MULTIROLE OF CHITIN NANOFIBRILS FOR A GREENER SOCIETY

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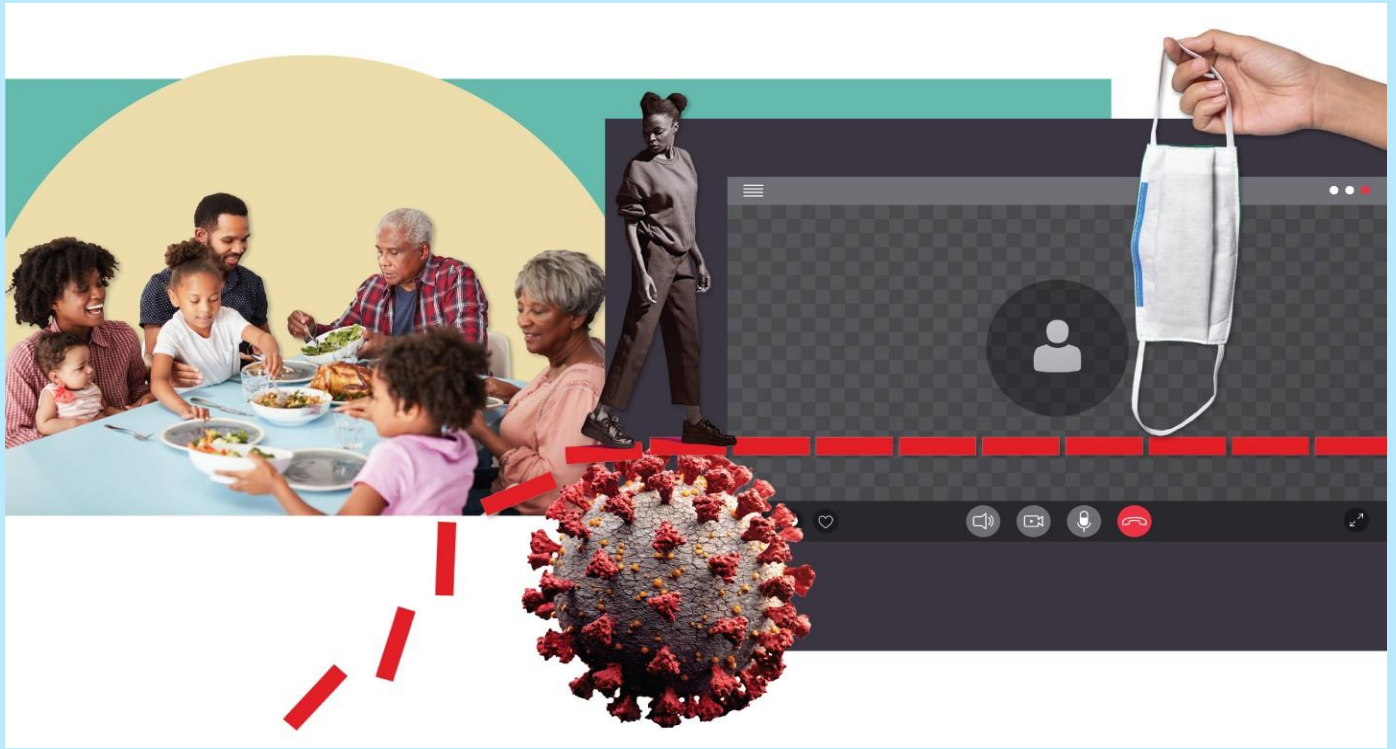
COVID-19 pandemic,impacting both health and wealth,has **changed** the people' **way of living**



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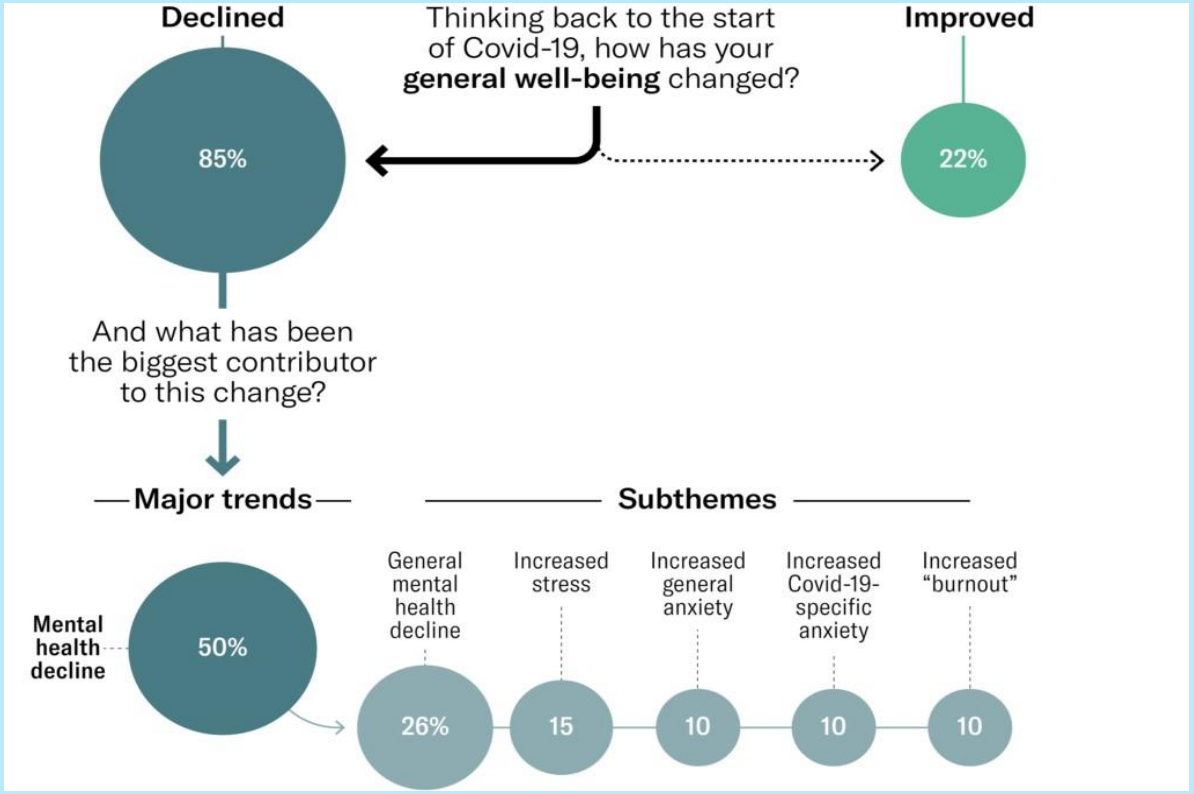
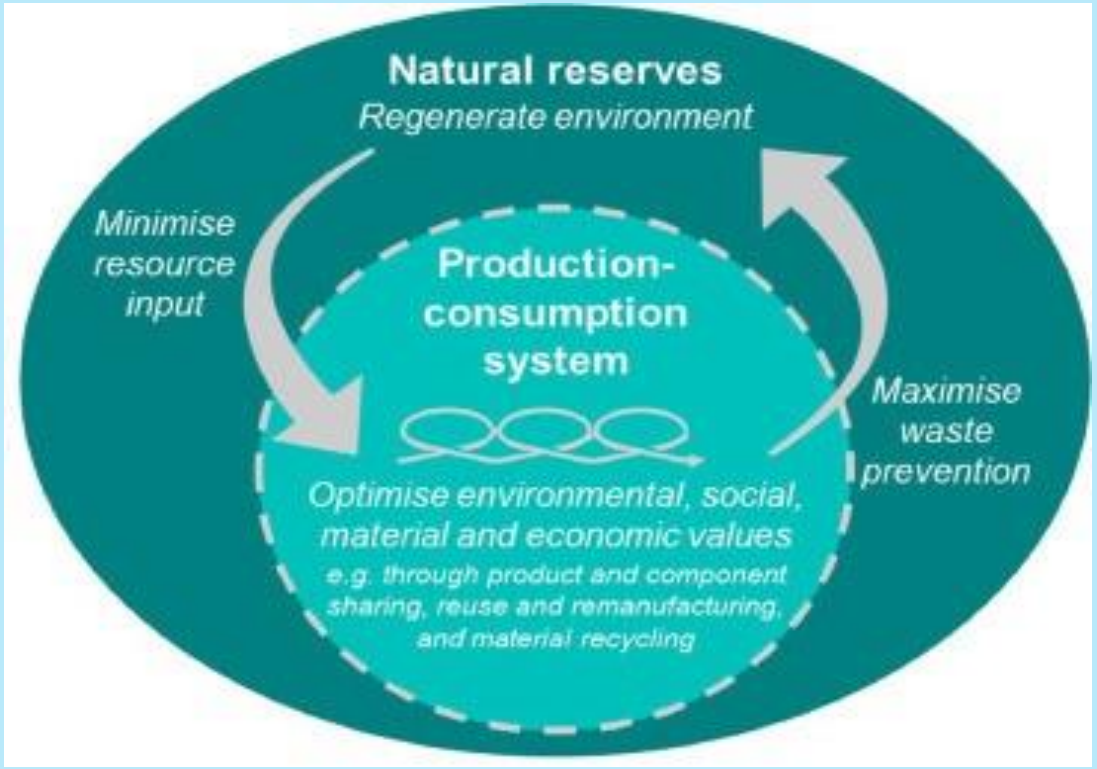
Consequently the general wellbeing changed with a **mental health decline** and **increase** of **stress** and general **anxiety**



Therefore people worldwide are looking for **holistic** and **resilient** solution with a better **production-consumption** system based on the maintenance of natural raw materials and **zero waste**.



Consequently, consumers are more oriented to buy products **nature-derived**, price-sensitive and made by ingredients **skin**- and **environmental-friendly**

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They, in fact, are aware of the Planet' pollution and waste, cause of the increased human **diseases** and environmental **disasters** of the last years.

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Among the most dangerous pollution, is to underline the **waste** of **plastics** invading land and oceans

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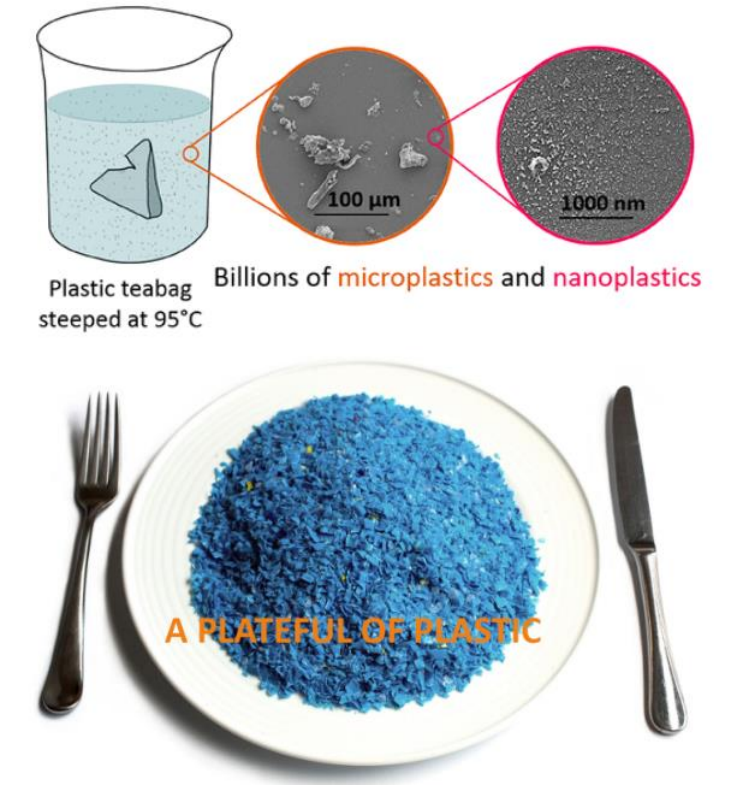
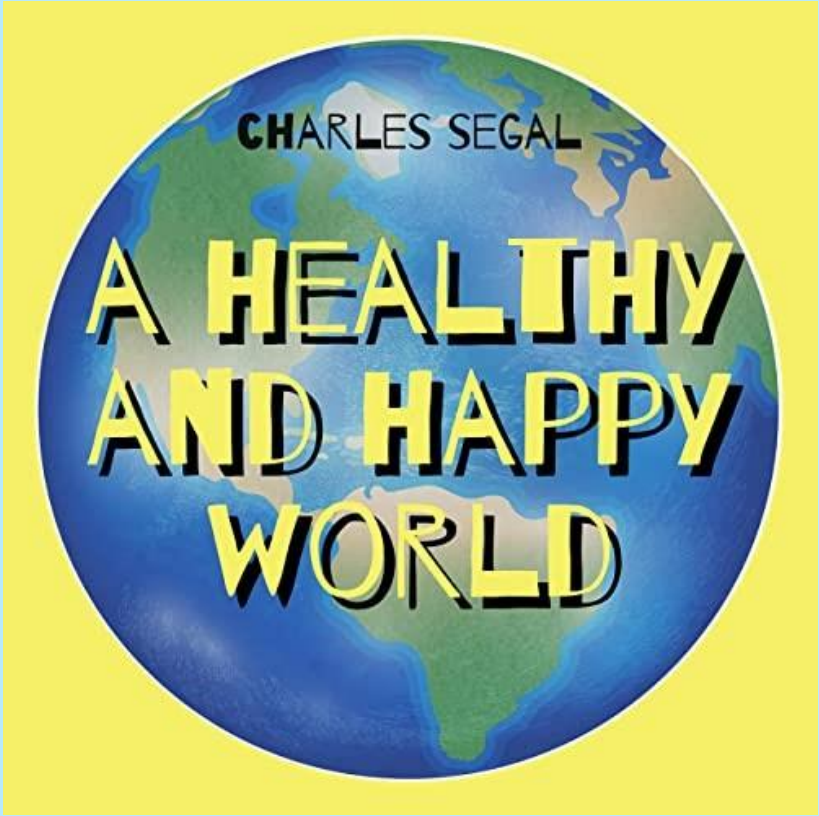
This synthetic material, reduced in **microplastics** elements by sun and enzymes and **ingested** from fish and sea mammals, became **human food** for people recovered in drinking tea, and placenta



