German Federal Institute for Risk Assessment

FAQ

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Fluoride: important for teeth

According to current knowledge, fluoride is not an essential nutrient and therefore does not need to be consumed through food. However, fluoride – in appropriate doses – can help maintain dental health and reduce the risk of tooth decay. It is added to dental care products, where it acts directly on the surface of the teeth. However, fluoride is also ingested through food, including drinking water and mineral water, as well as by use of fluoridated table salt.

In order to protect the healthy general population from the risks of excessive fluoride intake, the German Federal Institute for Risk Assessment (BfR) advises against fluoride being used in food supplements and recommends that the addition of fluoride to other foods for general consumption be limited to table salt. For preventing tooth decay, the BfR particularly recommends the local application of dental care products containing fluoride.

Special care should be taken when using fluoride-containing toothpastes for infants and children up to the age of eight, as excessive fluoride intake in these age groups increases the risk of dental fluorosis. In early childhood, children often accidentally swallow toothpaste, which can contribute significantly to fluoride intake.

What is fluoride?

Fluorides are salts of hydrofluoric acid. In trace amounts, they are ubiquitous and enter the human body via food. Approximately 99 percent of the fluoride in the human body is stored in bones and teeth.

What is fluoride needed for in the body?

According to current knowledge, fluoride is not essential for humans. This means that it is not absolutely necessary to obtain it from food. However, it is undisputed that fluoride helps prevent tooth decay by making tooth enamel more resistant to the effects of organic acids and by inhibiting the growth of acid-forming bacteria in the mouth. It therefore contributes

to maintaining dental health in various ways. In principle, the body only needs relatively small amounts of fluoride to prevent tooth decay.

What is the daily required amount of fluoride?

According to current scientific knowledge, fluoride is not considered an essential nutrient for humans, meaning it does not have to be obtained from food in order to maintain health. For this reason, the European Food Safety Authority (EFSA) has not been able to define an amount required for maintaining physiological functions. However, studies have shown that fluoride has a protective effect on tooth enamel and inhibits the growth of acid-forming bacteria in the mouth. Fluoride thus helps reduce the risk of tooth decay.

In view of the importance of fluoride for preventing tooth decay and taking into account the risk of dental fluorosis (a mineralisation disorder of the tooth enamel), EFSA defined an amount of 0.05 milligrams (mg) per kilogram (kg) bodyweight (BW) per day as Adequate Intake (AI). This value covers the intake from all food sources, including drinking water, but also from supplements and from cosmetic products such as toothpaste and other dental care products.

The German Nutrition Society (DGE) has also derived guidance values for an adequate intake of fluoride based on an appropriate total fluoride intake of 0.05 mg/kg bodyweight per day and taking into account age- and gender-related reference bodyweights. These values range from 0.25 mg/day for infants under 4 months to 3.0 or 3.5 mg/day for women and men aged 15 and over. The DGE's guidance values can be found here (in German only).

Which foods are good sources of fluoride?

In general, natural foods contain only very small amounts of fluoride. However, fish, black and green tea, and some mineral waters can be good sources of fluoride. In Germany, table salt with added fluoride is also available.

Fluoride concentrations in mineral and table water can vary greatly. According to the German Mineral and Table Water Ordinance (document available in German only), the following applies:

- Natural mineral water containing more than 1 milligram (mg) of fluoride per litre (l) must be labelled as “containing fluoride”.

- Mineral waters containing more than 1.5 mg/l (but less than 5 mg/l) of fluoride must have the fluoride level indicated on the label together with a statement that these waters are not suitable for regular consumption by infants and children under the age of seven.

- Mineral waters containing more than 5 mg/l fluoride may not be placed on the market.

- Mineral water, table water and spring water labelled as suitable for infant nutrition may only be marketed if they meet certain requirements laid out in the German Mineral and Table Water Ordinance. One of these is that they must not exceed a fluoride concentration of 0.7 mg/l.

Drinking water also contains fluoride. However, concentrations in Germany are generally low. Analyses show that more than 90% of drinking water samples tested contain less than 0.3 mg of fluoride per litre. The relevant health departments or regional authorities can provide information about fluoride concentrations in drinking water in your region.

How much fluoride is consumed through food in Germany?

There are currently no data on the exposure to fluoride in the German population. The BfR currently estimates the intake via foods based on data from the BfR-MEAL study.

Where is fluoride added?

Fluoridated table salt has been available in Germany since 1991. It has been approved for domestic use with special exemptions. It may contain up to 310 milligrams of fluoride per kilogram of salt (equivalent to 0.31 mg per gram of salt).

To prevent tooth decay in children, there are also fluoride supplements, mainly in combination with vitamin D, that are recommended for infants from birth until the eruption of their first tooth. More information on this can be found at the Netzwerk Gesund ins Leben ("Healthy Start—Young Family Network", in German only).

