

Nano-chitin and Nano-lignin to Age Well

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Abstract

Chitin nanofibrils (CN) and NanoLignin (NL) are natural polymers used from our research group for realizing complexes able to encapsulate selected active ingredients. The obtained original capsules designed as CN-NL and activated by the ingredients, have been embedded into specialized tissues that, made by natural biodegradable polymers, have been used as novel vehicles (carrier-tissues). These novel tissue-carriers, embedded by the encapsulated active ingredients have been used for realizing innovative pro-aging cosme-nutraceuticals. The paper after a short Introduction on the problems regarding the skin aging phenomena, will report some data on Chitin and Lignin focusing the attention on the capacity they might have to ameliorate the skin's health and beauty of aged skin, when embedded into specialized fabrics (tissues) used as activated effective cosme-nutraceuticals.

Keywords: Chitin nanofibrils; Nanolignin; Vehicles; Tissue-Carriers; Polymers; Pro-aging

Introduction

The skin as all the human organs, modifies its structure due to environment, lifestyle and the skin aging that is a progressive process that begins in the intrauterine life and continues throughout the entire lifetime [1]. However it is necessary to distinguish two different mechanisms of action: the intrinsic aging that is a natural chronological phenomenon due to genetic and hormonal influences and the extrinsic aging caused by the environmental damages provoked for example by The Sun Rays and the Toxicity of the air nanoparticles' activity and the passing of the years [1]. However, it is to underline that both intrinsic and extrinsic aging contribute to the formation of wrinkles, fine lines, pigmentation, skin laxity and thinning that appear on the face of women and men who don't want to age but desire to remain younger as much as possible and for the most longer period. But which the reasons these unaesthetic signs appearing at skin level.

One of the more studied causes of skin aging are 'nanosize structures to be connected with the oxidative stress due to the Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS). They are a group of compounds that, based on the presence of oxygen and nitrogen respectively, possess an high oxidative potential and chemical reactivity produced by biological processes under the influence

of the environment and the lifestyle also [1]. Other causes of aging are due to the telomere shortening, DNA mutations, advanced glycation and loss of collagen at level of the Extra Cellular Matrix (ECM), hormonal decline, impaired autophagy, just for remembering the more studied and recovered ones [1]. The activity of cosmeceuticals as reported by this paper, are discussing the effectiveness of the Chitin nanofibrils and Nanolignin' complex as novel vehicle and active ingredients to be used for an aged skin also. At this purpose it seems that Chitin may be transformed in hyaluronic acid enriching the ECM of the skin depleted of this polymer for the aging process, the worldwide changing environment and a no more regular lifestyle. To understand the purpose this paper would have and the ingredients normally used for ranging a better aging, the physicochemical characteristics of Chitin nanofibrils (CN), nanolignin (NL) and their complexes will be reported together with the supposed role of the proposed tissue-carrier, as novel vehicles for made innovative cosme-nutraceuticals, 100% biodegradable and plastic-free

Chitin

Chitin is a biopolymer that, found in insects, fungi and crustaceans and representing the most abundant natural raw material after cellulose, is produced in biosphere in a quantity between 10 billion and 1000 billion metric tons every year [2].

It is composed by a long chain of semi-crystallin nanofibers made by the assembly of (1-4) β -N-acetyl-D-glucosamine and D-glucosamine units, connected by β -bonds. However Chitin has a backbone similar to the Hyaluronic acid structure: the first polymer is made of glucuronic acid assembled with acetylglucosamine while the second one is acetylglucosamine assembled with glucosamine units (Figure1) [3,4]. In any way it should be noted that although these two polymers have similar structures and linkages, HA is closely associated with many molecules of water while Chitin is a waterphobic Compound (Figure2) [5,6]. This interesting nanostructure is a cationic

polysaccharide that may occur in its α , β or γ form, depending to its source and functions (Figure3) [2-6]. When reduced to its nanosize this cationic structure The Chitin 'nanosize structure, covered by positive electrical charges on its molecular surface, has the capacity, by the gelation method, to easily form complexes with electronegative polymers such as Hyaluronic acid and Nanolignin. The obtained complexes, able to easily overcross the biological barriers of skin and mucous membranes, release their ingredients' content (Figure 3) [7,8] repairing any possible damage [3,4,7,8].