Therefore, **reducing waste** and **pollution** and investing in nature has became an **urgent necessity** to create an healthier and **happy world**.



Thus the **urgent need** to reduce consumption of water, energy and natural raw materials, taking a **more sustainable** way of living to preserve the planet biodiversity

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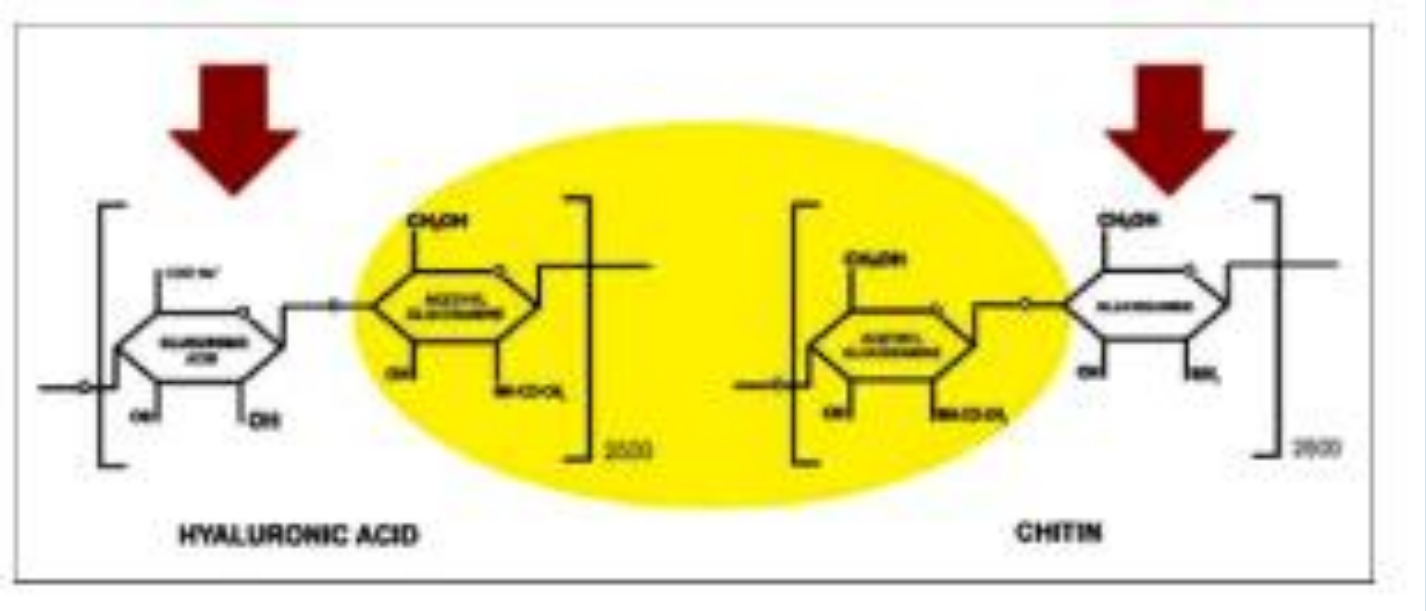
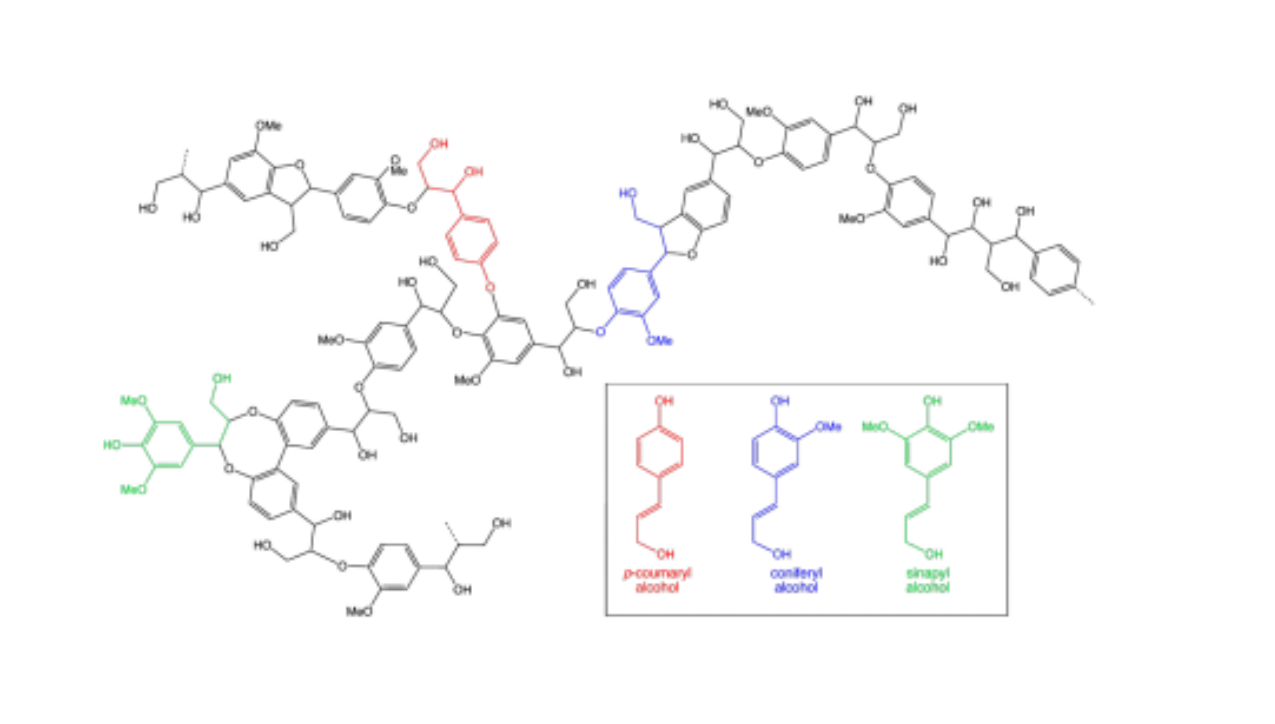
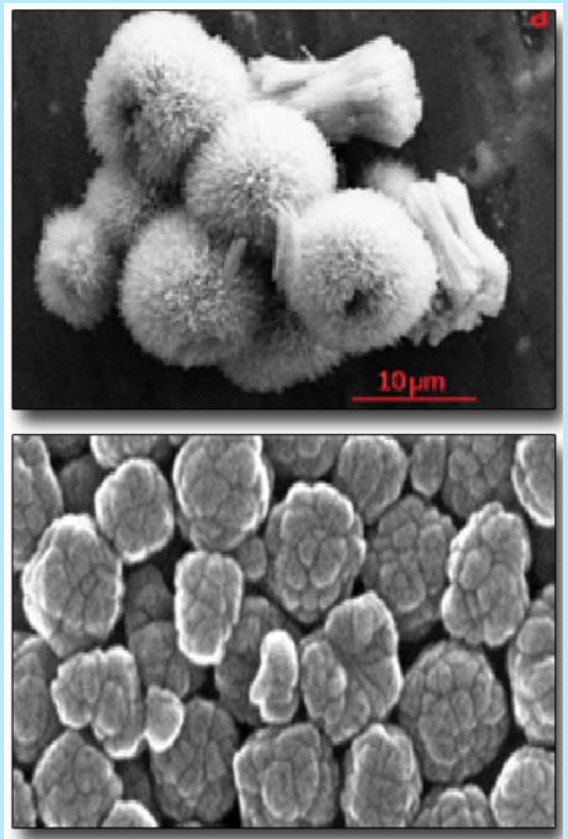
Therefore, it is possible to **make innovative products** by waste materials, such as **chitin**, with **a hyaluronan**-like structure,



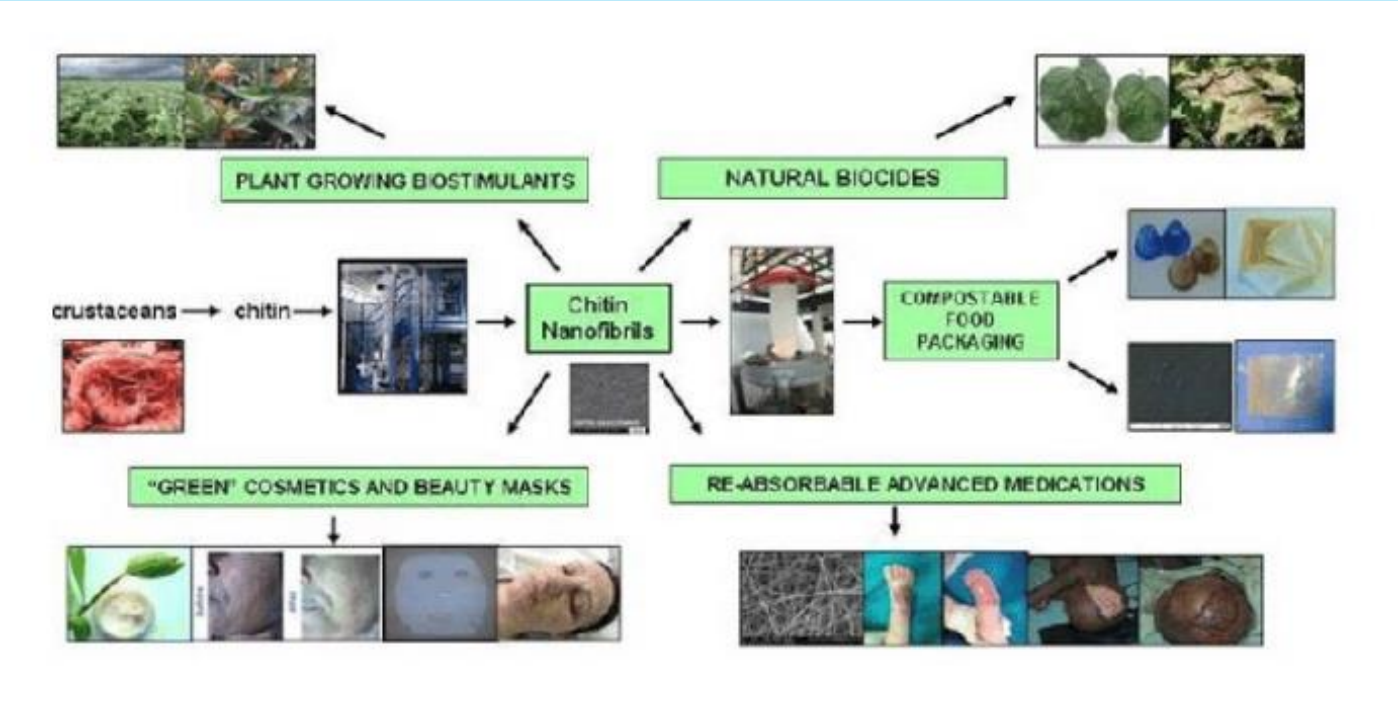
Or **lignin** rich of interesting antioxidant phenolic groups



