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FEDIOL code of practice for the management of mineral oil hydrocarbons presence in vegetable oils and fats intended for food uses

The Code of Practice (CoP) developed by FEDIOL, in cooperation with its members, is a non-binding recommendation developed for the use of members and non-members. This CoP is based on the current status of knowledge at the moment of publication and is reviewed on a regularly basis.

This CoP is applicable to all vegetable oils and fats intended to be used (as such or after processing) for food uses.

For several years, FEDIOL has proactively set up monitoring measures to address mineral oil hydrocarbons (MOH) contamination in the supply chain of vegetable oils and fats. FEDIOL has also worked on best practices for its sector to manage both identified and possible sources of MOH. These best practices are presented in this CoP.

1. Introduction

1.1 Definition

MOH comprise a diverse group of complex mixtures of hydrocarbons derived **from crude mineral oil**, containing a huge number of chemical compounds which are varying in size (carbon number) and structure.

At the moment, MOH are defined from an **analytical standpoint** and are divided into two main types, depending on the analytical fraction in which they are recovered when using GC-FID¹ methods:

- Mineral oil saturated hydrocarbons or MOSH: correspond to straight and branched open-chain alkanes (paraffins) and largely alkylated cyclo-alkanes (naphthenes).
- Mineral oil aromatic hydrocarbons or MOAH: correspond mainly to alkylated (and in smaller amounts non-alkylated) polyaromatic hydrocarbons.

As per their definition, MOH exclude:

- Hydrocarbons naturally occurring in food: such as n-alkanes of odd numbered carbons (from C21 to C35) or natural olefins of terpenic origin (such as squalene, sterene or carotenoids).
- Hydrocarbons from synthetic origin: such as POSH (polyolefin oligomeric saturated hydrocarbons) or PAO (poly alpha olefins). POSH are oligomeric substances, potentially migrating from plastic packagings (e.g. polyethylene or polypropylene packagings). PAO are synthetic isoparaffins with short and long side chains used e.g. in synthetic lubricants and adhesives.

1.2 Risks associated with MOH

In 2012, the European Food Safety Authority (EFSA) published an opinion related to MOH in food².

- In its opinion, EFSA found that MOH was present at different levels in nearly all foods.
- For MOSH, EFSA estimated that there was potential concern associated to the background exposure to MOSH and with the use of white mineral oils as release agents in bread and for spraying of grains.
- EFSA also considered the exposure to MOAH through food to be of potential concern because of its specific health risk.

Toxicological data on the relevant fractions of MOSH and MOAH which are found in food are today still missing. The outcome of recent toxicological studies is also currently being discussed in the scientific community.

Lastly, it should be kept in mind that MOSH and MOAH are analytical concepts: because of the chemical and toxicological complexity of the mineral oil hydrocarbons encompassed under these 2 fractions, many uncertainties remain as to the risk for health associated with a certain level of MOSH or MOAH.

¹ GC-FID: gas chromatography equipped with a flame ionization detector.

² EFSA Panel on Contaminants in the Food Chain (CONTAM); Scientific Opinion on Mineral Oil Hydrocarbons in Food. EFSA Journal 2012;10(6):2704. [185 pp.] doi:10.2903/j.efsa.2012.2704. Available online: www.efsa.europa.eu/efsajournal

1.3 Scope of this CoP

There is today no EU legislation regulating the limits of MOH in vegetable oils and fats. Some discussions around possible MOH legislation (to restrict migration of MOH to food packed with recycled paper and board) are ongoing at national level.

FEDIOL is committed overall to ensuring the safety and quality of vegetable oils and fats placed on the market in the EU. FEDIOL has therefore engaged proactively in the MOH issue in order to better understand it and to reduce the occurrence of MOH in marketed vegetable oil and fat products, and in particular reduction of MOAH (given their suspected toxicological profile).

The following CoP is setting best practices:

- To prevent MOH contamination in vegetable oils and fats.
- To manage and mitigate identified sources of MOH.

