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Designing natural cosmetics through the dynamics of naturally derived lipids

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We all should strive for enhancing individual beauty without threatening the beauty of our planet. In recent years natural products have grown from a niche segment to one of the fastest-growing categories in personal care. In fact, natural personal care (NPC) has outperformed other natural product segments such as functional foods and supplements. Growth of NPC will continue following the growth of the nutraceutical market.

Although all attempts are being made to replace petroleum-based products with natural ones the substitution is far from complete, owing to the lack of in-depth knowledge of the raw materials as well as product formulations and stability. Application of natural oils and fats was severely restricted due to oxidative degradation of lipids resulting in malodors, color changes, viscosity increases, and changes in specific gravity, solubility and appearance. We recently described the development of a unique means of stabilization of exotic butters and natural oils, thus avoiding any cumbersome application of antioxidants and avoiding heating, homogenization, extra labor, and handling of additional powders.

While using natural oils and butters, one can use either the properties of triacylglycerol constituents or nontriacylglycerol components or both as per the specific requirements of the product formulation in question.

Skin

The skin is the largest organ of the human body. The approximate surface area of the skin for an adult weighing 65 kg is 1.8 m^2. The skin represents the barrier of the human body that shields it from a variety of strains such as heat, cold, and light including ultraviolet (UV) and other types of harmful irradiation. Other stressing factors with which the skin has to cope are dehydration, noxious substances, insect bites, and infection. To survive these strains, the skin performs a variety of specialized functions and reactions, for example, production of melanin and sebum, keratinization, sweat excretion, and so on.

Natural lipids may be beneficial for the physical and biochemical properties of the skin. The physical benefits include occlusivity, which, in cosmetic and pharmaceutical practice, refers to the ability of a substance to create a film on the skin surface that interferes with the evaporation of water from the skin surface. Any increase of transepidermal water loss (TEWL) decreases the level of water retained in the epidermis. This is a significant problem in people with atopic eczema, chronic contact eczema, and other forms of dry skin. In the design of cosmetics for the repair of damaged skin and for skin protection, it is therefore important to assess the effect on TEWL. In this context it is important to notice that the term "moisturization" is often preferred because "occlusion" may imply retention of dirt. In cosmetics, natural lipids are thus used as occlusive agents, but promoted as moisturizers.

The biochemical benefits of natural lipids include the regulation of epidermal growth, reduction of skin inflammation, and provision of a skin barrier function. The barrier properties of the skin and the skin's ability to retard transepidermal water loss depend on the presence of epidermal lipids. The permeability barrier in human skin is mediated by three lipid families—ceramides, free fatty acids, and cholesterol -present in an approximately equimolar ratio. The epidermal lipids are formed *de novo* by keratinocytes, although some lipids or their precursors are supplied from the circulatory system. Variations in the composition and proportion of these lipid families can lead to either deterioration, normalization, or acceleration of barrier repair.

Lipids in cosmetics

The cosmetic industry has developed products to cure skin disorders and to retain the skin's natural beauty. Long ago, natural fats were the dominant emollient material, but later these were replaced in many applications by mineral oils. However, because of the growing awareness in the 1980s and 1990s of the environment, an increasing interest in environmentally friendly products, such as naturally renewable vegetable lipids, are finding ever-increasing use in a wide range of cosmetic applications.

More systematic studies of a wide range of plant seeds and their oils have identified many interesting materials. Previously unknown oils with unusual properties and chemical structures have been discovered.

Most lipid-based products are nontoxic, nonhygroscopic, and normally are nonreactive with active ingredients. Some oils are rich in essential fatty acids whereas others contain natural antioxidants or sunscreens. Therefore, it is no surprise that such oils are receiving much more attention as safe, environmentally friendly ingredients for the cosmetic formulator.

Lipids play an important role in the formulation and performance of many cosmetic products. They may act as binders, lubricants, solubilizers, carriers, viscosity modifiers, spreading agents, emollients, and emulsifiers in a variety of applications including lipsticks, creams, lotions, makeup bases, moisturizers, bath oils, pressed powders, fragrances, and a variety of cleansers for hair, face, and body.

Vegetable oils are primarily triglycerides (triacylglycerols), in which the predominant fatty acids are palmitic and stearic acids and their mono- and polyunsaturated forms such as palmitoleic, oleic, linoleic, and linolenic acids. However, many other fatty acids also occur, usually in smaller quantities.