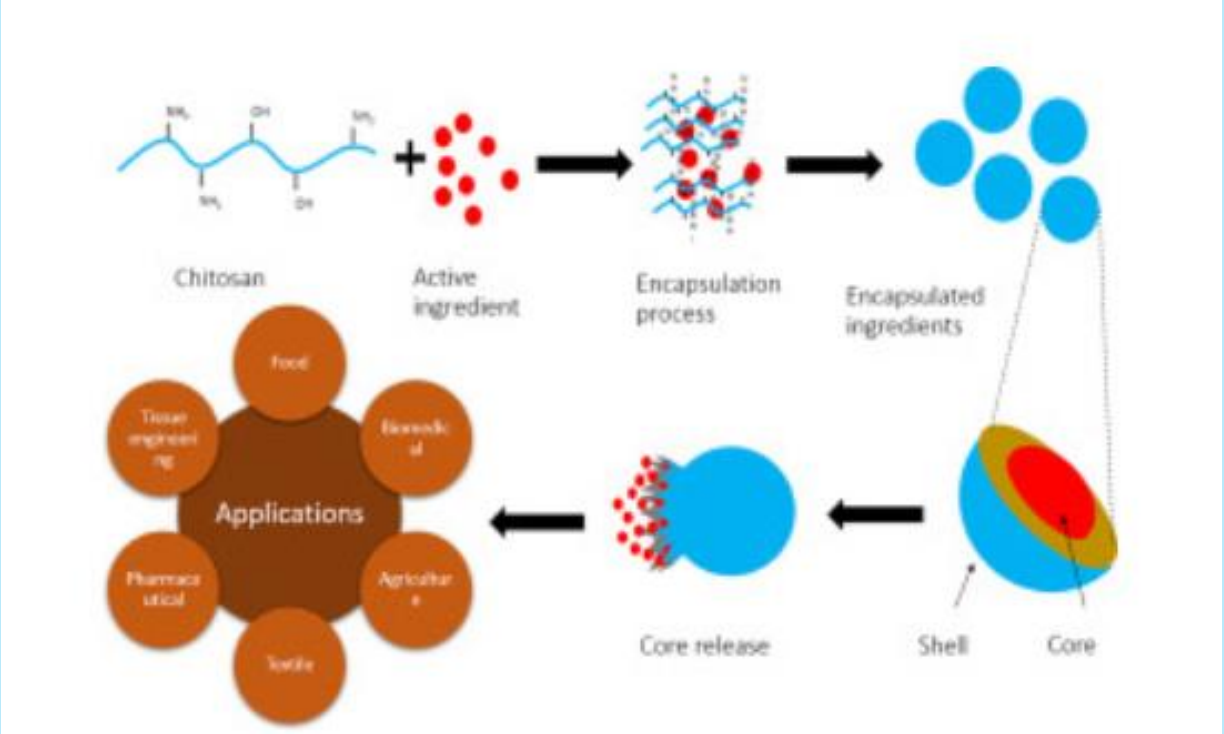
Both the polymers are skin- and environmentally – friendly, easily biodegraded, and useful to make **nanoparticles** and **nanocomposites** of multiple industrial use.



Thus, for example by the use of **chitin** it is possible to realize innovative products to be used in the **Medical, Food** and **Cosmetic** field, as well as in **Agriculture**, as plant **growing stimulants**.



On the other hand **Lignin** for its antioxidant and UV shielding activity may be used in the Medical and Cosmetic fields, also for its **self-assembly property**



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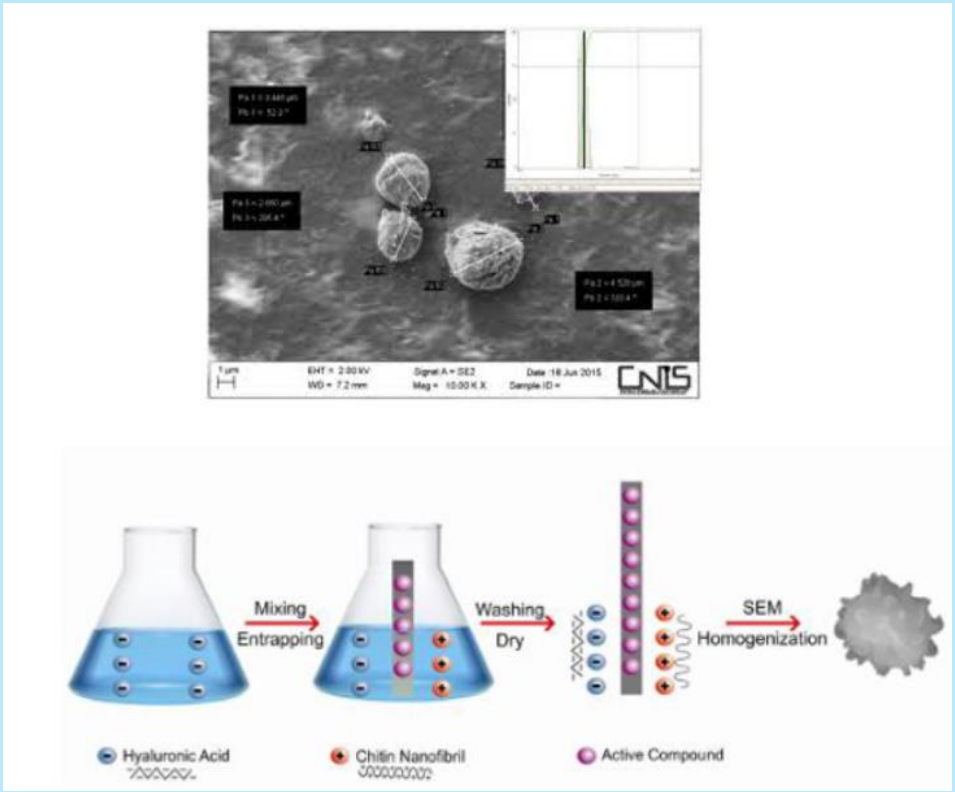
In fact, being **Lignin** and Hyaluronic acid **electronegative** polymers while **chitin** is an **electropositive** compound, they may be combined each other for making micro/nanoparticles (NPS), by the **gelation method**



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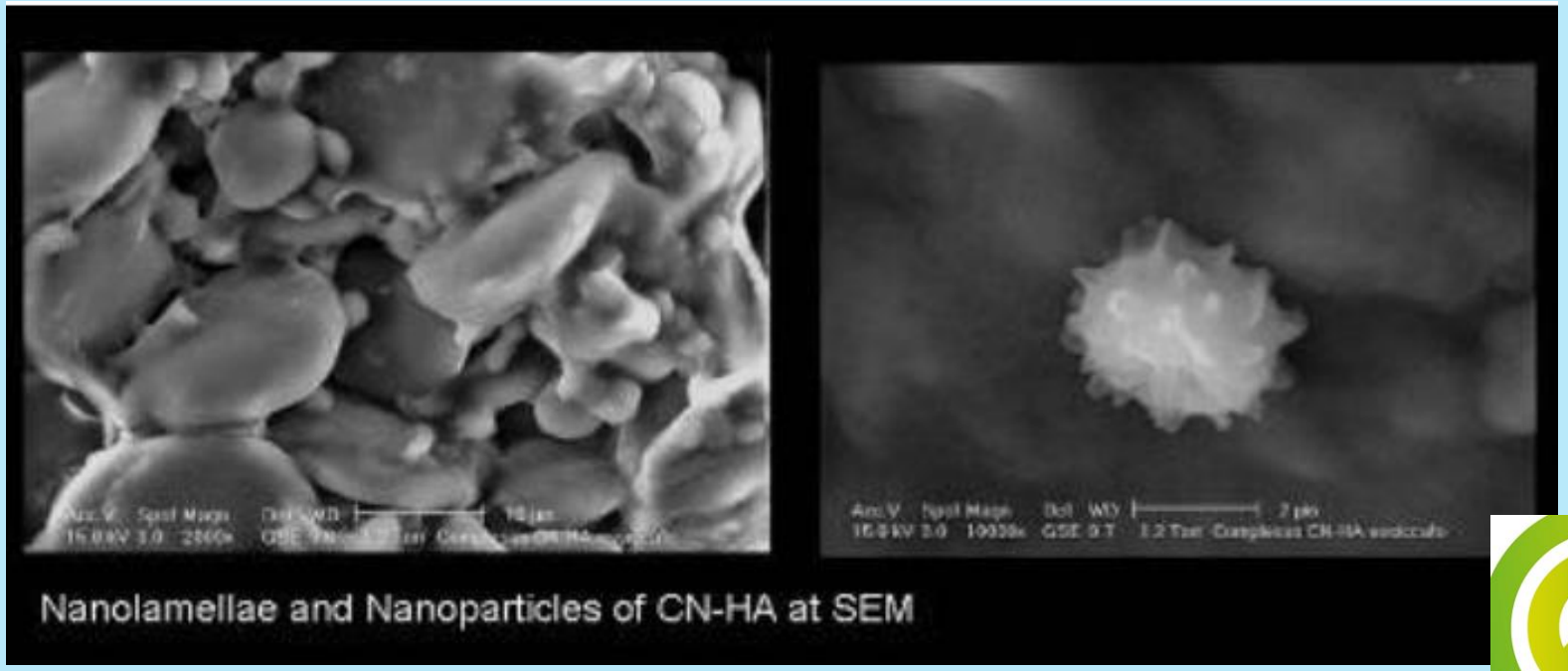
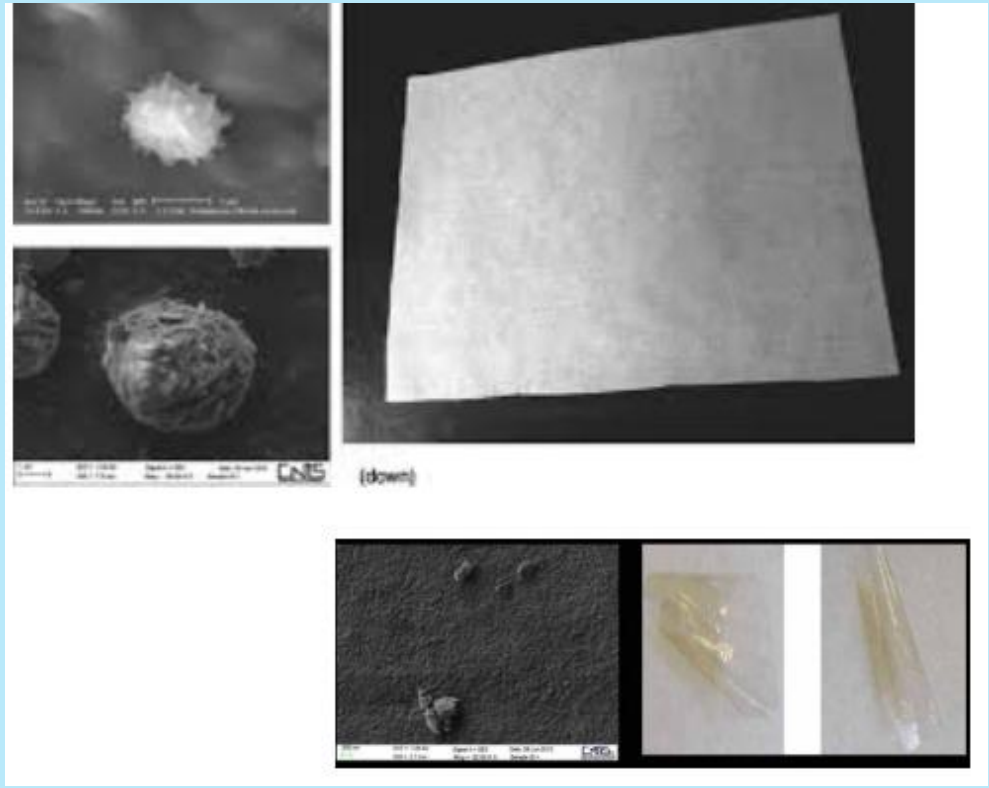
Morevoer, these **NPs**, obtainable in a variety of forms, including nanoparticles, nano lamellae etc, may be diversified in their function **entrapping** different **active ingredients** into their structure