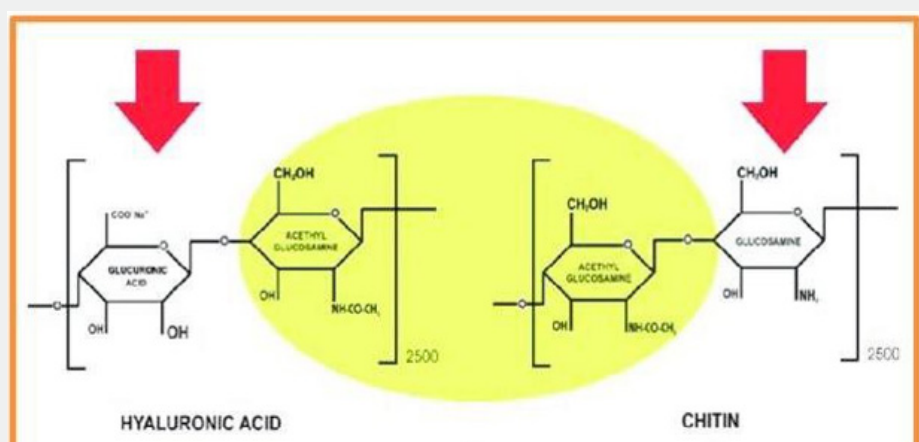


Figure 1: The backbone of Hyaluronic acid and chitin (Courtesy of Morganti et al [3]).

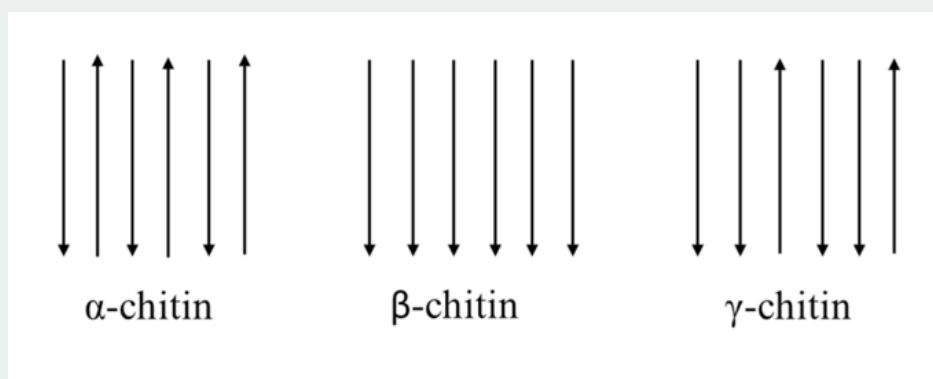


Figure 2: Spatial disposition of α , β and γ Chitin (Courtesy of Triunfo et al [5]).

Lignin

Recovered in great quantity by the plants and grass' biomass, lignin is a complex-branched polyphenolic polyether that, composed by the Union of three monolignol units, p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol, has

the supposed formulation reported below (Figure 4) [9-11]. Due to its great number of functional chromophore groups adsorbing UV Rays, this organic polymer may be considered an interesting natural broad-spectrum sun blocker [9]. Moreover biolignin, for the presence into its molecule of numerous polyphenolic antioxidant groups also, may be used to make

cosme-nutraceuticals for healthy and aged skin specifically when complexed with Chitin nanofibrils. These protective-reparative antioxidant groups, in fact, neutralizing the environmental Radical Oxygen Species (ROS) and Radical Nitrogen Species (RNS) cause of damages to the structural membranes, lipids, proteins and DNA of

the cells, are able to slow down, neutralize or avoid the accelerated aging processes due to the increased endogenous and exogenous oxidative stress [12-14]. The complementary activity of the Chitin nanofibril' components strengthens and invigorates the pro-aging activity of the Chitin nanofibril-Nanolignin complexes (CN-NL).

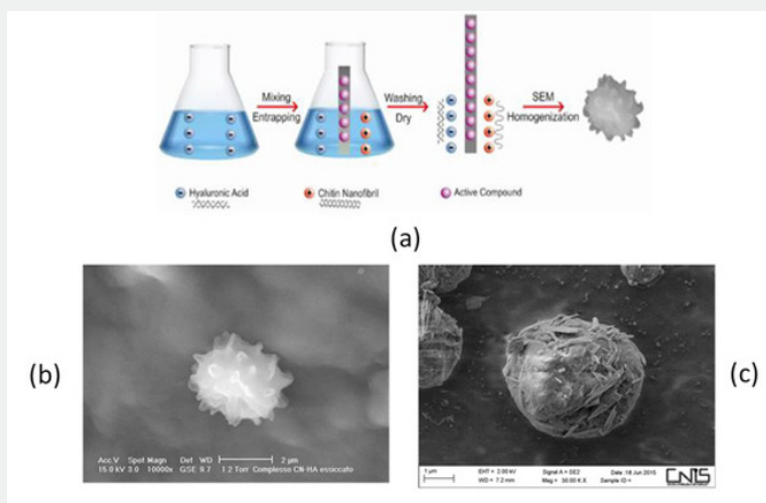


Figure 3: Gelation Method for making (a) the complex Hyaluronan-Chitin nanofibril (b) and chitin nanofibril-nanolignin (c) (Courtesy of Morganti/ Coltelli [8]).

