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Green chemistry: the future or 'green-wash'?

Just because it says it is 'green', it does not mean that it is. While there are a lot of 'green-washed' products on sale, there are also some trustworthy products. But organic or natural cosmetics, ecologically sensitive or ethically correct products have a confusing array of certifications from around the world, including BDIH, Cosmos/ Ecocert, Ecolabel, and the Fair Trade label.

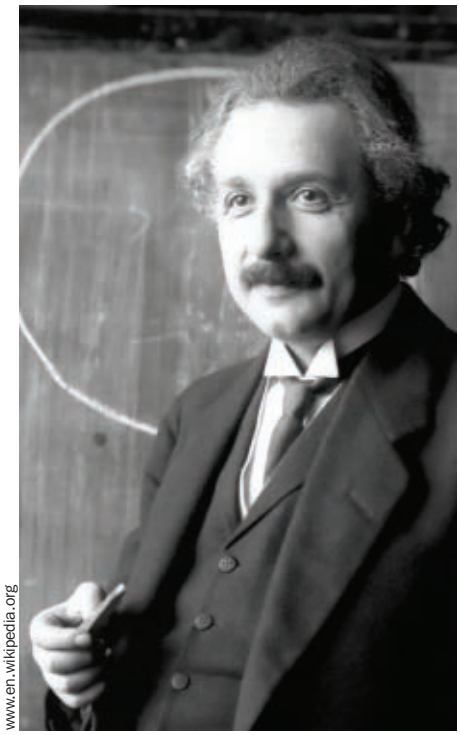
More and more consumers are environmentally conscious and like to buy personal care products that fit their mind-set. But they do not understand the differences between all the labels. The media does not help either; with emotional campaigns, they can potentially cause more fear and confusion than clarification.

On one side we have finished goods that use raw materials and packaging that ensure they are produced under ethically correct production conditions, without child labour involved and distributed according to Fair Trade guidelines.

Then we have beauty products which contain a portion of natural or organic raw materials. The range varies from almost zero to 100% and a strict differentiation between natural and organic has to be made. There are many products on the market that only have a natural appearance thanks to marketing strategy and do not contain anything natural besides a fruity or flowery fragrance.

The third group consists of personal care items that contain mostly biodegradable raw materials and/ or are produced under environmental friendly conditions. They do not need to contain any type of natural ingredients, but these ecology-minded products can really make a difference to our environment as they have a minimal or no negative impact. For many years there has been the Ecolabel which certifies the biodegradability and aqua toxicity of detergents and rinse-off toiletries. This label is more popular in Northern and Western Europe, but is almost unknown for beauty products.

In 1998 a book was published by PT Anastas and JC Warner, called '*Green Chemistry: Theories and Practice*'[1] which is the handbook for effective application



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Albert Einstein influenced the development of green chemistry.

of green chemistry in chemical and related industries. These guidelines make a great deal of sense for reducing the negative impact of cosmetic raw material production, but it has only been in the last few years that they have become better known and popular. When raw material suppliers apply these guidelines they do not offer producers of cosmetic products another unnecessary label, but a strong and meaningful concept that their marketing department can also use for promotion.

The principles of green chemistry

Overconsumption of non-renewable and renewable resources, as well as the production of waste at the same time has brought the world into a critical position. The thinking behind green chemistry (environmentally benign chemistry) rests heavily on a quote from Albert Einstein (1879–1955):

"We shall require a substantially new manner of thinking if mankind is to survive."

The book summarised the principles of green chemistry in 12 points:

- *Prevention*: Prevent the formation of waste
- *Atom economy*: Synthetic methods leading to maximisation of the incorporation of all raw materials used into the final product.
- *Less hazardous chemical synthesis*: Synthetic methods should be designed to use and generate materials that possess minimal toxicity to people and the environment.
- *Designing safer chemicals*: Chemical products should be designed to minimise their toxicity, but having expected properties.
- *Safer solvents and auxiliaries*: The use of auxiliary substances (e.g., solvents) should be made unnecessary whenever possible and innocuous when used.
- *Design for energy efficiency*: Energy requirements of chemical processes should be minimised.
- *Use of renewable feedstock*: A raw material or feedstock should be renewable rather than depleting.
- *Reduce derivatives*: Unnecessary derivatisation should be minimised or avoided if possible, because such steps require additional reagents and can generate waste.
- *Catalysis*: Selective catalytic reagents are superior to stoichiometric reagents.
- *Design for degradation*: Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
- *Real-time analysis for pollution prevention.*
- *Inherently safer chemistry for accident prevention*: Substances and the form of a substance used in a chemical process should be chosen to minimise the potential for chemical accidents, including releases, explosions, and fires.