In addition, many dental care products contain fluoride. Most commercially available toothpastes contain fluoride (the vast majority in the form of sodium fluoride or sodium monofluorophosphate) in concentrations of 1,000-1,450 ppm (parts per million or 0.1 to 0.145% fluoride). According to the German Cosmetics Regulation (KVO), the maximum permissible concentration is 1,500 ppm (VO (EG) No. 1223/2009). Toothpastes with lower fluoride concentrations of around 500 ppm (0.05% fluoride) are also available for children. However, in 2021, dental and paediatric professional associations in Germany adopted joint recommendations for the use of fluoride for tooth decay prevention in infants and early childhood. According to these recommendations, a very small amount – about the size of a grain of rice – of toothpaste with 1,000 ppm fluoride can be used from the first tooth onwards (see: Netzwerk Gesund ins Leben).

Fluoride is mainly absorbed directly into the tooth enamel during brushing. In addition, fluoride can enter the body if toothpaste is swallowed, either intentionally or accidentally. Infants and young children in particular are not yet able to spit out toothpaste (completely). To avoid unintentional excessive fluoride intake, it is therefore important that parents use the correct amount of toothpaste carefully and either brush their child's teeth or help them to do so, depending on their age.

How much fluoride is contained in tap water in Germany?

The natural fluoride concentration in Germany is very low, averaging 0.1 milligrams per litre (mg/l). In more than 90% of the drinking water samples tested, the concentration is below 0.3 mg/l; there are only a few regions (e. g. in the Eastern Eifel) where the drinking water has a geologically determined fluoride concentration of more than 0.3 mg/l.

Currently available information on the quality of drinking water in large water supply areas (water supply areas supplying more than 1,000 m^3 of drinking water per day or more than

5,000 people) in Germany indicates that the fluoride concentrations in all samples tested are below the limit value of 1.5 mg fluoride per litre set in the German Drinking Water Ordinance. Drinking water is not fluoridated in Germany.

Is there a fluoride deficiency?

Since fluoride is not an essential nutrient, according to current knowledge, fluoride intake is not necessary for maintaining health. Therefore, there are no known symptoms of fluoride deficiency in humans. However, it is undisputed that fluoride has a beneficial effect on the resistance of tooth enamel and thus on dental health. Inadequate application of tooth decay prevention measures, which include dental care with fluoride toothpaste, can therefore increase the individual risk of tooth decay.

What is known about the health risks of high fluoride intake?

Acute, very high oral fluoride intake can cause nausea, vomiting, abdominal pain, diarrhoea, drowsiness, headaches, polyuria (excessive urination), polydipsia (excessive thirst), coma, convulsions, cardiac arrest and even death. The minimum acute dose that causes gastrointestinal effects is reported to be 0.4 to 5 mg/kg bodyweight.

Chronic high intake of fluoride can have adverse effects on teeth up to the age of about eight years, leading to dental fluorosis. Dental fluorosis is caused by excessive fluoride deposition in the tooth enamel before the teeth erupt and is characterised by a reduced mineral content (hypomineralisation) of the developing teeth. This is accompanied by the formation of whitish spots on the teeth. In severe cases, discolouration and even loss of tooth enamel can occur. Susceptibility to this ends at around the age of 8, when the enamel of the permanent teeth is fully developed.

In view of the risk of dental fluorosis, the European Food Safety Authority (EFSA) has recently derived age-dependent tolerable upper intake levels (UL) for fluoride of 1 mg/day for infants, 1.6 mg/day for children aged 1 to 3, and 2 mg for children aged 4 to 8 (EFSA). For pregnant women and all age groups from eight years onwards, the EFSA has derived a safe level of intake of 3.3 mg/day.

Extremely high fluoride intake (10-25 mg/day) over many years increases the risk of skeletal fluorosis. Initially, an increase in bone density is observed. The increased bone density reduces the elasticity of the bones, which increases the risk of fractures. This is followed by joint pain and stiffness. As skeletal fluorosis progresses, skeletal deformities and severe calcification of the ligaments occur.

Can fluoride impair neurocognitive development?

For several years, there has been (renewed) international debate about whether there could be a causal link between high fluoride intake in pregnant women and/or infants and impaired cognitive abilities in children. To investigate this question, both the US National Toxicology Program (NTP) and EFSA have assessed the potential effects of fluoride on neurocognitive development based on the available study data.

The data available for risk assessment mainly come from epidemiological observational studies conducted in China, Iran, India, Pakistan, Mexico and Canada. Based on these data, it was concluded/assumed that high fluoride intake (as it occurs, for example, in populations where fluoride levels in drinking water are above the WHO guideline value of 1.5 mg/l) may be associated with lower IQ in children. A causal link between fluoride and these observations cannot be derived from those studies. The majority of the observational studies have methodological weaknesses. In particular, other factors that could influence cognitive development, such as nutrition or the socio-economic status of the study populations, were not (sufficiently) taken into account in most studies. Finally, no reliable statement can be made about underlying physiological mechanisms, meaning that the biological plausibility of the observed association remains unclear.