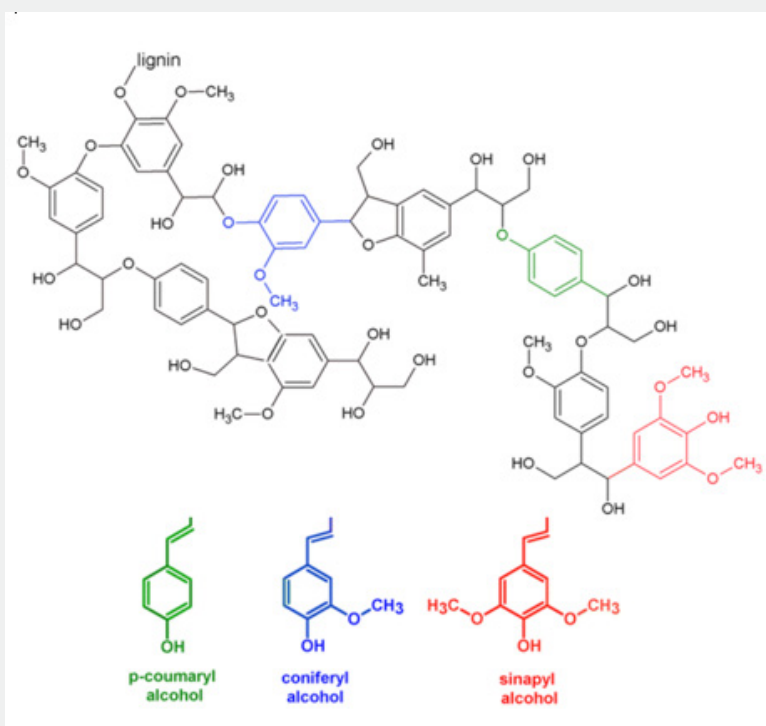


Figure 4: The supposed formulation of Lignin (Courtesy of Serrano et al. [11]).

Hyaluronic Acid (hyaluronan)

Hyaluronic acid(HA) is a Linear ,water soluble viscoelastic ,monosaccharide ,electronegative polymer,composed by two repeating units of N-acetyl glucosamine and D-glucuronic acid linked alternatively by Beta 1,4 and Beta 1,3 glycosidic bonds, as reported in (Figure 1) [15,16]. HA is found in all the organs, representing over 50% of the skin as important component of the Extra Cellular Matrix (ECM) necessary to maintain elasticity,hydration and firmness of the entire body.Its content slows down due to the environmental and the aging phenomena,so

that wrinkles and fine lines appear first of all on the face. Consequently HA ,able to envelop itself by an amount of water up to several times its weight, is used in advanced biomedical treatments and in aesthetic medicine,as biocompatible hydrating raw material for making cosmetics (cosmeceuticals) and diet supplements(nutraceuticals) [15,16]. However,it has also to be remembered that the receptor CD44 bound to the HA surface and responsible of many cells processes such as their migration, adhesion and relative signaling transduction pathways,results to possess fundamental functions.for the cell health living [15,16].