Green chemistry involves the utilisation of this set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture, and application of chemical products. But in practice, green chemistry covers a much broader range of issues than the definition suggests. In addition to using and producing better chemicals with less waste, green chemistry also involves reducing other associated environmental impacts, including a reduction in the amount of energy used in chemical processes. Green chemistry is no different to traditional chemistry as it embraces the same creativity and innovation that has always been central to classical chemistry. However, there is a crucial difference in that, historically, synthetic chemists have rarely ranked the environment very high in their priorities. However with an increased awareness for environmental protection, environmental pollution prevention, safer industrial ecology, and cleaner production technologies worldwide, there is a heightened interest and almost a new challenge for chemists to develop novel products, processes, and services that achieve the necessary social, economic, and environmental objectives. Since the types of chemicals and the types of transformations are very varied in the chemical industry and chemical research world, so are the green chemistry solutions that have been proposed.

Sales of 'natural' products within the personal care industry continue to show significant growth. Popular culture has driven this growth by popularising the idea that there may be potential adverse effects to the body (toxicity) and to the environment (pollution, hastening of climate change, and environmental toxicity) associated with the use of ingredients derived from fossil fuels. The personal care industry has rapidly advanced its attempts to identify ingredients described as 'renewable' and 'sustainable', that is, ingredients of non-fossil fuel origin for use in the formulation of virtually all cosmetic product types and forms.

In many instances, the industry has successfully identified replacements for many ingredients that are historically of fossil fuel origin. Examples of this are the replacement of mineral oils, silicones, and petrochemically-derived synthetic esters with vegetable oils and natural esters, synthetic fragrances with essential oils, and petrochemical preservatives with certain extracts.

Although used in marketing materials, the term 'natural' has not yet been completely defined. However, efforts are underway by industry trade organisations

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The Earth as seen from Apollo 17 in 1972.

to give the term a more concise and consistent meaning. Historically, it has been generally recognised that materials derived from renewable and/or sustainable, or otherwise non-fossil fuel sources are considered to be 'natural' by the marketplace. More recently the definition of 'natural'has been further refined. For example, there is a trend within the trade to prohibit animal-derived materials and plant-derived materials that are obtained from the use of genetically-modified organisms (GMO) from use in natural products.

Also, certain chemical processes used in the manufacture of ingredients, especially those processes that employ petrochemical solvents, generate unrecoverable waste, and/or consume excessive resources, are frowned upon or may otherwise be prohibited. The use of green chemistry principles in the production of cosmetic and personal care ingredients is rapidly becoming a positive benefit that can be exploited in the marketing of products produced using those principles. Thus, the evolving definition of 'natural' currently includes products that are not petrochemically derived.

A new natural, cationic emulsifier and conditioner

One particular challenge facing formulators of natural products relates to the identification of suitable emulsifiers. An emulsifier is a type of surfactant typically used to keep emulsions (metastable mixtures of immiscible fluids) well dispersed. Emulsifiers typically have a hydrophobic (water-repelling) and a hydrophilic (water-loving) moiety. In an emulsion involving oil and water, emulsifiers will surround the oil with their hydrophobic moiety oriented toward the oil, thus forming a protective layer so that the oil molecules cannot coalesce. This action helps keep the dispersed phase in small droplets (micelles) and preserves the emulsion. Emulsifiers may be anionic, nonionic, or cationic. A good emulsifier for use in a personal care product is one that will maintain consistent emulsion characteristics such as particle size, appearance, texture, and viscosity, substantially constant for as long a period as possible since by their very nature, all emulsions due to their metastable nature will eventually separate into their constituent oil soluble and water soluble components. Stability of the emulsion is

highly desirable in most products, since among other advantages, this stability contributes to an extended shelf life of the product and the maintenance of its initial aesthetic properties over time.

