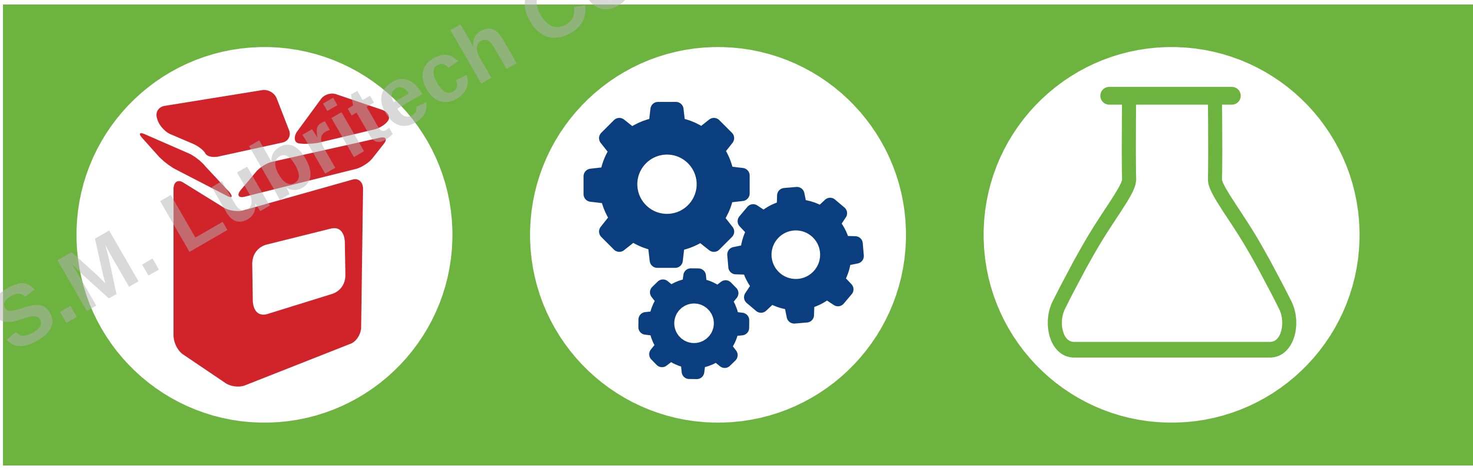
Toolbox for Preventing the Transfer of Undesired Mineral Oil Hydrocarbons into Food



Spitzenverband der
Lebensmittelwirtschaft

BLL

German Federation of Food Law and Food Science

CONTENT

PREFACE

Almost all sectors of the food industry including laboratories and supplying companies have been concerned with the presence of mineral hydrocarbons (= mineral oil hydrocarbons) for a number of years. The abbreviation "MOSH/MOAH" has been established as the (generic) term for all substances derived from mineral oil including chemical analogues from non-mineral oil sources. Today, the complexity of the issue is well known and consideration of this topic has been expanded beyond "recycling fibre" as the source of contamination; it now includes all possible routes of entry along the entire value chain for food and food packagings.

The industry is striving to contribute in a feasible way to reducing the transfer and the occurrence of undesired mineral oil hydrocarbons in food. Many measures that have already been applied show objectively measurable success, as can be seen, for example from several product tests and examinations.

Prerequisites for an effective prevention are process analyses, the scale-up of findings and their strict application to industrial level.

In general, the concept of a "Toolbox" has been proven well for offering summarising background information and practical support in decision-making. The *"Toolbox for preventing the transfer of undesired mineral oil hydrocarbons into food"* presented here by BLL provides an overview on the currently known and potential routes of entry of mineral oil hydrocarbons in a tabular format (as per 2017). Based on this information, every company can individually review their own processes and derive at product-related measures for the reduction of migration.

It is the intention of the "BLL Toolbox" to control the introduction of preventable contamination with mineral oil as much as possible and to identify approaches that aim at reducing the amount of contaminants. This procedure focuses on controllable sources along the entire value chain. Contaminations that are beyond any control, for example because of ubiquitous environmental pollution and indispensable substances will be discussed. However, prevention or reduction does not mean that there are target values provided for analytical measurements across the board or that there is any "zero tolerance" for mineral oil hydrocarbons in general in place. Rather, the point it to enable (food) companies to review appropriate and feasible problem solution approaches while exercising their due diligence. This concept aims at shared responsibilities for all levels of the entire value chain. It complies with the "ALARA principle " ("as low as reasonably achievable") according to which measures shall be reasonable and affordable.

The BLL Toolbox is explicitly open to the industry and accessible for all interested stakeholders.

With this documentation, the BLL as the editor will also contribute to increased objectivity in problem solution and to strengthening the discourse within the supply chains, with politics and official authorities as well as with the public. The BLL Toolbox shall be understood as a dynamic document that shall be further developed based on a growing body of findings.

The BLL is grateful to the Association of the German Confectionery Industry (BDSI) and the Food Chemical Institute (LCI) for providing the BDSI Toolbox as a template. The BLL also wishes to thank the group of experts amongst its members for their active support.

