

Sterile packaging – products and methods

published in medical Beauty Forum 2017 (2), 12-16

There is one thing in common with food and skin care preparations: both are perishables. This is why sterile conditions are required for manufacturing, storage and application. Preservatives are just one of the options to ensure sterility.

Good example for the intense activity of germs is yeast dough that usually doubles its volume in about half an hour. Another example is the conversion of wine into vinegar caused by acetobacter. Things become dangerous if aspergillus (mould), pseudomonas (waterborne germs) or clostridium botulinum (foul meat) are involved. They excrete toxic metabolic products or are involved in infections.

Germs subsist on organic material – preferably carbohydrates, fats and proteins – and always need water to metabolize this material. This is why for them emulsions (creams, lotions) provide almost ideal conditions to spread while they cannot survive in non-aqueous conditions such as essential and fatty oils, fats, oleogels, sticks and powders.

To protect the emulsions, often preservatives in low concentrations are added which attack and destroy the vital germ structures, for instance by perforating cell membranes, blocking sulphurous structural elements of proteins or by inactivating enzymes that are required for their growth. Hence preservatives more or less behave like antibiotics in contagious diseases in humans.

Unwanted adverse effects

Accordingly, just as the administration of antibiotics, the use of preparations with preservatives may lead to unwanted adverse effects¹ due to the interactions in the skin. They manifest themselves in the form of sensitizations, allergies and possibly also irritations. Taking this into account, the German legislator has introduced a licensing procedure for preservatives. The licensed preservatives are listed in the annex of the German Cosmetic Directive (KVO).²

If risks become apparent after the licensing procedure, preservatives can again be banned – as occurred in the case of formaldehyde, or the application can be limited, as recently occurred with triclosan and (chloro)methylisothiazolinone, which both only are licensed for use in preparations that immediately are removed from the skin such as for instance cleansing products.³

The risk of unwanted adverse effects is increasing if the skin shows a high transepidermal water loss (TEWL) or, in other words, if the skin barrier is disordered or damaged due to neurodermatitis or other dermatoses. In these cases, preservatives can penetrate into the deeper layers of the skin. Preservatives also pose a problem to the so-called sensitive skin. In addition to it preservatives damage the natural microflora (microbiome) of the skin. The microbiome consists of characteristic germ populations on the skin surface which, among other functions, adjust the acid mantle of the skin, or in other words, the typical pH level for adults of 4.5 to 5.5.

As with antibiotics, preparations with preservatives will support the growth of resistant germs. These can have counterproductive effects on the natural symbiosis between skin and germs, a fact which can be compared with the disordered intestinal flora after frequent and careless administration of antibiotics.

A number of chlorophenolic preservatives are suspected to have features of endocrine disruptors.

Unpreserved products

The easiest way of preventing adverse effects of preservatives still is to dispense with them altogether. This can either be realized by the composition of preparations or by appropriate manufacturing techniques:

- Non-aqueous preparations (see above)
- Sterile bottling in ampoules. There are however certain limits in this case: Af-

¹ Lautenschläger H, Unerwünschte Nebenwirkungen, Ästhetische Dermatologie (mdm) 2016 (7), 50-55

² Verordnung (EG) Nr. 1223/2009 des europäischen Parlaments und des Rates vom 30. November 2009 über kosmetische Mittel (Neufassung)

³ Lautenschläger H, Triclosan – teils verboten, weit verbreitet, Beauty Forum 2016 (5), 92-94

ter the ampoules have been opened, the stability in the refrigerator is reduced to several days only. This kind of bottling also is limited to solutions that can be sterilized. A large number of natural substances lose their efficacy when sterilized at temperatures of about 120 °C.

- Sterile filling of aqueous, relatively low consistent formulations in compressed gas cylinders, as for instance by pressure admission of the preparations with carbon dioxide as propellant gas. The products then are dispensed in the form of foams.
- Every now and then there are products with preservatives on the market although they are declared as non-preserved products. Such products usually contain preserved extracts with the effect that these preservatives have an impact on the whole product ("carry-over" preservation). The INCI only shows the botanical term of the extracts. Such products are not compliant with the German Cosmetic Directive (KVO).

The question arises whether aqueous products can be protected against germs or, in other words, can be preserved without using preservatives? As a matter of fact they can and the following examples show the alternatives:

- By using natural substances with preserving effects similar to the preservatives listed in the German Cosmetic Directive (KVO): Usually it is a matter of extract ingredients that do not need to be quantified and declared. Examples are rosmarinic acid, salicylic acid, phenylethanol, miscellaneous polyphenols, farnesol and essential oils. From an allergological point of view however they are not really an alternative as in terms of their adverse effects, the mentioned substances only gradually differ from the substances listed in the German Cosmetic Directive.
- By using hypertonic water phases in emulsions: This can be compared with the pickling of food in concentrated brine (fish). In this case however, other water-soluble substances with low molecular weight are used instead of salt. Products preserved in this way are free of adverse effects provided that the skin can compensate the associated high osmotic pressure of the preparations. In the case of open

sores or also in the case of rosacea-prone skin, a temporary however harmless burning sensation can occur.

