German Federal Institute for Risk Assessment

FAQ

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Uranium – useful information on sources of exposure, effects on the body and legal regulations

Uranium is a radioactive heavy metal that occurs naturally in our environment. It can be found in the air and in water and is a component of all rock-forming minerals such as mica and all types of rock such as granite. Additionally, mineral phosphate fertilisers can contribute to an increase in uranium levels of agricultural land.

Humans can ingest small amounts of uranium via drinking water and food.

In assessing health risks, both the toxicity of the heavy metal and the exposure of humans to radioactivity play a role. The health effects of uranium primarily affect the kidneys; at higher levels of exposure, they also affect reproductive capacity, bone growth and the nervous system. The World Health Organisation (WHO) has derived a tolerable daily intake (TDI) of 0.6 µg per kg body weight per day for soluble uranium compounds. This value is also recommended by the European Food Safety Authority (EFSA). The TDI value indicates the amount of a substance that can be ingested daily over a lifetime without any discernible health risk.

The Federal Institute for Risk Assessment (BfR) has compiled the following frequently asked questions and answers on uranium.

What is uranium?

Uranium is a radioactive heavy metal that occurs in a mixture of three isotopes in the soil, rocks, water and air. Isotopes are atoms with the same number of protons but a different number of neutrons. Uranium occurring naturally in minerals consists predominantly of the isotope uranium-238, with less than one per cent being uranium-235 and traces of uranium-234. The chemical properties are the same for all three isotopes; they differ in their radiological properties. Uranium occurs naturally in various oxidation states (+2, +3, +4, +5 and +6), frequently in its tetravalent and hexavalent forms, bound to oxygen as uranium oxide (UO_2) and uranyl ion (UO_2^{2+}).

Where does uranium occur in the environment?

Uranium is widespread in nature. It can be detected in trace amounts in air, water and food, amongst other things. In the air, it is usually bound to dust particles. In particular, it is a component of around 200 rock-forming minerals, such as pitchblende or mica, but also of rocks such as granite. The uranium content in soil varies depending on geological conditions, the level of uranium-containing emissions and active inputs. Mineral-based phosphate fertilisers can lead to inputs on agricultural land. Groundwater and drinking water can contain varying concentrations of uranium depending on the type of rock they are sourced from.

From which sources do humans ingest uranium?

Humans tend to absorb relatively small amounts of uranium via the air, and comparatively higher levels via water and food. The population's uranium intake occurs mainly via drinking water and, to a lesser extent, via food. Foodstuffs generally contain low levels of uranium (from just under one to a few micrograms per kilogram).

What are the distinctive features of uranium?

Unlike other substances that harm a biological organism (toxic substances), uranium compounds have two distinct effects: In public perception, the focus is usually on the radioactive effects of uranium, i.e. the consequences of radioactive decay. Responsibility for assessing radioactive effects lies with the Federal Office for Radiation Protection (BfS).

In addition, uranium compounds can have harmful effects on the body due to their chemical properties. The BfR is responsible for assessing these chemico-toxicological effects.

What are the chemico-toxicological effects of uranium in the body?

After ingestion, only a small proportion of the uranium is absorbed into the body. Initially, the highest amounts are found in the liver and kidneys, and later in the bone tissue. Within approximately six months to a year, half of the absorbed uranium is excreted. The absorbed uranium is excreted via the urine.

Uranium primarily affects the kidneys and their function. Furthermore, at higher doses, uranium can have harmful effects on development and reproductive capacity, bone growth and the nervous system.

In 2001, the WHO derived a Tolerable Daily Intake (TDI) of 0.6 µg per kg body weight per day for soluble uranium compounds. The TDI value indicates the amount of a substance that can be ingested daily over a lifetime without any discernible health risk. This value is based on the nephrotoxic effect observed in male rats following administration of uranyl nitrate hexahydrate over 91 days and an uncertainty factor of 100. This WHO value was also used by the EFSA in 2009.

In order to assess the health risk to humans associated with a specific intake of uranium, both the toxicity of the heavy metal uranium and the human exposure to radioactivity must be taken into account.

What data is available on uranium levels in food?

The BfR conducted the first Total Diet Study in Germany, known as the MEAL study (Meals for Exposure Assessment and Food Analysis). In this study, food samples were analysed for their levels of various substances.

In the case of uranium, the foods were not examined with regard to the 'chemical' content of the heavy metal. However, selected samples from the MEAL study were analysed by the BfS for the levels of the radionuclides lead-210, uranium-234, uranium-238, radium-228 and radium-226. The highest average uranium-related radioactivity levels were found in mussels and processed cheese. Overall, the radionuclide activity concentrations for uranium-234 and uranium-238 in the tested samples were low.

As part of routine food monitoring by the official laboratories of the federal states, samples can be tested for uranium levels or radioactive contamination.

Are there any legal regulations regarding uranium in mineral water?

According to the Mineral and Table Water Ordinance, table water and natural mineral water advertised as 'suitable for the preparation of infant formula' must not exceed a uranium content of 0.002 mg per litre.

Under the Drinking Water Ordinance, drinking water must not exceed a uranium content of 0.010 mg per litre.

Are there any legal regulations regarding uranium in food?

The EU Regulation on maximum levels for certain contaminants does not set any maximum levels for uranium in food.

Further information on the BfR website regarding uranium

Study analyses foods for radioactive substances
https://www.bfr.bund.de/en/press-release/study-analyses-foods-for-radioactive-substances/

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientific independent institution within the portfolio of the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). It protects people's health preventively in the fields of public health and veterinary public health. The BfR provides advice to the Federal Government as well as the Federal States ('Laender') on questions related to food, feed, chemical and product safety. The BfR conducts its own research on topics closely related to its assessment tasks.

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

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