An antipollution shield from sustainable sericin

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Abstract

Particulate matter in the atmosphere has been proven to be one of the main causes of skin ageing.[1] Studies have shown that PM0.3 - 2.5 particles condition the inflammatory response of both skin receptors and the epidermal structure. The most recent scientific evidence suggests that the mechanisms by which environmental pollution causes damage to the skin are: free radical formation, alteration of the skin microflora, activation of the aryl hydrocarbon receptor (AhR) and of the inflammatory cascade. PM2.5 can cause alterations in the epidermis by increasing cholesterol synthesis with a transient accumulation of epidermal cholesterol content and decrease of squalene.[2]

Data show that a pure, regenerated sericin, obtained by a circular economy process, has an anti-pollution effect, creates a protective film on the skin and hair and promotes the removal of atmospheric particulate matter. The regenerated sericin helps prevent the accumulation of particulate matter on the epidermis and improves skin appearance, making it brighter and smoother. Applied on the hair, it has shown to exert a film-forming action and promotes an 'instant repair' effect.

Sericin regeneration is an example of a truly circular process in which materials that have concluded their life cycle, in this case in the silk processing industry, can be recovered and give form to new, exceptional grade material.

The silk industry is one of the oldest and most fascinating industrial realities, where tradition, history and innovation fuse perfectly. Silk has recently found new applications in the field of bio-materials as it has a unique polymeric structure which makes it one of the most resistant materials in nature.

Sericin, which composes only a small part of silk and is a production by-product, is a highly interesting protein for the cosmetic industry. It has known high affinity for the skin and hair on which it creates a protective film from atmospheric particulate matter.

Processing of silk to produce the thread (filature) involves washing and degumming phases in which the thread is washed and soaked in soapy water in order to soften and remove the sericin. The degumming water, rich in sericin at different molecular weights, is then properly purified, concentrated and dried. This standardised, rigid procedure produces a high quality 'waste' sericin powder.

The 'zero-waste' philosophy at the basis of this process, has given an added value to a raw material that otherwise would have remained waste. A real example of sustainable recovery. The sustainable process includes a 'Km-0' approach for raw materials which are supplied by selected textile industries within a range of 200 km.

Cosmetic activity

Environmental pollutants are mainly composed of inorganic carbon particles and fibres conglomerated together by organic molecules of various kinds which are often very harmful to the body and the skin. These particles have a diameter varying between 1 and 500 µm; their toxicity increases with decreasing diameter, reaching the maximum dangerousness and transdermal penetration at 1 - 5 µm. It has been widely demonstrated that the penetration of atmospheric particulate matter through the skin stimulates lipid peroxidation3,4 accelerates oxidative stress5 and causes cellular damage which are amplified by UVB rays.[6] All of these factors put together lead to premature skin ageing that manifest as skin spots, loss of

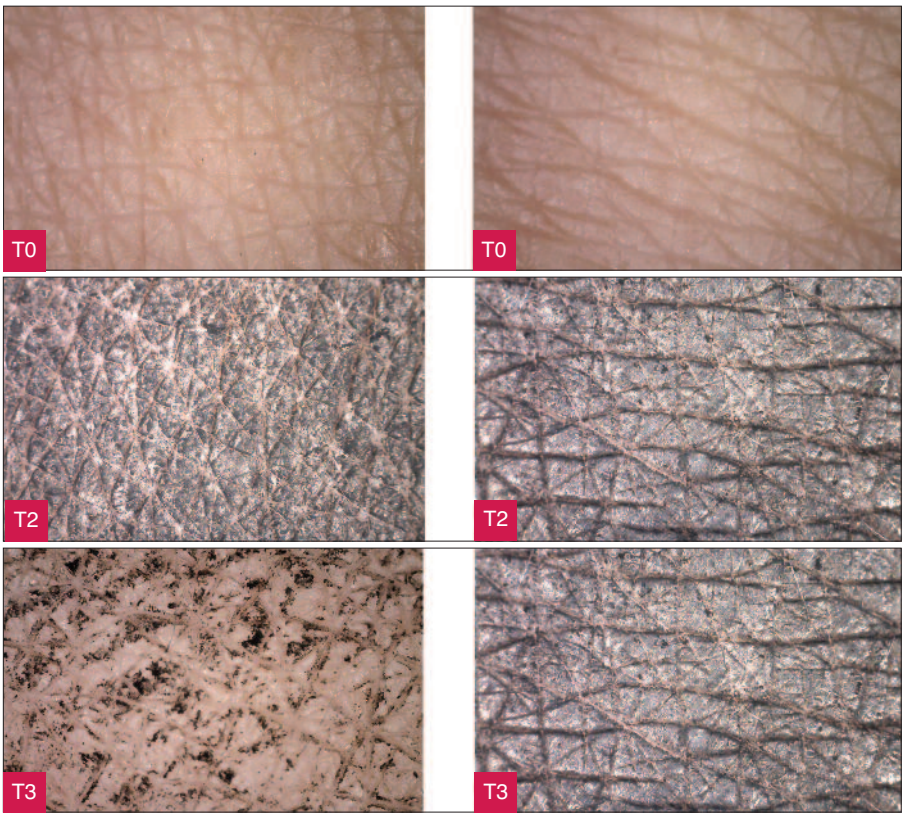

Figure 1: Photographs at different times (T0, T2 and T3) for both areas, treated and untreated.

luminosity and an increase in skin sensitivity.