Thus, selected ingredients have been **entrapped** into the natural fibers of **innovative tissues** and **films** to realize new, smart and biodegradable, medical device, cosmeceutical and nutraceutical systems and



Biodegradable food packagings

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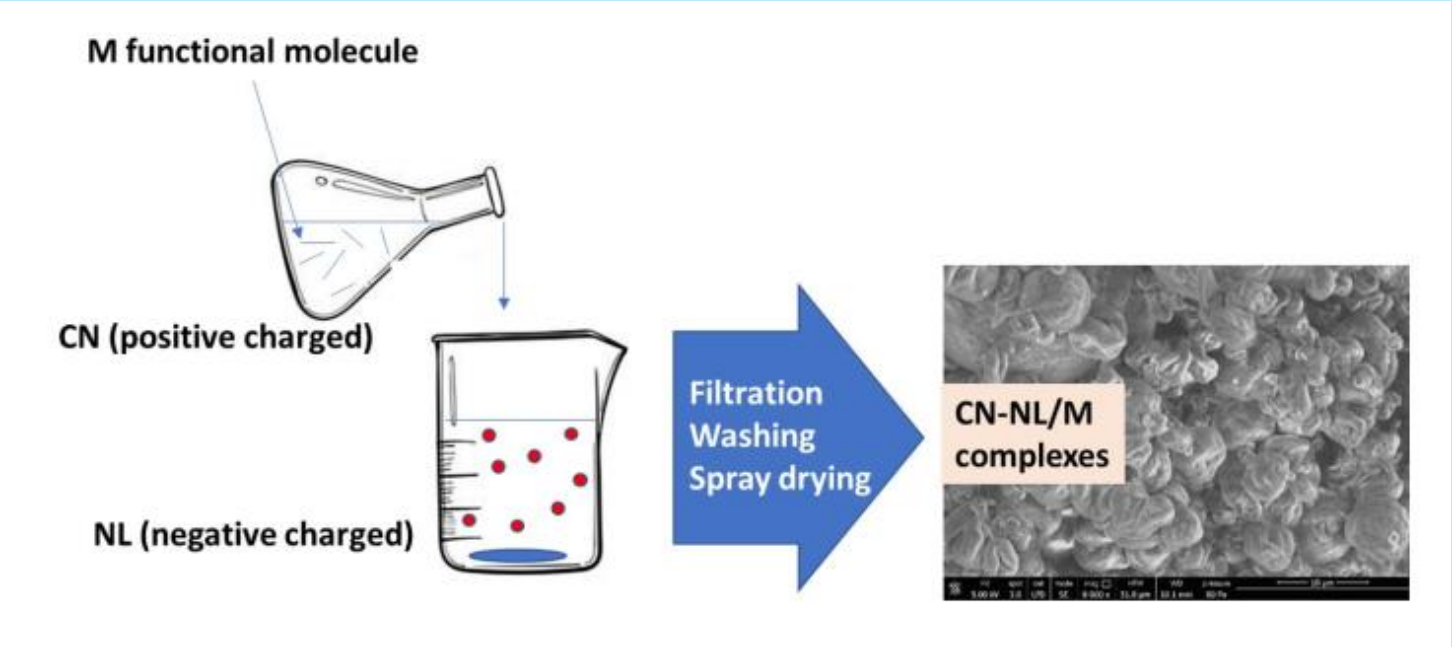
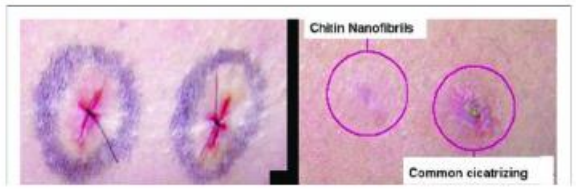
At this purpose, many studies have been dedicated to realize gels and **smart tissues** embedded by active nanoparticles to be used as **innovative carriers** for Medical devices and Cosmetics



Gels and **tissues**, in fact, have shown to be effective to **repair** burned/wounded skin or



Rejuvenate a prematurely aged ones, slowing down **fine wrinkles**, teleagectasia and

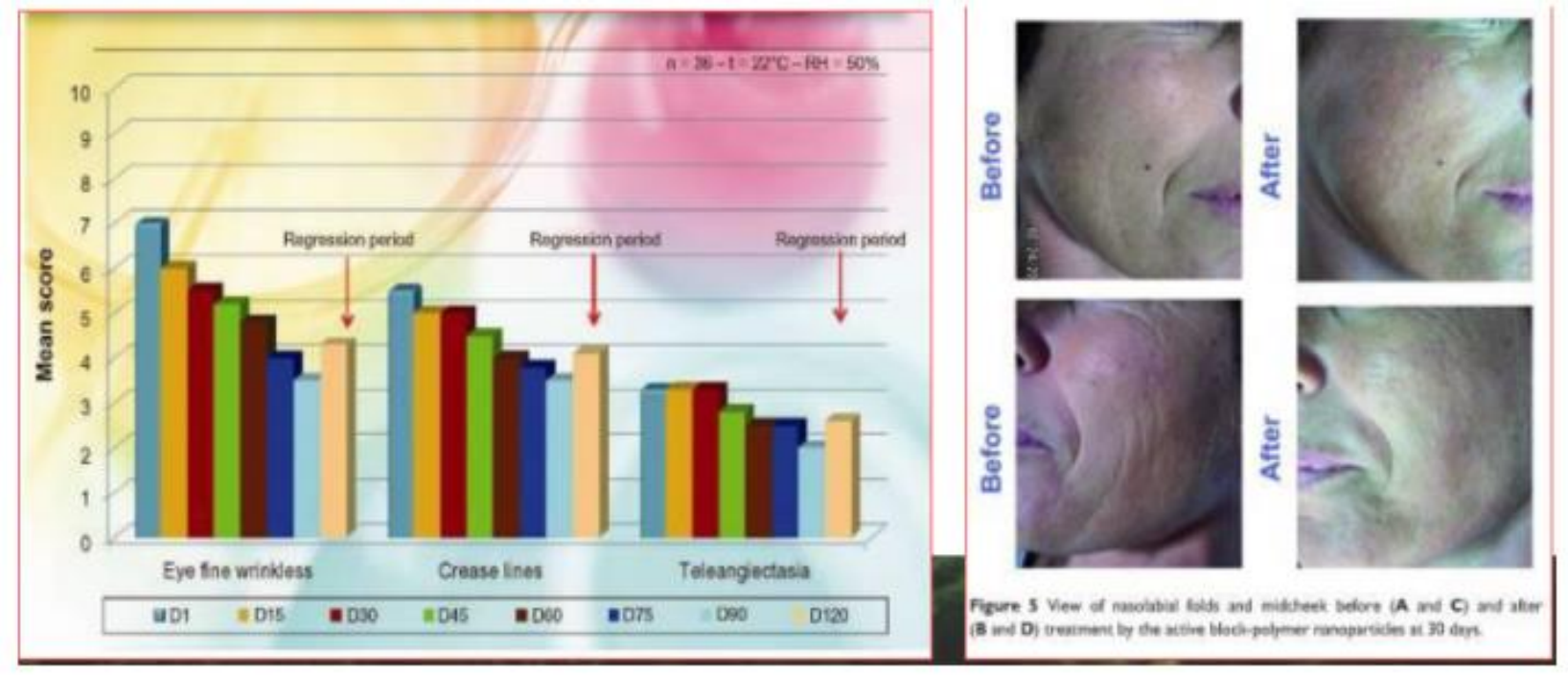


Figure 5 View of nasolabial folds and midcheek before (**A** and **C**) and after (**B** and **D**) treatment by the active block-polymer nanoparticles at 30 days.

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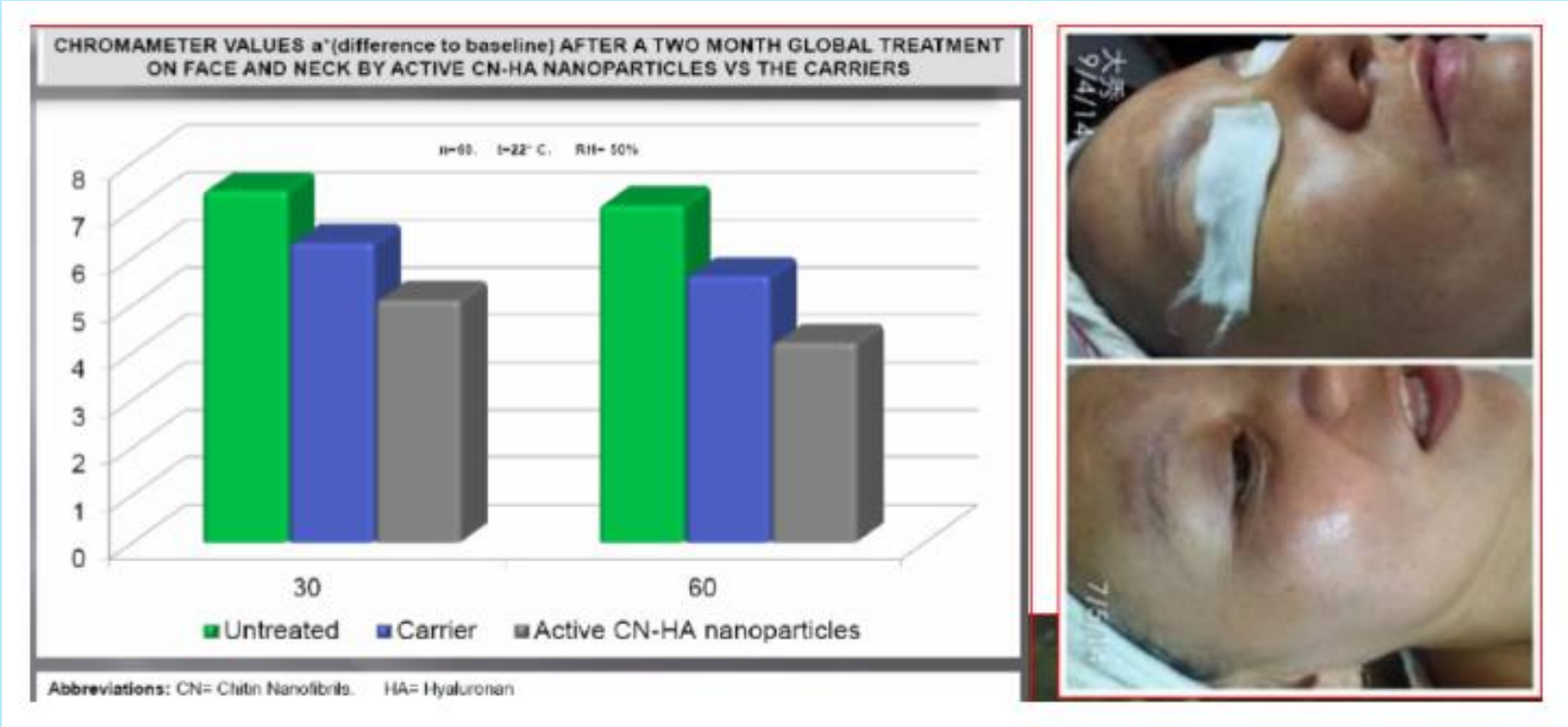
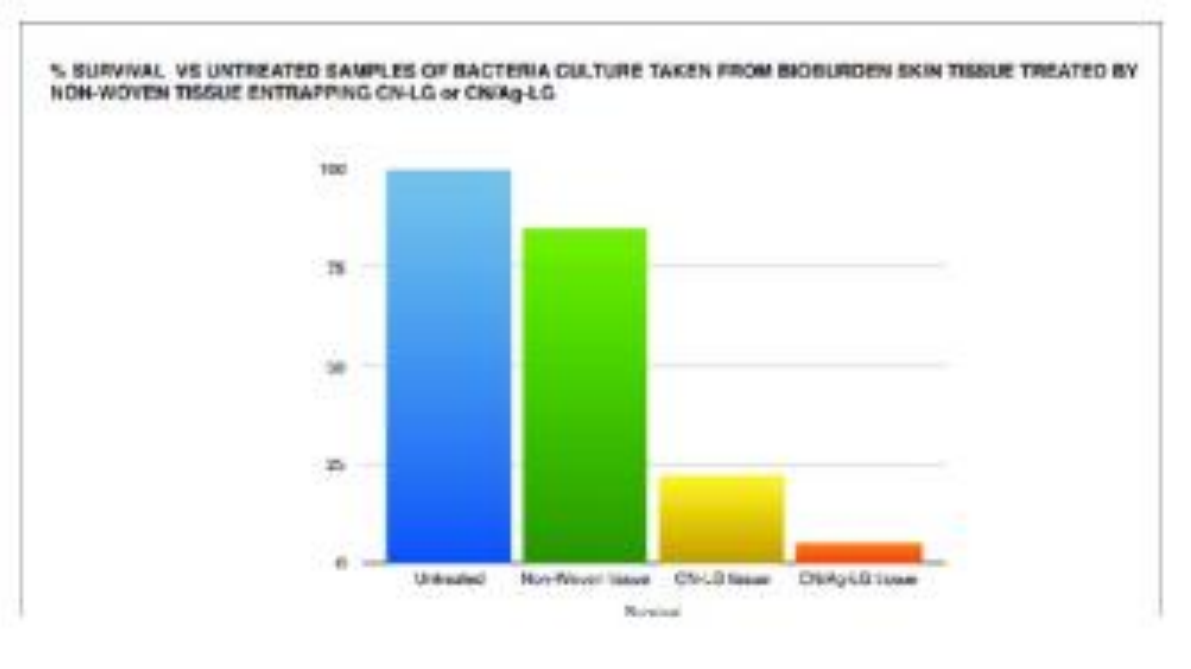
aged spots



