Nanotechnology and Photoprotection from Within Out

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Introduction

Excessive exposure to ultraviolet radiation (UV) leads to Development of various skin disorders, such as erythema and hyperpigmentation. Both UVA and UVB rays induce adverse biological effects, including DNA damage, oxidative stress, free radical production, photoaging and skin cancer [1]. Moreover, infrared radiation (IRA) contributes to photoaging by upregulating MMP1 expression in dermal fibroblast [2]. To obtain a more stable and broader photoprotective activity it seems necessary to combine topical and endogenous photoprotection by the combined use of sunscreen emulsions and specific nutraceuticals [3] (Figure 1).

Activities of Nano chitin and Lignin

Nanochitin (Chitin Nanofibrils) has shown to modulate the interleukins activity, slowing down the inflammatory processes, and to normalize the keratinocytes turnover [10,11]. On the other hand lignin has shown to possesses antioxidant, antimicrobial and antimitagenic activities [12] as well as to have a sun blocker effectiveness, notably increasing the UVA and UVB absorbance, when used as ingredient for sunscreen formulations [13].

By a study in progress, these micro/nano particles of CN-LG, produced by gelation method and spray dried, have shown an interesting antioxidant effectiveness as well as the capacity to reduce the MMP1 and IL-8 release (Figures 2 and 3).

Figure 1: Overlap between nutraceuticals, beauty-food, cosmeceuticals and sunscreen products for a global photoprotection.

Figure 2: MMP1 release in aged fibroblasts treated by a beautiful mask made by non-woven tissue of chitin nanofibril-biolignin entrapping active ingredients.
Figure 3: Reduction of IL-8 induced release on irradiated keratinocyte cultures treated by beauty mask made by non-woven tissue of chitin nanofibril-biologin entrapping selected active ingredients.

Increasing also the skin antibacterial activity by stimulating the synthesis of defensine 2 [11,14,15] (Figure 4).

Figure 4: Skin protection activity recovered by beta-defensine-2 on chitin nanofibrils/lignin complex.

It is interesting to underline that both the polymeric nanostructures are able to load bioactive compounds with diverse chemical nature, favouring their skin penetrability in a time-dependent manner. Their penetrability, in fact, depends on the size and the electrical charges covering the superficial structure of the nanoparticles, as well as on their mechanical flexibility [6,16,17].

As previously reported by Morganti [6] the SEM and the light scattering analysis of the block-co-polymeric nanoparticles of CN-LG displayed on a nanometer scale textured surface consisting of a tender and regular granular morphology where LG is intimately incorporated and linked to the CN nanocrystals to form prevalently nanoballs (Figure 5) with an average mean size equal to 61.9 nm (Figures 5 and 6).

Figure 5: Chitin nanofibril-lignin at SEM.

Figure 6: Particles size distribution of the block co-polymeric nanoparticles of CN-bio-lignin.

Moreover our in-progress studies designed smart nanopreparations capable not only to release their active cargoes at the right sites, but also to offer a spatial and temporal control over their properties exerted by the right dosage [16,18].

Conclusion

Natural ingredients, such as Chitin Nanofibrils and Lignin, known for their safeness and easy biodegradability [18,19] could be used as interesting antiinflammatory, antibacterial and antioxidant ingredients for formulating innovative topical and systemic photoprotective products. Moreover, the nanoparticles obtained by complexing Chitin Nanofibrils and Lignin have shown a supramolecular architecture which allows...
delivering natural active ingredients with different physical-chemical properties that increase their bioavailability [20,21].

These new delivery systems represent interesting new and safe nanocarriers which can promote the delivery of active ingredients across the skin, controlling their release and providing a local depot and transport through a specific skin or mucous membrane.

In addition, this innovative carrier may be considered active because composed of polymers with a theirselves effectiveness. On one hand CN, metabolized by the chitotriosidase enzymes of our body give rice to the formation of glucosamine and acetyl glucosamine, utilized for the cartilage activities, or glucose used as energetic ingredient of the cells. On the other hand Lignin, as polymer consists of phenolic, carboxylic carbonyl and methoxyl groups having many biological activities. Thus it, capable to capture or inhibit the free radicals present in living systems, displays antioxidant and photo-protective effectiveness. For all these reasons both the polymers and their block co-polymeric nanoparticles, non-toxic, skin friendly and environmentally-friendly could be innovative ingredients for a broader photo-protection from within out.

References