Sodium and potassium

published in Medical by Beauty Forum 2023 (3), 14-15

Metals are mostly solid matter. It is quite different with the light metals sodium and potassium. You don't even see them, and yet they are present everywhere – even in your own body. Since the beginnings of life in the primordial oceans, they have always been present.

When the soft metals, placed on a filter paper floating on the surface of the water, ignite, burn with a yellow or violet flame and a white cloud of smoke, and after a short pause say goodbye with a loud bang, then you are in a chemistry lesson. The sensitivity of sodium (Na) and potassium (K) to oxygen and other elements shown in the experiment means that the two elements only occur in nature as salts. One example is table salt in the kitchen, consisting of the elements sodium and chlorine - in short: sodium chloride or "salt".

Sodium chloride

In earlier times, the trade in salt was a lucrative business, as it had to be transported from far away places - either from the coasts of warm countries, where it was extracted from seawater by evaporation, or from rock salt deposits created by the silting up of former seas. Apart from the comparatively low price, nothing has changed to this day.
Humans depend on salt because sodium, as a component of the blood, tissues and cells, is essential for maintaining blood pressure, cellular functions and nerve conduction. Together with other water-soluble components, the concentration in the blood is equivalent to a solution of 9 g of common salt per litre. Known as isotonic saline solution, this dosage is also used for injections. In the blood, about 2 thirds of the sodium is present as sodium chloride and about 1 third as sodium hydrogen carbonate (see below).
Sodium chloride levels in sweat are variable and can be up to 4 g/l and losses through renal activity (urine) up to 4-5 g sodium per day. 1 g sodium chloride is equivalent to about 0.4 g sodium. At a weight of 70 kg, one calculates with about 100 g sodium in the body.

Osmoregulation

Sodium chloride is the main component of the salts dissolved in seawater (35 g/l) with about 85.6 %. From the first life forms in the primordial oceans, the salt concentration in organisms has gradually decreased during evolution via fish to later land dwellers. In order to be able to live, the salt concentrations in higher organisms must be kept constant in relation to their respective environment. This is called osmoregulation. Saltwater fish are hypoosmotic (lower salt concentration than the surrounding seawater), whereas freshwater fish and land animals are hyperosmotic (higher salt content than the environment). The concentration gradient between inside and outside is associated with the osmotic pressure – this is exactly the pressure that has to be applied, e.g. in the case of reverse osmosis, to produce drinking water from salt water via a membrane.

Potassium

While sodium is the most important component in the extracellular spaces such as the blood, it is potassium in the intracellular spaces. In between, complex regulations take place that are controlled by transport and transmembrane proteins. Disturbed balances and exchanges in and between the individual compartments lead to a variety of serious diseases.
Potassium dominates in the plant world. The white potash that remains when wood is burned, for example, is pure potassium carbonate, an important starting material at the beginning of soap boiling. When dissolved in water, potash reacts strongly alkaline (high pH) and is able to break down the triglycerides of vegetable oils and animal fats to form potassium soaps ("soft soaps"), glycerine and carbon dioxide. The colourless tartar that often remains in a wine bottle consists of pure potassium hydrogen tartrate, a salt of potassium with tartaric acid. As an essential element for plants, potassium is contained in mineral fertilisers.
Abundant plant-based diets tend to lower blood pressure, which is dependent on the sodium-potassium ratio. Other plant components probably also play a role. Too much potassium is lethal, as shown by the poison syringe used in the USA, which consists of a solution of potassium chloride in water. Potassium chloride,

analogous to sodium chloride, consists of the elements potassium and chlorine.

Carbonates

Salts of sodium and potassium with carbonic acid are called alkali carbonates. Analogous to the potash, with sodium there is sodium carbonate (soda) and sodium hydrogen carbonate (sodium bicarbonate). The latter is also used as baking powder, as it releases carbon dioxide and water in the heat of the oven and thus serves as a leavening agent for the dough. Sodium hydrogen carbonate is responsible for the weakly alkaline reaction of the blood (pH value about 7.4). Dissolved in water, all carbonates of sodium and potassium react alkaline. This property, which also affects the strongly corrosive alkaline lyes (sodium hydroxide solution, potassium hydroxide solution), has led to the name alkali metals. Incidentally, the light metal lithium (Li) also belongs to this group.
Sodium carbonates in particular are popular ingredients of all kinds of effervescent tablets. For this purpose, they are compressed together with solid acids, such as citric acid, tartaric acid, and possibly release agents. On contact with water, they begin to effervesce and release carbon dioxide. Bath tablets additionally contain essential oils, fragrances and dyes, which are finely dispersed in the bath water in this way.
Alkaline skin care adjusted to a pH > 7 by means of sodium hydrogen carbonate is supposed to have a deacidifying effect on the skin. However, the acids in the skin barrier are dissolved; endogenous regeneration reacts by increasing acid production to restore the barrier.

Soaps

Sodium soaps (curd soaps) and potassium soaps (soft soaps), initially made from alkali carbonates and vegetable oils, and later also from alkali lyes and long-chain fatty acids, went out of fashion long ago after it was discovered that their high pH had a damaging effect on the skin barrier especially in the case of prolonged and intensive skin contact. They were mainly replaced by skin-neutral, synthetic-based liquid soaps. Today, however, superfatted products made from high-quality oils appear from time to time. This means that they contain unsaponified vegetable oils and free fatty acids in addition to the fatty acid salts. The pH of the emulsions formed with water can thus be lowered considerably.
In very small doses, curd soaps can be useful for hard tap water, as they render the hardness components, consisting of calcium and magnesium hydrogen carbonates and sulphates, harmless (flocculation) and lower the surface tension of the water. This means that the hardness components can no longer attack the skin barrier, forming lime and magnesium soaps. On the other hand, the fatty acids contained, such as palmitic acid in the skin barrier and linoleic acid in ceramide I, are present. The buffering effect of the skin with its low pH is sufficient to release them from the small amounts of soap.

Salts

Brine, salt and seawater baths, largely using the chlorides and sulphates of sodium and potassium, are used for dermatological therapy, physiotherapy and wellness treatments. Spray inhalations together with the essential oils released from fir trees are also still popular.
Salt scrubs, i.e. the combination of ground salt (sodium chloride) with high-quality skin care oils, have the advantage of developing a skin care effect that remains after the salt has been removed in the shower, provided that no body shampoo is used at that time.

Auxiliary materials

Sodium and potassium are very often found in the INCI of cosmetics. This is because the alkaline lyes like Sodium Hydroxide (INCI) and Potassium Hydroxide (INCI) are often used to neutralise acidic ingredients or to adjust the pH. In many cases, however, ready-made buffer solutions are also used for this purpose; they keep the pH of the products stable. These are usually phosphoric acid and citric acid salts, e.g. sodium phosphate (INCI) or potassium citrate (INCI).

Finally, it should be mentioned that alkaline preparations are sometimes used in cosmetics and as medical products to remove keratinisation and to treat actinic keratosis. Sodium fluoride (sodium salt of hydrofluoric acid) is used in toothpastes for caries prophylaxis.

Dr Hans Lautenschläger

Blue: not contained in the published manuscript.