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Review Article

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Natural Polymers For A Cleaner Environment

P.Morganti[1], M. B.Coltelli[2] and G.Morganti[3]

[1]*Professor of Skin Pharmacology, Dermatology Unit, Campania University "Luigi Vanvitelli", Naples, Italy; Visiting Professor, China Medical University, Shenyang; Director of R&D Nanoscience Centre MAVI, Aprilia (LT), Italy*

[2]*Researcher in Materials Science, Interuniversity Consortium of Materials Science and Technology (INSTM), Research Unit of Pisa, Department of Civil and Industrial Engineering, University of Pisa, Pisa, Italy*

[3] *R&D Nanoscience Centre MAVI, Aprilia (LT), Italy*

***Corresponding author**

Pierfrancesco Morganti, Professor of Skin Pharmacology, Dermatology Unit, Campania University "Luigi Vanvitelli", Naples, Italy; Visiting Professor, China Medical University, Shenyang; Director of R&D Nanoscience Centre MAVI, Aprilia (LT), Italy E-mail: info@iscd.it.

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Introduction

Natural polymers or biopolymers, produced by living organisms, are organized as monomeric units covalently bound to form larger structures [1,2]. They in nature play an essential role, performing many fundamental functions like cell energy storage as well as preservation and transmittance of genetic informations. Moreover, they represent an inexpensive biomaterial, easily degraded to chemical compounds that, while release carbon dioxide, resorb it directly on the land by crops, reducing its level in the atmosphere [1,2]. However, the majority of the biomaterial present on the Earth is represented by polysaccharides, such as starch, lignin, chitin and other polymers, the most common of which cellulose, comprises 33% of all the plant components. On the other hand chitin, the second component present in nature after cellulose, is industrially obtained in quantity of 1 billion tons from marine source. This biomaterial, obtainable by agricultural or industrial by-products is considered of great interest to produce, for example, biodegradable plastics.

Because of the presence of the too high non degradable petrol-derived plastic waste that invades land and sea (Fig.1) in the world, its harmful effect on human and the environment could be greatly reduced by the use of green biomaterials for producing bio-plastics or biodegradable plastics [3].

Figure 1: Plastic waste in land and sea

But what the difference among biopolymers, biodegradable plastics, bio-plastics and traditional plastics? Biopolymers are polymers produced by living organisms, biodegradable plastics are materials which, degraded by microorganisms into water, CO_2 and biomass under specific conditions, can be made by the use of organic and/or fossil, resources; bio-plastics (bio-based plastics) are plastics created by biodegradable polymers and sustainable processes, that reduce or eliminate the generation of substances hazardous to humans, animals, plants and environment; traditional plastics are obtained by petrol-derived polymers, not degraded by human and environmental microbiota and, when partially degraded, often release toxic compounds. Thus the necessity to use natural polymers and bio-based plastics to try to reduce air pollution, land and ocean waste, for saving the Earth ecosystem and its biodiversity (Fig.2) and the incoming generations health and wellbeing [4].

Figure 2: The earth biodiversity

According to WWF, in fact, "ecosystems sustain societies that create economies" able to develop sustainable goals , so that the awareness of biodiversity continues to grow worldwide (Fig.3), as reported by UEBT Barometer 2017 [5,6]. However, natural polymers still amount to less than 1% (Fig.4) of the 300 million tons of plastic produced annually (Fig.5), although their producing capacity is increasing and it has been predicted its continue rise, with an annual expansion of 6.9% until 2021 [7].

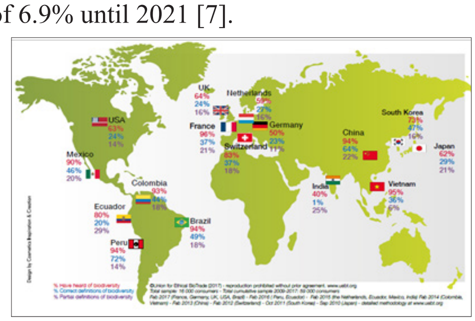

Figure 3: Biodiversity at world level (source: Barometer 2017 [6]

