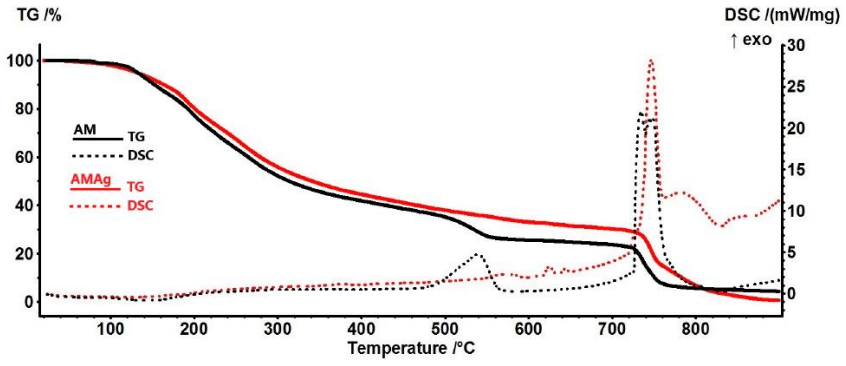


Fig. 14 Thermal analysis for AM (black curves) and AMAg (red curves) samples: the TG curves are represented as solid lines, and the DSC curves are represented as dotted lines

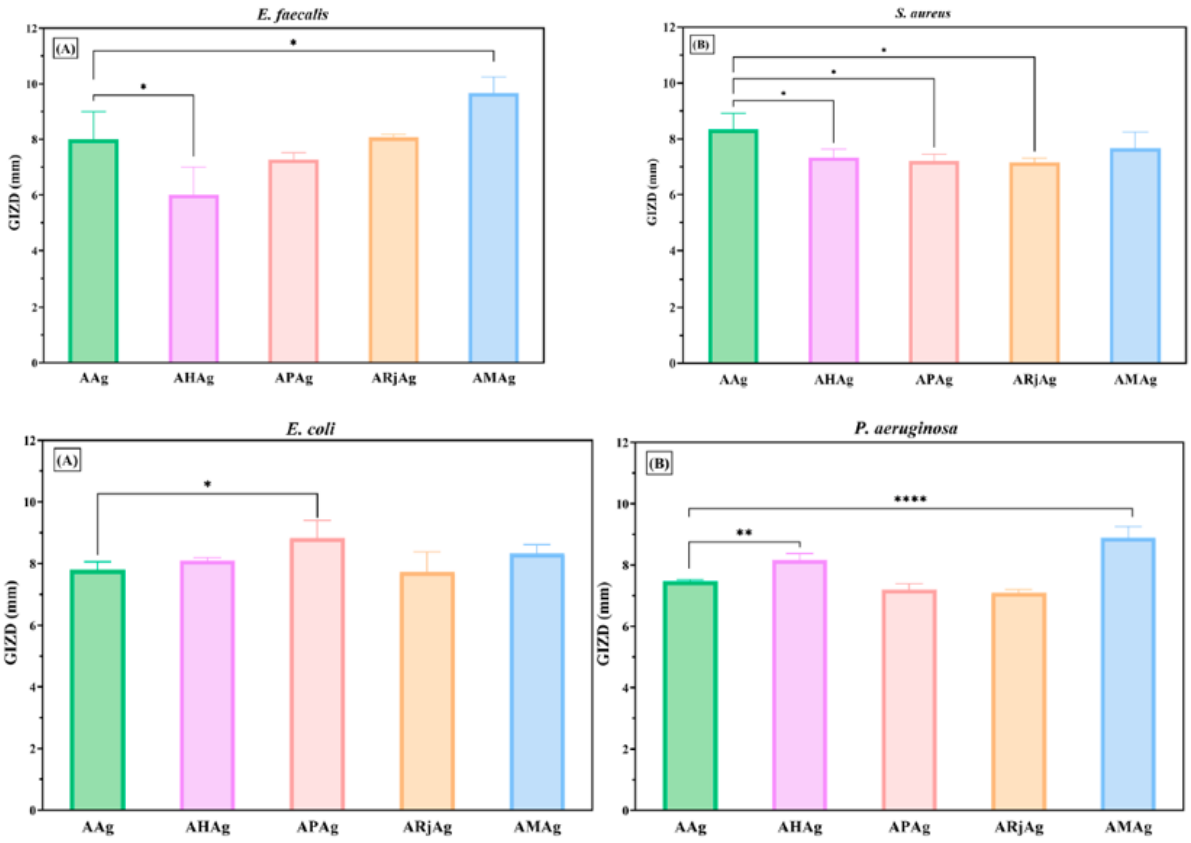
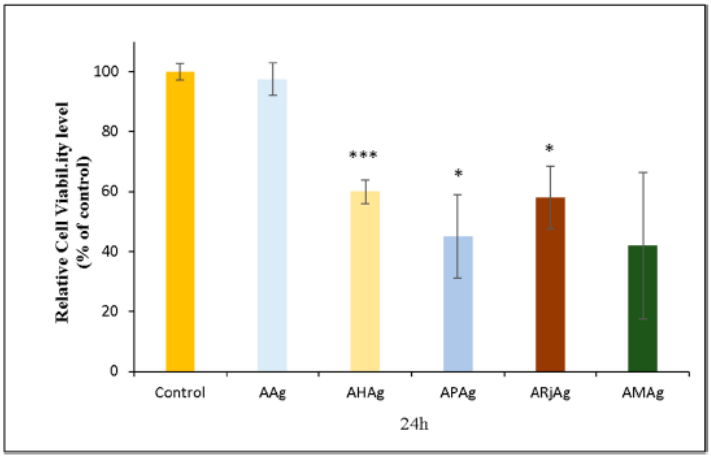
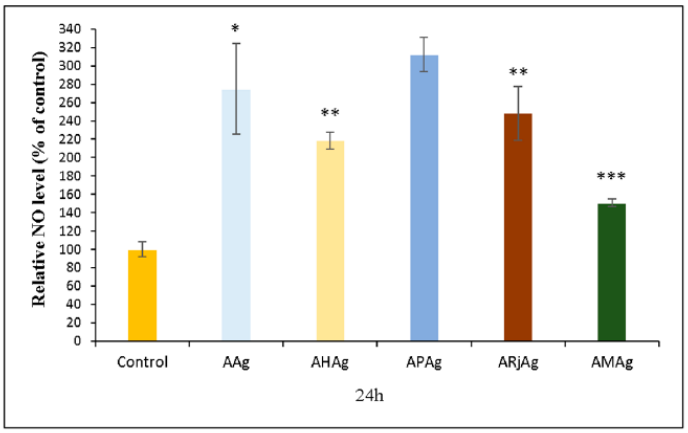