The protection against urban pollutants is therefore one of the new cosmetic objectives to safeguard the appearance and health of the skin.

Results obtained have shown how regenerated sericin, obtained through the circular economy process described above, added to a simple formulation creates a protective shield 'second skin' effect, limiting the deposition of pollutants on the skin leading to a brighter skin. The same formulation applied on damaged strands of hair has also demonstrated to have a film-forming action with an 'instant repair' effect resulting in more compact strands and closed cuticles, a further confirmation of how this regenerated and sustainable sericin is able to create a protective film on skin and cuticles.

Antipollution action

Results from a clinical study

A formulation (Table 1) containing 0.4% regenerated sericin was tested in a clinical study in order to evaluate the efficacy in protecting the skin from air pollutants. Micro-particles of carbon black with a chemical composition and grade abiding to scientific and ethical standards for clinic studies, were used with the purpose to mimic cutaneous penetration of the polluting particles.

This clinical study was carried out on 20 volunteers, evaluated as suitable for participation and without skin pathologies in areas to be treated.

Methods and materials

On each volunteer, 2 different areas on one of the two forearms were contoured; one was treated with the product (Table 1) under test, the other acted as control.

Application method can be followed as below:

- The product was applied at a dose of 2 mg/cm² with a pipette and spread on the identified area with a fingerstall. The area considered as control was untreated. Subjects waited 20 minutes in order to let the skin dry.
- Carbon black was applied on the tested areas with a clean makeup sponge.
- The areas were rinsed with the same dose of water.

In order to assess the anti-adhesion effect of the micro-particles on the skin surface, two different parameters were evaluated:

The average number of black pixels around the treated area was photographed by a digital micro-camera (Dino-lite digital microscope) with high resolution. Photographs at different times (T0, T2 and T3) were carried out in the same room, with controlled lighting conditions and with area under examination placed in the same position. The image was transposed on a black/white axis to highlight black dots and standardise the image. Then the black pixels were quantified using specific software (GIMP).

Parameter L, one of the coordinates of the CIE 1976 (L*, a*, b*) colour space, used to express the brightness of the colour L*=0 indicates black, L*= 100 indicates white. The increase of the L- parameter of the analysed area indicates a shift in the colour toward white. A Minolta Chromameter CR200 was used for an accurate and objective evaluation of the colour of surfaces.

These evaluations were carried out at the following times:

T0 = before product application
T1 = after product application
T2 = after applying carbon black
T3 = following rinsing

Table 1: Formulation tested

Tested Formula	%
Water	Qb 100
Preservative	Qb
Xanthan gum	1
MORIPURE® Powder SD Sericin	0,4

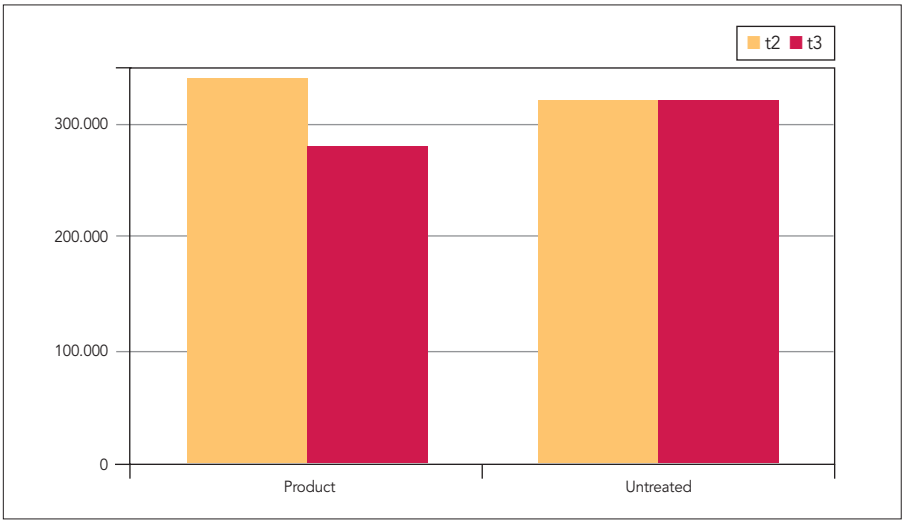

Figure 2: Number of black pixels (mean) at T2, T3. At T3, the number of black pixels were reduced compared to the previous measurement (T2) by 17.4% in the treated area and 0.4% in the untreated area (not significant).

