

Moisturizers in the skin care

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The term moisturizer generally stands for moisturizing creams. The present overview will inform on components that influence the skin hydration.

Terrestrial organisms have developed a number of strategies to protect against dehydration and certain death. Mother Nature has optimized cell membranes, cell components and the skin barrier in this regard.

- **Aquaporins** are peptides that are integrated into the cell membrane. They control the transport of water and specific substances, as e.g. glycerin, through the cell membranes. Aquaporins can be stimulated by various substances, such as vitamins.
- **Bacteria** protect themselves against dryness with water-retaining substances, against cold with substances that inhibit the formation of ice crystals and against temperature rises with materials that impede the denaturing of proteins. Examples here are ectoin and diglycerol phosphate.
- **Amphibians** have their body surfaces covered with mucus in order to retain water for a considerable time. Animal mucus mostly consists of glycoproteins (combination of proteins with carbohydrates) while vegetable mucus consists of polysaccharides. Also the leaves of succulents contain high concentrations of mucus. Aloe vera can be mentioned here as an example.
- The human stratum corneum has **effective barrier layers** which impede the loss of water. They consist of long chained ceramides, cholesterol and fatty acids.
- The **NMF (Natural Moisturizing Factor)** of the human skin consists of a multitude of water retaining substances, in particular amino acids.
- The **sebum of the skin** seals the skin surface with lipid substances, such as squalene, in order to reduce the evaporation of water.

Measurement of skin hydration

The purpose of moisturizing creams is to stabilize the regular skin hydration of the individual person. In terms of measurement, the effects of the creams can be evaluated by reading the skin hydration and the transepidermal water loss (TEWL), however, it can also be visually validated by observing the behavior of little dry

skin wrinkles. Excessive increase of the skin hydration with the help of occlusive waxes and hydrocarbons is not recommended as it only causes skin swellings and subsequently leads to disorders within the skin structure. Traditional anti-wrinkle creams are based on this principle: they remove minor wrinkles via swellings.

The skin hydration is easy to measure with a Corneometer®. It basically is a flat condenser whose capacity is modified and measured via the dielectric medium water. The minimal tissue penetration of the Corneometer® only allows statements on the surface layers of the stratum corneum. The transepidermal water loss (TEWL) is the equivalent of the quantity of water evaporated through the skin in form of vapor. It is used as a measure for the permeability and the condition of the skin barrier.

The sebum activity influences the TEWL and that is why the measuring of skin hydration and sebum allows conclusions on the transepidermal water loss, some experience is required, though. This is helpful for skin analyses in summer when the TEWL will yield more or less inaccurate readings.

Skin barrier and TEWL

The majority of emulsifiers used interferes with the layered structure of the skin barrier and increases the TEWL. As a consequence, they are frequently combined with hydrocarbons or, in other words, with paraffins and mineral waxes which again reduce the TEWL with their impermeable surface film. Evidence of the barrier disordering effect of emulsifiers is the wash out effect which means that the natural lipids of the skin are washed out with skin cleansing. Today's moisturizing creams refrain from emulsifiers or contain emulsifiers that quickly metabolize in the skin.

Many substances have an indirect effect on the TEWL. Among them is linoleic acid (essential fatty acid) or linoleic acid providing vegetable oils. Linoleic acid serves as a substrate for barrier active ceramide I. A deficit in essential fatty acid shows by dry and scaly skin.

Other substances directly influence skin hydration or TEWL by binding water molecules. This

capacity is due to the hygroscopic (water attracting) functional groups.

- **Hydroxy groups (-OH):** alcohols, glycols, glycerin, saccharides (sugar) etc.
- **Carboxy groups (-COOH):** organic acids and their salts
- **Polyethylene glycols (-O-CH₂-CH₂-)_n:** for details on PEGs please refer to Kosmetische Praxis 2009 (1), 12-15
- **Amino groups (-NH₂, -NH-):** amines, amino acids
- **Amide groups (-CO-NH₂, -CO-NH-):** urea, allantoin, fatty acid amides, peptides, proteins etc.
- **Metal ions:** magnesium (Mg²⁺), calcium (Ca²⁺). They are so-called cationic acids with hygroscopic features and should only be applied in chelated form (e.g. in combination with AHA acids). Otherwise there is a certain risk that they react with the skin barrier and cause disorders of the layered structure. Insoluble salts like magnesium or calcium palmitate or -stearate have no influence on skin hydration and remain on the skin surface.
- **Mineral salts:** sodium and potassium salts of the phosphoric acid (phosphates), hydrochloric acid (chlorides) and sulfuric acid (sulfates)

Popular active agents

Algae extracts: In combination with specific proteins, amino acids and mineral salts, the alginic acid in the extracts increases the skin hydration. Liposomal laminaria digitata extract sprayed on the closed eyelid may be beneficial against dry eye syndrome.

