Skin reactions - cosmetics and their effects

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The ingredients of skin care products may cause inflammatory processes in the skin under certain conditions. On the other hand there are also cosmetic components which may effectively impede inflammatory processes. In the following survey the contrary ingredients are exemplarily compared with each other.

Inflammatory reactions of the skin are caused by infections, radiation, injuries, mechanical strains and chemical substances and their symptoms in general are redness, topical temperature rise, swelling, soreness and itching.

It's the concentration

Irritations due to cosmetic ingredients may be induced by excessive concentrations i.e. that the specific threshold dose has been exceeded. This specifically applies for **cleansing tensides** of the sodium lauryl sulfate type which has been used for quite some time as a comparative standard irritant in skin tolerance measurements. Sodium lauryl sulfate denaturates proteins and has hemolytic effects.
High doses of **vitamin A (retinol)** lead to reactions that are already known from the vitamin A acid (retinoic acid). While sodium lauryl sulfate is an example for direct irritation the vitamin A reaction is indirect which means that it is caused later by biochemical modification into another substance. The grade of irritation depends on various individual factors like e.g. skin thickness, the integrity of the skin barrier and the individual tolerance. Therefore it should always be kept in mind for instance that the permeability of infantile skin is a lot higher.
Weakness of the connective tissue may cause a general sensitivity for hypertonic aqueous phases. In this case it is indifferent which specific substances are contained in the aqueous phase. Physically only the resulting overall concentration is deciding. In isolated cases the specific threshold in hypotonic aqueous phases already is reached if they cluster in concentrated form on the skin after evaporation of the water contained in the product.
An excellent example to underline the significance of concentrations actually are **fruit acid treatments.** In this specific case it is even intended to provoke irritations in order to induce the recovery process of the skin. The threshold dose depends on the pH value of the products: in case of a low pH value also the threshold dose is lower and with increasing pH with a proportionate content of fruit acid salts it also augments.

Phototoxic processes

The ingredients of vegetable extracts are more or less incalculable issues for individuals who are susceptible to allergies. Hence in case of any doubts it is recommended to run a test on the forearm. Perpetrators here may be **proteins**, **biogenic amines** and **substances which cause stinging irritations** like the capsaicin-related types.
By contrast, the reactions of other ingredients are quite predictable, if certain general conditions are given. This above all applies for phototoxic inflammations that can be observed with natural and synthetic ingredients. Under the influence of atmospheric oxygen and UV radiation the allergenic ascaridol, a terpene endoperoxide, may develop in tea tree oil.

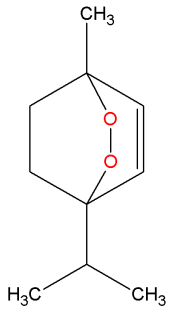

Fig. 1: Ascaridol; both oxygen atoms show the endoperoxide

A further allergenic autoxidation product of the tea tree oil is 1.2.4-trihydroxy-menthane. A similar case is **bergamot oil** with the ingredient bergaptene which is a psoralene derivative (5-methoxy-psoralene), and may cause inflammations of the skin in specific concentrations.
Psoralenes (furocumarines) are also found in citrus and orange peels so that sensitive individuals may end up with phototoxic dermatitis around the mouth after careless peeling and subsequent contamination.

Also **hypericin, an ingredient of St. John's wort,** has photo sensitizing characteristics. A further but rather harmless side effect are persistent spot-like hyperpigmentations.

Careful with phototoxic reactions!

St. John's wort is frequently medicated orally and hence requires additional cause studies besides the ones on the skin care products used in case that unusual skin reactions are observed. A frequently occurring natural substance used in mascara and eye shadows is **colophony resin** whose content of abietic acid causes contact allergies. The triggering substance in this case is not the acid itself but its reaction product with atmospheric oxygen.
Among the synthetic substances, above all the **polyethers** of ethylene glycols, also called PEG and their compounds with long chained alcohols, the "ethoxylated alcohols" like ceteareth, pareth, will react with the atmospheric oxygen under the influence of UV radiation.

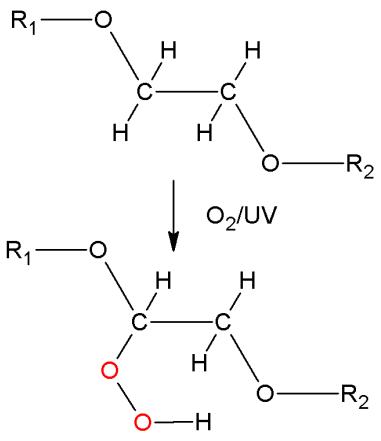

Fig. 2: Formation of hydroperoxide from PEGs
(R_1 and R_2 signify different PEG-chain remainders)

The hydroperoxides formed are very aggressive and one of the causes of the dreaded Majorca acne. It is recommended though to avoid direct sun after the skin has been treated with care products and perfumes as the UV share of the radiation will modify and degrade a whole variety of different substances, among others also antioxidative vitamins. The same applies for the use of **deodorant products** containing **essential oils** or **synthetic chlorinated hydrocarbons**. As these substances are applied on relatively sensitive areas of the human body specific caution is recommended here.
Allergic reactions to preservatives are well-known and it is not necessary at this point to lay particular emphasis on them. This applies without exception for all the substances listed in the Cosmetic Decree.

