

# Sulphur for a beautiful skin

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Sulphur compounds sometimes are inconvenient but both commonplace and vital for our body and in particular for our skin and hair.

**E**lementary sulphur (S) occurs in the vicinity of volcanoes. In a cave on the brink of Solfatara crater, west of Naples, cm-long yellow sulphur needles hang on the walls. The cave is heated by the former volcano and still today serves as a natural sauna just as in ancient Roman Times. Together with the neighbouring Glauber salt-rich thermal bath it is the epitome of natural wellness. Glauber salt is the sodium salt of sulphuric acid. It has a slightly laxative effect and occurs in various mineral waters.

## Antiseptic and preservative

Sulphur is listed in various pharmacopoeias. In the form of micronized yellow powder it is incorporated in pharmaceutical base creams or Vaseline. It has antiseptic effects in the case of acne. It is presumed that under the influence of atmospheric oxygen sulphur is slowly oxidised into sulphur dioxide that acts upon the microorganisms. Antiparasitic and keratolytic effects also are reported.

Sulphur dioxide (SO<sub>2</sub>) forms when burning sulphur. It is a gas with pungent odour that formerly was used for disinfection purposes, among others, for the disinfection of wine casks. Today mainly sulphurous acid in the form of its sodium salts (sulphites, bisulphites) is used, produced by reaction of sulphur dioxide with water. On the wine labels it is then indicated "contains sulphite". In food such as juices and dried fruit the antioxidant and antimicrobial potential also is used whereas finally also traces of sulphuric acid form through oxidation. In the cosmetic field a limited amount of sulphites (max. 0.2 per cent of SO<sub>2</sub>) is permitted for preservation purposes.

Sulphuric acid salts (sulphates) are the sulphur source for herbal and animal organisms. Belonging to this source, besides sodium sulphate, above all is calcium sulphate (alias gypsum) that is responsible for the permanent hardness of drinking water. Aluminium sulphate formed from clay (aluminium oxide) and sulphuric acid can be used for antiseptic mouth washes or antiperspirants analogous to aluminium chloride. Together with potassium sulphate aluminium sulphate forms a double salt called alum. It develops large colourless crys-

tals which formerly were successfully used to staunch minor wounds occurring with wet shaving. The astringent and antiseptic effects are based on the denaturing (precipitation) of proteins by aluminium ions.

Sodium thiosulphate which is known as a fixing salt in photography is an antidote after hydrogen cyanide (prussic acid) poisoning and an ingredient in sulphur baths. In such baths and in the slightly acidic milieu of the skin elementary sulphur and traces of hydrogen sulphide are released. Sodium thiosulphate or hydrogen sulphide can also be found in thermal springs. They are mainly visited to treat rheumatic diseases. The improved blood circulation observed in this context can presumably be ascribed to the content or the intermediary formation of hydrogen sulphide.

Prior publications describe the use of sodium thiosulphate in ointments against psoriasis and parasites.

## Sulphuric acid ester

Flora and fauna incorporate sulphates in their natural body substances. In this process sulphatases synthesize sulphuric acid esters that vice versa can again be cleaved by the mentioned enzymes. Sulphotransferases also form sulphate esters by transferring the sulpho group. In the following some examples for physiological sulphuric acid esters are listed:

- Heparins are anticoagulant polysaccharides with individual units that are more or less esterified with sulphuric acid. They are components of the extracellular matrix and determine its mechanical resilience.
- Cholesteryl sulphate is the sulphuric acid ester of cholesterol. It plays a part in the hair structure and the skin barrier lipids.
- Chondroitin sulphates are varying mucopolysaccharides with N-acetylgalactosamine units that are esterified with sulphuric acid. The polymer substance is responsible for the high resilience of the chondral tissue. The partly synthetic chondroitin polysul-

phate is a component of anti-inflammatory skin ointments.

Representatives of synthetic sulphuric acid esters are Sodium Lauryl Sulphate (INCI) which is used as a tenside in cleansing agents and well-known for its skin irritation potential, and Sodium Laureth Sulphate (INCI) which is better tolerated on the skin. The sodium salt of cetyl sulphate is a typical anionic emulsifier for O/W preparations.

### Peptides and vitamins

Not every organism can synthesize the sulphur compounds needed by the body exclusively from inorganic sulphates. Humans for example depend on the essential sulphurous amino acid methionine that they transfer, among others, via homocysteine into cysteine. Cysteine is integrated into proteins and one of the requirements for their tertiary and quaternary structure; the sulphhydryl groups (-SH) of two cysteine residues are oxidatively interlinked via disulphide bridge (-S-S-) into cystine.

Since about 11 per cent of the keratin of hair is composed of cystine the reversed reaction can be used for the treatment to set permanent waves. The disulphide bridges of the hair are broken down with thioglycolic acid with the effect that hair loses its stiffness in this process. After fixing the hair with curlers the disulphide bridges are oxidatively re-established (with hydrogen peroxide or air). The hair regains its stiffness and keeps the "curled" structure.

Many sulphurous peptides and proteins have reductive properties and are effective as antioxidants, reducing enzymes and oxidoreductases. Ferredoxins, thioredoxins and glutathione ( $\gamma$ -L-Glutamyl-L-cysteinylglycine) can be mentioned as examples here.

Lipoic acid which takes part in many of the enzymatic processes also has antioxidant-, radical scavenger- and coenzyme properties.

Coenzyme A also contains sulphur, transfers fatty acid residues and degrades fatty acids. The reactions take place via the energy-rich linkage of the fatty acids to a free sulphhydryl group.

The following vitamins contain sulphur:

- Thiamin (vitamin B<sub>1</sub>). In the cosmetic field it serves for the treatment of blemished skin.
- Biotin (vitamin B<sub>7</sub>) participates in the formation of enzymes of the amino acid- and fatty acid metabolism. Deficiency symptoms are disorders of the hair growth, nails and skin.

### Scents and smells

Sulphur compounds of onions, garlic, ramson (alias wood garlic, bear leek) and the like are odorous. Extremely low is the odour threshold of thioterpinol in grapefruits ( $2 \times 10^{-8}$  mg/kg water). Sulphurous odours in the form of thiols, thioethers and thioesters are produced by the bacteria residing in the foot skin; they can only be fought by providing a dry milieu or by applying bactericides.

The Maillard reaction (non-enzymatic browning reaction) occurring during cooking and baking produces pleasant flavours due to the sulphurous food components such as cysteine, cystine, methionine and thiamin.

Small amounts of hydrogen sulphide (H<sub>2</sub>S) occur in the body in the form of a vaso-dilating messenger substance. It is released for instance during the conversion of cysteine into serine (both amino acids). Some of the anaerobic bacteria and archaea (single-cell organisms) produce hydrogen sulphide from sulphates. Sulphur-oxidising bacteria, vice versa, generate their energy from the oxidation of hydrogen sulphide, sulphur or thiosulphates into sulphates.

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