Alginic acid (alginate): The polysaccharide is gained from brown algae and consists of manuronic and guluronic acid units. It is used as a consistency agent and forms a moisture-retaining film on the skin surface.

Alginic acid hydrolisates are fractions of the alginic acid. The smaller the size, the better they penetrate into the upper horny layer where they bind water just like any other short-chained carbohydrates.

Allantoin has structural elements of urea; hence it also supports the skin hydration and eliminates itching as well.

Aloe vera: The gels of aloe vera are rich in amino acids, polysaccharides and mineral salts, among others. They have anti-inflammatory effects and form moisture-retaining films on the skin.

Amino acids are the most important elements of the natural NMF. They have excellent water-retaining effects and are a natural protection of the skin against nitric oxides (radicals). Pyrroli-

done carbonic acid (PCA) belongs to the amino acids and is a popular component in skin care products. Amino acids belong to the group of osmolytes. This term stands for substances that are able to compensate concentrations in the skin and hence stabilize the individual osmotic pressure. Malfunctions of this control system may cause irritations after the application of water-containing skin care products, an effect which can be compared to irritations caused by sweat, whose salts concentrate while drying and build up hypertonic properties.

Carbomers (polyacrylates) are consistency agents and remain on the skin surface. They have no moisturizing capacities but may slightly reduce the TEWL due to their permeable film. Combined with penetrating moisturizers, they have synergetic effects and improve their efficacy in low atmospheric humidity. In this regard, it can be stated from experience that they also reduce sensations of tension.

Ceramides are basic components of the barrier layers of the skin and a base element of laminary-structured DMS creams. They are frequently gained from yeast.

Cholesterol occurs in the skin barrier and can be replaced in creams by phytosterols with similar structure (as e.g. from avocado oil or shea butter). The barrier activity is stimulated.

CM-Glucan is a chemically modified filming polysaccharide which impedes the evaporation of water through the skin and which can absorb and release moisture (hydration buffer).

Diglyceryl phosphate (DGP) is an osmolyte which suppresses the denaturing in thermophilic bacteria at higher temperatures. The substance also inhibits the collagen degradation caused by matrixmetalloproteinases.

D-panthenol: With its two alcoholic hydroxyl groups and its amide bond, the provitamin B₅ increases the skin hydration, has tightening effects and supports the cell formation.

Ectoin: The water retaining pyrimidine derivative increases the irritation threshold of the skin. It is used in products for the sensitive skin.

Glycerin is a component of the NMF and, despite contrary reports, has no dehydrating effects. Although hand creams with a high content of glycerin visibly augment the skin hydration, the major part of the glycerin as well as natural skin components are again released from the skin during hand cleaning. The skin then feels dehydrated. Hence, creams with a high fat and moderate glycerin content are more appropriate for the hand care.

Glyceryl glucoside: The combination of glycerin and glucose is a natural substance, binds water and stimulates aquaporin 3. There is a

multitude of analogous glycosides with similar behavior.

Glycols are bivalent (2 hydroxy groups) water retaining alcohols. Moderate concentrations of glycols impede the growth of microorganisms similar to ethanol. The most popular representatives are propylene glycol, butylene glycol, pentylene glycol and hexylene glycol.

Glycolic acid is the simplest alpha hydroxy acid (AHA) and its sodium and potassium salts can be found in moisturizing creams.

Hyaluronic acid, as one of the most popular high molecular moisturizers is active at the skin surface. Together with phosphatidylcholine, hyaluronic acid is used to treat dry eye symptoms similar to algae extract. In skin care applications, hyaluronic acid extends the bandwidth of low molecular moisturizers towards low atmospheric humidity.

Lactic acid: The sodium salt of lactic acid (INCI: sodium lactate) is a component of the NMF and a rather effective moisturizer.

Sodium chloride (table salt) only shows weak efficacy. Isotonic solutions (0.9% NaCl) and 3.5% sea salt solutions (mainly sodium chloride) are used for baths for the sensitive skin. Water of the Death Sea still shows higher concentrations: it contains considerable amounts of magnesium and calcium salts.

