

2- and 3-MCPD and Their Esters in Vegetable Oils

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What are process contaminants?

Process contaminants are chemical substances that have not been intentionally added to food but are produced during food processing steps such as cooking, heating or purification of foods or ingredients. This Q&A will address process contaminants in edible vegetable oils and fats that are formed during the processing (also known as refining) required to make these oils and fats suitable for use in food manufacturing. These group of substances includes 2-monochloropropane-1,2-diol (2-MCPD), 3-monochloropropane,-1,2-diol (3-MCPD) and its related fat soluble forms (also known as 3-MCPD esters), and glycidyl esters (GE).

3-MCPD and 3-MCPD esters

What is 3-MCPD and in what foods does it occur?

3-MCPD was first identified as a contaminant of soy sauce and acid-hydrolysed vegetable protein (a savoury food ingredient). Since then it has been detected at low levels in a number of foods and ingredients. Other common sources of exposure through the diet include vegetable fats and oils (in particular palm fats and palm oils), cookies, pastries and cakes, infant and follow up formulae, fried or baked potato products, and certain meat and fish products.

What are 3-MCPD esters and in what food do they occur?

3-MCPD esters are a fat soluble form of 3-MCPD. They are formed during the processing (refining) of edible oils and fats. This process is required to produce oils and fats that meet the standards of safety and quality that ensure they are suitable for use in food manufacturing.

3-MCPD esters were only recently discovered in foods and food ingredients. They highest levels of 3-MCPD esters have been found in palm oils and fats, but they are also present in most vegetable oils and fats, and all manufactured products containing them. They can also be found in a variety of foods including infant formula, follow-on formula, bread (crust), roasted nuts and dried milk.

Are there any health risks associated with 3-MCPD and its esters?

In 2016, the European Food Safety Authority (EFSA) Panel on Contaminants in the Food Chain (CONTAM Panel) published the results of its assessment of the safety of 3-MCPD and its esters with respect to human health. Available evidence from animal studies indicates that kidney toxicity is the most critical health effect of 3-MCPD in rats. Using this data, EFSA established a tolerable daily intake (TDI) for 3-MCPD for humans which represents the maximum amount that can be consumed daily over a lifetime without being

harmful to health. It includes a very large margin of safety. The TDI for 3-MCPD has been calculated as 0.8 micrograms per kilogram of body weight per day ($\mu\text{g}/\text{kg}$ bw per day.)

3-MCPD esters are considered to have the same toxicological profile as 3-MCPD. The TDI of 0.8 μg bw per day is therefore applicable to the combined intake of both 3-MCPD and its esters.

The Panel estimated the current exposure levels of European consumers over all age groups using data on the levels of 3-MCPD and its esters found in European food products. To determine whether there is a potential health concern, the exposure level of each age group was compared to the TDI (the recommended maximum limit for daily consumption over a lifetime). EFSA concluded that average exposure levels for infants, toddlers and children under the age of 10 are higher than the TDI. They concluded that current exposure levels to 3-MCPD and its esters may pose a potential health concern to these age groups.

Are any maximum limits set for 3-MCPD or 3 MCPD esters in food?

Maximum levels have been set in European food legislation (Commission Regulation (EC) 1881/2006) for 3-MCPD in hydrolysed vegetable protein and soy sauce. Currently, no limits have been set for 3-MCPD or its esters in any other ingredient or food.

2-MCPD and 2-MCPD esters

What is known about 2-MCPD and its esters?

2-MCPD was identified as a contaminant of soy sauce and acid-hydrolysed vegetable protein. The biggest source of exposure for humans is in fats and oils (especially palm oils and fats) and products containing them. It has been detected in bread, bakery products, certain fish and meat products, fried or roasted meat, and infant and follow-on formulae.

Less is known about the toxic effects of 2-MCPD and 2-MCPD esters than about 3-MCPD and its esters, which to date have been studied in more depth. Currently there is not enough information available to allow EFSA to set a safe level for 2-MCPD intake through the diet. Additional studies are necessary to form conclusions on whether there is a potential health concern related to the presence of 2-MCPD in food.

Glycidyl esters

What are glycidyl esters and in what foods do they occur?