2. Possible sources of MOH contamination in the vegetable oil and fat production

MOH may be introduced at different stages of the vegetable oil and fat production:

- Agricultural stage: leaks of diesel or lubricant from the agricultural vehicles, use of pesticides, contamination from the environment (exhaust gasses from vehicles,...).
- Storage of the seeds/beans: use of anti-dusting agent in the grain handling facilities/silos, leaks of diesel or lubricant (during handling of the seeds/beans), contamination from environment (drying of the beans/seeds with wood or diesel fire combustion gases, ...), migration (in case of packaging of the seeds/beans).
- Transport of the seeds/beans: use of anti-dusting agent (during oversea shipping), contamination from the environment (debris from tires and road tar,...), leaks of diesel or lubricant from the transport vehicles.
- Processing: leakage from the mineral oil absorber system (during crushing), contamination by lubricant (during crushing, refining or during maintenance procedures in the processing plant).
- Transport of the oil: contamination by a previous cargo, leaks from equipment (e.g. pumps).
- Packing: packaging materials can be a source of contamination. Lubricants used during the manufacture of food cans (in which vegetable oils can be packed) or recycled cardboards and paperboards (that can be used as secondary or tertiary packaging) are relevant for FEDIOL sector.
- Economic adulteration³

3. FEDIOL action plan

3.1. Prevention of MOH contamination in vegetable oil and fat crushing and refining plants

In FEDIOL members' HACCP⁴ systems, each point where MOH contamination may occur during crushing, processing and refining operation has been identified and procedures have been put in place so that the associated risk is kept under control.

³ In 2008, sunflower oil contaminated with mineral oil hydrocarbons (MOH) from unknown origin was exported from Ukraine to the EU (RASFF notification on 23 April 2008).

⁴ Hazard Analysis Critical Control Points

From the risk assessments conducted under their HACCP systems, FEDIOL member experts have particularly identified **lubricants** and **special fluids** (absorption oils, thermal heating fluids...) as possible contributors to the MOH contamination. A special attention is therefore paid to these products, especially from a MOAH perspective.

- Critical lubrication/fluid points⁵ in the plants are identified and clear procedures for the correct management of the lubrication/fluid systems are in place to prevent/minimize leakages/contact.
- In all critical lubrication points, only food grade lubricants are used (i.e. lubricants suitable for incidental contact with food⁶ or lubricants for direct food contact⁷).
Remark: equipment in the production chain requires proper lubrication to operate at optimum performance and reliability. In specific cases where no food grade lubricant with high quality could meet the particular lubrication requirements of an equipment, a technical solution should be found to avoid leakage/contact.
- For the absorption oil used in the hexane recovery system, control measures are implemented so as to minimize transfer in the crude vegetable oils.
- Fluids used in indirect heating systems have a potential to incidentally contaminate vegetable oils, reason why it is required to use steam in processing installations⁸.

3.2. Control of possible sources of MOH contamination in the vegetable oil and fat supply chain

Through detailed risk assessment along the main vegetable oil and fat supply chains, particular **points of attention** have been identified by FEDIOL members so that appropriate controls (and measures) can be implemented. In the context of such controls, sampling is handled in accordance with ISO 5555:2001⁹. Further investigation to determine the possible source(s) of contamination is carried out, when appropriate.

From a global supply chain perspective, FEDIOL members have notably introduced the following:

- The FEDIOL CoP for the **transport in bulk** of oils (14COD152) into or within the EU stipulates that:
 - For transport in bulk by road or rail tanks, tank containers, by barge and in drums, thermal heating fluids shall not be used in direct heating systems.
 - For transport in bulk by sea in ocean carriers, transshipment vessels and short sea voyage vessels, the ships should comply with the latest version of the "FOSFA qualifications and operational procedures for ships engaged in the carriage of Oils and Fats in bulk for edible and oleo-chemical use" in force at the date of the bill of lading. This means that thermal heating fluids shall not be used in direct heating systems.

⁵ A critical lubrication/fluid point is a lubrication point where there is some possibility of incidental or direct contact of the lubricant/fluid with vegetable oils or with the raw materials they are derived of.

⁶ H1 lubricants are considered safe in case of incidental contact with food. They may only be composed of one or more approved basestocks, additives and thickeners listed in the Food and Drug Administration (FDA) guidelines set for in the paragraph 178.3570 of the 21 Code of Federal Regulation (21 CFR 178.3570). H1 lubricants may be registered by the lubricant manufacturers through either the National Sanitation Foundation (NSF) in the US or through InS Services (InS) in Europe.

