Oils and fats in cosmetic products – Mother Nature contra petrochemical industry?

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A subject that has launched controversial discussions over and over again is the use of mineral oil based hydrocarbons in cosmetic products. Above all in the cold season it gains importance as the skin is sensitive to cold and dry air and should therefore be protected with re-fattening substances. Where is the difference between oils and waxes of petrochemical origin and natural fats and oils?

The human skin mainly protects itself with both, the barrier layers in the stratum corneum, which contain ceramides, fatty acids and cholesterol, and with the sebum of the sebum glands. Sebum consists of triglycerides (41%), fatty acids (16%), waxes (25 %), squalene (12 %) cholesterol (1,4 %) and cholesterol esters (2 %) and characterizes the lipid cover of the skin.

Taking the skin as model

It can be assumed that cosmetic products formulated like the barrier layers and sebum of the skin provide the best possible care system for the skin. As a matter of fact, studies with barrier components that were applied on the skin show optimal skin regeneration results if the natural mixing ratio i.e. a molar ratio of ceramides (50 weight %), fatty acids (15 weight %) cholesterol (25 weight %) = 1:1:1 is obeyed. The influence of the sebum lipids still is entirely ambiguous. In case of doubt however it may be advantageous to consider the individual physiological conditions.

Sebum

Sebum triglycerides (in triglycerides the glycerol is bonded to 3 fatty acids) resemble the fatty vegetable oils. Vegetable fatty acids however contain more unsaturated acids. Yet unlike triglycerides **squalene** is a pure liquid hydrocarbon i.e. it only contains carbon and hydrogen ($C_{30}H_{50}$). Squalene belongs to the group of triterpenes and in biological respect it is the pre-stage of cholesterol. For cosmetic purposes, the unsaturated squalene, i.e. containing double bonds, is generally replaced by squalane ($C_{30}H_{62}$) which is less sensitive to oxygen and gained of vegetable squalene through a hydrogenation process which means that hydrogen is added.
Lanolin is gained from the sebum glands of sheep and also contains hydrocarbon, unlike the human sebum however only traces of it (< 1%).

Hydrocarbons

Vegetable: Squalene and other hydrocarbons are widespread in the vegetable kingdom. Some of them can be found in fruits as flavourings with a balmy, spicy and pine-like note. Carotene ($C_{40}H_{56}$) is an unsaturated hydrocarbon. Vegetable waxes contain hydrocarbon as follows: beeswax 15 %, candellila wax 45 %, carnauba wax 2 %. Besides wax esters, wax alcohols and free fatty acids also the waxes on fruit peels carry hydrocarbons.

Mineral: Saturated and rather inert are mineral hydrocarbons like paraffin (solid), paraffin oils and vaseline (petrolatum) made from crude oil and mineral waxes. They are characterized by a broad spectrum of singular components. Highly purified fractions have found their entry into the pharmacopoeia as bases for ointments and suppositories. They generally show an excellent tolerance whereas white vaseline in its pure form has a considerably increased acanthosis factor. In other words, after a treatment of ten days a thickened epidermis with simultaneously increased stratum spinosum may be observed. It has not yet been proven whether this reaction is due to occlusivity and a subsequent swelling of the skin. As oils and fats only rarely are used in a 100 per cent pure from, these findings presumably are less relevant for their practical use in cosmetic creams. In the past however the contents of cancerogenic substances and mutagenous aromatic hydrocarbons have played a significant role regarding the tolerance of paraffin oils.

A comparison

What is to be said against the use of inexpensive mineral hydrocarbons in cosmetic pro-

ducts instead of sensitive vegetable oils as even the human body produces hydrocarbons? To approach this issue, the features of triglycerides gained from vegetable oils have been listed below:

- Vegetable oils are familiar substances for the skin. They integrate into the triglyceride balance of the skin and consequently can also be metabolized.
- Vegetable oils contain physiological barrier-active acids like palmitic acid. Linoleic acid indirectly reinforces the skin barrier as it is integrated into ceramide I. Linoleic acid, alpha linolenic acid and gamma linolenic acid produce strong and anti-inflammatory degradation products.
- Many of the vegetables contain phytosterols as side components which are related to the natural cholesterol in the skin. There may be further valuable natural additives like vitamin E among others.
- Due to their lipid character vegetable triglycerides have smoothing effects on the skin. The lipids cause a moderate reduction of the transepidermal water loss (TEWL). An extensive reduction of the TEWL however is not desired as it is still necessary for the skin to "breathe" in order to maintain its natural functions.

Vegetable triglycerides show manifold effects. Unsaturated vegetable oils however are sensitive to atmospheric oxygen and need to be stabilized with anti-oxidative vitamins. Water containing products have a limited shelf life due to the fact that the triglycerides will hydrolyze although in a rather slow process. In comparison, paraffin oil and its related substances show a high stability against atmospheric oxygen, water and microbial degradation. Mineral hydrocarbons however do not provide any active agent features.

A question of defining...