Berlin, December 2017

INTRODUCTION

The results from the study on the „Scope of migration of undesirable substances from packaging materials made from waste paper into food" (project to support decision making, Federal Ministry of Food, Agriculture and Consumer Protection, from 2010 to 2012, publication in 2013) revealed the possible pollution of packagings made from recycled fibres and the migration of mineral oil hydrocarbons, in particular. According to this study, which was performed on dry food in folding boxes made with recycled fibres, there is a high number of potentially migrating substances that may be introduced from the waste paper into the packaging material, which renders it impossible to perform a risk assessment of the individual substances. Therefore, "functional barriers" have clearly been recommended as protection of foods in such packagings [1].

Based on the comprehensive dealing of the entire industry including suppliers of paper packaging materials, plastics, printing inks and inspection facilities with the "mineral oil issue", there are more findings available today on possible routes of entry and sources of contamination, on avoidable and unavoidable ubiquitous loads and on analytical problems.

Preventive approaches in practice and individual company measures may be varied and may concern almost all stages of the different processing chains. Food and packaging materials are complex products. This is because, in general, there is no such thing as a single potential source of introduction in the production process and several sources and routes may play a role. Apart from recycled fibres contaminated with mineral oil residues from printing inks used in paper and cardboard packaging materials, there are also sources of contamination that stem from the use of certain substances.

Moreover, all refined mineral oil products including paraffin, microcrystalline wax and plastics are composed of hydrocarbons of mineral origin and thus belong to the group of MOSH when considered merely from the material point of view. For the purpose of differentiation, the material groups that are directly derived from fossil mineral oil are subsumed in the Toolbox under the term "MOSH analogues".

However, based on the impossibility of analytical separation, e.g. the targeted use of food additives based on mineral oil or technical processing aids, may lead to possible misinterpretation of analysis results. Often "humps" will be interpreted as MOSH in food and exclusively considered as introduced "mineral oil contamination". Without specifically scrutinising potential MOSH analogues under consideration of product and process, this may lead to unjustified and wrong conclusions.

Relevant Definitons

The following terms are used for mineral oil hydrocarbons (**MOH** = Mineral Oil Hydrocarbon):

- **MOSH** = Mineral Oil Saturated Hydrocarbons: paraffin-like, open-chained, commonly branched hydrocarbons (e.g. alkanes) and naphthene-like cyclic hydrocarbons (cycloalkanes) [2,3]
- **MOAH** = Mineral Oil Aromatic Hydrocarbons: hydrocarbons mainly consisting of highly alkylated mono- and/or poly-aromatic rings [2,3]

A large variety of possible compounds may be summarised under these terms that can be detected as complex mixtures of saturated (aliphatic) or aromatic hydrocarbons in food.

The following groups of materials play a role as so-called **MOSH analogues**:

- **MORE** = Mineral Oil Refined Products: certain MOSH that may be introduced into food through the use of additives and processing aids that are approved refined mineral oil products, such as paraffin-like waxes
- **PAO** = Polyalphaolefins: components in synthetic lubricants and hot melt adhesives that may migrate into food, can hardly be differentiated analytically from MOSH

- **POSH** = Polymer Oligomeric Saturated Hydrocarbons: oligomers of the plastics polyethylene or polypropylene, which are chemically similar to MOSH and cannot be separated analytically

MOSH analogues result in elevated analytical MOSH values and thus in a shift in the MOSH:MOAH ratio (approx. 4:1) which is common in mineral oil and which may be considered to indicate the migration of mineral oil from recycled fibres. A deviating ratio is considered to indicate a "feigned" MOSH level and the presence of MOSH analogues. However, it is not possible to distinguish analytically between MOSH, POSH, PAO and MORE with the established methods.

Occurence and routes of entry of MOSH/MOAH and MOSH Analogues into food

- **Inadvertent and unintentional presence**

such as

- packaging materials and transport materials for raw materials, intermediate products and final products, in particular through the use of waste paper based on mineral-oil containing printing inks in printed materials such as newspapers
- improper use of machine oils or lubricants or oil-containing compressed air throughout the entire raw materials and processing chain
- upstream treatment of packaging materials, process and transport materials with mineral oil products (e.g. mould oils or batching oils)

- **Targeted and necessary application of substances**

such as

- "food-grade" lubricants and technical lubricants
- oils for moulds and rollers, anti-friction agents for food contact materials
- white oils as food additives and processing aids
- waxes and paraffins as food additives, such as anti-caking or release agents, coating agents, brighteners
- waxes and paraffins as technical processing aids such as anti-foaming agents, anti-caking or release agents
- food contact materials made from plastics such as plastics packagings or processing materials
- adhesives, "hot melts", sealing agents
- components from animal drugs
- additives (carrier substances), adhesives or active agents in pesticides such as paraffin oil
- anti-freezing agents

Substances from these applications will be analytically detectable within the scope of food or packaging tests because their structure is similar to MOSH and they cannot be analytically separated with the currently commonly applied measuring methods. Therefore, they will be discussed within the scope of this Toolbox concept in general because the knowledge about their relevance and routes of entry is important. Often it is inevitable to use these substances for process or food technology reasons, thus making it impossible to prevent a respective transfer or migration. However, such substances should only be used in technically required amounts ("as little as possible, as much as necessary" or quantum satis).