⁷ 3H lubricants are considered safe in case of direct contact with food. They may only contain edible oils that satisfy FDA 21 CFR 172.860 (such as corn, soybean or cottonseed oils), certain mineral oils that meet FDA 21 CFR 172.878, and oils generally recognized as safe (GRAS) under either FDA 21 CFR 182 or FDA 21 CFR 184.

⁸ FEDIOL Code of Practice on the Heating of Edible Oils during Processing

⁹ ISO 5555:2001 Animal and vegetable fats and oils -- Sampling

- White mineral oils¹⁰ are today included in the **EU list of acceptable previous cargoes** for seagoing transportation of liquid oils and fats. In its 2012 opinion¹¹, EFSA concluded that white mineral oils were meeting the criteria for acceptability as previous cargoes since exposure to MOH *via* contamination of edible oils and fats from previous cargoes occurred only rarely and at very low levels.
- As a proactive measure, FEDIOL decided in 2017 to remove “paraffin wax” and “white mineral oil” from the **FEDIOL acceptable list of foodstuffs** (07COD140) (which serves as indication of previous loads in the case of truck transport of edible oils).
- FEDIOL members contact their **packaging material suppliers** for information about possible MOH migration from the packaging materials they use. If needed, migration tests are carried out. For food cans that can be used to pack vegetable oils, food grade lubricants (and if possible vegetable oils) are used.
- The spraying of white mineral oil as anti-dusting agent on soy beans has become a common practice in most exporting countries. In the US, grain elevators are obliged by OSHA regulation (29 CFR 1910.272) to control dust accumulation. Moreover, larger facilities are bound to reduce to 0% dust emission according technology-based pollution control standards promulgated by the Environmental Protection Agency (EPA). In several States, local legislation adds to EPA requirement regarding dust emission. Spraying of white mineral oil is one of the technologies to meet these requirements. This common practice is permitted by the US Food and Drug Administration (21CFR172.878, since 1983)¹². For those soybeans coming from origins where spraying is a common practice, FEDIOL recommends its members to monitor MOSH and MOAH levels in products derived from these soybeans.

3.3 Analytics

Natural hydrocarbons, that may be present in large quantities in some vegetable oils, may interfere in the GC- FID analysis of MOSH and especially MOAH. In order to limit such interference, careful cleaning/purification of the vegetable oil samples is needed.

- For MOSH: additional clean-up (with activated silica or aluminium oxide for example) is performed systematically for some types of vegetable oils when low level of quantification are targeted (<10 mg/kg).
- For MOAH: epoxidation is carried out systematically for all types of vegetable oils.

Due to their structural resemblance, POSH and PAO cannot be separated from the MOSH fraction.

3.3. Monitoring scientific developments and next steps

FEDIOL is continuously monitoring scientific developments including latest research on toxicology, analytical methods and mitigation in order to have a better understanding of this issue and to increase the knowledge of its members.

Toxicology

It should be noted that there is today still limited (or debated) toxicological information on the relevant classes of MOSH and MOAH that may be found in food.

¹⁰ White mineral oils are highly refined petroleum products in which aromatic hydrocarbons (which are analysed under the MOAH fraction) have been reduced to extremely low levels.

¹¹ EFSA Panel on Contaminants in the Food Chain (CONTAM). Scientific Opinion on the evaluation of the substances currently on the list in the annex to Commission Directive 96/3/EC as acceptable previous cargoes for edible fats and oils – Part III of III. EFSA Journal 2012; 10(12):2984. [82 pp.] doi:10.2903/j.efsa.2012.2984.

¹² Food and Drug Administration (FDA) Regulation 21 CFR Sec.172.878 (revised as of April 1, 2013) allows the use of white mineral oil as a dust control agent for grains with a limit of 0.02 percent by weight of grain.

Analytics and relevance to food safety

It is also not possible today to characterize the risk for health associated with a certain level of MOSH and MOAH.

Mitigation

To better mitigate the risk of MOH contamination in vegetable oils and fats, FEDIOL has worked to identify more precisely the possible entry sources of MOH across the vegetable oil and fat supply chains. Presence of MOH should be avoided from the beginning of the food chain. This can require cooperation with a wide range of stakeholders, including those producing raw materials as well as manufacturers of mineral oil based products. FEDIOL members also work on the MOSH and MOAH removal capability of refining and share relevant information via FEDIOL.