# Complexing agents & Co – ambivalent ingredients in cosmetic products

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Stable and long lasting products are popular. Short-dated products or, in other words, products with short expiry dates are hard to sell. Long-lasting products frequently are associated with poor degradation profiles, though. Dr Hans Lautenschläger discusses the pros and cons of such ingredients.

The shelf life of cosmetic products is subject to effective antioxidants, emulsifiers, consistency agents and preservatives but also to the stability of the lipids used in the products. The efficacy of such substances in terms of the storage features of the products often is contrasting with skin care and ecology characteristics, in other words, they affect the sustainability of the products.
Sustainability in skin care involves that products are not only focused on temporary immediate effects but also on long lasting efficacy without any adverse effects. Non-sustainable products contain for instance

- emulsifiers with high wash-out effect causing the loss of previously applied skin care substances and natural barrier components during skin cleansing.
- occlusive lipid components which down-regulate the natural regeneration potential of the skin
- non-physiological components such as preservatives which interfere with the biochemical processes of the skin and skin microbiome.

**Emulsifiers & tensides**

Non-degradable additives or such which take a long time to biodegrade neither are welcome in the outdoors. The older ones among us might remember the mountains of foam building up near river dams till the 1980s due to the non-degraded tensides in detergents and on a smaller scale, due to the non-degraded tensides in body cleansers. This problem seems to be resolved by now and the tensides respectively emulsifiers, as they are referred to when used in creams, have been further developed. The more or less irritant features, particularly in higher concentrations still are present, however. According to the German tenside regulation, tensides alias emulsifiers are regarded as biodegradable if they can degrade up to 80%. This is more or less due to the fact that they are so-called "technical“ components (also in the cosmetic field) which (in spite of a single INCI code) are not homogenous in terms of their chemical composition. By the way, cationic and amphoteric tensides were not included in the regulation.

**Non-degradable lipids**

The above-mentioned occlusive lipids respectively lipophilic components, which, in contrast to the triglycerides of vegetable oils and the natural waxes are non-biodegradable in OECD tests, are

- mineral oil components in the form of paraffins, ceresin waxes and Co.
- synthetic hydrocarbons
- poly-alpha-olefins and related synthetic polymeric hydrocarbons
- long-chained silicones and siloxanes

Synthetic emulsifiers and inert lipids are ideal components in terms of storage stability of cosmetic products. That is the reason why they are commonly used.
Inert lipids behave indifferently on the skin during and after the cosmetic treatment and remain on the skin surface. In the case of continued use they lead to dependency since the disposition of the skin to actively regenerate the barrier continuously declines due to the artificial film on the skin surface which the skin gradually accepts as being sufficient protection.
Instead of remaining at the skin surface, however, physiologically non-degradable emulsifiers interact with the protective components of the skin barrier and intensify the washout effect with every skin cleansing.

**Preservatives**

The usually non-physiological preservatives also have unfavourable degradation features. Triclosan is a typical example in this context, a chlorinated aromatic compound that chemically

and microbially is almost non-degradable. It impedes the microbial degradation of other components in rinse-off products. It should be mentioned that not all the preservatives are resistant to degradation. To impede the microbial degradation of other substances preservatives have to be used in concentrations above their minimal inhibitory concentration (MIC).
What should be mentioned is that an OECD tested non-degradability does not automatically exclude a potential long-term chemical or physical degradation due to atmospheric impacts. Triclosan is an excellent example also in this context. UV exposure (sun) will start the dioxin formation which means that toxic but also persistent compounds are built up.
The situation is similar with plastics (polymers): While plastics with functional groups (polyamides, acrylates etc.) also fail the tests, they are hardly found in nature since they are slowly but continuously degraded. By contrast the extremely inert polyethylene (PE) and polypropylene (PP) are dominant in the form of microplastics.

**Complexing agents**

Complexing agents (chelating agents) also belong to the group of frequently used, non-physiological components. This compound class reacts with metal ions. Depending on their individual structure, they are used for water-softening purposes as they bind the hardening calcium- and magnesia ions, or for inactivating the heavy metal traces.
Intercepting the heavy metals in cosmetic products and particularly those with oxygen-sensitive components is an important task. Heavy metal traces get into jars when the contents are taken out with the fingers. A contact with environmental heavy metal traces is given when the preparations are applied on the skin. Together with atmospheric oxygen and possibly still more intense with radiation exposure, heavy metals form aggressive oxygen radicals which cause an autoxidation of organic, particularly unsaturated compounds. The environmentally omnipresent, but also from endogenic sources originating iron may be stated as an example. Particularly fast attacks are launched on essential fatty acids gained from vegetable oils and on polyethylene glycols (PEG). Vegetable oils subsequently develop a rancid smell. The oxidation products on their part are very reactive and can cause irritations. Antioxidants only are of restricted help since they are fast consumed under these conditions. This is mostly due to the fact that the heavy metals continuously start new oxidation cycles. On the other hand is has to be mentioned that particularly high concentrations of antioxidants would maintain their own radical chain reactions. Strong complexing agents, by contrast, quickly come to grips with the problem.

**EDTA**

EDTA (Ethylenediaminetetraacetic acid) and its alkali salts are the most frequently used complexing agents in cosmetic products. The substance is very effective and inexpensive but is not degraded and hence passes through the municipal sewage treatment plants so that it is already present in the waterbodies and in part also in potable water. During the above-mentioned passage, the substance can also absorb heavy metals (cobalt, nickel, mercury etc.) originating from earlier industrial contamination.
EDTA in a product and hence later applied on the skin automatically binds the heavy metals iron, copper and zinc that, among others, also are required for the natural antimicrobial peptides (AMP) of the body and particularly the oxidoreductases. This unwanted adverse effect particularly occurs with a damaged skin barrier. It is still unknown whether it also affects the microbiome of the skin.
Degradable alternatives of complexing agents are citric acid and phosphates. The insoluble zeolits can also be used for water softening purposes.

**Consistency agents**

Consistency agents are a further group of cosmetic additives. They help to control the viscosity of cosmetic products and physically stabilize them so that lipid- and water phase will not separate with long storage periods and temperature changes. Insofar they support the emulsifier functions. Among them also are soluble polymers such as acrylates which, in chemical terms, contain ester structures. These structural elements provide for the very slow but continuous polymer degradation.
Consistency agents form films on the skin which have skin smoothing effects and are permeable to water vapour. That is why they are not counted among the group of occlusive compounds. As polymers, they often have been associated with microplastics. However, they hardly play any part when it comes to ocean pollution. Nevertheless there is great interest in biological alternatives and faster degrading compounds. The implementation up to now has proved very difficult, though since the features of natural polymers such as cellulose-, starch- and alginic acid derivatives are not as favourable as the consumers have been used to up to now.

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