## OPINION

# Biofunctional textiles for ageing skin

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**ABSTRACT**

The skin is the biggest organ in the human body, serving as the first line of defence against external aggressors such as UV radiation and air nanoparticulate pollution.

On the one hand, the skin uses several antioxidant molecules to maintain its natural oxidative equilibrium. On the other hand, the major cause of skin barrier breakdown is ageing, which causes a disequilibrium in the physiological redox system. As a result, new creative cosmetic means, such as biodegradable non-woven tissues capable of loading, carrying, and releasing active chemicals in the appropriate skin layers, are required.

When their fibres are coupled to the correct substances, these revolutionary cosmetic tissues may not only protect the skin from hazardous environmental agents, but also balance the natural skin barrier, serving as anti-ageing agents. The proposed tissues, which are composed of polysaccharide natural fibres made of chitin nanofibrils and nanochitin, appear to be an ideal candidate for the development of new and effective biofunctional textiles, in part because they can mimic the Extracellular Matrix (ECM) of the skin when electrospun.

These new cosmeceuticals have demonstrated the potential for application in food formulations as well as specific anti-ageing agents, demonstrating an intriguing mending efficacy on skin and hair. As a result, they might be employed as both active ingredients and skin smart active carriers in place of traditional emulsions, while also being biodegradable, chemical-free, and available from waste material.

**Key Words:** *Skin barrier; Chitin Nanofibrils; Nanolignin; Air pollution; Nanoparticulate; Reactive oxygen species; Environment; Cosmeceuticals*

## INTRODUCTION

The growing global population, which reached 7.5 billion in 2015 and is expected to reach 9.7 billion by 2050 and 11.2 billion by 2100 , is a result of declining fertility and improved human survival . The worldwide population of people aged 60 and more was 962 million in 2017, more than doubling from 1980, and is anticipated to double again by 2050. Thus, the worldwide population of people aged 80 and more is predicted to more than triple between 2017 and 2050, expanding from 137 million to 425 million.

In 2050, older people are anticipated to make up 35% of Europe's population, 20% of North America's, 25% of Latin America and the Caribbean, 24% of Asia, 23% of Oceania, and 9% of Africa's.

Finally, global life expectancy is expected to increase from 70 years in 2010-2015 to 77 years in 2045-2050, and finally to 83 years in 2095-2100. As a result, the skin loses its appealing and young aspect, displaying the dreaded signs of wrinkles, blotches, discolorations, laxity, blocked pores, dry roughness, and tumour growths.

Older persons who have maintained their looks as they age, on the other hand, are connected with youthfulness and the likeable attributes of being young and healthy.

To summarise, ugly individuals receive less assistance, are rejected, are seen to be morally or socially unfit, and are generally lacking in personality and worth. To mitigate some of these drawbacks, the function of cosmetics and aesthetic tools in boosting the more favourable elements of appearance, with or without probable plastic surgical operations, is seen as critical. This research suggests employing a smart carrier consisting of non-woven tissues infused with antioxidant compounds to try to improve the look of aged skin.

### Skin

Skin, the biggest human organ, accounts for 12%-15% of body weight and has a surface area of 0.5 m2 and a thickness of less than 3 mm . The epidermis, together with the Stratum Corneum (SC), constitutes the body's outer coating, forming a self-repairing and constantly replenished water and antioxidant barrier. As a result, it appears to be the body's first line of defence against environmental aggressions, preventing water loss and penetration by damaging agents such as sun UV radiation and air nano-particulates . As a result, skin is a complex and dynamic organ that is in contact with the environment and ages as a result of its hostile agents. The skin barrier is made up of particular proteins and lipids known as the epidermis's brick and mortar. Bricks are dead cells called corneocytes that are loaded with a huge protein complex called the cornfield envelop. The gap between these cells is filled with lipids that constitute the mortar and are

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linked to the cornfield envelop by calcium, which appears to be a fundamental creation of the barrier that varies its structure with age. However, skin becomes increasingly susceptible as it ages, as numerous naturally protective activities decline: tissues degenerate slowly and irreversibly, as seen first and foremost by fine lines and wrinkles of the face and neck. Desire for eternal beauty therefore plays a vital part in modern culture, which means that both men and women are seeking for therapies to avoid skin ageing phenomena via the use of novel rejuvenation products and procedures.

