German Federal Institute for Risk Assessment

FAQ

31 July 2023

Questions and answers on mineral oil components in food

→ Minor editorial changes on 4 August 2023: Update of external links and correction of max. determination limit for fats and oils on page 6

Mineral oil components can enter food in different ways. On the one hand, there are expected transitions into food, e.g. through approved food additives, additives for the production of packaging or during the processing of food. On the other hand, environmental contamination, agricultural machinery, unsuitable transport or processing methods and accumulation along the food chain are possible sources.

In this context, the BfR has been pointing out for years that the transfer of mineral oil components from recycled cardboard boxes to food is possible and to be expected, since printed waste paper is used for production, which may contain mineral oil components from newspaper inks. The transfer of these substances has so far been detected in particular in dry foods with a large surface area, for example rice or semolina.

Against this background, the Federal Institute for Risk Assessment (BfR) has carried out an assessment of whether mineral oil components in food can pose a health risk.

In the following, the BfR has summarised frequently asked questions and answers on mineral oil components that can migrate from packaging into food.

How can mineral oil components get into food?

On the one hand, mineral oil components can predictably end up in food. Certain waxes or so-called white oils are used, for example, as food additives, for the production of food contact materials or in the processing of food - among other things, in adhesives, in plastics, for the production of metal cans, to prevent flour dust, as cheese coatings or to improve the release of dough blanks and other moulded products from the corresponding moulds. The mineral oil products used are normally substances that may be used for the respective applications according to European legislation.

On the other hand, mineral oils in food can also be the result of contamination during the production of the food, for example through environmental inputs from contaminated soils,

through agricultural machinery or incorrect storage conditions, through packaging materials or through carry-over of contaminants, especially from animal feed, via the food chain.

In the case of packaging, so-called "batching oils" and printing ink components come into consideration as contaminants. The former are often used for the production of jute or sisal bags for the transport and storage of food. The latter result from paper packaging produced with recycled fibres. Printed newspaper are also a source for recycled paper used to produce cardboard. Most of the conventionally used newspaper inks contain mineral oils. So far, these cannot be sufficiently removed in the recycling process and thus end up in the food packaging made from recycled cardboard. Both "batching oils" and mineral oils from printing inks often contain comparatively high levels of aromatic hydrocarbons. However, by selecting suitable qualities of recycled paper and using so-called functional barriers (e.g. a separating layer) between the paper packaging and the food, it has been possible to significantly reduce the amount of recycled paper entering food in recent years.

What is meant by the term "mineral oil" in the context of food?

The detected mineral oil mixtures in food consist of complex mixtures of saturated hydrocarbons (Mineral Oil Saturated Hydrocarbons, MOSH) and aromatic hydrocarbons (Mineral Oil Aromatic Hydrocarbons, MOAH). The compounds usually contain between 10 and 50 carbon atoms.

From a chemical point of view, MOSH are branched or unbranched chains or (partially) ring-shaped molecules that consist only of carbon and hydrogen and do not contain double bonds (saturated compounds).

MOAH are compounds that have an aromatic ring system consisting of one or more rings. They sometimes also contain sulphur in addition to carbon and hydrogen. The aromatic rings also usually have one or more short or long side chains of saturated hydrocarbons.

Which foodstuffs can contain mineral oil components from packaging?

The BfR assumes that especially in dry foods with a large surface area, such as flour, semolina, rice, breadcrumbs or breakfast cereals, a transfer of mineral oils from the packaging to the food is to be expected.

Into which foods can mineral oil components from packagings transfer?

The BfR assumes that transfer of mineral oils from the packaging into foods is above all to be expected with dry foods with large surface area, such as flour, semolina, rice, breadcrumbs or breakfast cereals

When did the BfR draw attention to the problem of mineral oil components from packagings transferring into food?

In the light of findings of the Zurich Cantonal Laboratory in Switzerland, the BfR drew attention to the problem of mineral oil components transferring into food in 2009.

The laboratory detected a mineral oil mixture in rice that was stored in a cardboard box for eight months. It can be reasonably assumed that the detected transfer is largely the result of the outgassing of mineral oils from the cardboard.

What are the known health risks of mineral oil?

