Essential fatty acids - cosmetic from inside and outside

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Our body depends on numerous substances which have to be replenished with our daily nutrition. Certain fatty acids are among these essential substances. Deficiencies have a detrimental effect for the human organism and skin.

As the term already indicates, fatty acids are a component of fats (triglycerides) where they are combined with glycerine. Fats serve as the body's energy reserve and as a biochemical element. Free fatty acids as for example the palmitic acid are an important component of both the skin barrier and the acid layer of the skin. Palmitic acid and the related stearic acid belong to the so-called saturated fatty acids in contrast to oleic acid and linoleic acid which are part of the group of unsaturated fatty acids. They contain less hydrogen atoms than the maximum possible number. Characteristic for vegetable fats is the high percentage of unsaturated fatty acids. Hence they mostly come in liquid form (oils) while the saturated fatty acids predominantly contained in animal fats rather are solid.
The human organism synthesizes the mono-unsaturated oleic acid which is abundant in olive oil from stearic acid and so it is not essential and will not cause any deficiencies. Just like the palmitoleic acid which is formed from palmitic acid, it is a member of the family of omega-9 fatty acids.
The diunsaturated **linoleic acid** however is essential and indispensable for the human organism. As a member of the family of omega-6 fatty acids it can be found in high concentrations in safflor, soya, wheatgerm, grape seed, black caraway and sunflower oil.

The indispensable linoleic acid

A deficiency in linoleic acid shows various effects in the human organism. The skin develops barrier disorders: the transepidermal water loss (TEWL) increases, the skin dries out, becomes scaly and the complexion takes an unhealthy tone. The nails tend to crack, there might be an increased hair loss and cornification disorders may develop as for example at the sebaceous gland orifices. On the other hand, linoleic acid supports the healing process of dermatoses, sun burns and burns by noticeably accelerating the regeneration of the skin barrier. Mild forms of acne vulgaris may be efficiently treated with linoleic acid products. For a long time linoleic acid has been referred to as vitamin F until it turned out that it is not only the linoleic acid but also a multitude of different substances developed from it which are responsible for vital mechanisms of repair and control.
Thus, with the help of enzymes the body - not our skin however – converts part of the linoleic acid assimilated with nutrition into gamma linolenic acid (GLA) which is a triunsaturated omega-6 fatty acid and among others can be found in primrose oil, borage oil and in the seed oil of black currants. Neurodermatitis patients sometimes suffer from an enzyme defect which prevents the formation of GLA as well as of secondary substances essential for the body and the physiology of the skin. Consequently, products of the above mentioned oils may be very helpful for internal and external use.
Within the skin, linoleic acid either is integrated into ceramide I which is skin barrier active or it will be oxidized through enzymes to a fatty acid with anti-prolific effect. Through chain extension the GLA converts into dihomo-gamma-linolenic acid (DGL) and subsequently to the triunsaturated arachidonic acid (AA). Inter alia, arachidonic acid is intermediately stored in epidermal phospholipids and there it comes up to 9 % of the fatty acid percentage. Arachidonic acid is the vital base material for many of the tissue hormones with regulatory functions which are effective already in microscopic amounts right in situ of formation with various specific features. Just to mention a few examples:

- **Prostacyclins** are anticoagulants
- **Thromboxanes** are coagulants and support the closure of wounds
- **Prostaglandins** play a major role in inflammations among others also in the skin
- **Leukotriens** are responsible for immune responses and control allergic reactions for example