However, process analyses shall deal with all imaginable disasters and possible accident situations or abusive improper use at the different stages.

- **Native occurrence and biogenic substances**

such as

  - natural waxes in vegetable food including fruits and vegetables
  - biogenic waxes, terpenes, n-alkanes, olefins e.g. from vegetable raw materials, which may be a concomitant substance in vegetable oils in flavours or in pectin (from apple or citrus pomace)

Hydrocarbons innate to natural raw materials may also be analytically relevant "MOSH analogues". Thus their presence in certain vegetable-based foods (tea, herbal infusions, herbs, spices) is inevitable, even if no mineral oil based processing aids or additives are used.

Furthermore, natural hydrocarbons such as olefins, terpenes and carotenoids may increase the analytically detected MOAH value.

- **Ubiquitous loads and environmental impacts**

such as

  - emissions
  - oil vapours
  - combustion gases
  - particulate airborne matter
  - soot

Mineral oil hydrocarbons that are ubiquitously present in the environment may migrate into food raw materials e.g. through agricultural measures, transport and handling, storage or processing; this is inevitable.

Routes of entry into foods

From the described sources, MOSH, MOSH analogues and MOAH can migrate along the entire process chain into foods using different routes.

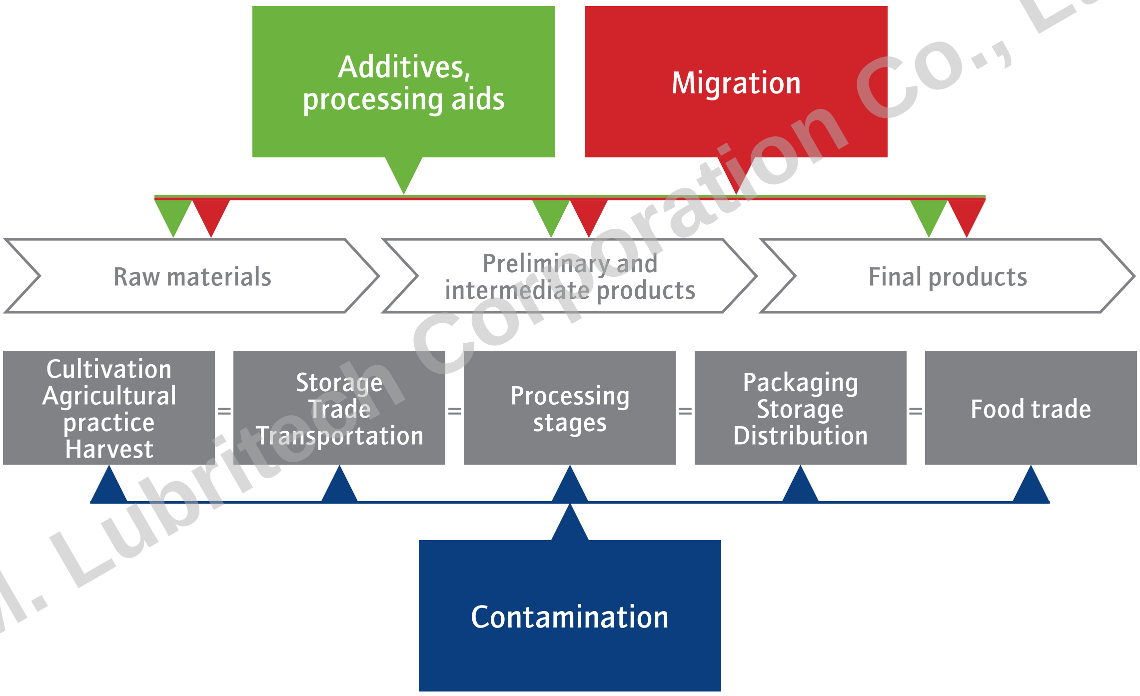


Figure 1: Systematic illustration of the routes of entry of MOSH/MOSH analogues and MOAH into food (according to [4])

Mögliche und relevante Eintragswege sind:

Transfer through **migration** from packaging materials that contain recycled fibre and/or from packagings with mineral oil containing printing inks into products packed in these materials. The transfer does not necessarily require direct contact between food and the material that contains the migrating mineral oil hydrocarbons such as the recycling material; it can also be gasborne, which makes cause studies and preventive approaches very complex. It was possible to minimise, to a large extent, the contamination caused by printed food packagings by changing to non-mineral oil or low mineral oil inks [5, 6]. Potentially, the introduction through migration from upstream packagings of food raw materials and semi-finished products is possible during transport and storage. The migration into food is temperature-dependent and occurs in general via evaporation, transportation in the gas phase and recondensation in the food. At ambient temperatures, it is the mineral oil hydrocarbons with a chain length of up to C_{25} that migrate; at elevated temperatures, hydrocarbons with longer chains may migrate as well. The migration of MOH above C_{25} requires direct contact [1].