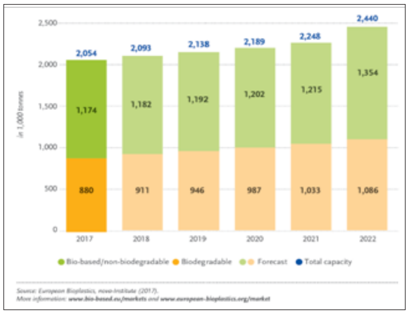

Figure 4: Global bioplastics production and increase

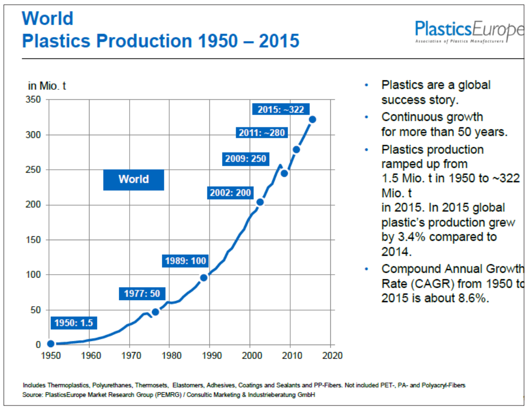

Figure 5: Estimated plastics increase

Biopolymers for an ecological footprint

With the described premises, the necessity to better recycle petrol-derived plastics, trying on one hand to reduce its production and consume, and on the other hand to drastically increase production and use of natural polymers and bio-plastics. Finally it is necessary to make consumers aware of the possibility we all have to save the Earth ecosystem by changing the way of working, living, and thinking. Zero waste became, therefore, a necessity because of the greenhouse emissions's daily increase and the forest destruction, which are contributing to produce the land disasters in full view of all the world (Fig.6). According to Engelbrecht "nothing came without side-effects " in the industrialization processes and use of the world's biological resources [8].

Figure 6: Some disasters of the last years

Current industrial activities, as for example the global food production [9], has been accomplished by dissipative and dispersive use of natural products. These human activities waste have created huge amounts of waste and toxic sites, resulting in health problems and damage to the world ecosystem [9]. Thus, physical, chemical and biochemical states of natural systems are substantially modifying the environment equilibrium, exposing fauna and flora to a greater adaptive pressure (Fig.7). As a consequence, we are facing with "atmospheric warming, acidification of oceans, eutrophication of lakes, air pollution, deforestation, and an accelerated loss of biodiversity", without taking their real meaning and tackling these problems one at a time and as they come. Thus the necessity to develop a global economy based on production and consume of products made by green bio-materials which, respecting the ecological footprint and the quality of biodiversity, could directly and positively influence the ecosystem functions and human health [10].

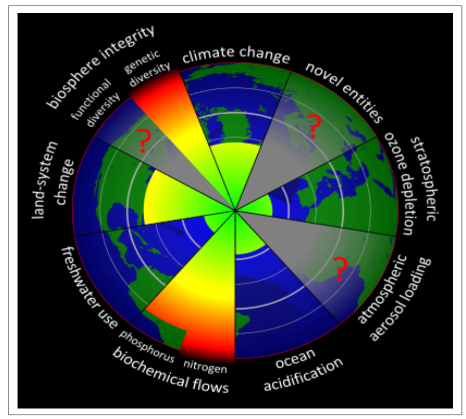

Figure 7: The planetary boundaries (10)

Moreover, as previously reported, it is to underline the seas' littering with plastic particles, that started with the beginning of its industrial mass production at the end of the first half of the 20th century [8]. At this purpose, it has been calculated that about 5.25 trillion of these micro particles are floating in the centers of the five largest oceans gyres, with an overall weight of ~268, 000 tons [3]. In addition, these plastic fragments, acting as transport vehicles for pathogens and organic toxins, represent a hazard for the human health. They, in fact, ingested from more than 26 marine species, could bio-accumulate in the food chain [11,12].

PolyBioSkin project

At this purpose, the European project PolyBioSkin has the aim to develop biopolymers which, being directly in contact with the skin, have to be skin-friendly also. This consortium, that combines the expertise of twelve partners from seven European countries, includes scientists from five academia and technology institute (Fig.8). The Consorzio Inter Universitario di Scienza e Tecnologia dei Materiali (INSTM), Italy; the University of Westminster, UK; Association pour la Researches et le Development des Methods et Processis Industriels (Armines - MT Mines, France; Technoloski Fakultet Novi Sad, Serbia; and University of Gent, Belgium. From the industries (SMEs) the six participants are: Innovation i Recerca Sostenibible (IRIS) as project coordinator, Spain; Bioinicia, Spain; Fibroline, France; Texol, Italy; MAVI Sud, Italy, and Exergy, UK, as well as the European Bioplastics Association, Germany.

Figure 8: PolyBioSkin participants.

PolyBioSkin has to develop and validate three different typologies of products, i.e. Biodegradable diapers for babies and elderlies; Bioactive facial beauty masks, and Advanced medications (Fig.9) [1-3].

Figure 9: The PolyBioSkin goals

According to the 2nd meeting held in Pisa University on last December, all the products will based on biodegradable non-woven tissues realized by the electrospinning and casting technology, and the use of two main bio-based polymers such as polysaccharides [cellulose, starch and chitosan/chitin Nanofibrils (CNs)] obtained from waste and polylactic acid (PLA) and polyhydroxyalkanoates (PHAs), biopolyesters 100% based on renewable resources. According to the results of the meeting, it will be realized biodegradable tissue/films which, made by the same natural polymers, will be modified by different active ingredients entrapped into the micro/nanoparticle complexes of nanochitin-nanolignin.

