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Editorial

Two Important Biopolymers: The Transformative Power of Chitin and Collagen in Multidisciplinary Applications

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Biopolymers are natural polymers produced by living organisms' cells, and have promising multidisciplinary applications. Chitin and collagen are the most important biopolymers in nature. Interestingly, these two biopolymers exhibit similar hierarchical structural organizations. After cellulose, chitin is the world's second most important natural polymer, and has been identified in bacteria, fungi, plants, and marine invertebrates. Chitin can also be enzymatically deacetylated to chitosan, a more flexible and soluble biopolymer. It has many applications, including in the medical, environmental, and agricultural sectors [1–5]. Similarly, nature is a source of massive quantities of collagen, especially in marine organisms. Collagen is the main fibrous structural protein in animals' extracellular matrix and connective tissue. It contributes greatly to biotechnology products and medical applications [6–9].

This Editorial is cover the Special Issue "Chitin and Collagen: Isolation, Purification, Characterization, and Applications". This Special Issue of *Polysaccharides* about chitin and collagen aimed at their isolation, purification, characterization, and promising applications, contains 10 high-quality original articles and two review articles. At this point, an overview of the research results and reviews of existing public literature by the authors is provided, which could help readers find appropriate articles for their field and findings of interest. The contributions are listed below:

Contribution 1 reported that the electrochemical determination of adsorption thermodynamics on chitin is directly linked to its applications in environmental monitoring and technology. There is a strong adsorption of metal ions and their complexes to chitin, which depends on both the oxidation and complexation states of many of the said elements. With chitin forming the outer hull of mobile organisms (animals), this biopolymer is expected to take part in metal distribution in aquatic (limnetic and riverine) ecosystems. The authors demonstrated how chitin properties can control element transport in aquatic ecosystems.

Contribution 2 developed a method for glucose oxidase (GOx) immobilization onto graphite rod electrodes, avoiding enzyme denaturation through adsorption by incubation in chitosan solutions. The suitability of this method in keeping enzyme activity, which is the key aspect regarding immobilization procedures for bioelectrodes development, is evaluated in this paper through cyclic voltammetry in oxygen-free solutions, in order to assess electron transfer between the graphite surface and the active centre of GOx. Furthermore, the catalytic response of the enzyme for energy harvesting in a glucose BFC has been evaluated to confirm the proper stability of the enzyme using this immobilization procedure.

Contribution 3 established a new electrostatic complex-based lecithin and chitosan crosslinked with sodium tripolyphosphate, its use for the encapsulation of orange essential oil, and a subsequent evaluation of its cytotoxicity in zebrafish liver cells (ZFL cell line).

Contribution 4 explored chitosan- and collagen-based materials containing curcumin as a bioactive compound for wound-healing targets. The effects of incorporating curcumin and increasing its concentration on both the rheological properties of the formed solutions

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and the morphological and thermal properties of the three-dimensional scaffolds obtained from them were evaluated. The authors show the appearances of the scaffolds obtained, as well as their surface and cross-sectional surface morphologies. The incorporation of curcumin into the polymeric matrix of chitosan and collagen led to changes in the coloration of the scaffolds. Concerning the surface morphology of the scaffolds, all presented interconnected pores in the polymeric network, which is advantageous and desirable for the proposed application, since scaffolds must allow for the transport of nutrients, absorb fluids and moisture, and allow for cell migration and proliferation. Regarding the cross-sectional surface micrographs of the scaffolds, the polymeric fibres were channelled-distributed, and the addition of curcumin in its highest concentration led to greater compaction of these channels, which was probably due to the cross-linking effect caused by the polyphenol. Therefore, the materials developed in this study were revealed as promising biomaterials for their biological evaluation in tissue regeneration.

Contribution 5 demonstrated that collagen, hyaluronic acid, and chitosan materials can be modified with laser treatment. Scanning electron microscopy (SEM) imaging and infrared spectroscopy (FTIR-ATR) were applied to evaluate laser beam effects on the surface structure. SEM images revealed important changes in the biopolymer film structure. The treatment performed in this article could be used for material modification of potential biomedical purposes.

Contribution 6 reported that chitin is an effective sorbent that can be used in environmental monitoring, without the applications in withholding metal-containing pollutants from wastewater or nuclear fuel reprocessing flows, since the background levels in chitin are very low, with the exception of a few metals.

Contribution 7 assessed the effects of pomegranate peel extract, which is an agro-industrial residue with active properties. The extracts were examined for the rheological properties of potential coatings based on chitosan and gelatine. The rheological properties of the polymeric solutions were also investigated, as was its incorporation order into the system.