Unintentional **contaminations**, which are possible at all levels of the entire processing chain. This may for one thing be due to the general environment and therefore inevitable contamination of food raw materials with mineral oil hydrocarbons, for example from combustion processes (amongst others, exhaust gases from combustion engines, emissions from the energy supply and industrial plants, wildfires etc.) and through particulate matter from paved roads. Alternatively, it is possible that oiled machine parts are the source of contamination when they come into contact with the raw materials or foods during harvesting or production.

Moreover, the use of **certain approved food additives and processing aids**, which are applied in many food processing areas and stages, may be the sources for the transfer of mineral oil compounds into food. These are always reliable and often technologically inevitable applications. In these cases, often MOSH analogues are transferred or the introduction is limited to the MOSH fraction because the substances are usually purified products such as approved paraffin-like waxes that were derived from refined mineral oils or white oils [9].

General information on analysis and issues of MOSH Analogues

The determination of mineral hydrocarbons in food is a highly challenging analytical task because they are present as a complex mixture that needs to be quantified as a sum of all components. Due to the extremely high number of individual chemical compounds, it is not possible to analyse individual components.

This is the reason why an analysis of complex mineral oil mixtures by gas chromatography does not deliver distinct peaks rather than broad signals. Such phenomena are referred to as chromatographic "humps" or "unresolved complex mixtures" (UCM) by analytical chemists.

The Scientific Opinion on Mineral Oil Hydrocarbons in Food published by EFSA [2] recommends that for quantification, a system consisting of liquid chromatography (LC) online coupled to gas chromatography with flame ionisation detection (online LC-GC-FID) is applied.

In July 2017, for the first time a standardised European method for the quantification of MOSH/MOAH in certain foods was published:

> *DIN EN 16955: 2017-08 "Foodstuffs – Vegetable oils and foodstuffs on the basis of vegetable oils – Determination of mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH) with online HPLC-GC-FID analysis".*

This European standard is very important in order to be able to compare the levels determined in different laboratories. The reference method has been confirmed in ring tests; it is suitable for MOSH and MOAH concentrations of up to 10 mg/kg each in food based on vegetable fats. According to the standard's recommendation, the fossil origin of the MOSH and MOAH fractions shall be verified by mass spectrometry (GC-MS) [10].

The performance achieved in MOAH/MOAH analysis via LC-GC-FID is dependent on the matrix of the food sample and here in particular on the fat content. Detection limits and the uncertainty of measurement increase with the fat level in the sample matrix.

Currently the sample preparation methods in the labs are usually performed based on the joint mineral oil analysis compendium of the Federal Institute for Risk Assessment (BfR) and the Cantonal Laboratory of Zurich (KLZH): "Determination of mineral oil hydrocarbons in food and packaging material" [11].

The MOSH : MOAH ratio

It is known that the targeted use of processing aids and approved food additives in the form of refined mineral oil products (MORE) such as paraffin-like waxes increases the MOSH level and results in a shift of the MOSH:MOAH ratio characteristic for mineral oils. Since it is not possible to distinguish MOSH, POSH, PAO and MORE analytically in online coupled LC-GC-FID, a mass spectrometric method such as the two-dimensional gas chromatography mass spectrometry (GCxGC-TOF-MS) may be helpful for further characterisation of the substance classes present. The European standard DIN EN 16955 as well as some newer publications refer to this method [12, 13].

There is no possibility of differentiating directly between the introduced MOSH, MOSH analogues (from mineral oil products such as paraffin) or POSH from plastics or adhesive applications or partially detected native saturated hydrocarbons with the currently commonly applied LC-GC-FID analysis method.

Other MOSH-like structures, so called Polyolefin Oligomeric Saturated Hydrocarbons (POSH) from polyethylene (PE) or polypropylene (PP) films or polyalphaolefins (PAO), which are components in synthetic lubricants and hot melt adhesives, further complicate the analysis. The respective substances may migrate into food; they are difficult to distinguish analytically from MOSH introduced from mineral oil [14].

Fossil mineral oil typically has a MOSH:MOAH ratio of 4:1; technical mineral oil products such as lubricants or printing ink oils still show this characteristic MOSH:MOAH ratio (15-35% MOAH in the MOH concentration) [2]. This is why such a finding can be taken as an indicator for a direct transfer of mineral oil and for recycled fibres with printing ink oils as sources. In purified, refined mineral oils (white oils), the percentage of MOAH is lower. Therefore, contaminations stemming from the use of products that are based on such refined mineral oil products, such as paraffin-like waxes, will increase the percentage of saturated hydrocarbons as MORE. Because these contaminations - with exemptions - are free from MOAH, the MOSH:MOAH ratio will shift due to the method-related inclusion of MOAH analogues [14] **(see figure 2)**.