Hydrocarbons undoubtedly cause an exogenic regeneration of the skin barrier to such an extent that mineral oils and vaseline may be integrated as droplets into the surface barrier layers. Emulsifiers support this process by dispersion of the droplets. Although this kind of superficial repair of the barrier layer does not correspond with the physiological natural model, it reduces the transepidermal water loss (TEWL) as desired and preserves the skin hydration. In how far stronger occlusive effects are caused which is indicated by a further reduced TEWL depends on the dosage of the mineral oil products. Vaseline shows the highest reduction of TEWL. An application of impermeable films on the skin after barrier disorders as e.g. for the treatment of dry skin, inhibits an increased epidermal fatty acid synthesis and prevents the natural stimulation of both the DNA and mRNA activities of the skin. In cosmetic practices the reports about very dry skin of consumers using mineral oil containing creams are above-average.
Mineral oils are not absorbed and accumulate in the superficial skin layers. The smoothing sensation therefore will last longer which is an advantage compared to the absorbable triglycerides with respect to the application and to sensory characteristics. The natural balance and regenerative capacity of the skin however is not supported but inhibited. The epidermal cell maturation is slowed down and the skin pH value impaired. Said effects however depend on the hydrocarbon content. As only a few of the cosmetic products contain such critical amounts, these effects should be seen in perspective.
Natural lipid substances and mineral oils pursue different purposes though. If skin protection is required mineral oils are a favourable solution considering the price differences and sensorial features although in the long run the skin becomes less active. In recent years however there has been observed the tendency to maintain a high regenerative activity of the skin as long as possible which should have priority over plain skin protection. Experiences with new barrier creams containing vegetable triglycerides which are free of emulsifiers and which have a physical structure similar to the barrier layers of the skin show that not only disordered barrier layers but also the skin which is susceptible to cornification disorders as e.g. acne skin will benefit in the long run.

Related hydrocarbons and silicones

Microcrystalline wax and mineral solid paraffins like ozocerite and ceresine (refined ozocerite) are related to the paraffin products. Their fields of application are quite similar to those of petrolatum. An interesting substance group with comparable features are the **poly-alphaolefins (PAO)**. They are synthetic hydrocarbons as e.g. polypropylene, polybutene or polydecene. By a specific polymerization process it is possible to achieve practically any type of viscosity desired, ranging from very light over viscous to semisolid. After all, the base substance here also is crude oil however, the finished products are not substance mixtures but uniform hydrocarbons with a precisely defined chain length and without irritating impurities. PAOs are also used in lipsticks (see be-

low).
Silicones are generally mentioned in the same breath with mineral products. The smoothing and adhesive effect of high molecular silicones is stronger than of mineral oils. The consumer above all appreciates the hydrophobic effect with the simultaneous velvety sensation. Just like mineral oils also silicones are not physiological. They do not contribute to the natural substance balance in the skin which means that the agreeable sensation does not correlate with a real endogenic regeneration of the skin. They practically have unlimited shelf life as they will not degrade through the influence of atmospheric oxygen or water nor can any significant microbial degradation be observed.

"Consuming" hydrocarbons

While vegetable oils are part of the every day nutrition, the long-term tolerance of hydrocarbons is a significant issue. As a rule, women may easily consume several lipsticks per year which means a steady intake of minor amounts of hydrocarbons. Traces of paraffin-based hydrocarbons and silicones are absorbed either orally or through the skin. As they are not metabolized, they are either stored in the fatty tissue or they leave the body unchanged. Due to the rather inaccurate conditions the literature available does not allow any valid conclusions. This is the reason why there are still no regulations to these for the manufacturers of cosmetic products.

Skin care strategy

The natural skin is the substrate for a natural skin flora which is severely changed by occlusive conditions. With the help of their own enzymes the natural flora gains free acids from triglycerides and hence creates a **low pH** value which protects the body against external infections caused by pathogenic germs.
It is an interesting fact that **phospholipids** which release the acids during the cornification process are a significant source of free acids. Hence it has a positive effect to favour a **physiological skin care strategy** and to prefer triglycerides to hydrocarbons for the refattening of the skin in order to support the symbiosis with the skin flora.
Emulsifier-free concepts frequently use **phosphatidylcholine** which belongs to the group of phospholipids to create skin-barrier-like structures.
Important: The use of vegetable oils requires a careful adaptation of the oils to the results of the skin analysis. Also potential sensitivities to certain components have to be considered. Depending on the refining processes and the provenance, oils with identical declaration may nevertheless have different characteristics. A well-funded and product-related consultation is very important for an adequate skin care result.
Skin and cold season: During the cold season the skin requires **lipid-containing products**. Besides water-containing creams also water-free products are recommended for extreme conditions whereas the latter-mentioned are of advantage as they are free of emulsifiers which cause the wash-out of both, cream and skin components during skin cleansing. As to that, there are now alternatives to vaseline products on the market which are based on triglycerides and have barrier cream-like effects however with far higher lipid contents. The focus here is on **oleogels** which contain phosphatidylcholine as a membrane-building substance that supports a quick penetration into the skin.

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