Saturated hydrocarbons (MOSH) of a certain chain length range (approx. between 10 and 45 carbon atoms) are absorbed by the body and can also be detected in humans in some organs such as the liver, spleen, fatty tissue or certain lymph nodes. It is known from animal studies that mineral oil mixtures containing certain MOSH (unbranched chains with approx. 25-35 carbon atoms) can lead to deposits and inflammatory effects in the liver in a certain strain of rats (so-called F 344 rats). In a preliminary opinion of March 2023 (https://connect.efsa.europa.eu/RM/s/publicconsultation2/a0l09000006qqHf/pc0400), the European Food Safety Authority (EFSA) concludes, based on new data from human and animal studies, that this animal finding is not relevant for humans. On the one hand, the MOSH fraction described above does not accumulate in the human liver and spleen, in contrast to the F 344 rats, and on the other hand, the toxicological effects described were not observed in human tissue samples. Apart from very high doses, EFSA has not identified any adverse effects of MOSH on humans. However, the data are incomplete, in particular long-term studies in animals and further data on MOSH levels in human organs after (lifelong) ingestion of mineral oil are missing. Accordingly, EFSA has based its health risk assessment on the effect of the accumulation of MOSH in organs and tissues, since an accumulation of exogenous substances is fundamentally undesirable and possible (as yet unknown) toxicological effects are most likely to be caused by the accumulating MOSH.

The fraction of aromatic hydrocarbon compounds (MOAH) detected in food can originate from different sources. MOAH are compounds that have an aromatic ring system consisting of one or more rings and sometimes also contain sulphur in addition to carbon and hydrogen. The aromatic rings also often have several short or long side chains of saturated hydrocarbons. Some MOAH are mutagenic and carcinogenic. Because of the large number of individual substances, toxicological data are only available to a very limited extent. However, new data, which are also described in the above-mentioned EFSA preliminary opinion, support the hypothesis of previous assessments that mutagenic and carcinogenic substances are found almost exclusively in the group of MOAH with three or more aromatic rings. Accordingly, EFSA (2023) has based its risk assessment on the presence of this group of substances in food.

In principle, such contaminations of food are undesirable. From BfR's point of view, the transfer of mineral oil - especially MOAH with three or more aromatic rings - from recycled paper and cardboard to food as well as entries from other sources should therefore be further minimised.

What was the outcome of EFSA's health risk assessment in 2023?

For MOSH, EFSA concludes that the current intake levels in the EU population via food are not a cause for concern. This is also a result of successful efforts by authorities and industry in recent years to reduce the transfer of mineral oil into food. However, EFSA points out that further data on toxicological effects and the accumulation of MOSH in human organs and tissues over a long period of time are needed.

For the assessment of MOAH levels in food, the fraction with three or more aromatic rings is particularly relevant, as mutagenic and carcinogenic substances may be present in this fraction. However, there is little data on the actual share of this fraction in the MOAH found in food. Accordingly, EFSA has worked with two scenarios, one representing the realistic "worst case" and the other the "best case". For the "worst case" scenario, a health concern resulted for all population groups and for the "best case" especially for the group of high

consumers among young children. EFSA's main comment here was that more data are needed on the actual occurrence of MOAH with three or more aromatic rings in food. In addition, there is a lack of data on the toxicology of MOAH with one or two aromatic rings in particular.

Are MOSH and MOAH the only petroleum hydrocarbons that can occur in food?

The definition of "mineral oil hydrocarbons" is somewhat arbitrary. It includes hydrocarbons obtained from mineral oil by physical and chemical processes such as distillation, cracking, hydrogenation, extraction and others. This also includes synthetic substances from coal, natural gas and biomass. Other substances are excluded from the definition, although they are chemically very similar and analytically not always completely separable or distinguishable. This applies, for example, to hydrocarbons formed by plants (e.g. as a protective layer on apples or pears). Oligomers derived from polyolefins, the so-called POSH ("polyolefin oligomeric saturated hydrocarbons") or short-chain synthetic polyolefins, the so-called PAO ("poly alpha olefins") can also be contained in food. They can migrate from containers made of certain plastics into food (POSH) or are used, for example, as synthetic lubricating oils in the processing of food (PAO).

What are POSH and PAO?

Polyolefin oligomeric saturated hydrocarbons (POSH) are saturated hydrocarbons which are contained as oligomers in certain plastics, the polyolefins (e.g. polyethylene, polypropylene). If such materials are used as packaging or for storing food, POSH can be transferred to the food in small quantities.

PAOs ("poly alpha olefins") are short-chain synthetic olefins that are used, for example, as solvents or lubricating oils in food processing. PAO can also be present in food in small quantities.

By definition, POSH and PAO are not mineral oil hydrocarbons.

What is the health risk of POSH and PAO in food?

The BfR has no toxicological data on POSH and PAO. A conclusive health risk assessment of these substances could therefore not be made so far. However, based on the chemical similarity to MOSH, it can be assumed that POSH and PAO do not pose a health risk according to current data.

What amount of mineral oil components do consumers ingest through food?

In 2023, the European Food Safety Authority (EFSA) estimated that adult consumers take up between 9 and 50 micrograms (µg) per kilogram (kg) of body weight (bw) of saturated hydrocarbons (MOSH) and between 0.4 and 13 µg per kg bw of aromatic hydrocarbons (MOAH) per day. Children consume about two to five times as much: 17 to 212 µg per kg bw per day for MOSH and 1 to 59 µg per kg bw per day for MOAH.