Although the vast majority of emulsifiers currently used in personal care products are wholly or partially petrochemically-derived such as polyethylene glycol (PEG) derivatives and amine quaternaries, a limited number of known emulsifiers may meet the current definition of natural. However, presently available natural emulsifiers fall only within the classes of nonionic and anionic emulsifiers.

The natural nonionic emulsifiers are typically partial esters of long chain fatty acids with a polyol. Examples are long chain partial esters of sugars, of alkylglucosides, and of polyglycerols. Although these nonionic emulsifiers can be effective in building stable emulsions, they do little or nothing to provide any conditioning and/or aesthetic benefits to the hair or skin because they are not substantive to these substrates, which are negatively charged.

The natural anionic emulsifiers are typically the long chain fatty acid soaps of fatty acids and sulfuric acid esters (sulfates) of fatty alcohols. These tend to be drying to the skin and provide no aesthetic or conditioning benefits because, like the hair and skin, they are negatively charged and therefore tend to be repelled by these substrates.

Currently there are no known natural cationic emulsifiers. All of the traditional cationic emulsifiers are petrochemically derived; therefore, all of these cationic emulsifiers are considered not to be natural and cannot be used in the formulation of natural products. Accordingly, there is a need for natural cationic emulsifiers that have performance and use characteristics and substantivity similar to the traditional cationic emulsifiers.

Inolex has been able to develop a range of sustainable personal care ingredients according to the guidelines of green chemistry. They are produced based on these principles in order to guarantee beyond the sources that these ingredients have minimum impact on the environment.

Emulsense (INCI: Brassicyl Isoleucinate Esylate (and) Brassica Alcohol) is the first sustainable cationic material that has been produced according to green chemistry; entirely non-petrochemical, made from 100% renewable resources, and compliant with the latest standards for natural cosmetics. It has an excellent toxicological profile and scored readily biodegradable and non-toxic to fish, daphnia and algae in extensive eco-toxicity testing. Emulsense is also very safe as it is non-irritating to the eyes and skin, and non-sensitising.

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Brassica is a genus of plants in the mustard family (Brassicaceae).

The ingredient is made from only non-GMO fermentation chemistry and the oil from brassica plants. It is produced using minimal, gentle processing and yields almost no waste – the only by-product is water. By being free of petrochemicals and palm-derivatives, it is perhaps the most sustainable and earth-friendly cosmetic ingredient on the market today.

Although there is a multitude of hair conditioning agents available to the personal care product formulator, when it comes to the creation of truly natural products the choice is limited. Only cationic ingredients are absolutely adhesive, but not approved for natural cosmetics in the past. Emulsense offers therefore new, exciting possibilities.

The core technology behind it is a novel, patent pending ester derived from the amino acid L-isoleucine and long chain fatty material derived from the brassica plant. Because the amine group of the amino acid is in its neutralised form, the molecule is cationic and substantive to the hair and skin.

Emulsense creates very stable formulations based on liquid crystals that can be prepared with higher oil loadings (30%) for improved moisturisation without greasiness or tackiness.

A very simple formula based on Emulsense has been shown to be comparable to high end commercial formulations in the areas of wet combing, fly-away, hair breakage after repeated combing, and elimination of static charge. Another benefit of the ingredient in hair care is that it will not build up on the hair and can be used in efficient and modern hair treatments.

Conclusion

There are plenty of different certificates and labels for natural beauty products available but most of them do not take sustainability of the used raw materials in account or only touch upon this topic slightly. But in fact the subject of renewable and sustainable raw materials is much more important for maintaining the integrity of our planet. In 1998 the handbook for green chemistry was published which states simple guidelines to follow for environmentally conscious production and handling of chemicals. Fortunately the cosmetic industry has realised the importance of this matter and offers more and more ecologically sensitive raw materials, products, and packaging.

Inolex has several functional ingredients in the product range that are produced according to green chemistry and will continue with this engagement for new product development. There are plans already to rebuild the whole plant in order to be able to produce in a more environment friendly manner. PC

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