From the BfR's point of view, based on the totality of the available evidence, there is therefore no reason to classify fluoride as neurotoxicant. In its opinion on fluoride published in 2025, EFSA also states that the scientific data are insufficient to establish a link between fluoride and adverse effects on the developing brain in populations where the fluoride content in drinking water is below 1.5 mg/l (as is the case in Germany). Further studies are therefore needed to clarify the kinetics of fluoride, its biological activity and the relationship between fluoride and neurocognitive development in order to classify the potential health effects of fluoride, even at lower intake levels.

Is fluoride supplementation recommended?

The German Federal Institute for Risk Assessment (BfR) advises against fluoride being used in food supplements and recommends that its addition to other foods for general consumption be limited to table salt. This is based on the notion that the tolerable upper intake level (UL) or the safe level of intake of fluoride could be reached or exceeded if consumers, for example, drink large amounts of fluoride-containing (mineral) water and/or black tea, use fluoridated table salt and also take fluoride tablets. To prevent tooth decay, the BfR particularly recommends the local application of fluoride-containing dental care products.

Are there legal limits for fluoride in food, drinking water and cosmetics?

In order to limit the health risks associated with excessive intake of vitamins and minerals, it is planned to set harmonised maximum amounts for food supplements and fortified foods at EU level. However, such maximum amounts do not exist yet. The BfR recommends not using fluoride in food supplements and limiting its addition to other foods for general consumption to table salt.

The underlying rationale is that under certain conditions – primarily through the use of fluoride-containing (mineral) water and abundant consumption of black tea – fluoride can be ingested in amounts that are in the range of the tolerable daily intake or the safe level of intake. Additional intake of food supplements containing fluoride would increase the risk of a high total fluoride intake. Therefore, in the opinion of the BfR, there is no scope for adding fluoride to other foods apart from table salt (see question "Is fluoride supplementation recommended?").

Fluoridated table salt has been available in Germany since 1991 under a special exemption and may contain up to 310 milligrams (mg) of fluoride per kilogram (kg) or 0.31 mg per gram (g) of salt. The packaging must indicate that fluoride has been added to the salt and that other fluoride-containing preparations in addition to the salt should only be taken on medical advice.

Mineral and table waters can contain very different concentrations of fluoride (between 0.1 and 4.5 mg/litre (l)), which do not have to be declared. Water containing more than 1 mg/l of fluoride may be labelled as "containing fluoride" in accordance with the German Mineral and Table Water Ordinance. Only water containing less than 0.7 mg/l may be labelled as "suitable for the preparation of infant formula". In addition, natural mineral waters containing more than 1.5 mg/l (but less than 5 mg/l) of fluoride must carry a note indicating that they are not suitable for regular consumption by infants and children under the age of seven. Mineral waters containing more than 5 mg/l of fluoride may not be placed on the market.

Drinking water in Germany is not fluoridated and the natural fluoride concentration is very low, averaging 0.1 milligrams (mg) per litre. However, in some parts of the country, drinking water has naturally high concentrations of fluoride, for example in the Eifel or Münsterland regions. The responsible health departments or authorities of the federal states can provide information about the fluoride concentration in the drinking water in your region.

In addition, many dental care products contain fluoride. Most commercially available toothpastes contain fluoride (the vast majority in the form of sodium fluoride or sodium monofluorophosphate) in concentrations of 1000-1450 ppm (parts per million or 0.1 to 0.145 % fluoride). According to the German Cosmetics Regulation (KVO), the maximum permitted concentration is 1500 ppm (Regulation (EC) No. 1223/2009).

Further information on fluoride on the BfR website

Proposed maximum levels for the addition of fluoride to foods including food supplements
https://www.bfr.bund.de/en/release/proposed-maximum-levels-for-the-addition-of-fluoride-to-foods-including-food-supplements/

BfR topic page: Health assessment of fluoride
https://www.bfr.bund.de/en/product-safety/health-assessment-of-cosmetics/health-assessment-of-fluoride/

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent public health institution within the portfolio of the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). The BfR advises the Federal Government and the States ('Laender') on questions of food, feed, chemical and product safety. The BfR conducts independent research on topics that are closely linked to its assessment tasks.

About microco.info

The internet portal www.mikroco.info provides information on vitamins, minerals and numerous other substances that we ingest with food or that are offered as food supplements. In addition, the individual pages contain the maximum levels of vitamins and minerals in food supplements and in fortified foods as recommended by the German Federal Institute for Risk Assessment (BfR).

This text version is a translation of the original German text which is the only legally binding version.

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