For a careful clarification and interpretation of MOSH values detected in food with common analysis methods (LC-GC-FID), differentiating questions and information must be evaluated, including:

- Does the MOSH:MOAH ratio indicate the presence of fossil MOSH from crude oil?
- Do other substances such as diisopropylnapthalene (diPN) indicate a migration from recycled fibres?
- Are there indicators for plastic-specific oligomers (POSH)?
- Which packaging materials, processing aids and additives are known to have been used along all different process stages?

In the case that information indicates sources other than recycled fibres or MOSH/MOAH of fossil origin, further verification is recommended. However, this does not guarantee a definite allocation of the actual source of contamination.

The commonly used unspecific summarising statement "MOSH/POSH" per kilogram of food for MOSH findings and presumed MOSH analogues may be taken as a general indicator for several sources but will still require plausible clarification. If for example the MOSH:MOAH ratio or other product information gives rise to suspect that possible sources other than mineral oil from recycled fibres may play a role here, a confirmatory analysis with mass spectrometric methods such as GCxGC-TOF-MS is required; however these are not suitable for routine analyses. The comparison of so called "fingerprints", e.g. of mineral oil based lubricants could in individual cases lead to their identification as sources.

Even if it is not possible to clearly identify the source, misinterpretations based on "false-positive results" and the resulting consequences within the supply chain will be avoided.

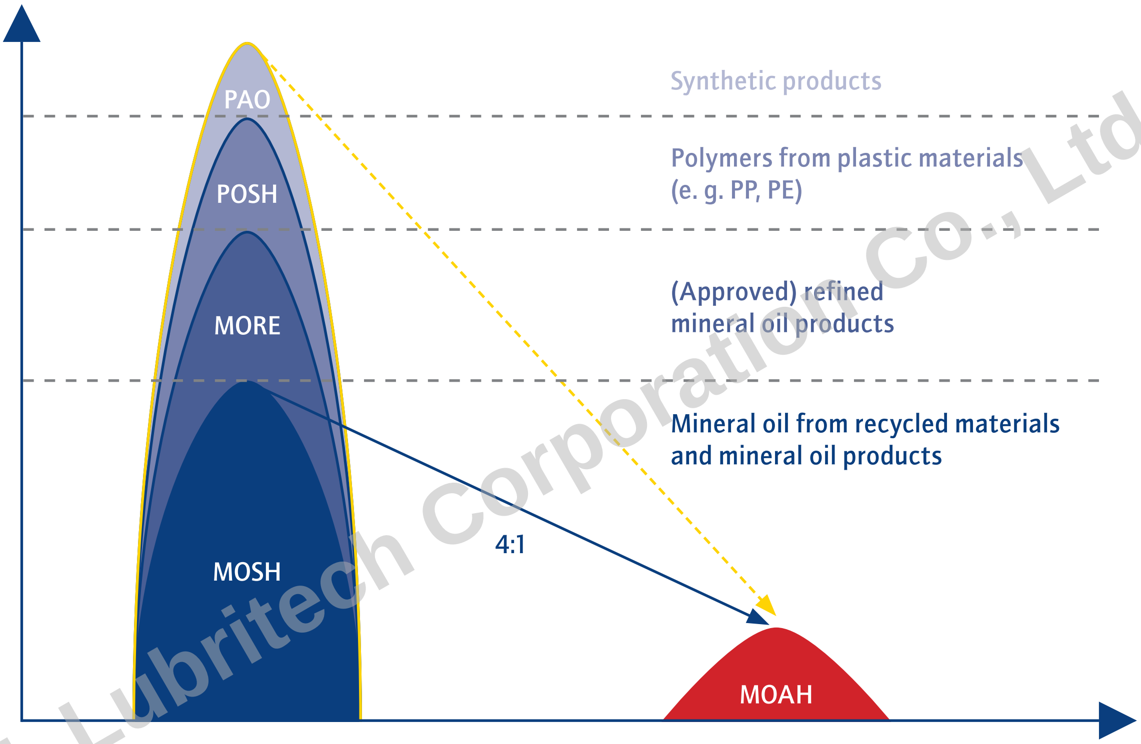


Figure 2: Shifting of the MOSH:MOAH ratio commonly found in mineral oil by MORE, POSH and PAO as MOSH analogues [according to 14 and 15] (abbreviations see definitions and text)

Other interferences in the LC-GC-FID chromatogram may be caused by natural hydrocarbons, which co-elute in the MOAH fraction in the hump. For example, olefins, terpenes and carotenoids that are present in the food by nature may by detected analytically together with the MOAH fraction and thus increase the MOAH concentration. According to the latest findings, extractable substances from wood such as abietic acid derivatives as well as resin compounds that are naturally present in papers or are used as binding agents in printing inks will also play a role. It is not clear whether these can be excluded by epoxidation.

Employing an epoxidation (e.g. with meta chloroperbenzoic acid, m-CPBA) for purification allows the separation of these biogenic hydrocarbons analytically from the MOAH compounds. It should be noted that with this purification step, aromatic components might also be removed, depending on the amount of epoxidation reagent, thus resulting in possible false low readings for MOAH after epoxidation.