These fatty acids can be combined in endless variations resulting in a wide range of chemical and physical properties. Oils from the same plant species can show variations in the ratio of the same key fatty acids; this may occur as a result of genetic differences and weather influences.

Vegetable oils vs. synthetic chemicals

Several factors need to be considered when comparing possible replacement of petroleum-based chemicals, such as mineral oil fractions, with natural vegetable oils. These include economy, health aspects, functionality, and stability

In general, vegetable oils are more expensive than the synthetic substances and are not as homogeneous in content. Many types of vegetable oils have specific beneficial physiolog-

ical effects, as shown in numerous studies. Choosing the right type of oil can result in positive results for a given cosmetic application.

Edible plant-derived butter can, in general, be anticipated to be innocuous. The major drawback in the use of vegetable oils instead of mineral oil fractions is the poorer oxidative stability of vegetable oils, especially polyunsaturated oils, which pose an extra problem that until recently has been difficult to resolve.

However, progress is being made to ensure consistent quality and improved stability of unsaturated oils, which will allow wider use of vegetable oils as a basic cosmetic formulation ingredient. The importance of nontriacylglycerol constituents (unsaponifiables) in vegetable oils with regard to the stability of natural oils has been recognized in recent years. Many of these constituents are potent natural antioxidants.

Physical effects of vegetable oils

Natural oils and fats are used for differing effects in a variety of cosmetic products. They remain on the skin, and their presence results in several important physical effects, including emolliency and occlusivity.

Emollients are defined as substances that impart softness, smoothness, and flexibility to skin and that have the ability to maintain these conditions for some time. Water alone can produce these effects, but the perceived benefits are rapidly lost as the water evaporates. Emolliency in practice is rarely differentiated from the tmoisturization, although the latter implies that the water content of the skin is raised. It is well established that the application of a water–oil mixture in a simple emulsion causes a temporary increase in the skin's water content. Most of this water is lost within a few minutes, but the residual effect of the nonvolatile lipid produces emollient benefits. The lipid film on the skin surface may help to retard the evaporative loss of water when the emulsion dries on the skin.

With regard to occlusivity, any reduction of TEWL raises the level of water retained in various strata of the epidermis. The occlusive character of fats and oils can be utilized to increase the water content of the skin. This increase alters the viscoelasticity of the *stratum corneum* and makes the skin more supple. Occlusive substances impede the escape of water vapor; these materials, as a rule, also can act as water repellants, i.e., interfere with access of water.

Skin lipids

One of the rationales for the use of natural oils in cosmetics originally arose from the fact that these lipids are similar or even identical to those found normally in or on human skin. Solvent extraction of skin yields a blend of lipids from several sources, including the sebaceous gland. The major components of sebaceous lipids are squalene 12–15%, wax and sterol esters 25%, free fatty acids 10%, and triglycerides 45–60%. The fatty acids found in sebum include odd- and even-numbered carbon chain acids not normally found in ingested lipids. They may be saturated or unsaturated and include some unusual substances such as sebaleic acid (18:2n-10).

Essential fatty acids (EFA)

The biological significance of polyunsaturated fatty acids (PUFA) is related to the term "essential fatty acids" provided from dietary sources. The PUFA are n-6 and n-3 PUFA. The cascade of n-6 and n-3 PUFA is shown below (Figure 1).

From the foregoing we can conclude that it is highly desirable to concentrate on the development of noninflammatory eicosanoids through n-3 oils. The main drawbacks associated with these oils are their oxidative stability. We have been studying the quality of encapsulated products in the world market for two decades and found extremely high oxidation values as well as polymer development.

These polymers were due to oxidative stress and therefore we have developed a vegetable source of n-3 oil, Danomega 3, which has been produced through our internal stabilization procedure and provides an excellent source of n-3 in formulating cosmetic products that are highly stable.