Fig. 15 Antibacterial profiles of alginate–chitosan films against Gram-positive and gram-negative bacteria

We evaluated the antimicrobial activity of the alginate–chitosan films by measuring inhibition zones. The combination of all three bee products with AgNPs, AMAg, showed the highest efficacy, suggesting a synergistic effect (fig. 15). The simple AgNP film, AAg, exhibited good activity against S. aureus, confirming the role of silver. Propolis combined with AgNPs was most effective against E. coli, while honey enhanced the effect against P. aeruginosa. Interactions between the bioactive compounds and AgNPs, also indicated by UV-Vis and fluorescence analyses, may influence the release and intensity of the effect. These results highlight the potential of combinatorial formulations for antibacterial wound dressings, although future studies will need to quantitatively assess activity and investigate synergistic or antagonistic effects.





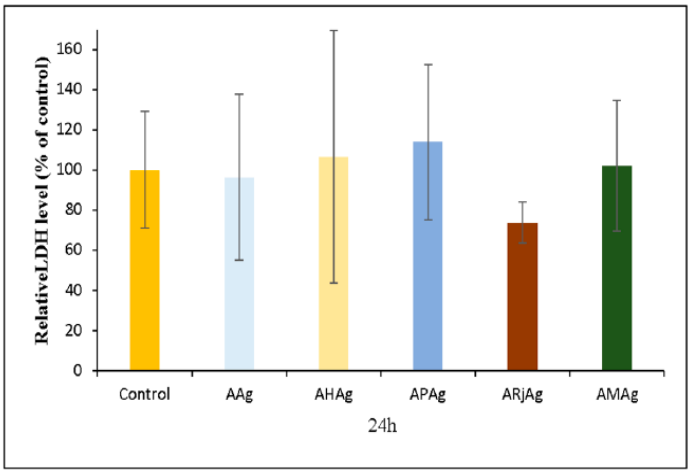


Fig. 16 Citotoxicity assays – MTT, LDH and NO of human gingival fibroblasts (HFIB-G cell line) cells measured by LDH assay after 24 h of incubation with medium previously incubated for 24 h with the samples based on bee products: AAg, AHAg, APAg, ARjAg and AMAg.