Health evaluation, limits, reference values

In its Opinion of 2012, the EFSA estimates the exposure of humans to mineral oil hydrocarbons from various sources to be between 0.03 and 0.3 mg MOH/kg body weight with a higher exposure in children. It is assumed that approximately 20% of this exposure is MOAH [2]. Saturated hydrocarbons may accumulate on human fatty tissues. MOSH up to C_{45} was detected and quantified in rats' organs (liver, spleen). MOSH with a carbon chain below C_{16} does not accumulate in the human body [2, 16].

Thus the Federal Institute for Risk Assessment (BfR) has defined a value of 12 mg/kg food for MOSH with a carbon chain length of C_{10} to C_{16} as a reference value for a tolerable migration from papers, cartons or cardboards made with recycled fibres. For a chain length of >C_{16} to C_{20}, a tolerable migration level of 4 mg/kg food was established [17, 18].

Due to missing toxicological data, no tolerable migration has thus far been defined for the other fractions. Since 2014, studies with newer data have been performed on the accumulation of MOSH with different molecular weights within the scope of an EFSA project aimed at further assessment of the toxicity of MOSH. The EFSA has not yet published a new Opinion (as of December 2017) [19].

Because the MOAH fraction mainly consists of highly alkylated aromatic hydrocarbons, which may also include some potentially carcinogenic compounds, no tolerable intake levels for MOAH have been defined.

Legislation and recommendations

There is no binding regulation containing legal limits in place.

For findings in food or packaging materials, the general food legislation (according to EU Basic Regulation 178/2004 and framework regulation (EC) no 1935/2004 on food contact materials) is used as a basis for evaluation in principle.

For the evaluation of paper packaging materials, the following recommendations may be used:

Since paraffin-like hydrocarbon solvents are used as a formulation aid in paper production, the XXXVI. BfR Recommendations on papers, cartons and cardboards as food contact materials specify the migration level of hydrocarbons (up to C_{20}) corresponding to the toxicologically deduced limits (see above) [17] as follows:

- 12 mg/kg food for $C_{10} – C_{16}$
- 4 mg/kg food for $C_{17} – C_{20}$

According to the last (4th) draft of a so-called German "Mineral Oil Regulation" (22th Ordinance amending the Consumer Goods Ordinance) of the Federal Ministry of Nutrition and Agriculture (BMEL) of March 2017 [20], no migration of MOAH into food shall be permitted from food contact materials that are produced with the use of recycling materials. The migration of <0.5 mg MOAH/kg food or food simulant is considered to be "not detectable". In order to achieve this, it is intended that a legal ban is imposed on the production and marketing of respective MOAH-contaminated packaging materials made from recycled paper to be used as a food contact material without a functional barrier. If a migration can be excluded, the regulation will provide for certain exemptions from the obligatory barrier.

In the current 4th draft of the Federal Ministry of Food and Agriculture it is not intended to regulate MOSH in recycled fibre containing packaging material and MOSH migration limits in food; according to the official reasoning in the draft, there is no need for that in terms of consumer health protection. Moreover, because of the issue of MOSH analogues there is no legally compliant measuring method available that specifically detects MOSH only.

The concept from earlier BMEL drafts is no longer the subject of regulation and may at best only be considered for orientation:

- Recycled fibre material for food contact: 24 mg MOSH/kg paper and 6 mg MOAH/kg paper
- Migration limits for food in recycled fibre containing packagings: 2 mg MOSH/kg food and 0.5 mg MOAH/kg food

When using these values for product evaluation or in specifications, it should be noted that they are by definition migration limits, which have been proposed for the material migration of MOSH/MOAH from one single source, which is packaging materials made with recycled fibres. Therefore, these values cannot be translated into generally applicable MOSH and MOAH limits in food; they are too restrictive.

In general, limits in Germany require a not yet performed scientifically verified exposure assessment and the health evaluation of MOSH, which are prepared by the European Monitoring Program (see below).

In Belgium, since November 2017, the recommendations of the Belgian Food Safety Authority FAVV have applied as assessment criteria for MOSH levels in food. The FAVV has derived "action limits" for MOSH (C_{16}-C_{35}) from the ADI values of EFSA and described for several food groups [21; translation by BLL]:

- 5 mg MOSH/kg milk and milk products
- 15 mg MOSH/kg food for cereals
- 20 mg MOSH/kg food for vegetable products, snacks and desserts
- 30 mg MOSH/kg for products of animal origin, sugar and confectionery
- 60 mg MOSH/kg food for fish and fish products
- 70 mg MOSH/kg food for spices and herbs
- 100 mg MOSH/kg food for animal and vegetable oils
- 150 mg MOSH/kg food for vegetables, tree nuts and oil seeds as well as for egg products

European Monitoring

In view of EU Monitoring according to Commission Recommendation (EU) 2017/84 [22] introduced by the European Commission in January 2017, this Toolbox can also be viewed as a collection of potential sources of contamination and information about the products and process chain highlighted in the recommendation.

