APPLICATION OF GREEN CHEMISTRY IN SKIN CARE PRODUCTS

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Abstract: Everyday, millions of people use skin care products (SCPs) and often times are unknowing that these products are inflicting harm to the environment. It is of dire importance to address the ramifications these products have to the environment. Owing to the fact that consumers drive the market, scientific knowledge regarding the implications of commonly used ingredients commonly, could help mitigate the associated negative impacts. This review underscores the harmful effects of current ingredients in SCPS, more specifically; ingredients used in skin care products. With sustainable development in mind, the alternative ingredients suggested and industry are evaluated with the green chemistry principles in mind.

***Index Terms*- Skin Care Products, Green Chemistry**

I. INTRODUCTION

The skin care product industry is predominately driven by diversity and innovation because we demand it. Cosmetics products is characterized as- "Any substance, or blend of substances, made, sold or represented for use in cleansing, improving or altering the complexion, skin and incorporates deodorants and perfumes" (Naik, P. J. et. al., 2013). Everyday many of us use skin care products (SCPs) and unknowingly expose the environment and ourselves needlessly to harm. Elimination of these products entirely is ideal but grossly unrealistic. Skin care industry shows an upward trend which is a result of an improvement in the economy (Cizmas, L. et. al., 2015). In the approaching years, consumers are more likely to look for products that promise multiple benefits. With this knowledge, it is imperative to know when it comes to your SCPs, what the ingredients are. Moreover, are the ingredients harmful to you as well as to environment?

With the ubiquitous use of these products, the risks posed by these to our environment need to better understood. Many skin care products contain several chemicals used to achieve various functions or provide a specific benefit. Studies have provided proof that the chemicals currently used in skin care products have a negative effect and pose a risk to the environment. Identifying the problems can help steer a more focused research in the direction of tackling these issues.

Currently, a globally overarching goal, is to achieve sustainable development, defined as "development that meets the needs of the present without compromising the ability of future generations to meet their needs"(Brundtland, G. et. al., 1987). Along with the market forecast for this industry, the most viable option for obtaining sustainable development is by means of 12 principles of green chemistry (Anastas, P.T., 1998), a pivotal element to accomplishing this goal. Along with these green chemistry principles, Jessop et al (2015) suggested cost-effectiveness and the carcinogenicity of ingredients needs to also be considered. The objective of this paper is to review some of the current ingredients used in skin care products and the problems that arise, hindering a sustainable development. The focus will mainly be on commonly used ingredients in skin care products and their environmental impacts.

II. SKIN CARE PRODUCTS

With the growing recognition of the harmful effects of ultraviolet (UV) radiation this has lead to the development of chemicals, more specifically; UV filters to mitigate the effects. These filters have become popular because of their protective role in reducing skin damage which has shown to eventually lead to premature skin aging (Seite, S. et. al., 2000).They work to absorb UV radiation and mitigate the negative effects of sunlight exposure and protect skin.

III. ENVIRONMENTAL IMPACTS OF SKIN CARE PRODUCTS

These UV filters are meant to be applied externally to the outermost layer of the skin; however, concerns have risen with regard to their ramifications to the environment. UV filters approved for use have been detected in surface water, and drinking water (Ramos, S. et. al., 2016). Nowadays, UV filters are considered emerging contaminants due to their widespread presence in the environment and because of the unknown risks associated with their presence (Ramos, S. et. al., 2016). UV filters can enter the environment in various ways, for instance, directly from recreational activities when they are washed off from the skin as a result of swimming. The UV filters are lipophilic and end up accumulating in sediments and biota (Cizmas, L. et. al., 2015) proving to be a problem.

IV. GREEN ALTERNATIVES

In addition to meeting as many of the 12 principles of Green Chemistry as possible, desirable alternatives to these UV filters would need to be characterized as readily biodegradable, low toxicity to aquatic organisms, non-sensitizing, non-irritating and pose little to none toxicological problems to humans.

Gelatin, produced by the partial hydrolysis of collagen, is a natural biopolymer widely used due to its biocompatibility, biodegradability, and low cost and have been employed in various cosmetic products (Elzoghby, A. O., 2013). Moreover, it does

not produce unsafe byproducts upon enzymatic degradation. Rutin- entangled gelatin nano-particles (GNPs) were planned and connected with ethylhexyl dimethyl PABA (EHDP), ethylhexyl methoxycinnamate (CHMC) a substitute to synthetic-based sunscreen. Encapsulation of natural ingredients such as rutin, can offer improvements in sun protection effectiveness by reducing the amount of UV filters in sunscreens (Oliveira, C. A. De. Et. al., 2016). This leads to the prevention and inherently safer chemistry.

Some plant oils have been shown to possess some natural sunscreen abilities. For example, sesame oil resists 30% of UV rays. Additionally, the active ingredient, epigallocatechin-3-gallate (EGCG), a phytochemical found in green tea has shown to work as sunscreen (Korac and Khambholja, 2011). However, they cannot be used as a sole sunscreen ingredient and must be used along with current UV filters. The benefit with using the plant extracts or biopolymers is this minimizes the need for UV filters despite not completely replacing them**.** Additionally, green coffee oil (Chiari, B. G. et. al., 2014), and extracts of carica papaya (Gupta. D., 2013), natural products, have undergone cytotoxicity assay and are safe for use as additives to personal care products which would lead to a reduction of commercial UV filters.

Lignin (Qian, Y. et. al., 2015), one of the most abundant biopolymers on earth (Lanzalunga and Bietti, 2000) Qian et. al. (2015), studied the effectiveness of lignin addition to pure sun creams via magnetic stirring. They demonstrated that the commercial sun protection factor (SPF) 15 sun lotions saw an enhancement, in fact with the addition of lignin the SPF could reach up to 30. This nature-inspired lignin system provides an alternative to replace some synthetic chemicals. The use of microbial *sunscreen* compounds has been growing as they have shown to provide a photoprotective mechanism. Scytonemin, a cyanobacterial, is a lipid-soluble and stable pigment. Under UV light it was seen to be effective in acting as a shield for the cells. Melanin (known from fungi and bacteria) has shown resistance to UV light and could potentially be employed in personal care products.

V. ISSUES WITH GREEN INGREDIENTS

Achieving high performing products with more green alternatives is the biggest challenge faced and the performance does not yet match that of conventional ingredients. A suggested alternative blending ingredient could reduce harmful ingredients as was the case with some of the proposed green alternatives for surfactants and UV filters. Additionally, problems can occur when trying to scale up from laboratory to manufacturing which could mean a less controlled environment. Moreover, natural ingredients tend to be more susceptible to bacteria as it finds it more nutritious.

VI. CONCLUSION

Eliminating current toxic chemicals in skin care products (SCPs) need to be addressed. With some of the green chemistry principles viable alternatives can be found and success can be made. Efforts need to be focused on understanding the full implications of the SCP ingredients as there is a lack of information regarding this. For improving the biodegradability of ingredients, the reduction of harmful chemicals must be carried out either by completely replacing the toxic chemicals or by finding ways to reduce the need of the harmful chemicals through blending them with natural products. Lastly, biodiversity needs to be considered when trying to find ‘green’ alternatives, it is important not to put at risk the system.

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