or reducing the burden **pathogen bacteria** affecting a diseased skin.



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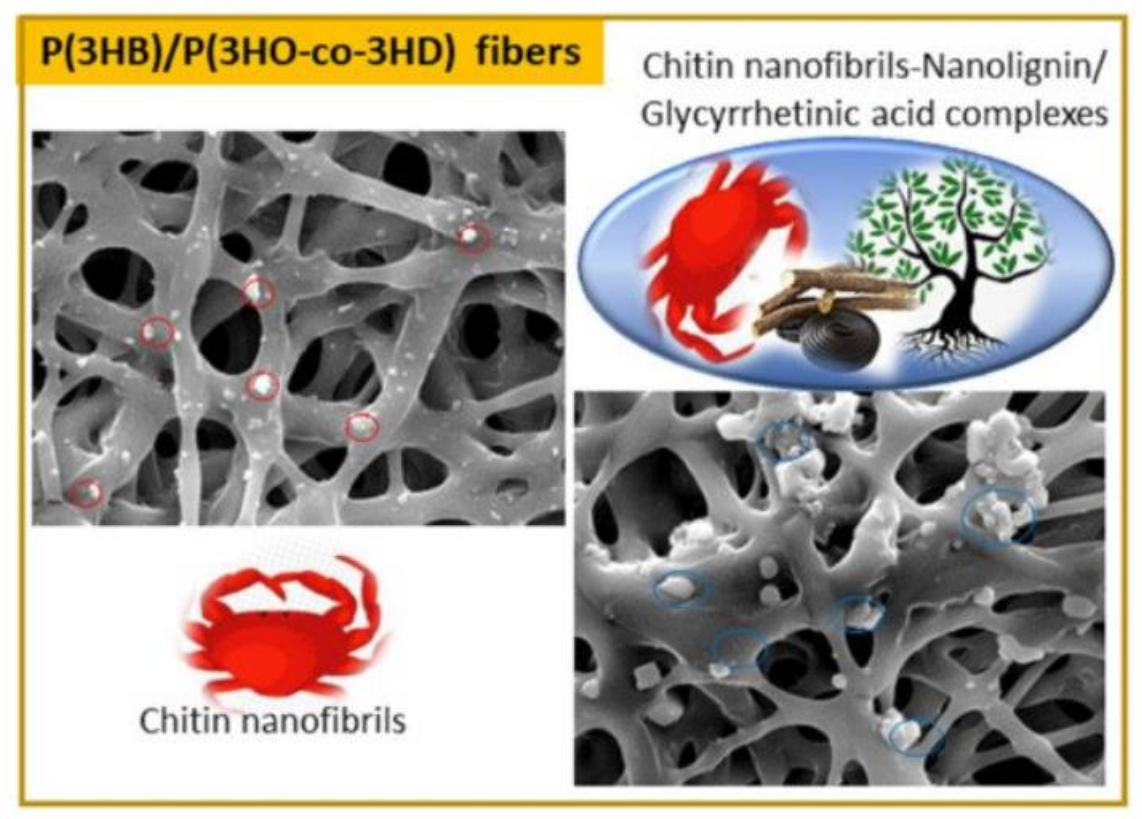
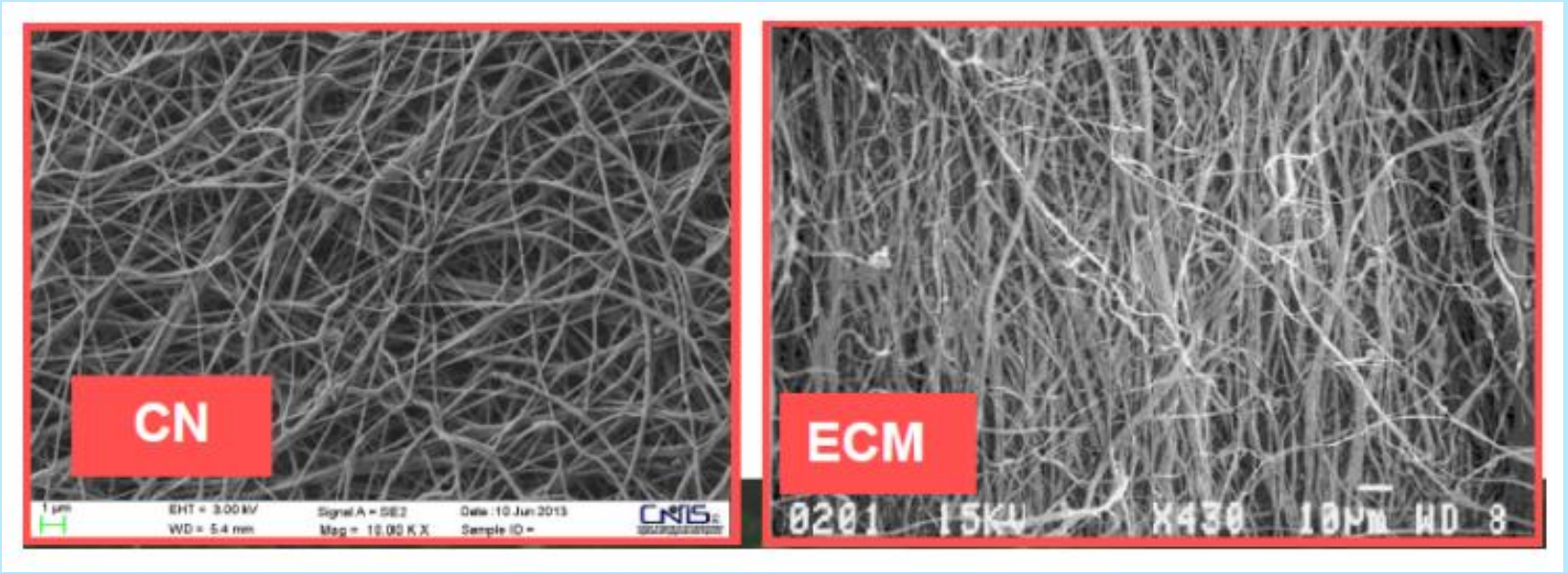
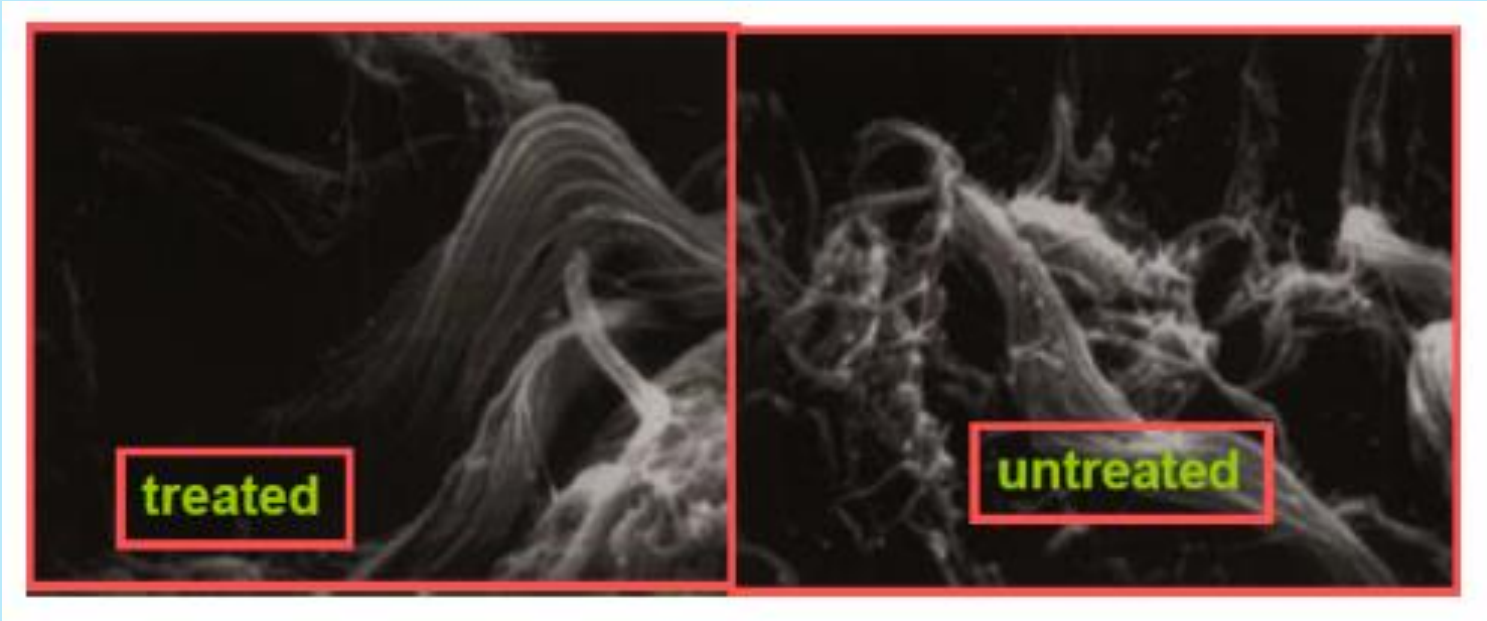
Moreover, it is interesting to underline that these tissues, **functionalized** by low molecular weight **peptides** and **CN-LG** micro-nanoparticles, have shown to be **excellent scaffolds** for supporting cell adhesion and proliferation.