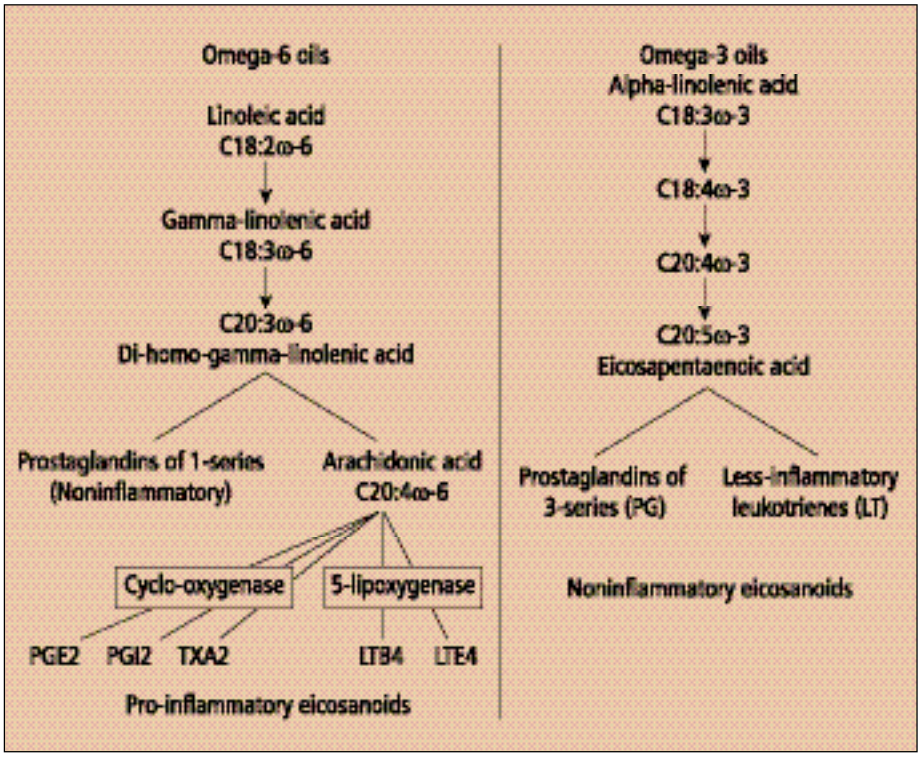

Figure 1. EFA Metabolism and Eicosanoid Consequences

Danomega-3

This special blend of cold-pressed vegetable oils has a very high content of n-3 fatty acid. The n-6/n-3 ratio is <1. Its uniqueness is its very high content of EFA. Overall, PUFA content and total unsaturation are very high. The PUFA are stabilized by an herbal extract. The oil has an extended shelf-life, anti bacterial properties, and strong anti-inflammatory and anti-aging properties. The most recent beneficial effects of n-3 are in reducing the risk of getting sunburned.

Cosmassage

We have further developed an engineered vegetable oil, cosmassage, which provides following properties:

- Blend of cold-pressed vegetable oils.
- High in unsaturated fatty acids like oleic acid.
- High content of EFA. Overall PUFA content is much higher (32%) than ordinary massage oils (27.5%).
- Excellent cold weather stability. The oil is stabilized with herbal extracts.

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- It is non-sticky and penetrates the skin rapidly.
- Growth-promoting anti-aging properties.

The products can be successfully used in formulating natural cosmetics, and the recommended doses are as follows (in %):

hair care, 1–2;
baby care products, 5–8;
hand cream. 5–10;
lip care products. 5–10;
massage cream/lotion, 10–20;
night cream, 8–15;
dry sensible skin cream, 5–12;
soap, 2–3;
sun care, 6–20;
winter sport cream, 2–15;
day cream, 4–6;
body lotions, 2–5;
and antiwrinkle products, 5–7.

Future research in cosmetic formulations must focus in the following directions:

- Structured lipids: It is possible to design triglycerides with specific fatty acids. These fats can provide unique functional and nutritional properties.
- As no single oil or fat can provide optimum nutrition it is advisable to apply recipe engineering to design properties of interest in formulating various products.
- Abundance of specific nontriacylglycerol components provides ample scope in designing bioactive formulations.

Future perspectives

The future belongs to the products that are natural, safe, innovative, high performance and above all elegant feeling. The aging population is seeking products that show measurable effects for minimal cost. The new anti-aging ingredients being developed are the best hope for conserving youth. The newly developed solutions that claim to protect from UV rays and pollutants are continuously in demand.

Products produced with natural ingredients have always been and will always be in consistent demand with consumers. Multifunctional properties provide significant value in beauty care as consumer is getting more for the money. These products are mainly successful because of their advertising effect, providing a strong and clear message that is attractive, persuasive, and memorable.

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