The daily intake for both MOSH and MOAH has thus roughly halved for all population groups since EFSA's last opinion in 2012.

The main source of MOSH and MOAH intake for infants and young children are food products for the young population. These include infant formula and follow-on formula, but also other products such as ready-to-eat meals and biscuits for infants and young children.

For adolescents and adults, almost all food groups contribute to MOSH intake, but especially cereal products, dairy products and fats and oils. Cereal products, fats and oils, and beverages such as tea, cocoa and coffee are the main contributors to MOAH intake in adolescents and adults.

How does the BfR assess the health risk of mineral oil components in chocolates from Advent calendars?

Based on the data provided by the Stiftung Warentest in 2015, the BfR has conducted a preliminary assessment of the health risk posed by mineral oil components in chocolate. Assuming the worst-case by using the maximum level of approx. 7 milligrams per kilogram of chocolate, the concentration of aromatic hydrocarbons in the individual chocolate pieces from the calendars, was calculated to 0.022 milligrams. Based on the assumption that a person eats one chocolate piece per day, this translates into only a very small additional intake on top of the daily intake of aromatic mineral oil hydrocarbons via foods estimated by the European Food Safety Authority (EFSA 2012).

Although this proportion is low, aromatic hydrocarbons are undesirable in foods because it cannot be ruled out that they may contain substances with mutagenic and carcinogenic potential.

Can mineral oil components also be transferred to frozen foods that are offered in cardboard packaging?

The BfR currently has very limited data concerning the transfer of mineral oil components into frozen foods. However, migration is unlikely at freezing temperatures, as mineral oil components do not outgas under these conditions.

Are there limits for mineral oil components in food?

Currently, there are no legal limits regulating the levels of mineral oil components in food. However, since MOAH can also include mutagenic and carcinogenic compounds, MOAH should not be detectable in food. The Standing Committee on Plants, Animals, Food and Feed (SC PAFF) of the European Commission published guidelines in April 2022 (https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/281161/081467/1/attachment) and then again in October 2022 (https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/299917/085826/1/attachment), which defines what is meant by the term "undetectable" and how to deal with foodstuffs in which MOAH have been found. Accordingly, all foodstuffs are to be removed from the market and, if necessary, recalled if MOAH are found in them above the following maximum limits of determination.

- 0.5 milligrams per kilogram of dry food with low fat/oil content (≤ 4 %)
- 1 milligram per kilogram food with higher fat/oil content (> 4 % and ≤ 50 %)
- 2 milligrams per kilogram fat/oil or food with a fat/oil content > 50%

What limit values for the transfer of aromatic hydrocarbons (MOAH) and saturated hydrocarbons (MOSH) from packaging does the BfR recommend for foodstuffs?

Toxicological data for the assessment and derivation of health guidance values for MOAH are not available. The opinion of BfR that the aromatic hydrocarbon fractions passing from

recycled cardboard may have mutagenic and carcinogenic properties was confirmed by a preliminary opinion of the European Food Safety Authority from 2023 (EFSA 2023). According to this opinion, MOAH from the group with three or more aromatic rings are responsible for the mutagenic and carcinogenic effects. The analytical proof of whether and to what extent MOAH found in food are substances with three or more aromatic rings is not yet possible in routine analysis. Therefore, no detectable transfer of MOAH from packaging to food should take place according to the specifications of SC PAFF (see above).

For solvents containing MOSH with carbon chain lengths from C10 to C16 and from C16 to C20, the BfR has derived a guideline value for the transfer to food of 12 milligrams per kilogram of food and 4 milligrams per kilogram of food, respectively.

EFSA has recommended a specific migration limit of 5 milligrams per kilogram of food in the re-evaluation of low-viscosity waxes for the production of plastic food contact materials in 2022 (EFSA 2022, https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.7761). BfR was involved in the evaluation and supports this value.

What does the BfR recommend to further reduce the content of mineral oil components in food?

The transfer of mineral oil components from paper and cardboard packaging into food is not only influenced by their content in the packaging material, but also by the storage conditions and the type of food. It can be prevented by the use of virgin fibre cartons, the use of mineral oil-free printing inks or the inclusion of functional barriers in the packaging structure. Not only the direct food packaging must be considered, but also the possibility of transfer from outer packaging.

Other remaining sources of entry into food, for example from agricultural production, transport and food processing, should be identified and reduced as far as possible. In the opinion of the BfR, the minimisation efforts undertaken in recent years, for example within the framework of the recommended benchmark levels project, should be continued.

Further information on mineral oil components

New EFSA risk assessment: Some mineral oil residues in food remain a health concern
https://www.bfr.bund.de/cm/349/new-efsa-risk-assessment-some-mineral-oil-residues-in-food-remain-a-health-concern.pdf

About the BfR

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

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

Imprint

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Responsible according to the German Press Law: Dr Suzan Fiack

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