The AMAg formulation showed the highest inhibition against E. faecalis, while AAg (AgNP only) was most effective against S. aureus. These results suggest that combining bee products with AgNPs enhances antimicrobial effects more pronouncedly against certain Gram-positive strains, particularly E. faecalis. APAg and AMAg were also effective against Gram-negative bacteria (E. coli, P. aeruginosa).

We assessed the biocompatibility of the films using MTT, NO, and LDH assays (fig. 17). The MTT assay showed that AgNPs alone (AAg) maintain cell viability close to 100%, while the addition of bee products slightly reduces metabolic activity, with AMAg showing the lowest viability (~50%). The NO assay indicated immunomodulatory effects, with APAg producing the highest nitric oxide levels, whereas AMAg exhibited moderate levels, suggesting balanced stimulation. The LDH assay confirmed that all samples preserved cell membrane integrity, indicating low cytotoxicity. Overall, the films are safe for cells, but optimizing the concentrations of bee products is important to balance antimicrobial efficacy and cellular compatibility.

Cytotoxicity evaluation (MTT, LDH, NO) demonstrated that chitosan–alginate films with AgNPs (AAg) are biocompatible, whereas incorporation of bee products—especially in combination (AMAg)—can increase cellular stress and reduce fibroblast viability. Therefore, optimizing the composition and concentrations of natural additives is essential to achieve a balance between antimicrobial effectiveness and cytocompatibility, which is critical for the safe and effective development of advanced wound-healing biomaterials.

III. General conclusions

Wound healing remains a major clinical challenge, and traditional strategies do not always provide the necessary bioactivity. This research developed multifunctional natural biomaterials—collagen sponges with propolis and chitosan–alginate films enriched with honey, propolis, royal jelly, and green-synthesized silver nanoparticles.

The materials obtained demonstrated structural stability, effective antimicrobial activity, and good biocompatibility. Synergistic combinations of natural polymers, bee products, and AgNPs led to promising performance in skin regeneration and infection prevention.

Limitations include variability of raw materials, moderate cytotoxicity at high concentrations of AgNPs or propolis, and the lack of in vivo testing, indicating the need for formulation optimization and long-term evaluation.

In summary, this thesis provides essential insights into the design and fabrication of natural, bioactive biomaterials for dermal tissue engineering and wound healing. By harnessing the unique properties of bee products alongside biopolymers and ecologically synthesized silver nanoparticles, the research establishes a solid foundation for creating efficient, multifunctional dressings that support tissue regeneration and combat infection. Although challenges and limitations remain, the encouraging results motivate continued research and refinement of these materials to enable translation to clinical applications. Continued interdisciplinary collaboration in this field holds significant potential to improve patient outcomes and raise standards of wound care.

Through ongoing investigation and interdisciplinary collaboration, the biomaterials developed here can contribute significantly to advancing effective, natural product–based therapeutic solutions in modern medicine.

Future perspectives

Future research can proceed in multiple directions. First, in vivo studies and clinical evaluations will be essential to test the efficacy and biocompatibility of these materials in real models. Second, optimization of composition and controlled release of bioactive compounds can enhance therapeutic performance.

Additionally, the inclusion of other bioactive agents, such as plant extracts, pollen, or antimicrobial peptides, may expand material functionality. Advanced material engineering techniques, such as electrospinning or 3D printing, could improve structure, porosity, and mechanical properties. Finally, long-term evaluation of antimicrobial efficiency and biofilm resistance will be crucial for durable clinical applications.

In conclusion, this research opens multiple avenues for future development, and the biomaterials developed here could contribute significantly to natural and effective solutions in modern medicine.

List of publications

ISI articles

- Corina Dana Dumitru, Ionela Andreea Neacsu, Alexandru Mihai Grumezescu, Ecaterina Andronescu. *Bee-Derived Products: Chemical Composition and Applications in Skin Tissue Engineering.* **Pharmaceutics** 2022; Q1; IF=5.5.