- Another effective method of preservation is to use physiologically well tolerable metabolic products of microorganisms. Yeasts for instance die off whenever the concentration of the alcohol they produce reaches a certain level. Alcohol also is very effective against all kinds of other germs. Alternatively, substances with alcohol-like structural elements can be used. These include glycols⁴, glycerin and monosaccharides such as sorbitol. There are practically no intolerances. A further advantage is their multifunctionality since they also improve the skin hydration. A number of mono-di-glycerides have similar characteristics.

Microbiological product safety

Absence of the preservatives listed in the annex of the German Cosmetic Directive does not influence the shelf life and period of use after opening the preparations. All cosmetic products are subject to a preservation challenge test, which includes that the filled material is contaminated with selected germs and subsequently the reduction of germs is measured at specified intervals of time.⁵ Independently from the content the impact of the container material is examined:

- Jar contents usually are contaminated when the contents are taken out with the fingers. If the surrounding temperature changes and condensations form below the lid of the jar the minimum inhibitory concentration (MIC) of preservatives in the condensate falls below the required level. A typical consequence will then be the growth of mould.
- Plastic tubes generally suck in the mostly humid and contaminated ambient air. In the bathroom environment the minimum inhibitory concentration (MIC) may no longer be ensured on the product surface and the process can still be accelerated when the

⁴ Gloor M, Thoma K und Fluhr J, Dermatologische Externatherapie, Springer-Verlag, Berlin 2000, S. 146-147

⁵ DIN EN ISO 11930:2012 "Kosmetische Mittel – Mikrobiologie – Bewertung des antimikrobiellen Schutzes eines kosmetischen Produktes"

- emulsion breaks apart due to physical instability.
- Depending on the quality of the container material it can absorb preservatives analogous to the plasticizers. The minimum inhibitory concentration (MIC) no longer is ensured.
 - The safest containers in terms of microbial stability are airless dispensers with double bottom. Remaining product residues at the orifices are negligible since the evaporating water leads to an increased concentration of the preserving substances.

The microflora of the skin

Usually epidermis and microflora on the skin live in perfect synergy. Any kind of disorders will cause problems:

- Certain germs of the microflora are facultative pathogens. In other words, if the skin barrier is damaged or the natural antimicrobial peptides (AMP)⁶ of the skin are out of balance, the germs can deeply penetrate into the skin and trigger infections.
- Among germs, there are aerobic organisms which depend on atmospheric oxygen, and anaerobic organisms which thrive in the absence of air. Fatty creams support anaerobic organisms; they can proliferate in the case of a disordered skin barrier and pre-damaged connective tissue which is a typical condition with rosacea.⁷
- A moist skin surface leads to swellings and increased penetrability of the skin. Hyphae thus have an easy job in penetrating the skin barrier. In this way, fungus infections develop after a visit to swimming pools and spas.⁸
- The sweaty skin-to-skin contact in the armpits which is facilitated by shaving the armpits supports the fast proliferation of bacteria. Volatile odorous metabolic products develop.⁹ The same applies for heavy sweating of feet par-

ticularly in combination with tightly closed shoes.

- Dry skin leads to reduced skin elasticity and actually is a synonym for disordered skin barrier. The penetration of germs is facilitated.
- Overdone intimate hygiene destroys the natural, protective vaginal flora¹⁰ and facilitates infections caused by opportunist germs such as candida albicans.

Conclusion

Skin care products with or without preservatives should maintain the skin barrier, avoid sensitisation and preserve the natural composition of the local microflora. Reactions of the microflora to endogenic and exogenous influences show that carefulness and attention are required and that the skin care should be individually adapted. Less is more is a general rule in this context. The use of the preservatives listed in the German Cosmetic Directive (KVO) or of comparable natural substances can be accepted in terms of product stability however is counterproductive with respect to the complex interrelationships in and on the skin.

Product concepts without the preservatives listed in the German Cosmetic Directive (KVO) generally are more expensive in terms of manufacturing technology and this is a major reason for the comparably poor market share.

Furthermore it sometimes is difficult to explain to consumers but occasionally also to cosmeticians that each and every aqueous product is preserved but does not necessarily contain preservatives (KVO). Vice versa it is also argued that the slogan „no preservatives“ is discriminating since all the aqueous preparations are preserved. In this context it often is not mentioned that all preservatives without exception have allergenic potential.

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⁶ Lautenschläger H, Antimikrobielle Peptide, Kosmetik International 2016 (7), 28-31

⁷ Lautenschläger H, Überpflegung – Einfach zu viel des Guten, Kosmetik International 2015 (3), 22-25

⁸ Lautenschläger H, Die Barriere schützen - Hautpflege bei Pilzinfektionen, medical Beauty Forum 2013 (4), 48-50

⁹ Lautenschläger H, Kosmetische Pflege bei starker Schweißbildung, Ästhetische Dermatologie (mdm) 2014 (7), 32-35

¹⁰ Lautenschläger H, Die Facetten der Intimpflege – Weniger ist mehr, medical Beauty Forum 2014 (2), 35-37