PEGs: Long chained PEGs (macrogols) form moist surface films on the skin. PEGs with alkyl chains (emulsifiers) cause washing out effects. Attention should be paid to their sensitivity to UV/atmospheric oxygen which leads to irritations of the skin.

Phospholipids: Phosphatidylcholine (PC), phosphatidylinositol (PI), phosphatidylethanolamine (PE) and phosphatidylserine (PS) are components of lecithin and increase the skin hydration. PC temporarily also augments the TEWL though, as it fluidizes the skin barrier (effective principle of liposomal preparations). Native phospholipids contain linoleic acid which is integrated into the ceramide I of the skin barrier. Related to phospholipids are sphingomyelins.

Polyglutamic acid (PGA): The polypeptide is a filming agent with water retaining and tightening characteristics.

Polysaccharides (polymer sugars): Many filming cellulose derivatives such as hydroxyethyl cellulose and hydroxypropyl cellulose belong to this group (rf. Kosmetische Praxis 2009 (4), 12-15).

Proteins of vegetable origin are used as base substance for protein hydrolysates. Depending on their manufacturing process, they contain protein fractions such as peptides or amino acids. Protein hydrolysate serves as a starting material for condensates with fatty acids (protein hydrolysate condensates) with excellent

skin caring characteristics such as skin tightening and moisture retention.

Urea belongs to the NMF substances. Urea can crack hydrogen bridges. Its keratolytic activity in higher concentrations results from this specific property. Among other applications, it is also a component of non-dehydrating powders and suppresses itching.

Xanthan gum: The polysaccharide has thickening characteristics and improves the lubricating and glide properties of gels. It forms a surface film combined with pleasant skin tightening effects and also retains moisture in the skin.

Sugars (saccharides) retain water, however, their adhesive properties account for the fact that they are not very popular. There are also products with honey additives.

Sugar substitutes: The 6-valent sugar alcohol sorbitol (sorbite) is a naturally occurring carbohydrate with water retaining properties similar to glycerin. In combinations with ethanol, glycols or glycerin, sorbitol has antimicrobial effects in preservative free preparations without sensitizing potential. Similar features show the related mannitol (mannite) which occurs in algae, beach or tideland plants, and the natural inositol (inosite) of the human body. Other sugar alcohols with comparable effects are xylitol (xylite) and maltitol (maltite).

The limits of efficacy

On the one hand, the skin hydration depends on a functioning NMF, skin barrier and balanced sebum, but it is also determined by the atmospheric humidity. The skin per se is capable of adapting to different conditions. In case of a fast change of atmospheric humidity between the interior of the house and the external atmosphere, but also in case of skin disorders, the skin has more difficulties to adapt, which particularly applies to the mature skin. There are three simple rules to illustrate the effects:

- When air with a relative humidity of 100% at a temperature of 0° C is warmed up to 10° C, it features an atmospheric humidity of about 50%. Warmed up to 20° C, the humidity is around 25%. The atmospheric humidity approximately halves with every 10° C.
- The TEWL increases with decreasing air humidity.
- The efficacy of moisturizers decreases with the decline of air humidity. There is a characteristic threshold for every moisturizer where it becomes inefficient and releases the moisture into the circumambient air.

The following transitions stress the skin and are particularly demanding for moisturizers:

- cold outside air ⇔ heated rooms with extremely low air humidity (Central European winters)
- muggy outside air ⇔ chilly rooms with extremely low air humidity (air condition)

In case of low air humidity, low molecular and well penetrating moisturizers like urea, glycerin, glycols, salts etc. alone are unable to cope. Even frequent re-applications will not be beneficial in this context. On the contrary: In this case, the moisturizers will concentrate in terms of hypertonic properties, which may lead to irritations of the skin particularly in case of rosacea-prone skin. The range of low molecular moisturizers can be enlarged by high molecular moisturizers like hyaluronic acid, CM-Glucan and other filming agents. Filming agents form an additional barrier for the TEWL on the skin surface. With even lower air hydra-

tion and possibly higher external temperatures the dosage of lipid substances including phyosterols in skin care preparations should even be increased. Sensitive dosing is required here to avoid both imbalances and undesired swelling of the skin due to occlusion as well as a disordered natural recovery of the skin. In cases of rosacea skin, there even is an increasing risk of creating the ideal living conditions for the typical anaerobic bacteria that cause the rosacea-specific blushing.

Conclusion: Skin hydration is one of the most important factors for a healthy skin. In terms of preventive measures, particular emphasis should be laid on a stable skin barrier and the preservation of the natural NMF. Externally applied and preferably physiological moisturizers may be beneficial here.

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