DGL also forms a prostacyclin which has tissue-specific effects, thromboxanes, prostaglandins (”series 1”), with various compositions and effects which however widely differ from the products developed from arachidonic acid (”series 2”). They may even prove to be opposing and competing. Hence the prostaglandin E2 (from arachidonic acid) promotes inflammations whereas the prostaglandin E1 (from DGL) will prevent them. As arachidonic acid is found in egg yolk and lard in concentrations from 0.3 % and 1.7 % respectively and high doses of linoleic acid prevent the natural formation of arachidonic acid, it is obvious that an adequate adjustment of the nutrition to appropriate vegetable oils may have a positive influence on various different skin problems.
In this connection, another essential family of fatty acids the omega-3 fatty acids should be mentioned whose pentaunsaturated member, the eicosapentaenoic acid (EPA) is assimilated with the consumption of cold-water fish. In a process of several consecutive stages fish is able to form EPA from the alpha linolenic acid taken in with algae. EPA also is a base substance for a prostacyclin, thromboxanes, prostaglandins and leukotriens (”series 3”). Furthermore, EPA will be converted into the hexaunsaturated docosahexaenoic acid (DHA) which on its term is able to form hormone-like substances.

Valuable substances from fish oil

The rather rare cases of psoriasis in the Eskimo population with a predominantly fish-based diet prove the influence of these fatty acids. Eskimos who changed to our eating habits have an increased psoriasis percentage settling around the ”standard value”. The same also applies for arteriosclerotic modifications in the vascular system. The significantly higher percentage of arachidonic acid in psoriatic skin should also be mentioned. As the human organism is able to convert EPA from alpha linolenic acid the importance of vegetable oils in the nutrition should again be emphasized. High concentrations of **alpha linolenic acid** can be found in linseed oil which some time ago in Germany was used as a bread spread or in combination with potatoes boiled in their skins and quark (low to medium-fat cream cheese, sometimes spiced with herbs). The acid is also contained in rape seed oil, rose hip oil and, in lower amounts also walnut and wheat germ oil. Sizeable amounts can however also be found in leafy vegetables like purslane. When restricted to dietary food it should be kept in mind that a simultaneously assimilated high dosage of omega-6 fatty acids may impede the transformation of alpha linolenic acid to EPA. As animals living in their natural habitat consume more alpha linolenic acid with their nutrition, their omega-3 fatty acid level is higher than in domesticated animals. This also applies for salmons living in their natural habitat in comparison to farmed salmons.

Beauty coming from inside

Today not only the percentage of fat in our daily nutrition has risen in comparison to past times but also the proportion of omega-6 fatty acids in comparison to omega-3 fatty acids. Besides a general reduction of the fat intake it is also recommended though to evenly balance the different essential fatty acids. A variety of fruits, vegetables and oils with the appropriate amount of linoleic acid, gamma and alpha linolenic acid and moderately increased fish consumption already may be significant preventive measures to keep our skin and body healthy. Very often acne symptoms already will start to improve if animal and hydrated fats contained e.g. in pork or chocolate products are reduced. As ever the old saying ”the skin reflects the inner harmony of the body” is still applicable.
However, an unbalanced fatty acid level may increase the rate of heart attacks, asthma, high blood pressure, gastroenteric diseases, allergies, inflammations, rheumatism, arteriosclerosis, lipometabolic disorders, and disorders of the blood functions as well as skin diseases.

Medication and skin

As various drugs as e.g. the non-steroidal anti-inflammatory drugs (NSAIDs; antirheumatic drugs) like aspirin interfere with the complicated fatty acid metabolism via enzyme inhibition it is recommended to take into account any possible side effects of medication. By means of the enzyme phospholipase A2, arachidonic acid is released from phospholipids. Prescriptions containing **cortisone** act as enzyme inhibitors and thus will prevent the formation of arachidonic acid metabolites which support inflammations. Any inflammatory processes in the skin can thus be treated immediately and also very effectively. The **other side of the coin** is, however, that the skin will develop deficiencies in the supply of other important fatty acids, a fact that will consequently result in atrophic skin.