They, in fact, having the **same architecture** of the **natural extracellular matrix** (ECM), facilitate the cell survival and reproduction,

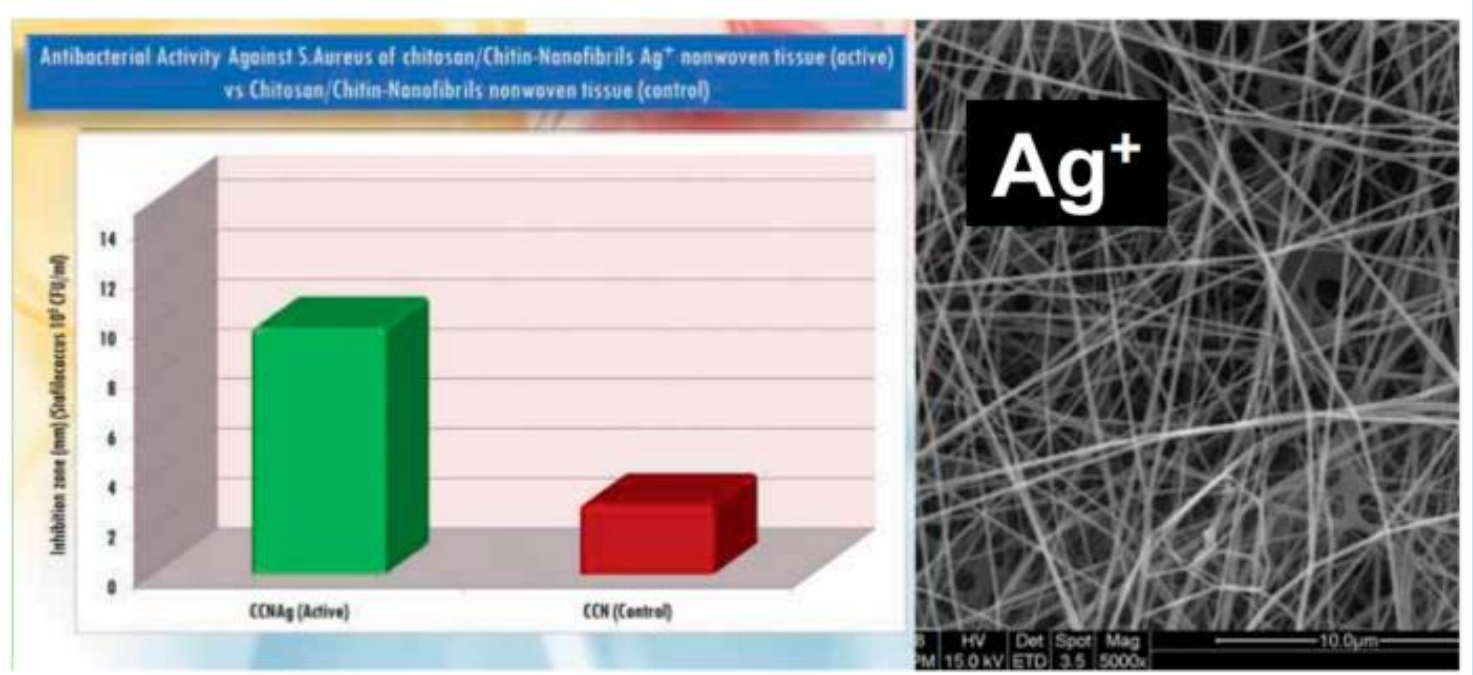


While the **CN-LG nanoparticles** induce the **regular disposition** of the **collagen fibers,** and the cicratizing process, because of their biological characteristics and nano dimension.



Moreoveer, for their **glue properties** and the capacity to **repair** the **hair** affected by longitudinal and apical **trichloclasis**, these innovative nanoparticles may be used to formulate hair-repairing shampoo and masks

Thus, the tissue made by natural polymers embedded by a complex of **chitin nanofibril-nanolignin** particles linked to Ag+ ions has been used to make medical bendages, because of its antimicrobial effectiveness and **skin repairing** activity.



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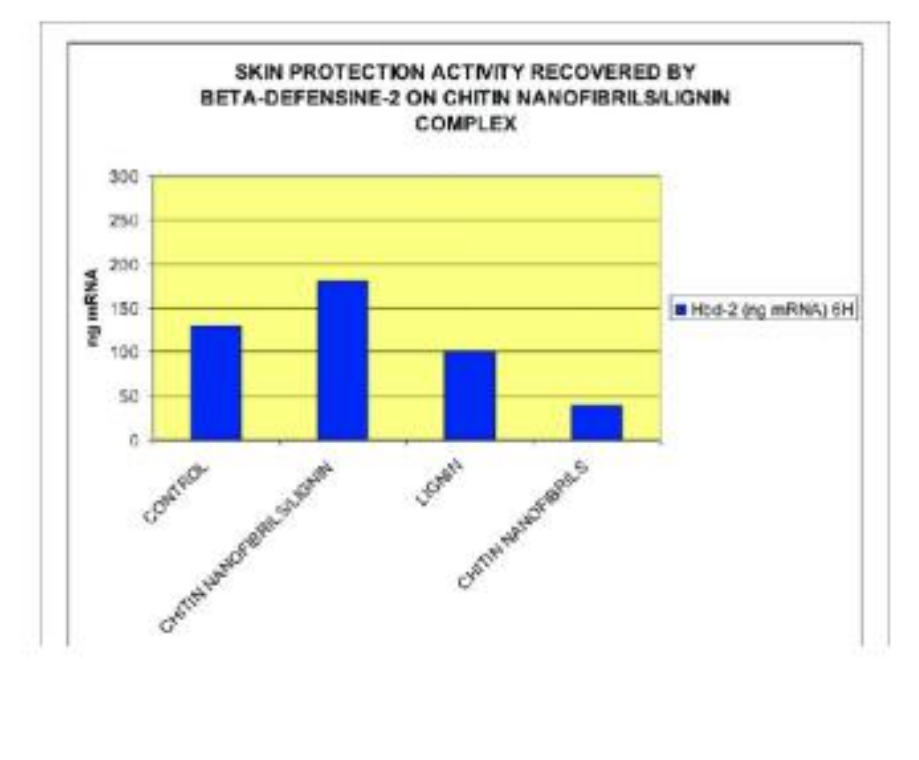
On the other hand a tissue made by water-insoluble polymers embedded by active ingredients such as **vitamin C** and **E** and **nicotinamide**, was used to make an **anti-aging** cosmeceutical due to its ability to improve the **defensine** synthhesis, while.



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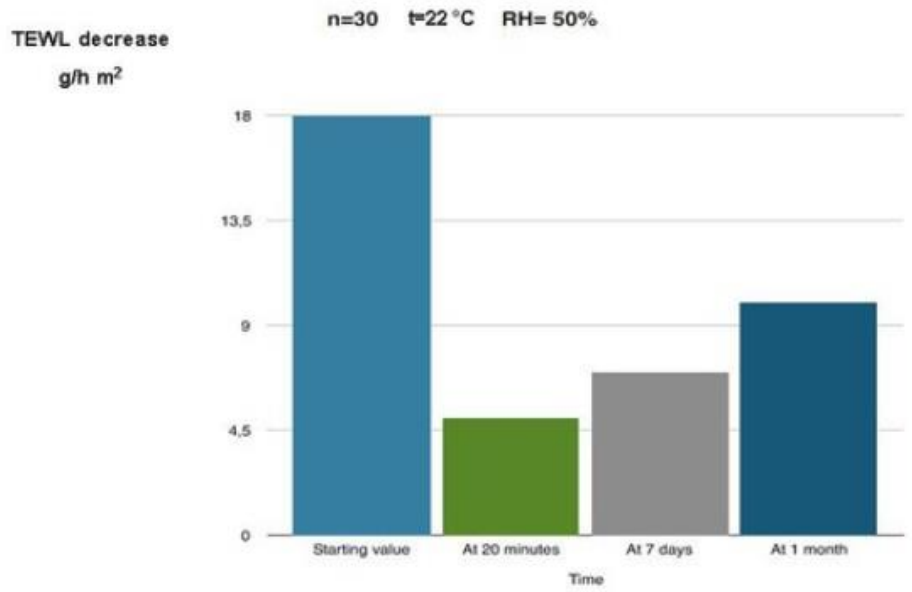
the same tissue made by **soluble-polymers**, enriched by **glycirrhetic acid** and **nicotinamide**, was used by a **beauty mask** to **reduce** the **TEWL** of a photo aged skin,

TEWL RECOVERED ON WOMEN AFFECTED BY PHOTOAGED SKIN AND TREATED BY A BEAUTY MASK MADE BY A NON-WOVEN TISSUE OF CHITIN NANOFIBRIL-BIOLIGNIN



All p values are highly significant as starting value (control) and as to groups (p<0.005).

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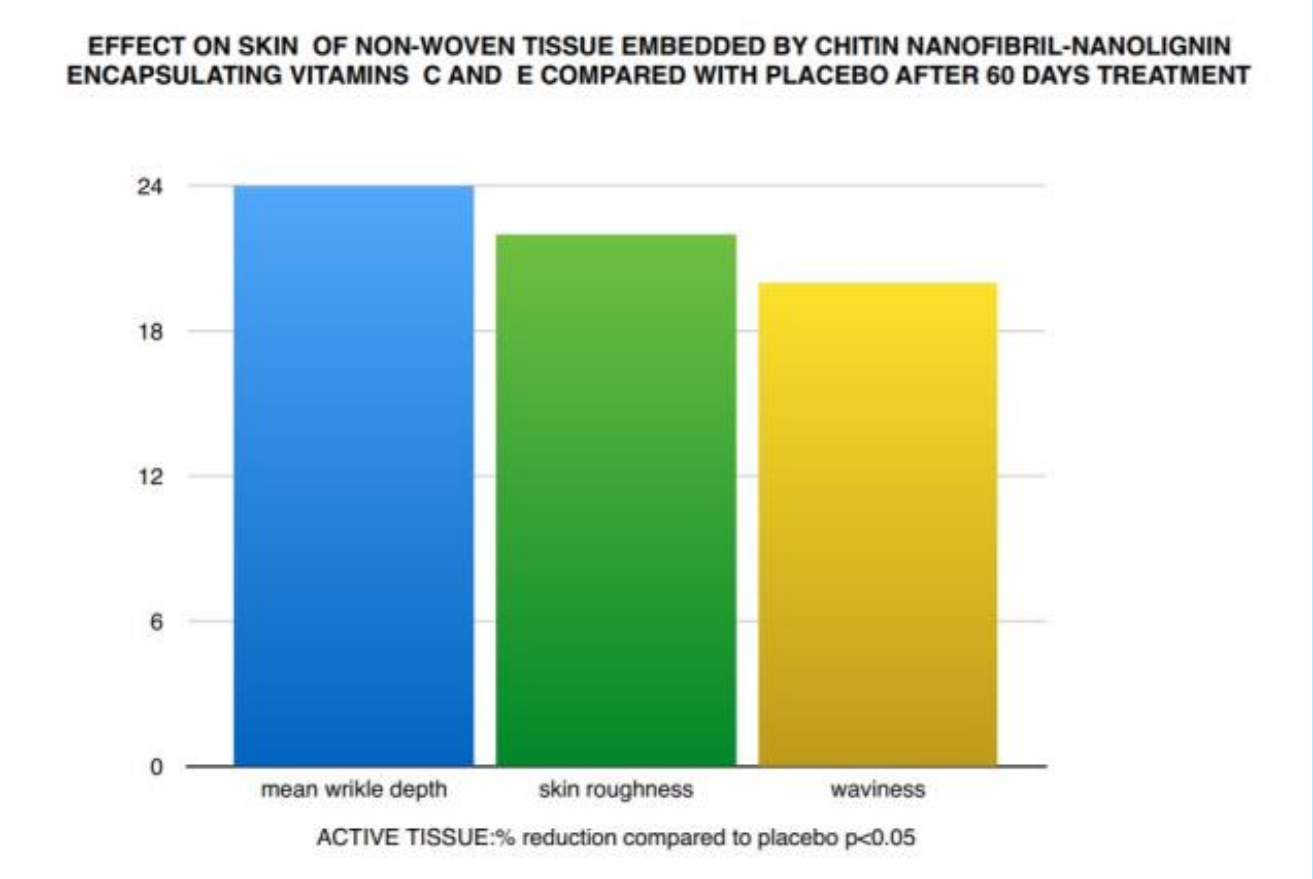
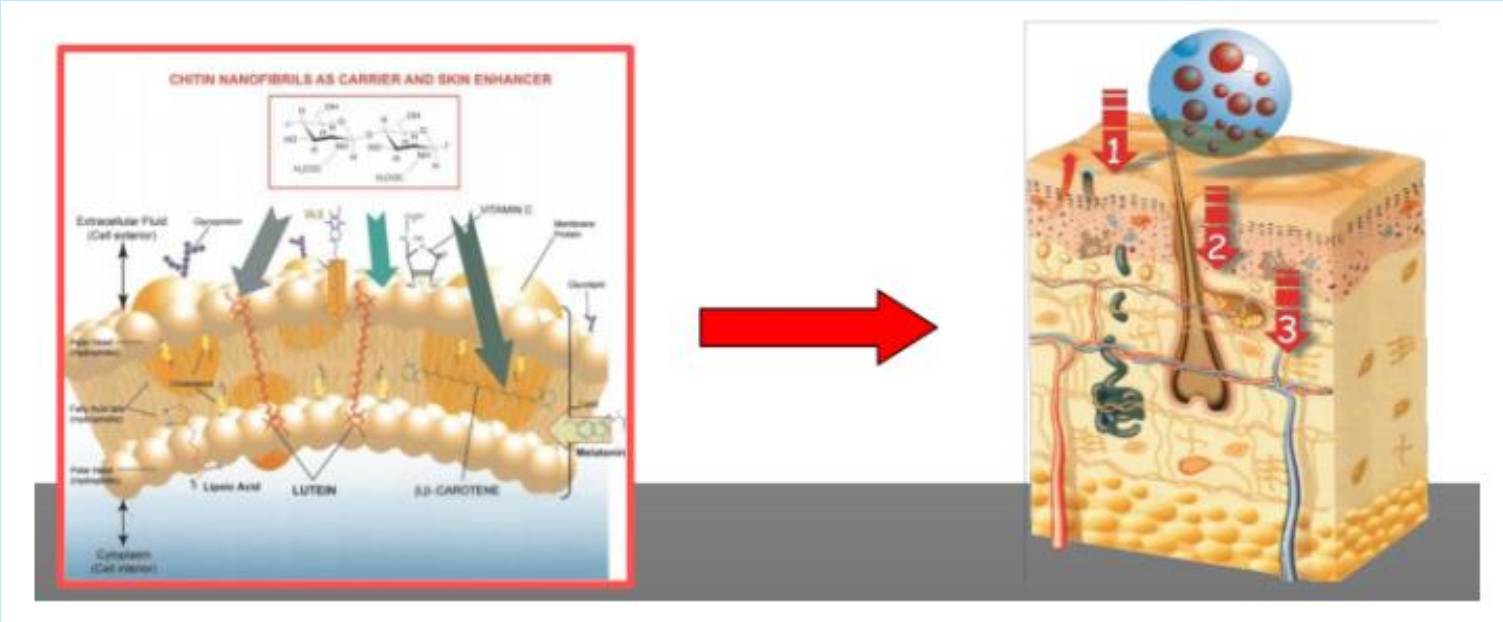
Moreover, when embedded by **vitamins C** and **E** have reduced the skin roughness and waviness



