# The water balance in our skin: moisturizers & Co.

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The term moisturizing cream has different meanings according to whether we are in the English-speaking world or the German-speaking part. Two terms are essential in this context: moisturizers and emollients. Information on common features and on the way how they influence the water balance of the skin is provided in the following.

In English-speaking countries, a question on the effects of a moisturizing cream would have been answered as follows: a moisturizing cream or abbreviated also moisturizer refreshes the skin and makes it agreeably soft without leaving dry areas. The developers of the cream would describe the cream formulation as follows: main ingredients are emollients, a term which is less common in the German-speaking language area. Details in this context are compiled in the following survey.

Emollients usually are skin care components with fatty character that smooth the skin and reduce the transepidermal water loss (TEWL), while moisturizers in the German skin care context are hydrating substances. The natural moisturizers of the skin are summarized with the term “Natural Moisturizing Factor (NMF). The NMF mainly consists of amino acids, salts, glycerin and urea, or in other words, water soluble substances that retain water. The “German” moisturizer hence basically differs from an emollient.

**Moisturizers** and **emollients** have a common feature though: they influence the water balance of the skin, although in a basically different way. And yet, they complement each other. Let’s take a look on the microcosm of the water in the skin in order to understand the way it works:

- The water content of the skin cells determines the turgor, i.e. the internal pressure of the cells. With increasing age the turgor is reduced, hence the skin is less plump and firm and loose parts appear. The water transport in cells is controlled by particular proteins among others by “aquaporins”. They are located in the cell membranes.
- Main components of the extracellular matrix are collagen and hyaluronic acid. Hyaluronic acid retains large amounts of water and is an important component for the pressure resistance of the connective tissue.
- The skin barrier near the surface consists of layered ceramides, fatty acids and cholesterol as well as of sebum from the sebum glands which is composed of lipids such as triglycerides, squalene, fatty acids, and wax and cholesterol esters. All the different components together determine the TEWL of the skin or in other words, they determine the amount of water that evaporates in the form of water vapour and hence will be lost. A high TEWL supports the dehydration of the skin.
- The Natural Moisturizing Factor (NMF; composition already mentioned above) of the skin barrier has two functions: it binds the moisture in the skin and neutralizes the radicals from the environment.

**Sebum** is a natural emollient. Examples for natural variants in the fauna are the wool wax (lanolin) of sheep and the preen wax from the uropygial gland of birds. They also are used in the skin care however are less popular today due to their animal origin. Single components such as squalene, cholesterol, triglycerides and fatty acid esters serve as a model for similar substances form herbal sources or for chemically synthesized substances.

**Along with the aging process of the skin,** its water balance also changes:

- The turgor decreases. The skin surface tends to extend through wrinkles, roughness and a reduced elasticity. Inevitably the TEWL also increases.
- With the aging process of the skin, build-up and degradation of the collagen and hyaluronic acid of the extracellular matrix tends to be imbalanced. The water binding capacity of the connective tissue is reduced.

- Skin thickness and sebum production decrease. Consequently, the TEWL increases and the hydration of the skin will be reduced.
- The regeneration of the skin barrier also slows down. External influences, such as for instance the wash out of the natural protective substances of the skin after skin cleansing, have a stronger effect and interfere with the skin hydration and the natural TEWL.

To prevent and treat age-related changes in the water balance of the skin, the cosmetic skin care has the following substance groups at its disposal, including emollients and moisturizers:

**Emollients** (substances with lipid features): According to the efficiency and dosage and dependent on the condition of the skin barrier, emollients reduce the TEWL – in extreme cases even to almost zero. This particular effect is called an "occlusive" condition. Occlusive conditions trigger unwanted swellings of the skin and are counterproductive if the natural skin functions shall be preserved on a long-term base.
Hence the range of emollients is rather broad. Native oils, vegetable and animal mono-, di- and triglycerides, long-chained and partly branched fatty acid esters, fatty acid alkanolamides, hydrocarbons such as squalene, squalane, vegetable and montan waxes, paraffins and long-chained silicones belong to this group.
According to the penetrability and biodegradability, emollients will show different effects after their application. Vegetable triglycerides for instance are largely degraded and metabolized due to their high bioavailability. The inert paraffins, by contrast, more or less remain on the skin surface and will reduce the TEWL over a longer period of time.

**Barrier active substances:** These are substances that either occur in the skin barrier or have more or less the same features as ceramides, cholesterol, phytosterols and long-chained fatty acids. Sometimes they also are counted among the emollients. It should however be mentioned that they act in a different way insofar as they smoothly integrate into the skin barrier structure and develop a natural, physiological TEWL. The skin is protected but still is able to "breathe".