The European Commission has requested that Member States collect, with the active involvement of companies from the supply chains, data on the presence of mineral oil hydrocarbons in certain products. In particular packaging materials are intended to be included as is the identification of possible sources in the case of positive MOSH and MOAH findings. Relevant product groups include fine bakery wares, breakfast cereals, confectionery, chocolate and cocoa, ices and desserts, tree nuts, vegetable oils as well as the paper and paper packagings used for those products.

The monitoring shall create a database for a science-based assessment of exposure and risk evaluation by the EFSA. For concrete implementation of monitoring, the European Joint Research Centre (EU-RL, Ispra) shall develop specific guidelines based on the methodology developed by BfR/KLZH, which have not yet been published (as of December 2017).

Information on the selection and evaluation of barrier materials

When using packaging materials with recycled fibres, the migration of mineral oil components is not only dependent on their level in the packaging materials but also on the type of food and the condition of its storage. For many packaging concepts, the inclusion of an appropriate "functional barrier" is the method of choice. Functional barriers are defined as layers or coatings of the packaging material that ensure that – referred to the respective length of time and application - no undesired substances will migrate. This means that no general statements can be made on the effect of barriers.

Paper liners or liners based on polyolefins will retard the migration but do not stop it completely. They are not considered to be „barriers" for the migration of MOSH and MOAH. Polypropylene (PP) films have a limited barrier effect that depends on the layer thickness as well as on the time and temperature profiles. Aluminium, polyethylene terephthalate (PET) or polyamide (PA) barriers as composite layers are considered to be migration-proof barriers that are able to almost completely prevent the migration of MOSH and MOAH. However, the potential migration of plastic oligomers as POSH has to be taken into consideration.

Other functional barrier materials e.g. for liners (Bag-in-box), besides PA and PET, in general may be ethylene-vinyl alcohol copolymer (EVOH), polyvinylidene chloride (PVDC) or bi-axially oriented polypropylene (BOPP).

For the modification of recycled fibre containing paper and carton materials (such as folding boxes), different barrier materials were developed such as plastic coatings, coatings, adsorbing layers etc.

The possibility of predicting the extent of mineral oil migration is essential for the selection of suitable packaging materials aimed at preventing mineral oil migration. Different concepts and measuring methods are available for functionality tests of barrier layers and adsorbing materials. MOSH and MOAH are mixtures of substances that make the prediction of permeation rather complex. Individual case studies are required [23, 24].

The permeation of a substance through a functional barrier is influenced amongst others by the concentration in the contaminated packaging material or in the gaseous phase, by the thickness and quality of the barrier layer, the packaging design and the temperatures. The diffusion coefficient in the barrier layer is the material constant that is decisive for the evaluation of mineral oil barriers. The characteristics of a functional barrier may be determined with the following methods [25]:

- Migration tests
- Permeation tests with static acceptor
- Permeation tests with dynamic acceptor
- Lag-time tests

Within the scope of a research project conducted by the Fraunhofer Institute for Process Engineering and Packaging (IVV), guidelines are being developed that can be used to assess the migration behaviour and the interaction of the food matrix and the type/design of packaging. Applying mathematical modelling, the predictability shall be made available in a verified way relevant for the practice (Research Association of the German Food Industry, research project “Minimisation of mineral oil migration”, AiF research project no. 19016N, as of November 2017).

THE BLL TOOLBOX CONCEPT

Use and objectives of the Toolbox

The information in this BLL "Toolbox" shall help in the identification of appropriate and constructive approaches for the prevention and reduction of MOSH and MOAH. This applies to the different stages of the sometimes highly complex process and value-added chains in the food industry.

The use of a "tool" is not necessarily aimed at treating or eliminating an identified source in any event. The Toolbox shall contribute to the decision-making process in a company regarding the question as to which approaches shall be focused on in terms of prevention of transfer and risk.

Therefore, the objective is to enable individual companies to control the risk of the actual transfer of mineral oil as much as possible and to identify problem-solution after stage-related analysis. Potential changes to the process and the product must be appropriate, economically reasonable and product-specific. Within the scope of a risk-based procedure, the prevention of migration of MOAH is key.

In terms of MOSH and MOSH analogues, the Toolbox shall support the discussion on the technical prevention limits, in particular of ubiquitous or systemic transfer or migration from indispensable processing aids.

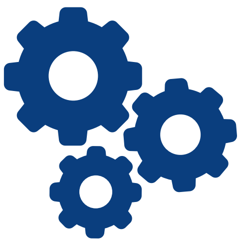
Analysis has the role of supporting and verifying a successful prevention measure. Examinations shall be performed as stage controls and as close to the source as possible. In complex processes, several routes of entry for MOSH and MOSH analogues are possible which in general renders final product control unfit for "monitoring the performance" of a measure aimed as reducing migration or contamination. Moreover, requests for complete "absence of MOSH" as a result of such implemented measures are neither feasible nor the goal of an appropriate prevention strategy based on the ALARA principle.

The collection of information in the "BLL Toolbox" does not claim to be complete and should not be considered to be a "best practice" document. The procedures introduced here are simply examples; they are based on the state of knowledge and current research (as per December 2017).