It is also interesting to underline that these **cosmeceutical-tissues**, loaded by the well selected active ingredients, encapsulated **by CN-LG** particles have the capacity to **carry** them at the designed **skin layer**, at the **right dose** and **time**.



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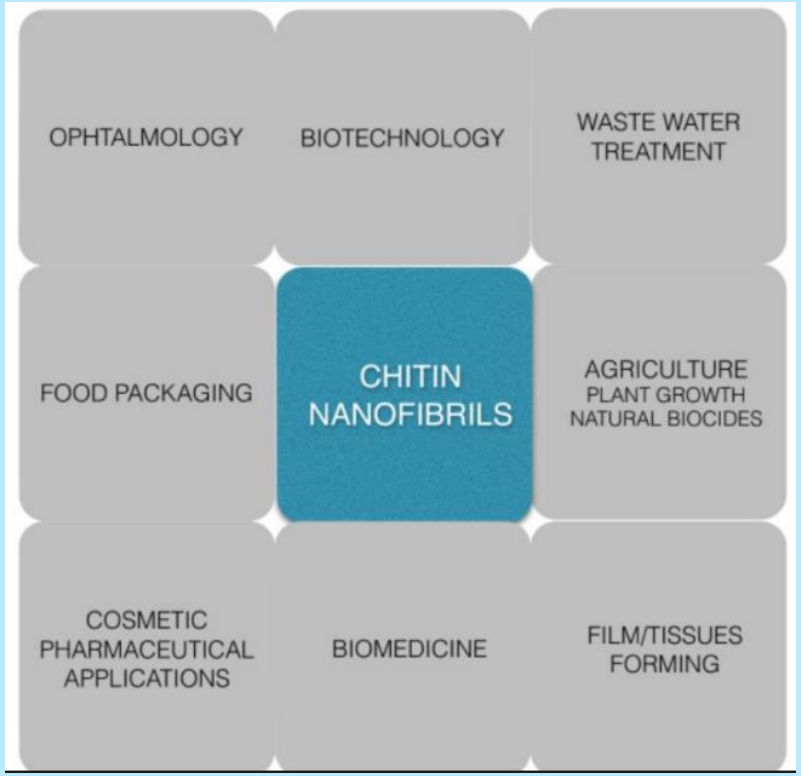
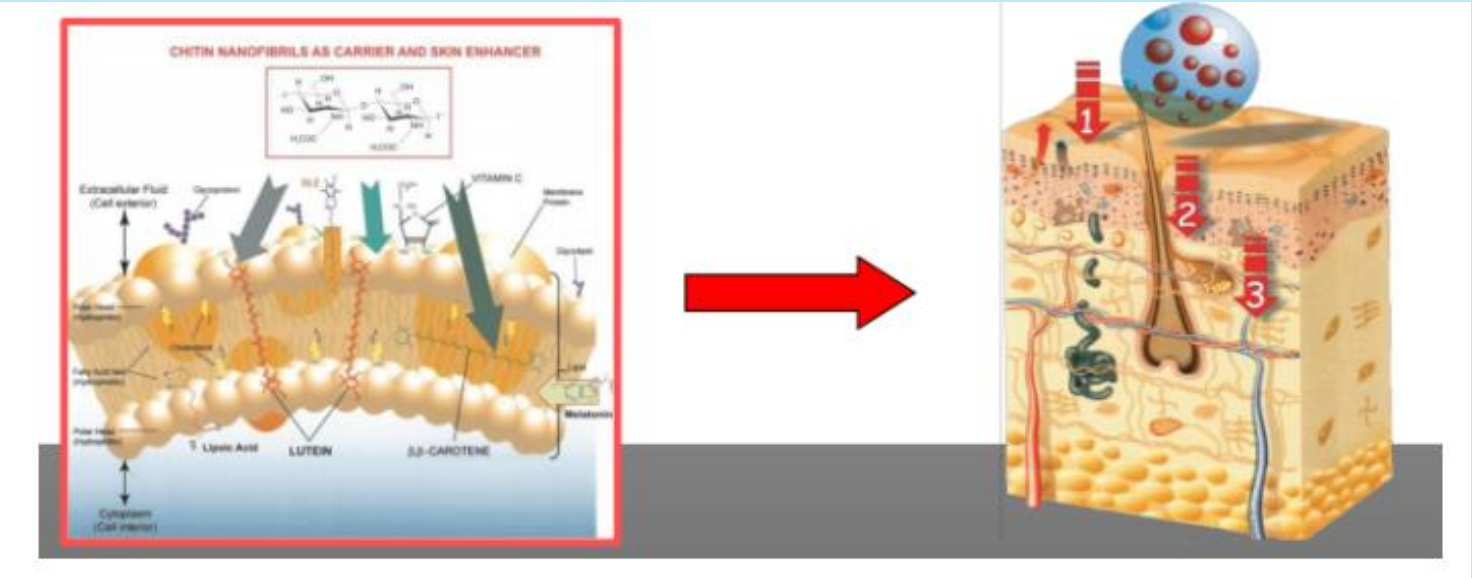
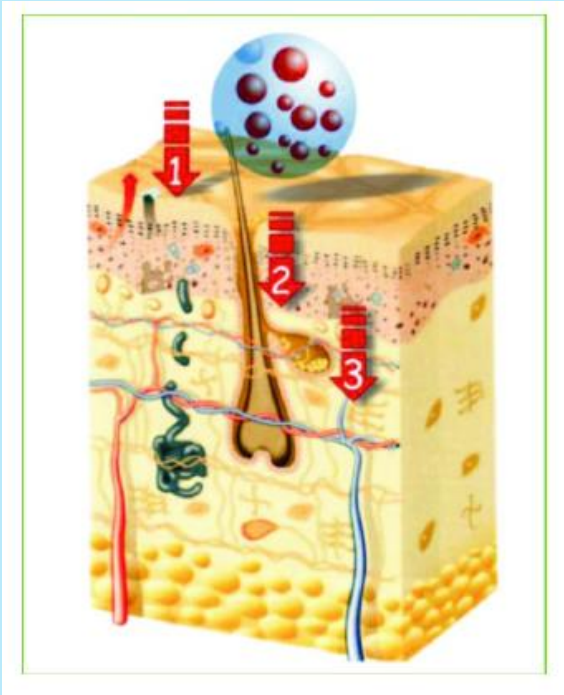
However, it isn’t to be forgotten the **reported activities** may be obtained only by the use of **chitin** and **lignin** at micro/**nano** dimension, polymers that may be used for many purposes



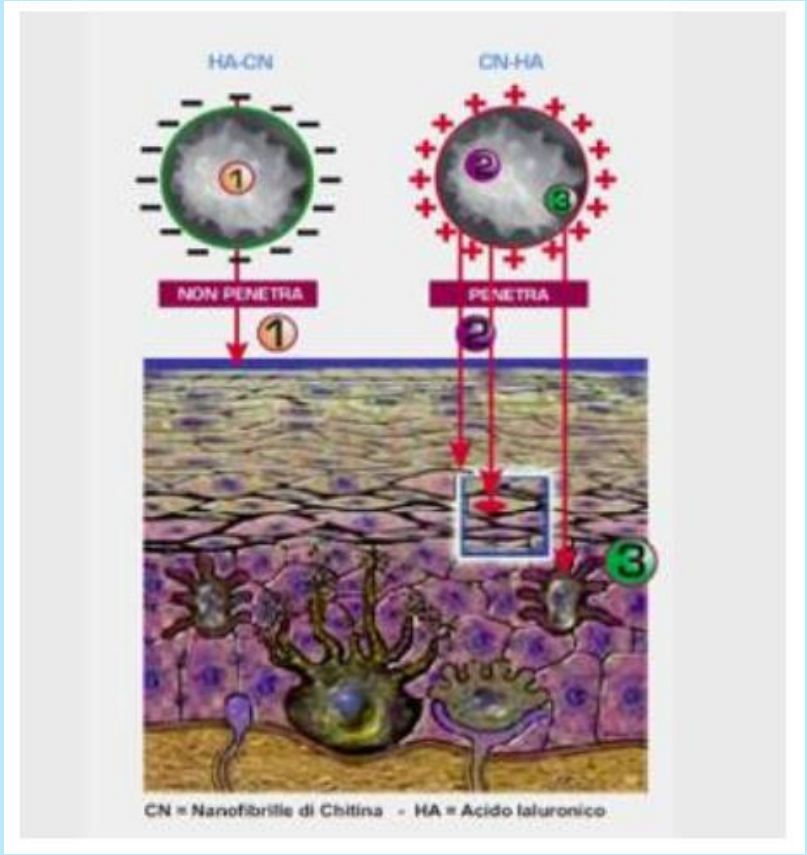
However, **effectiveness** and **safeness** of particles and tissues and their **skin penetration** depend among others upon the size, source, nature and molecular weight of the **active ingredients** selected, the **CN** and **LG** charges and the environment pH, together with the **polymers'** selection.