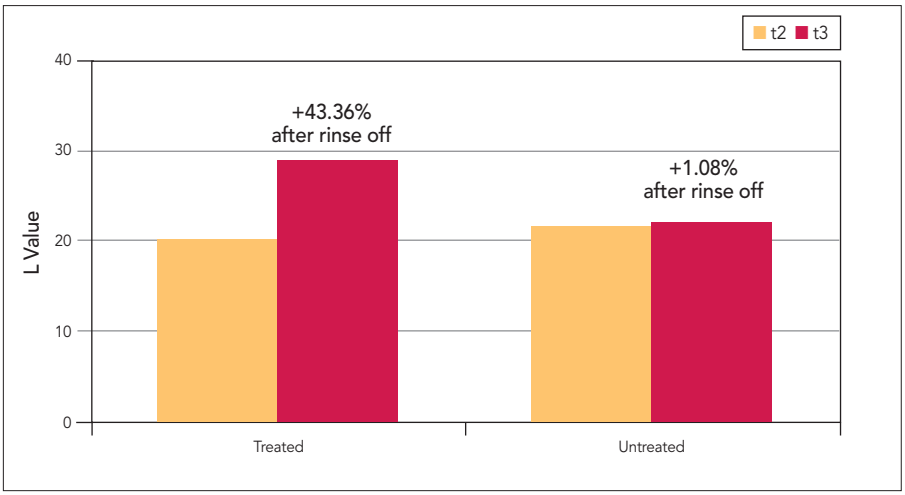

Figure 3: Evaluation of L parameter at T2 and T3 in the treated and in the untreated area.

Results

Evaluation of microparticle adhesion by GIMP

Under the experimental conditions described, using the Dino-Lite micro-camera, black pixels at T0, T1 T2, T3 were counted. The values recorded at T2 and T3 were then normalised with respect to T0.

The tested product has been shown to be effective in promoting the removal of microparticles from the skin. At T3, the number of black pixels were reduced compared to the previous measurement (T2) by 17.4% in the treated area and 0.4% in the untreated area, reaching statistical significance* in the treated area (Figure 1 and Figure 2). $p < 0,0001$*

Evaluation of skin radiance through analysis of the parameter L

The results obtained (Fig 3) showed a statistically significant increase of 43.36% of the L parameter at T3 in the area treated with the product and a 1.08% in the untreated area (not significant).

This showed that the product containing

regenerated sericin was effective in improving skin radiance.

Discussion

The results obtained show a quantitative and statistical difference on the treated area. Regenerated sericin is able to adsorb micro-particles, creating a 'second skin' shield and preventing particulate matter from reaching the skin. After washing, the amount of particulate matter is reduced by 17.4%.

Regenerated sericin has also shown to be effective in decreasing the adhesion of carbon black micro-particles. In fact, following application, the number of black pixels in the images was decreased and the skin brightness (L parameter) was increased, indicating a reduction in particulate matter present in the treated area.

Regenerated sericin: an instantaneous repair protective shield for your hair

Sericin, thanks to its structure, has a high affinity with hydrophobic proteins (such as fibroin in silk) and therefore also with hair keratin. Thanks to these bio-adhesive properties, it adheres to the hair fibres, protecting and restructuring them.

The regenerated sericin has been tested on damaged hair strands, proving to have

Figure 4: Comparison among strands.

excellent, instant restructuring capacity and leading to an 'instant repair' effect.

Test on strands

To confirm the 'instant repair' effect, a formulation containing 0.4% regenerated sericin was tested on human hair strands damaged with a 30% solution of SLS (Sodium Laureth Sulphate). The experiment was conducted under standardised and controlled conditions described as follows:

Methods

Two strands were moistened with 100 ml of tap water and then dabbed dry. The strands were then damaged by soaking them in 30 % SLS solution for 24 hours. Following the induced damage, the strands were washed out with tap water at temperature of 30 ± 2 °C until all foam disappeared, dabbed with absorbent paper and dried with a 2100 Watt hairdryer.

A fixed quantity, 0.7-1 grams, of product was applied to the strands and then combed with a tooth comb. This quantity mimics the intended for use quantity of the consumer. The negative control group followed the same procedure on the same number of strands, but no product was applied.

The strands were again dried and then left on a vertical support for thirty minutes.

Photographs and visual inspection used to evaluate the product tested and negative control group, were performed after these procedures.

A clear improvement of the aesthetic characteristics of the hair strands treated with the compound can be observed versus the control group.