- Corina Dana Dumitru, Ionela Andreea Neacsu, Alexandru Mihai Grumezescu, Ecaterina Andronescu, *Collagen Based Systems with Propolis Tincture for Dermal Tissue Engineering. U.P.B Sci. Bull., Series B, Vol.87 , Iss.3 , Year 2025*; *IF=0.38.*

- *Corina Dana* Dumitru; Ionela Andreea Neacsu; Ovidiu Cristian Oprea; Ludmila Motelica; Bianca Voicu Balasea; Cornelia-Ioana Ilie; Florica Marinescu; Alexandra Ripszky; Silviu-Mirel Pituru; Ecaterina Andronescu. *Biomaterials Based on Bee Products and Their Effectiveness in Soft Tissue Regeneration*. **Materials** 2025, 18, 2689; Q2; IF=3.2.

- Corina Dana Dumitru; Ionela Andreea Neacsu; Ovidiu Cristian Oprea; Ludmila Motelica; Bianca Voicu Balasea; Cornelia-Ioana Ilie; Florica Marinescu; Alexandra Ripszky; Silviu-Mirel Pituru; Ecaterina Andronescu. *Antimicrobial Composite Films Based on Alginate–Chitosan with Honey, Propolis, Royal Jelly and Green-Synthesized Silver Nanoparticles*. **International Journal of Molecular Science** 2025; Q1; IF=4.9.

Participation on conferences

- Corina Dana DUMITRU*,* Ecaterina ANDRONESCU, Ionela Andreea NEACSU, Alexandru Mihai GRUMEZESCU, Denisa FICAI. *BIOMATERIALS BASED ON BEE PRODUCTS FOR DERMAL TISSUE REGENBERATION.* Application of Chemestry in Nanosciences and Biomaterials Engineering –NanoBioMat 2021, INTERNATIONAL SCIENTIFIC CONFERENCE → 25-26 June 2021 – Virtual conference

- Corina Dana DUMITRU*,* Ecaterina ANDRONESCU, Ionela Andreea NEACSU, Alexandru Mihai GRUMEZESCU, Denisa FICAI. *THE BIOLOGICAL EFFECT OF*

BIOMATERIALS BASED ON BEE PRODUCTS IN WOUND HEALING PROCESS. Application of chemistry in Nanosciences and Biomaterials Engineering –NanoBioMat 2021, INTERNATIONAL SCIENTIFIC CONFERENCE → 25-27 NOVEMBER 2021 – Virtual conference

- Corina Dana DUMITRU, Ecaterina ANDRONESCU, Ionela Andreea NEACSU, Alexandru Mihai GRUMEZESCU, Denisa FICAI. *BEE DERIVED PRODUCTS AND THEIR APPLICATIONS IN SKIN TISSUE ENGINEERING.* Application of Chemistry in Nanosciences and Biomaterials Engineering –NanoBioMat 2022, INTERNATIONAL SCIENTIFIC CONFERENCE → 22-24 June 2022 – Virtual conference

- Corina Dana DUMITRU, Ecaterina ANDRONESCU, Ionela Andreea NEACSU, Alexandru Mihai GRUMEZESCU, Denisa FICAI. *THE POTENTIAL OF BEE PRODUCTS IN DERMAL TISSUE ENGINEERING.* Application of Chemistry in Nanosciences and Biomaterials Engineering –NanoBioMat 2022, INTERNATIONAL SCIENTIFIC CONFERENCE → 24-26 November 2022 – Virtual conference

- Corina Dana DUMITRU, Ecaterina ANDRONESCU, Ionela Andreea NEACSU, Alexandru Mihai GRUMEZESCU, Denisa FICAI. APPLICATIONS AND PROPERTIES OF HONEY, PROPOLIS AND ROYAL JELLY IN SKIN TISSUE ENGINEERING. Application of Chemistry in Nanosciences and Biomaterials Engineering –NanoBioMat 2022, INTERNATIONAL SCIENTIFIC CONFERENCE → 28-30 June 2023 – Virtual conference

Awards

- ✓ ***Best Poster Award*** for *BIOMATERIALS BASED ON BEE PRODUCTS FOR DERMAL TISSUE REGENBERATION* granted by International scientific conference, APPLICATIONS OF CHEMESTRY IN NANOSCIENCES AND BIOMATERIALS ENGINEERING –NanoBioMat 25-26 June, 2021 Virtual Conference
- ✓ ***Best Poster Award*** for *THE BIOLOGICAL EFFECT OF BIOMATERIALS BASED ON BEE PRODUCTS IN WOUND HEALING PROCESS* granted by International scientific conference, APPLICATIONS OF CHEMESTRY IN NANOSCIENCES

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