Glycidyl esters are formed from a group of substances that is naturally present in all vegetable oils (diglycerides or monoglycerides) when they are heated to temperatures $> 200^{\circ}\text{C}$ e.g. during the deodorisation stages of refining. They are consequently found in foods that contain refined oils and fats. This includes vegetable fats and oils (particularly palm oil), cookies, pastries and cakes, infant and follow on formula, margarine, fried or roasted meat and some chocolate (or similar) spreads.

Are there implications of glycidyl esters for human health?

After consumption through the diet, glycidyl esters are converted into free glycidol. Based on the available evidence from animal studies, there is sufficient evidence to conclude that glycidol is genotoxic (i.e. it can damage our genetic material, or DNA) and carcinogenic (i.e. it can cause cancer).

In 2016, EFSA's CONTAM Panel concluded that at current exposure levels glycidyl esters are a potential health concern for all younger age groups (infant, toddler and children under the age of 10). The exposure of babies consuming only infant formula to glycidyl esters is of particular concern.

In each population age group, there are some people with higher than average exposure levels (i.e. those eating larger quantities of foods containing glycidyl esters than the average population). EFSA has concluded that glycidyl esters pose a potential health concern for consumers with high levels of exposure regardless of their age group.

Are there any limits for glycidyl esters in food?

To date, no maximum levels have been set by European authorities for glycidyl esters in foods. However, over the past five years there has been an important decrease in levels of glycidyl esters in palm oils and fats due to voluntary steps taken by producers of these products.

Why are the highest levels of contaminants found in palm oil?

The highest levels of 2- and 3-MCPD esters and glycidyl esters have been found in palm oil/fat. As explained above glycidyl esters are formed from diglycerides when heating vegetable oils to temperatures in excess of 200°C, for example during the deodorisation stages of refining. Palm oil is naturally rich in diglycerides which make up between 4 to 12% of its composition.

Following voluntary steps taken by food producers to lower consumer exposure, the levels of glycidyl esters in palm oil have been halved between 2010 and 2015.

What are the next steps?

EFSA's assessments of consumer exposure and risks associated with process contaminants is a continuous process. As new research emerges and consumption patterns change the body of available evidence is re-assessed and measures are then taken by the European Commission or other stakeholders (for example industry) to ensure the safety of the population. The outcomes of EFSA's risk assessment will be used by the European Commission to implement measures to reduce or eliminate the potential health concerns related to process contaminants. This will include for example setting up maximum limit values for the presence of these contaminants in concerned products.

Much research is also on-going to better understand the mechanisms of formation of 2 and 3-MCPD esters and glycidyl esters during processing of vegetable fats and oils. This type of information is important for the

oil industry to continue to develop and implement the strategies needed to reduce the level of the esters in oils and fats intended for food manufacturing. While food producers, especially oils and fats manufacturers, will continue their efforts to reduce the presence of these substances, developing processes to achieve this takes time. A number of different techniques may need to be combined as the refining steps that introduce process contaminants remain necessary for removing undesirable impurities that can affect the quality and safety of vegetable oils and fats and lead to unpleasant tastes.

There has been a significant improvement in analytical techniques for detecting 3-MCPD and glycidyl esters since safety concerns were first raised about these compounds. Reliable testing methods allow for the detection of low levels of 2 and 3-MCPD and glycidyl esters in oils and fats which allows for better monitoring of the impact of technologies that aim at reducing the levels of 3-MCPD and glycidyl esters

For more information

1. European Food Information Council. Information on palm oil: </page/en/page/FAQ/faqid/question-answer-palm-oil/>
2. European Food Safety Authority (EFSA). [3-Monochloropropane-1,2 Diol Esters \(3- MCPD\)](#).
3. German Federal Institute for Risk Assessment (BfR) . [Frequently Asked Questions about 3-monochloropropane-1,2-diol \(3-MCPD\)](#).
4. Institute of Food Science & Technology. [Information Statement. 3-MCPD and glycidyl esters](#)
5. International Life Sciences Institute (ILSI). [3-MCPD Esters in Food Products](#). Summary Report of a Workshop held in February 2009, Brussels.
6. European Food Safety Authority (2016) [Risks for human health related to the presence of 3- and 2-monochloropropanediol \(MCPD\), and their fatty acid esters, and glycidyl fatty acid esters in food.](#)