Contribution 8 explored how to control the surface properties of chitosan/hyaluronan multilayered coatings for a tumour cell capture. The authors looked for a marker for the development of prostate cancer. In this scenario, films composed of hyaluronic acid and chitosan have demonstrated significant capture potential of prostate tumour cells. This study shows that surface chemistry and morphology are critical factors for the development of biomaterials designed for several cell adhesion applications, such as rapid diagnostic, cell signalling, and biosensing mechanisms.

The application of chitosan from edible cricket species was demonstrated as a Hypolipidemic and Antimicrobial Agent in Contribution 9. The authors successfully converted cricket chitin to chitosan with an approximately 72%, 76% and 80% degree of deacetylation, achieved by varying deacetylation times using concentrated alkaline treatments. This study concludes that chitosan derived from U.S.-reared edible crickets has physicochemical and bioactive properties, similar to commercial crustacean (e.g., shrimp) chitosan. The results established that there is huge potential for the mass production of cricket-based chitosan as the consumer acceptability for arthropods widens outside the traditional source of crustaceans.

Toncheva-Moncheva N. et al. [10] have discovered the conversion of electrospun chitosan into chitin (Figure 1). This innovative procedure allows for tuning and modifying the thermal and mechanical properties and, more importantly, the biodegradation of the prepared nanofibrous mats. This is a reproducible method that offers the unique advantage of modulating the membrane properties leading to stable 2D biomimetic CsU and/or chitin (CsE) scaffolds tailor-made for specific purposes in the field of tissue engineering. This is a robust strategy to tune the properties of 2D biomimetic nanofibers and to transfer chitosan to chitin.

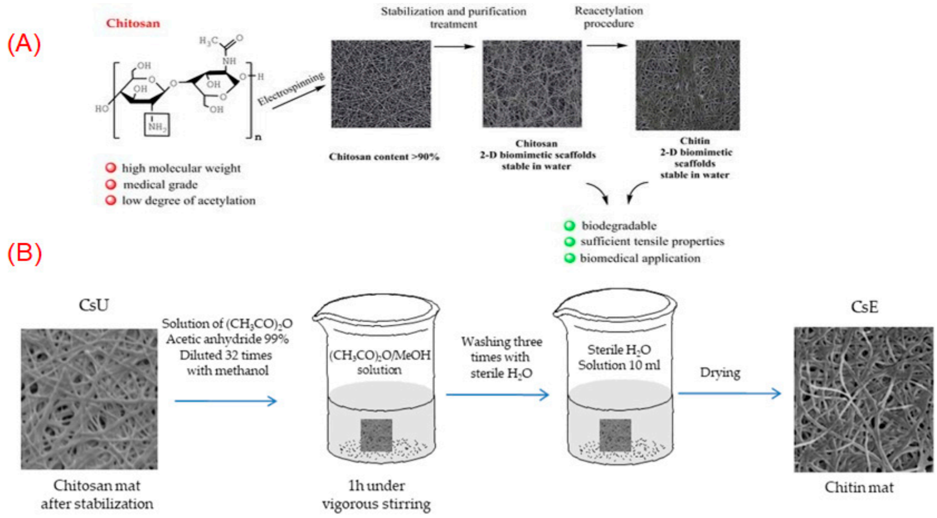

Figure 1. (**A**) Conversion of electrospun chitosan into chitin. (**B**) Reacetylation reaction procedure of chitosan into chitin [10].

Contributions 11 and 12 reviewed the polysaccharides stalk of *Didymosphenia geminata*, which is a species of freshwater diatom seen as invasive and which propagates quickly around the world. Although invasive species are generally considered a nuisance, the authors explored some useful applications for *D. geminata* in the biomedical field and wastewater remediation. Here, the authors highlight the polysaccharide-based stalks of *D. geminata* that enable versatile potential applications and uses as a biopolymer, in drug delivery and wound healing, and as biocompatible scaffolding in cell adhesion and proliferation. Moreover, this article focuses on how the polysaccharide nature of stalks and their metal-adsorption capacity allow them to have excellent wastewater remediation potential. They also aim to assess the economic impact of *D. geminata*, as an invasive species, on its immediate environment. Overall, the authors described both the benefits and environmental concerns of this invasive species, which could help researchers and communities around the world understand the facts.

As a guest editor, I highly appreciate the efforts provided by all the authors who contributed their excellent results to this Special Issue. I thank all the reviewers who carefully evaluated the submitted manuscripts. I would also like to thank the editorial board, managing editors and editorial assistants of *Polysaccharides* for their support and kind help.

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List of Contributions

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