Anti-inflammatory effects

Yet, cosmetic products also contain substances with the potential to inhibit inflammatory reactions. It should be mentioned at the outset that these substances have to be protected against direct sunlight as they are quite sensitive to degradation and even may become ineffective. They are based on different mechanisms.
Depending on their structure, **anti-oxidants** inhibit the above mentioned photooxidations by:

- Deactivating the hydrocarbon radicals generated by UV light
- Scavenging activated oxygen molecules or
- Reacting with the formed oxidation products.

However, they are no universal remedy as they are consumed themselves in the process and therefore have a limited capacity only. Another disadvantage is that they are also affected by the combination O_2/UV. In addition to that they cannot be applied in randomly selected concentrations as they can start their own radical chain reactions like vitamin E for instance and then have counterproductive effects. A solid and basic protection though is provided by an intact NMF of the skin. Detailed information on this topic can be found in Kosmetische Praxis 2006 (2), 12-14. Extracts and Co. with their content of anti-inflammatory agents may help to treat sun erythema. Among those are aloe, echinacea and D-panthenol (rf. Kosmetische Praxis 2006 (3), 8-9).
Only part of the inflammatory processes in the skin are caused by atmospheric oxygen and sun light. Other triggers are infections, injuries, mechanical irritations as well as chronic barrier and cornification disorders. Independent from the triggering factor though, the inflammatory cascade frequently follows the same pattern in which the natural enzymes of the body are part of the process. A significant key enzyme here is 5-lipoxygenase which oxidizes arachidonic acid into 5-hydroperoxyeicosatetraenic acid (5-HPETE) of which subsequently the pro-inflammatory leukotriens LTE4, LTB4, LTC4, LTD4 and LTE4 then develop.

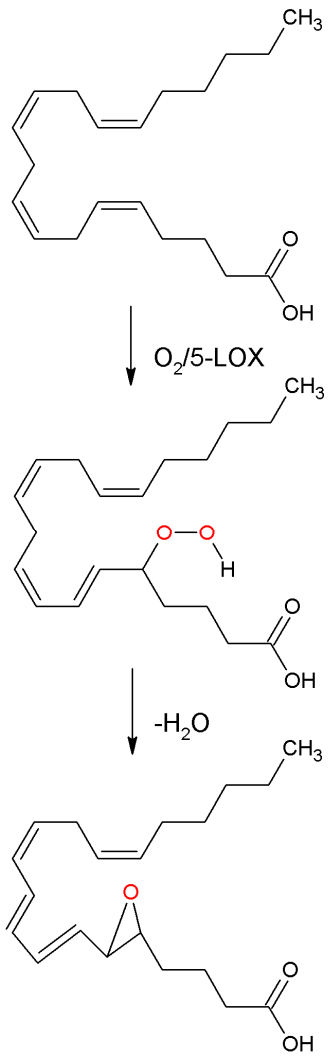

Fig 3: Formation of pro-inflammatory leukotriens (molecular formulas top-down: arachidonic acid, 5-HPETE, leukotrien LTA4)

Boswellia acids from the incense resin are capable of inhibiting the 5-lipoxygenase. For individuals susceptible to acne vulgaris, actinic keratoses, psoriasis and neurodermatitis the skin care with boswellia nanoparticles has proved very successful. The formation of the above mentioned leukotriens is also impaired by **omega-3 acids** among others, like α-linolenic acid (contained in linseed oil and rose hip oil) and eicosapentaenoic acid (component of fish oil).
Omega-3 acids and **omega-6 acids** (linoleic acid, γ-linolenic acid) belong to the essential fatty acids and regarding their inhibitory effects they show another very interesting characteristic. In the skin they are oxidized by means of 15-lipoxygenase into anti-inflammatory acids. Thus natural oils with a high content of combined essential acids are valuable substances for the skin care. Due to their sensitivity it is recommended to apply them in the evening.
In place of a variety of other anti-inflammatory extracts, **calendula** (active agent: terpenes), **ribwort** (active agent: acetoside), **mahonia** (belongs to the barberry family, active agent: berberin), **chamomile** (active agent: among others α-bisabolol), **willow bark** (various phenolic agents), and **arnica** (helenalin-derived agents) should be mentioned. Specifically arnica is a good example for the individually differing tolerance of vegetable extracts. Besides the wound healing features also adverse effects like arnica allergy, dermatitis and eczema may occur.

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Remark: The figures have not been published in Beauty Forum 2008 (9), 114-116.