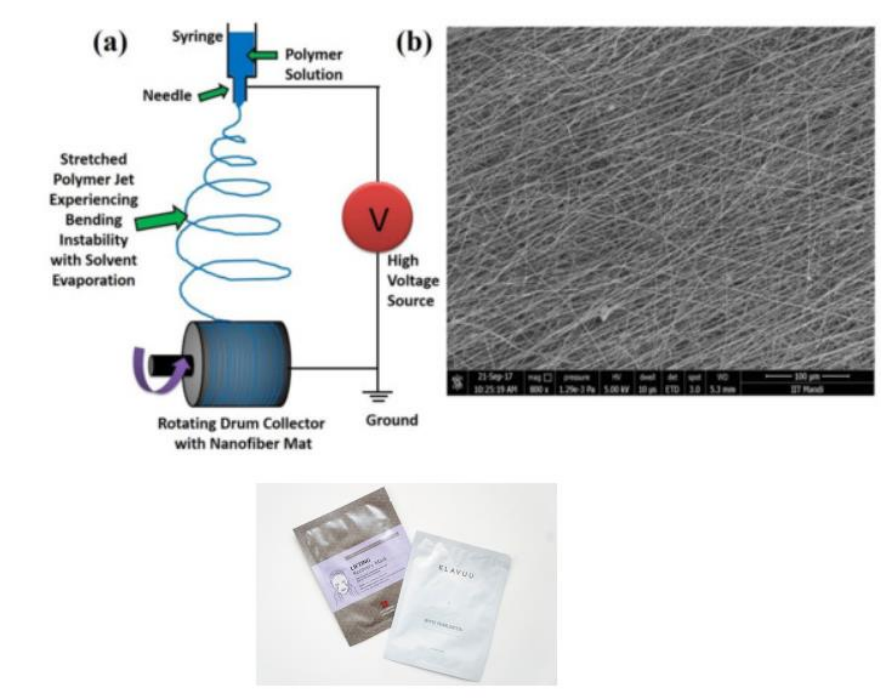
It has been shown, for example, that **positively** charged **Nanoparticles** are able to increase the **skin penetration** of different active ingredients, overcoming the Stratum Corneum' barrier, while **negatively charged** ones remain at level of the **outermost** corneocytes



Therefore, the major **advantages** of these micro**/nanoparticles** is their 100% **natural** composition and the possibility to manipulate their properties for **obtaining** the **release** of the active ingredients at the **designed** tissue/cell.



On the other hand, it is possible to produce **innovative** cosmetic lines made by 100% **natural ingredients** free of water, emulsifiers, preservatives, colors, fragrances which embedded on these **Smart tissue** used as Carriers may be **electrospun** on a support made by a natural biodegradable **bamboo** and **packed** by a simply foil of **aluminum** or **paper**.



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It is interesting to underline the possibility to **electrospun** these **tissues** on the **bamboo support** instead of the usual **polyethylene** for obtain a global **biodegradability**

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Thus the first obtained electrospun tissues were controlled *in vivo* on a group of volunteer to verify their effectiveness on skin irritated for an excessive sun exposure

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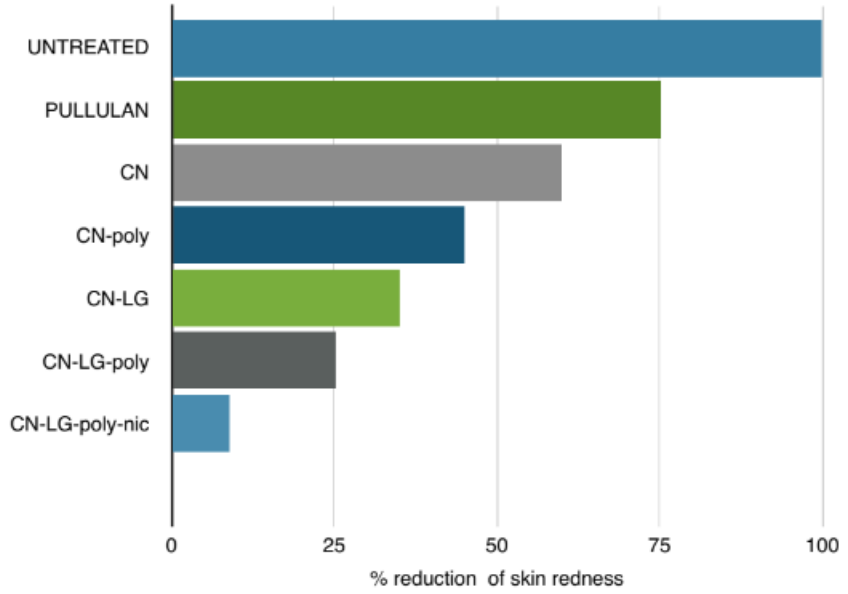
The effectiveness of the tissues was verified in comparison with the untreated normal skin

These the obtained results of the first test realized on the **skin-back** of volunteers by **pullulan-tissues** embedded by different **nano-chitin-nano lignin** particles

SKIN REDNESS TREATED BY A PULLULAN TISSUE EMBEDDED BY CN-LG NANOPARTICLES ENCAPSULATING DIFFERENT ACTIVE INGREDIENTS

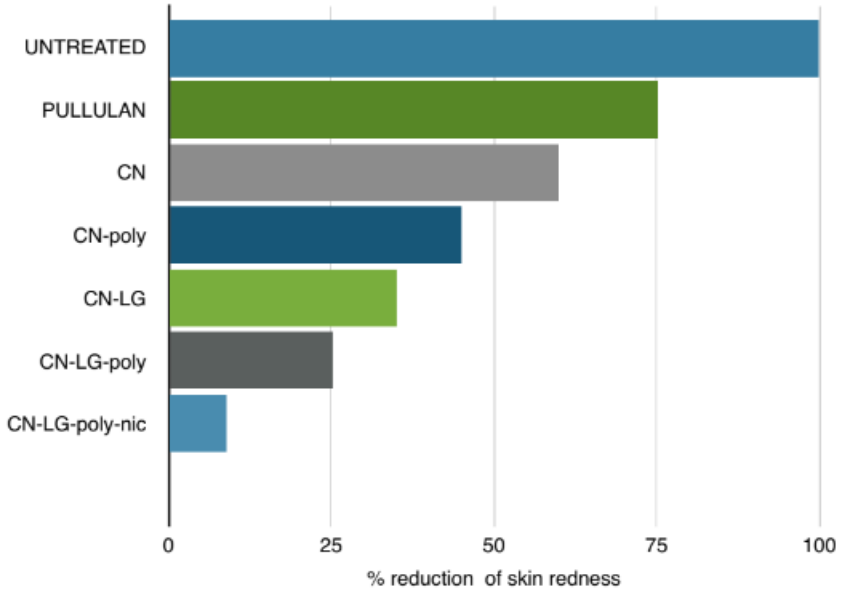
untreated vs Pullulan< 0.05; untreated vs CN<0.005; pullulan vs CN<0.05; CN vs CN-poly<0.05;CN vs CN-LG<0.005;CN-LG<CN-LG-poly <0.05;CN-LG-poly<CN-LG-poly-nic <0.001



As it is possible to control, the **effectiveness** is strictly connected not only with the **active ingredients** encapsulated but also with the components of the carrier

SKIN REDNESS TREATED BY A PULLULAN TISSUE EMBEDDED BY CN-LG NANOPARTICLES ENCAPSULATING DIFFERENT ACTIVE INGREDIENTS

untreated vs Pullulan< 0.05; untreated vs CN<0.005; pullulan vs CN<0.05; CN vs CN-poly<0.05;CN vs CN-LG<0.005;CN-LG<CN-LG-poly <0.05;CN-LG-poly<CN-LG-poly-nic <0.001



Last but not least, it is possible to extract the **natural skin care ingredients** from agro-forestry waste, including **lignin, vitamin C** and **natural polymers**, used to produce tissues and nanoparticles as previously reported.

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Thus, considering all the reported advantages and the high **bio**- and **eco-**compatibility of **CN** and **LG**, we are trying to ameliorate the global technical processes to **optimize** all the parameters and **scale up** the production to an industrial level.

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Therefore, the use of the reported **innovative tissues** as **active carriers** for Medical device, diet supplements and Cosmetics, go in this direction, being able to **safeguard** the environment and **useful** to **rejuvenate** the **skin**, maintaining the body in good health.

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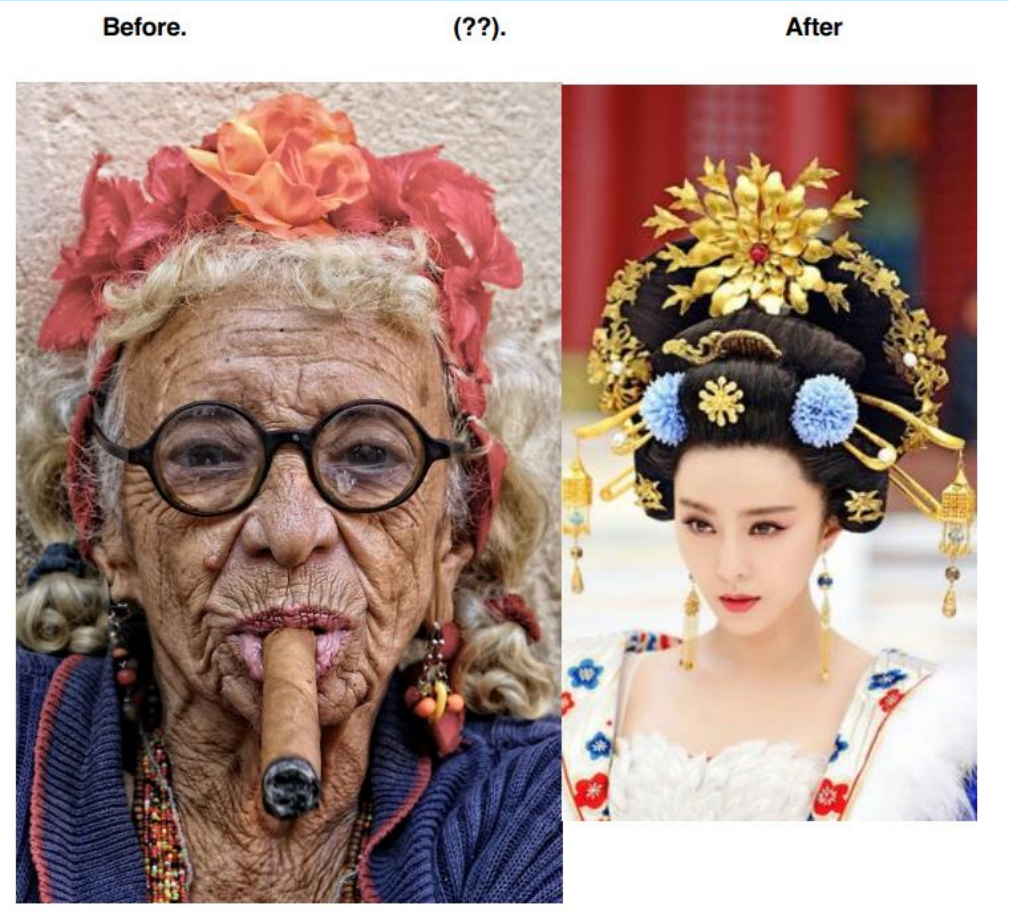
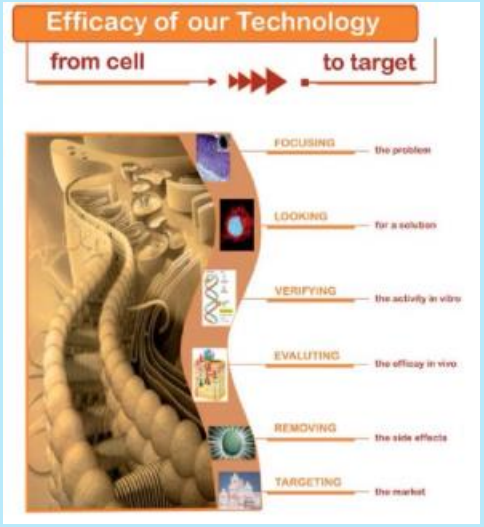
The final hope of these new cosmeceutical-tissues is also to try to rejuvenate the human skin as reported below!



THANK YOU FOR YOUR KIND ATTENTION!



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