Scientific Facts on

Boron

Source document:
IPCS (1998)

Summary & Details:
GreenFacts

Context - Food and drinking water commonly contain some boron. Boron is used for instance in laundry products. Could boron exposure affect my health? Under what conditions could it be beneficial or harmful to the environment?

This Digest is a faithful summary of the leading scientific consensus report produced in 1998 by the International Programme on Chemical Safety (IPCS):
"Executive Summary of the Environmental Health Criteria for Boron (EHC 204)"

The full Digest is available at: https://www.greenfacts.org/en/boron/

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- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. What is boron?

Boron is a naturally occurring element. In the environment, boron is combined with oxygen and other elements in compounds called borates. Borates are widely found in nature, and are present in oceans, sedimentary rocks, coal, shale and some soils. There are several commercially important borates, including borax, boric acid, sodium perborate, and the minerals ulexite and colemanite.

Different borates react differently with water.

2. Where is boron found?

2.1 Boron is primarily obtained from boron mines, located in arid regions of Turkey and the USA, and also in Argentina, Chile, Russia, China, and Peru.

Boron can also be found in different final products made from these boron minerals, including fibreglass, borosilicate glass, fire retardants, laundry bleach, agricultural fertilizers and herbicides, and many others.

2.2 Boron enters the environment mainly from the weathering of boron-containing rocks, from seawater in the form of boric acid vapour and from volcanic and other geothermal activity such as geothermal steam. Boron is also released, though to a lesser extent, from human activities. These include the use of borate-containing fertilizers and herbicides, the burning of plant-based products such as wood, coal, or oil, and the release of waste from borate mining and processing. Borates also reach the environment due to the use of borates and perborates in the home and in industry, through leaching from treated wood or paper, and from sewage and sewage sludge disposal.

2.3 Borates dissolved in the water can adsorb onto, and desorb from, the many different surfaces which can be found in rivers and streams. This is the only significant reaction that these boron-containing compounds will undergo.

Borates are also adsorbed onto soil particles. The degree of adsorption depends upon the type of soil. Plants can accumulate boron, which is necessary for plant growth. Boron can build up in plants, but does not subsequently accumulate to a greater extent along the food chain, i.e. in animals which eat the plants, or in predatory animals which eat these animals.

3. What levels of boron are found?

3.1 Boron occurs at different concentrations in soil, water or air. Boron accumulates to different degrees in aquatic and terrestrial plants and animals, but does not increase in concentration through the food-chain.

3.2 Humans are exposed to boron from their diet, from drinking water, and from some consumer products. They may also, to a much smaller extent, ingest boron from the soil, or breathe in boron from the air. Overall, more than half of the average total exposure to boron comes from the diet.

4. What are the effects of boron on humans and mammals?

4.1 Boron acts in the same way in humans as in other mammals. These similarities help to make it possible to make reliable predictions of effects on humans from effects observed on laboratory animals such as rats. When swallowed and inhaled, boron is widely distributed throughout the body, and some is taken up by the bones. It is then rapidly excreted, with boron incorporated in bone taking a longer time to be eliminated.

4.2 In **laboratory animals**, boron can affect reproduction and the development of the fetus. Animal studies on mice and rats show no evidence of boron carcinogenicity.

4.3 Because of the lack of human data and the limited amount of animal data, the **EPA** has classified boron as "not classifiable as to human carcinogenicity" in 1994.

The very few studies on humans showed that short-term exposure to boron can cause irritation of the eye, the upper respiratory tract, and the nasopharynx. This irritation disappears when the exposure stops. No long-term health effects have been found. No effects have been found of boron exposure on human fertility. However, further study is needed to identify groups of people that might be sensitive and to evaluate reproductive effects more fully.

5. What are the effects of boron on organisms in the environment?

Different **organisms in the environment** are affected differently when exposed to boron:

- **Bacteria** are relatively tolerant towards boron, as are freshwater green **algae** and blue-green algae.
- **Protozoa** are more sensitive to boron than bacteria.
- **Invertebrates**, such as worms and mussels, are less sensitive to boron than bacteria and protozoa.
- Adult **fish** are relatively tolerant towards boron, with rainbow trout and zebra fish being the most sensitive. However, boron may be more toxic during the early life stages of some fish, especially rainbow trout.
- Boron is an essential nutrient for **plants**, but different plant species require different boron levels for optimum growth. In some plants, there is only a narrow margin between too little or too much boron.

6. Conclusions

Boron is a naturally occurring element that is found in oceans, sedimentary rocks, coal, shale, and some soils. Boron is released into the environment from the oceans, volcanic and other geothermal activities such as geothermal steam, and natural weathering of boron-containing rocks. Boron is also released, to a lesser extent, by human activities.

Boron is an essential micronutrient for plants, with differences between plant species in the levels required for optimum growth. There is a narrow margin between boron deficiency and toxicity in some plants.

The risk of adverse effects of high boron concentrations on aquatic ecosystems is small because boron levels are generally low, and below the no-observed-effect concentration.

For humans, boron exposure occurs primarily through the diet but also through drinking-water. Animal experiments have shown harmful effects on reproduction and

development, but only at boron levels that are approximately 100 to 1000 times greater than normal exposure levels. Though there is insufficient toxicity data for humans, a Tolerable Intake (TI) of boron has been established based on animal data.