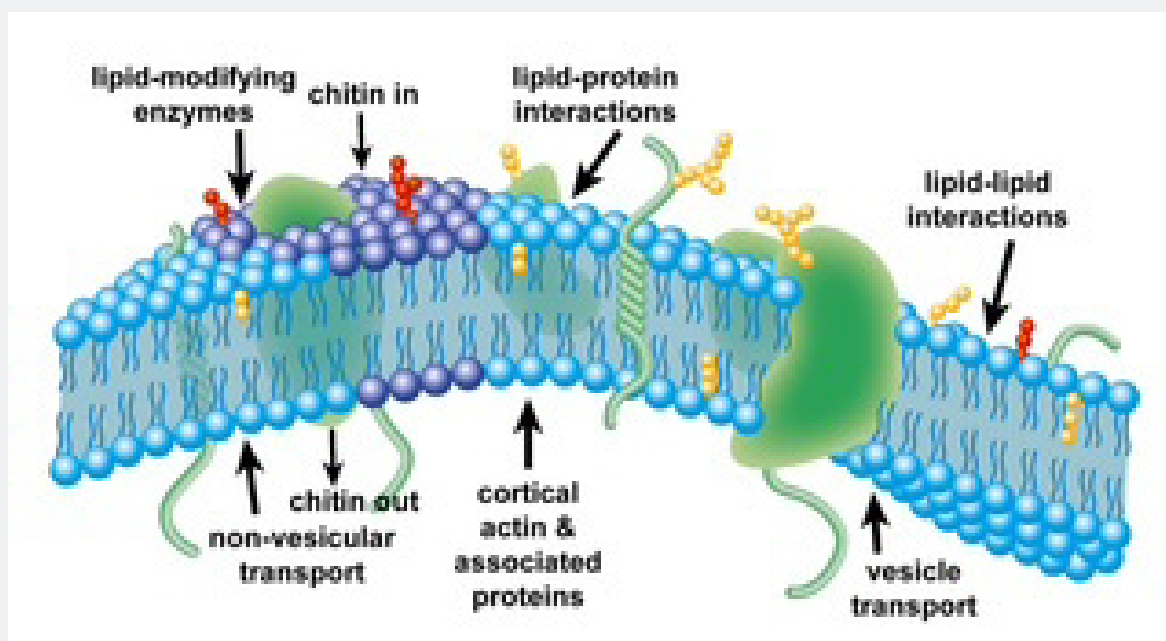


Figure 5: The Hyaluronan synthesized into the cell cytoplasm by some Chitin Saccharidic fragments (Courtesy of [27,28] modified figure).

Chitin-Lignin Complexes(CN-NL)

These specialized complexes (Figure 3) seem able to positively affect the aging process, scavenging the free radicals caused by the increased production of ROS and RNO also [4,17,18]. But how these complexes are made? The CN-NL complexes have been made by the gelation method mixing together the alkaline solution of Lignin with the acid suspension of Chitin nanofibrils at high speed and temperature of 50 C for obtaining the designed CN-NL capsules.Finally and during the mixing electrospinning-process,the selected-encapsulated active ingredients have been added to the final gel-suspension and used to make the projected cosme-nutraceutical tissues(Activated-tissue) [19-26]. The gels,necessary to make the designed tissue-vehicles(Tissue-carriers),have been made by the electrospinning technology and the use of natural biodegradable polymers [22]. Successively ,they have been enriched by the CN-NL complexes, encapsulating the active ingredients and selected in reason of their designed role(activated-tissue) [22-26]. At this purpose,It is interesting to

underline that all the CN-NL complexes have not only the function of novel vehicles able to load,carry and release the selected ingredients at the skin and mucous membranes'level,but act as active ingredients also.Both nanochitin and nanolign polymers ,in fact hydrolyzed by the biological enzymes,release antioxidant,skin repairing and pro-aging agents. Moreover,it is to remember that CN,penetrated through the cell membrane as a needle and recovered as saccharide units into the cytoplasm,seem to be used for synthesizing the hyaluronan polymer,thus enriching the cell'ECM functions (Figure 5) [26-28].

Conclusive Remarks

As previously reported, the novel tissue-carrier may function as novel vehicle to load, carry and release different active ingredients at the right areas of skin and mucous membranes, acting, as pro-aging agent by the use of innovative Cosme-Nutraceuticals realized, at this specific purpose [16-25,28]. To better understand why it's important to change partially or totally

the cosmetic vehicles, some considerations have to be reported and discussed such as the consumption of water and energy for their manufacturing. At this purpose it is to remember that by 2020 the water consumption for making cosmetics accounted to about 10.4 million tonnes, remembering that 60% to 85% of cosmetics consist of water [29-31], necessary to produce the emulsions made by the consumption of an high quantity of energy also [32,33]. Moreover the majority of cosmetics are packed by plastic-containers contributing to increase the waste recovered into the oceans as micro-nano-toxic-particles that, consumed by fishes, birds and sea mammals are entering into the human food also. As a consequence, these toxic plastic particles have been recovered into the tea-caps [34], the Human placenta [35], blood[36], Brain[37] and Other organ systems[38]. In conclusion, the partial use of these novel vehicles as novel carriers for making innovative, skin- and eco-Friendly Cosme-nutraceuticals plastic-free together with the change of the actual lifestyle might be of help to reduce the actual waste ameliorating the human health and preserving the Earth 'environment and its biodiversity for the future generations. This is our dream for a better future.

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