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Chitin Nanofibril and Nanolignin: Natural Polymers of Biomedical Interest

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ABSTRACT

Degradable and natural polymers constitute the class of biomaterials most commonly used as nanocarriers or tissue engineering scaffolds for cosmetic and biomedical applications. Scientists were encouraged to use them as drug delivery systems for their interesting properties as well, increasing their performance and enhancing their versatility and bioavailability to achieve optimum clinical outcome. Examples of the most oriented nanocarriers capable of loading active ingredients to intracellular sites are polymeric compounds such as liposomes, chitosan, chitin and chitin nanofibrils identified by various scientific papers. These natural fibers are used as the most advanced and adaptable engineered polymers for producing safe matrices and innovative carriers, making biocomposite materials. The right combination of polymeric matrices and natural fibre-reinforcing will create composites with the finest properties of each product. In addition, the fibre-reinforced composites have the potential to enhance or change the altered or variable properties (mechanical, thermal, optical or electrical) of the matrices in which they are integrated at the concentration rate from 1% to 10%. The ideal material for biomedical use, however, should be biocompatible, biomimetic, non-toxic and non-immunogenic and should also be capable of facilitating cell adhesion, development, migration and in vivo responsibility at the molecular and physical level.

Therefore, the biodegradability of all the materials used should be another important aspect of the tissue design, keeping in mind that a slow biodegradation should be preferred for a long-term human implant, whereas a fast biodegradation should be necessary for the tissue to be repaired. In addition, the use of polymeric tissues with the same skin structure Extra Cellular Matrix (ECM) will promote cell proliferation and differentiation. The development of nanoparticles will also help to improve therapeutic effectiveness and reduce the undesirable side effects of the polymer option mechanism by monitoring its drug / active ingredient's bioavailability and release. For example, this type of release system can carry a wide range of active ingredients through the epidermis, keeping them in the right time and dosage at the action site. Consequently, nanotechnology may aim at (a) facilitating the transport of ingredients, increasing their efficacy and reducing possible toxic side effects; (b) maximizing contact time with the skin, minimizing transdermal absorption; and (c) releasing the active substances in the designated sites. Additionally, these polymeric nanostructures prefer further interaction with the skin stratum corneum and increase the amount of active ingredients incorporated to enter the site of action. The need to design the correct protocol, (a) characterizing the size and morphology of nanoparticles and fibers, (b) achieving both the proper nano-encapsulation of the active ingredients and their inclusion in the polymer fiber / tissue, taking into account the stability of the entire system and its loading efficiency, release pattern and activity.

Lignin and Chitin are two building materials, produced from waste, which give strength to the exoskeleton of crustaceans and plant cells. Both polymers appear to be a dynamic structural source of molecules that trigger immune responses to humans as well. Furthermore, due to their different electrical charges covering the surface of these natural ingredients, they may be bound to form micro / nanoparticles and innovative nanocomposites to be embedded in non-woven tissues for the production of advanced drugs, which are more effective when used in their nanodimensions. By using these polymers, porous scaffolds can be produced which, by imitating the natural Extra Cellular Matrix, can facilitate appropriate cell infiltration, proliferation and differentiation. In fact, both chitin and lignin have an interesting antioxidant, anti-inflammatory and healing effect and are easily metabolized from environmental and human enzymes without producing toxic secondary ingredients. To support these activities, some data are reported in this paper.

Keywords: Chitin; Lignin; Chitinase; Nanofiller; Biocomposite; Chitin nanofibril

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