**Moisturizers:** The multifaceted substance class excels by a strong interaction between substance and water molecules. For this purpose not only a single but several hydrophilic groups in their molecules are needed. In extreme cases they can bind water in such a way that we speak of hygroscopic effects. The water retained this way is no longer available in a sufficient quantity to the surrounding skin structures. In this context also the balance of the moisturizers and the temperature-related atmospheric humidity is important. Depending on the location as for instance in closed rooms, in the airplane or outside in summer or in winter season, a particular moisturizing substance can be effective or ineffective. By the way, this is the most important cause of complaints of users who think that their cream became useless.
Typical moisturizing substances are allantoin, alkanolamines, amino acids, alginic acid hydrolysates, diglyceryl phosphate, D-panthenol, ectoin, glycerin, glyceryl glycoside, glycols in general, glycolic acid, lactic acid and other AHA acids, minerals salts, mono saccharides including sugar substitutes such as sorbitol, phospholipids including glycerophosphocholine (GPC) and phosphatidylcholine (PC), protein hydrolysates and urea. Details on the particular substances and their chemical features have been discussed in "Moisturizers for the skin care", Beauty Forum 2011 (3) 86-88 and 2011 (4) 46-49.

**Film-forming substances** remain on the skin surface after application and are an additional barrier that impedes water from evaporating out of the skin. They help to slightly reduce the TEWL. Alternatively an additional water retaining effect may be present as in the case of moisturizing substances. Film-forming agents consist of synthetic, biosynthetic or vegetable polymers. Typical representatives are algae extracts, alginic acid, aloe vera gels, carbomers, CM-clucan, hyaluronic acid, polyethylene glycols (PEG), polyglutaminic acid, polypeptides, polysaccharides and xanthan.
The issue, whether hyaluronic acid can penetrate into the skin in spite of its high molecular weight and will act as a moisturizer there has been discussed over and over. In this context, it is mostly neglected that the molecular weight stated is a mean value based on the Gaussian distribution. This means, that a small amount of very small molecules always is present.

**Growth factors** and the modulation of aquaporins are further options in order to influence the water balance of the skin.

As already mentioned above, not only the condition of the individual skin but also the **environmental conditions** have to be considered in order to achieve the desired effect of the applied or combined active agents. Besides

temperature and atmospheric humidity, also atmospheric pressure and even wind force are relevant. Some examples are:

- The atmospheric pressure in the cabin of airplanes is reduced by about 20% which corresponds to a stay in about 2400 m of altitude. The boiling point of water in this case is about 92°C instead of 100°C. Consequently, the TEWL considerably rises and the skin becomes rapidly dehydrated, an effect which still is increased by the relatively low air humidity in airplanes. An optimal skin care at sea level conditions will no longer be sufficient. Particularly the flight crews experience the mentioned effects day in, day out.
- The same applies for alpine climbing. A rule of thumb says that the boiling point of water decreases by 1°C per 300 m of height. On the Zugspitze (with its almost 3000 m the highest mountain in Germany), the boiling point will then be at about 90°C. Such conditions skyrocket the TEWL while at the same time the skin hydration is reduced to the same extent – most evident proof are dry and cracked lips. A reverse influence is experienced with perspiration due to the physical effort, although the concentrated sweat then may lead to irritations in the case of sensitive skin.
- An additional effect not only in mountainous areas or at the sea though is the wind-induced increase of the evaporation rate of the retained water in the skin.
- Varying air humidity between inside and outside demand for a high adaptability of the skin. Due to skin aging as well as barrier disorders this adaptability cannot be taken for granted. Some examples for extreme situations are:
  - The Central European winter climate with cold outdoor air and almost 100% air humidity and heated interiors with very low air humidity: At 0°C outdoor temperature the air humidity indoors is at about 25 % (room temperature 20°C).
  - Equatorial Singapore with its muggy outside air (32°C, 90% air humidity) and cool interiors (20°C) with an air humidity of below 50% (air condition).

The **efficacy** of moisturizers decreases with reduced air humidity and atmospheric pressure as well as increasing temperature. Given these conditions of temperature and air pressure, any moisturizer will lose its efficacy at a certain degree of (low) air humidity and dissipate the water into the surrounding air. With low air humidity, low molecular well penetrating moisturizers such as urea, glycerin, glycols, salts etc. are unable to cope. Even the reapplication of creams will be of no use. On the contrary: reapplications would result in hypertonic concentrations of the moisturizers in the skin which for instance could cause irritations in the sensitive skin prone to rosacea.
The range of low molecular moisturizers can be enhanced with high molecular film-forming substances such as hyaluronic acid, GM-glucan and other polysaccharides (see above). If this is not enough, the dosage of emollients in the form of lipid substances including barrier-active substances could be increased in order to lower the TEWL. Selecting the adequate preparations in order to find the appropriate balance and avoid occlusive conditions for a longer period which would interfere with the natural recoverability of the skin requires some experience. In the case of rosacea skin there is an additional risk that a high dosage of lipid substances would create ideal conditions for the typical anaerobic bacteria that cause the skin to “explode”. The use of liposomal active agent concentrates with up to 1% azelaic acid may be beneficial up to a certain degree. Persons with an excellent knowledge of active agent concentrates can also use modular systems in order to optimize the skin care with regard to the water balance of the skin and the respective conditions.

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