The polymer-based nano-formulations, in fact, could constitute the majority of the nanoparticle therapeutic agents available for clinical use [13]. However, the diapers have to be characterized by an anti-inflammatory and antimicrobial activity, for protecting the skin from urine irritation; the facial beauty masks have to show an anti-aging, whitening, or anti-inflammatory activity, in dependence of the effectiveness declared by the claims, while the advanced medications have to possess antimicrobial anti-inflammatory, and skin repairing activity, necessary for their use as wound or burn dressings.

As reported by some published papers on the consortium program , during the meeting some studies on the effectiveness of the different active ingredients selected has been controlled as well as their physicochemical characterization. Moreover it has been evidenced the degradability and sustainability of CNs and PLA as well as the anti-inflammatory and repairing activity of CN and the antioxidant activity of the nanolignin which, used as carrier, have shown to increase the effectiveness of the final tissues [14-19].

Conclusive remarks

During the last few years, natural polymers and nanotechnology represented important emerging fields of interest, providing preventive and therapeutic applications in both the field of Dermatology and Cosmetology. Naturally, due to the higher activity shown from the ingredients, when used in their nano-dimension, both safety and benefits of the final products have to be accurately controlled by rigorous scientific methods. Moreover, it is important to underline that by the developed sustainable technologies and the biopolymers selected should be possible to make scaffolds which, targeting specific cells to proliferate and regenerate, may be able to restore and increase the skin functions.

Thus, the realized non-woven tissues and films could be used not only for wound and burn covering and physical barrier to external infections, but also to induce the proliferation of dermal fibroblasts and keratinocytes, repairing and slowing down the skin aging phenomena also.

Finally, according to the scientific community and the consumer requests, these tissues will be biodegradable by the enzymatic systems of both humans and the environment, resulting skin-friendly and free of toxic side effects.

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References

1. Heinze T (2005) Polysaccharides I:Structure, Characterization and Use.Springer, New York
2. Benkeblia N (2014). Polysaccharides :Natural Fibers in Food and Nutrition.CRC Press, New York.
3. Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, et al. (2015). Plastic waste from land into the ocean. Science 347: 768-771.
4. Mulhaupt R (2013) Green Polymers Chemistry and Bio-based Plastics :Dreams and Reality. Chemistry and Physics 214: 159-174.
5. Lambertini M (2014). Living Planet Report. WWF International, Gland, Switzerland.
6. UEBT (2017) Biodiversity Barometer 2017. Union for Ethical BioTrade, Amsterdam, Netherlands.
7. The Freedonia Group (2012) Natural polymers.US Industry Study with Forecasts for 2016 & 2021. Freedonia Report, Cleveland, OH, USA.info@freedoniagroup.com
8. Engelbrecht H (2018) 250 Years of Industrial Consumption and Transformation of Nature: Impact on Global Ecosystems and Life. Bentham eBooks, New York, USA.
9. Alexander P, Brown C, Arneth A, Finnigan J, Moran D, et al. (2017) Losses inefficiencies and waste in the global food system. Agric Syst 153:190-200.
10. Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, et al. (2015)."Planetary boundaries: Guiding human development on a changing planet". Science 347 : 1259855.
11. Bailie JE, Collen B, and Amin R (2008) Toward monitoring global biodiversity. Conserv Lett 1: 18-26.
12. Cole M, Lindeque P, Halsband C, Galloway TS (2011) Micro

plastics as contaminants in the marine environment: a review. Mar Pollut Bull 62: 2588-2597.
13. Tibbetts JH (2015) Managing marine plastic pollution policy initiatives to address way ward waste. Environ Health Perspect 123: 99-93.
14. Morganti P (2017) Biodegradable polymers for a better future. J Appl Cosmetol 35: 35-40.
15. Morganti P and Febo P (2017) Problem & Solution for biodegrading baby diapers. Eurocosmetics 25: 44-46.
16. Morganti P, Coltelli MB, Danti S and Bugnicourt E (2017) The skin: Goal of the EU PolyBioSkin Project. Global Res J Pharmacy Pharmacol 2: 7-13.
17. Morganti P and Febo P (2017) Innovative Tissue Engineering for an Enlarged Market. J Clin Cosmet Dermatol 1.
18. Cinelli P, Coltelli MB, Mallegni N, Morganti P, Lazzeri A, et al. (2017) Degradability and Sustainability of Nanocomposites Based on Polylactic Acid and Chitin Nanofibrils. Chem Engin Transaction 60: 115-120.
19. Morganti P and Stoller M (2017) Chtin and Lignin:Natural Ingredients from Waste Materials to make Innovative and Healthy Products for Humans and Plant. Chem Engin Transaction 60: 319-324.