For example, a combination of the correct photo-protective agents, such as sunscreens and synergistic co-antioxidants like vitamins E and C, as well as other natural components like lutein, applied topically and consumed orally. Their action, in fact, may aid to preserve the skin cell membrane, preventing damage to the SC's lipids and proteins caused by free radicals' pro-oxidative activity.

**Skin dressing**

Some writers believe that bio-functional non-woven tissues should be manufactured as novel textiles made of biologically active materials with smart biological features. They must, in fact, maintain the skin and prevent its ageing processes by engaging with it intensively and intelligently, controlling factors such as surface microbiota, the inflammatory cascade, and the mending processes of old, damaged, or burned skin.

For this reason, and based on our previous experiences, the fundamental scaffolds built for these artificial tissues and closely imitating the ECM architecture appear to be capable of respecting the structure and function of skin cells when properly made.

Non-woven tissues composed of Chitin Nano-Fibrils (CN), Nano-Lignin (LG), and biodegradable green polymers bound to antioxidant ingredients appear to be the best solution for creating engineering scaffolds in which cells can grow, proliferate, and differentiate into a specific tissue during skin regeneration, demonstrating their effectiveness in combating the effects of ageing on the skin, as evidenced by wrinkles and fine lines.Nano-fibers have not only superior stiffness, tensile strength, and flexibility in surface functionalities due to their unique physicochemical properties, but also the same structure organisation as ECM, thus playing a significant role in the transportation of bioactive molecules to the appropriate body sites . This is also why the ongoing European Research Project PolyBioSkin combines natural polysaccharides such as cellulose, chitin, and starch with bio-polyesters such as Polylactic Acid (PLA) and Polyhydroxyalcanoates (PHA) to create biodegradable tissues for the industrial production of innovative baby diapers, bio-active beauty masks, and advanced medications.

## CONCLUSION

The major role of skin, as previously stated, is to act as a barrier against material flow in both ways, from outside to inside and vice versa. In reality, this vital organ constantly interacts with its surroundings, resulting in scenarios that impact the physiological equilibrium of the skin and the entire body. As a result, there is a need to develop biodegradable and biocompatible carriers capable of not only protecting the skin from environmental aggressors, but also temporarily loading and transporting designed and selected active ingredients in order to release them in controlled doses at a chosen level of its various layers. The suggested tissue carriers, which are constructed of biodegradable sugar-like biopolymers reinforced and orientated by nano-chitin, appear to be an ideal choice for promoting cell adhesion and proliferation, which are required for tissue engineering and regeneration.

Their fibres, in fact, have demonstrated excellent mechanical properties, as well as the ability and flexibility to protect skin from environmental aggression, as well as porosity and pore interconnectivity, achieving a proper skin response with antibacterial, anti-inflammatory, antioxidant, and skin repairing effectiveness, without producing any adverse effects. These tissues, consisting of polysaccharide-natural fibres derived from waste materials, have the potential to be employed as new carriers for the production of various cosmetic products, which are distinguished by the presence of appropriate and carefully chosen active components. Thus, it will be feasible to create revolutionary anti-aging beauty masks for example, by binding antioxidants and immunomodulating chemicals to tissue fibres.

As previously reported by the PolyBioSkin project, this breakthrough technology will allow the production of novel and smart cosmeceuticals without the need of preservatives, emulsifiers, and other chemical agents. The major role of skin, as previously stated, is to act as a barrier against material flow in both ways, from outside to inside and vice versa. These new cosmetics, composed of biodegradable and skin-friendly tissues, when bonded to the proper active chemicals and applied painlessly, softly, and directly on the skin as clothes, are able to deliver a fast-repairing and rejuvenating effect in around 30 minutes. Furthermore, because these substances are derived from waste products, they may minimise $CO_2$ production, benefiting both health and the environment.