The hair was also photographed under a microscope. The horizontal section of the hair shows the presence of three concentric layers called marrow, bark and cuticle, the outermost layer. The negative control hairs strands showed deterioration of the cuticle, whilst the treated strands showed a partial restructuring of the cuticle.

Micrographs (photomicrographs) show a repairing effect observed as the partial restoration of the damaged hair cuticle.

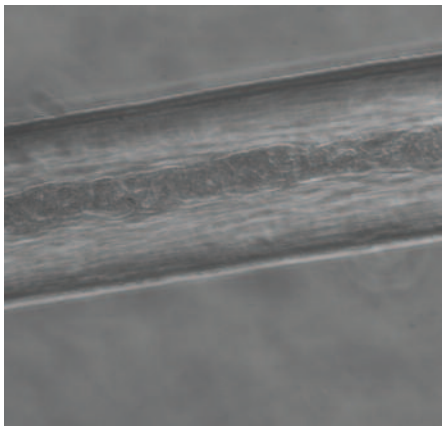

Figure 5: Hair strands stressed control (not treated).

Conclusion

Optimising waste recovery from silk processing has made it possible to obtain a very pure regenerated sericin, ideal for use in skin care, makeup and hair care formulations. This is an example of how innovation can extend into sustainability, enhancing its expression.

Not only is it sustainable, but also efficacious. Studies and tests conducted have demonstrated its ability to protect the skin from the harmful action of atmospheric particulate matter. Our regenerated sericin therefore has dual efficacy: it acts as a shield, protecting the skin from direct deposition of particulate matter; it facilitates its removal during washing, as it limits particulate matter skin adhesion. It can therefore be added to any cleanser, making it more active and effective in the daily purification of facial skin. Its use in medicine is known for wound suturing and coagulation.

Its use results in a more radiant skin (+ 43%). Regenerated sericin, thanks to its ability to preserve the skin from adverse external actions, acts as a booster of its natural radiance: the skin is purified more effectively, resulting in a natural and healthy glow.

The potential for a new generation of makeup-to-fight-pollution could be developed with innovative claims: it is not simply makeup but 'caring makeup' able to protect the skin every day from pollution.

The natural 'shield-former' inclination of regenerated sericin offers new perspectives also for hair care. Sericin is certainly well known for its hair-affinity, but the test results underline how it can re-texturise hair cuticles, re-structure hair fibres, and give a fuller, healthier look to hair.

In today's world, new, sustainable resources must consider transformation processes linked to each and every resource; sustainable, transforming, natural are the basis of a global circular economy.

Innovation, sustainability and beauty are all terms of a perfect equation, capable of supporting the contemporary formulation. The idea of transforming a waste product, in this case from silk processing, to an effective skin product becomes sustainable innovation, the only one possible today. It is a synonym for beauty and sensory awareness linked to sustainable, effective and innovative ingredients. PC

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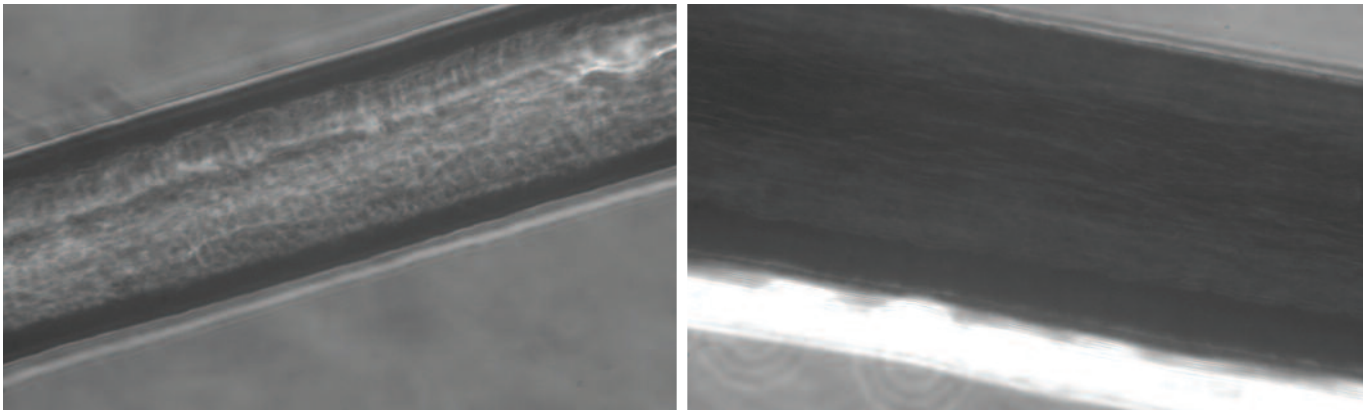

Figure 6: Hair strands stressed then treated with product.