Cosmetic products

For cosmetic products, linoleic acid is the most frequently used essential fatty acid. It prevents barrier and cornifications disorders, lowers the transepidermal water loss and increases skin moistness. The most appropriate aids here are spherical transport bodies like liposomes or nanoparticles in which linoleic acid already is chemically combined in natural phosphatidyl-choline, the liposome base substance. It belongs to the group of membrane-forming phospholipids which also act as a depot for other fatty acids. Linoleic acid is formed by hydrolytic or enzymatic cleavage.
Linoleic acid is part of the ceramide I which is the most important barrier substance in the horny layer. Products containing linoleic acid are the appropriate skin care for individuals suffering from neurodermatitis as their skin generally shows a ceramide I deficiency. While pure liposomal products are recommended for acne and simultaneously oily skin, symptoms of barrier disorders like dry skin and neurodermatitis should be treated with nanoparticles or DMS bases with a skin-like structure and a high fat content together with appropriate additives in form of phosphatidyl-choline or oils which are rich in linoleic acid. Combinations with primrose oil are advisable if neurodermitic patients tend to develop enzyme deficiencies.
The disadvantage of oils containing linoleic acid is the relatively limited shelf life as they are sensitive against atmospheric oxygen. Safflor oil for example has a considerably shorter shelf live than olive oil. Oils with a natural content of antioxidants like for example vitamin E have a substantially longer shelf life. Essential oils in cosmetic products are stabilized with vitamin E and C respectively their derivatives like tocopherol acetate, tocopherol palmitate or ascorbyl palmitate.
For the processing of essential fatty acids in cosmetic and dermatic products it is recommended to use as little additives as possible. A simultaneous use of mineral oils in cosmetic products should absolutely be avoided as they will not be integrated into the skin barrier and hence rather prevent the regeneration of the skin. Neither should emulsifiers be used. A variety of other additives may however be useful as for example urea which has anti-pruritic effects in cases of neurodermatic skin and simul-taneously contributes to the stability of unsaturated fatty acids.
Due to the rather complex issue it is very important to gather detailed background information in order to appropriately balance and adequately adapt nutrition and cosmetics for the individual customer.

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Metabolism of unsaturated acids

omega-9-family (n-9; not essential)	**omega-6- family** (n-6; essential)	**omega-3- family** (n-3; essential)
	enzyme	**enzyme**
oleic acid (18:1 n-9) (from stearic acid)	**linoleic acid (18:2 n-6) (LA)**	**alpha-linolenic acid (18:3 n-3) (ALA)**
↓	Δ^6-desaturase ↓	Δ^6-desaturase ↓
18:2 (n-9)	**gamma-linolenic acid (18:3 n-6) (GLA)**	**18:4 (n-3)**
↓	elongase ↓	elongase ↓
20:2 (n-9)	**dihomo-gamma-linolenic acid (20:3 n-6) (DGLA)**	**20:4 (n-3)**
↓	Δ^5-desaturase ↓	Δ^5-desaturase ↓
eicosatrienoic acid (20:3 n-9)	**arachidonic acid (20:4 n-6) (AA)**	**eicosapentaenoic acid (20:5 n-3) (EPA)**
		elongase ↓
		docosapentaenoic acid (22:5 n-3) (omega-3)
		Δ^4-desaturase ↓
		docosahexaenoic acid (22:6 n-3) (DHA)

Introduction to abbreviations:

18:2 n-6 is the technical short term for **linoleic acid**.

- Linoleic acid has **18** carbon atoms arranged in a chain.
- The variable **n** (number of carbon atoms) in this case is: **18**.
- Linoleic acid has **2** double bonds (**di**unsaturated); in contrast to the saturated stearic acid (18:0) it has 4 hydrogen atoms less.
- The first double bond begins at position **n-6**, i.e. at the 12th carbon atom (**n-6** =12).
- **n = 18** is the so-called **omega**-position, i.e. the end of the carbon chain.
- The double bonds of essential fatty acids are following each other with an alternating CH_2-group in between.

CH_3-CH_2-CH_2-CH_2-CH_2-**CH=CH**-CH_2-**CH=CH**-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-**C**OOH
(position **18**) (position 12) (position **1**)