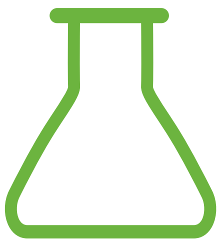
Organisation of the tools and notes

The Toolbox is structured along the potential routes of entry (see also Figure 1):

Migration



Contamination



Additives / processing aids

The following tables with the tools are organised as follows:

Sequential number	To facilitate discussions
Source	Subject matter, substance or material that may result in an introduction of MOSH, MOAH or MOSH analogues
Route of entry/cause	Possible path of transfer/migration of MOSH, MOAH or MOSH analogues or causes
Substances/substance groups	Expected substances or substance groups in relation to the route of entry or cause, defined and differentiated here (see "relevant definitions" and Figure 2) • **MOSH/MOAH** • **PAO, POSH, MORE and other MOSH analogues**
Tool	Proposal of a possible action based on specific reduction or prevention measures for such introductions
Notes and examples	Exemplary information which may facilitate understanding and decision making – no claim for completeness
Reference	Relevant literature is listed under References (see below); oral notes from experts are described as [Expert]

Recommendations in the Toolbox: Specification within the supply chain

Communication along the supply chain may be a decisive factor in the minimisation of risks and prevention of undesired introductions. It has been shown by experience that coordinated specifications are one suitable way of communication within the supply chain, which shall contain product-related requirements agreed with the supplier as well as agreements for the fulfilment and verification of customer requirements. Therefore, the use of "specifications" as a supporting tool will be recommended at different points throughout in the Toolbox.

In this context, the BLL would like to refer to the information leaflet "Specifications in the food packaging chain" (2011): https://www.bll.de/de/lebensmittel/verpackung.

The symbol indicates that respective specifications should be reviewed at this stage.

I. Tools: MIGRATION

Migration predominately takes place via packaging materials made with recycled fibres; these materials are basically used at all stages (production, storage and processing of raw materials, transport, refining and production stages and trade) of the food supply chain. Points of entry may be at all processing stages of a value chain.

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
1	Paper/carton/ board	Primary packaging	MOSH/MOAH	Where necessary, use **fresh fibre products**: Bags, folding boxes and corrugated board made from fresh fibres	Consider recommendations (BfR or CoE) for the production and use of papers, cartons and cardboard coming into contact with food; GMP guidelines of the associations for folding boxes and prints. Not all fresh fibres are free from MOSH/MOAH because introduction through processing aids used in paper production is possible; fresh fibre fraction can absorb MOSH/MOAH during storage; fresh fibre is not a barrier. Specified primary fibre cartons according to DIN, such as GC1, GC2, GN4 and others.	[6a] [6b] [17] [27] [26]
2	Paper/carton/ board	Primary packaging	MOSH/MOAH	Where necessary, use **functional barriers** for final product packagings: coatings, bag-in-box systems or liners (Kraft bags), corrugated boards Applies also to packagings of upstream products	Use barrier materials suitable for raw materials/ upstream and intermediate products: e.g. EVOH, PVDC, PA, PET, BOPP for Bag in Box Coatings: co-extruded plastics or surface finish of cartons e.g. in cartons or paper bags Barrier optimised products, e.g. for folding boxes or corrugated paper cartons.	[17] [24] [25]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
3	Paper/carton/ board	Primary packaging	MOSH/MOAH	When using **barrier materials**: · Consider **permeation time** of barrier · Adapt packaging design	Depending on the nature and storage conditions of the food, permeation of MOSH/MOAH is possible (sponge effect). Within one packaging unit, the parts at the edges may be more contaminated than parts in the middle. There are different suppliers of barrier-optimised products on the market. Suitable barrier layers delay migration. When using recycled material, combination with barrier or absorber materials is possible. Reduce trimmed edges, minimise flap surfaces that are freely accessible in the packaging head space.	[25] [24] [6b]
4	Paper/carton/ board	Primary packaging	MOSH/MOAH	When using **recycled materials**: · Specify **quality** (define max. MOSH/MOAH level) · Check for food-grade quality · Choose the **storage and transport conditions** for making migration impossible	When using recycled fibre in the production of food contact materials, the selection of type of waste paper is relevant. No use of recycled fibre material for primary packa-gings for dry, non-fatty food including flour, semolina, rice, sugar with large surface, etc. without suitable barriers. Migration is dependent on contact time and storage temperature. There is no relevant migration into frozen products and at short contact times. Remove transport cartons made from recycled fibres as soon as possible; do not store products in transport cartons made from corrugated board.	[17] [27] [10] [1]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
5	Paper/carton/ board	Primary packaging	MOSH analogues (MORE)	Request information on the **materials** used in paper production and finishing: · Request the use of **glue substances** that do not transfer any MOSH analogues · Avoid **waxes** used for paper production · Use non-paraffin anti-foaming agents	· Glues are used in paper production to keep the ink (in the pulp); they may give false positive results. Wax and paraffin dispersions, di-alkyl (C10-C22) diketene. · Waxes make the papers easier to print (water-repelling action); introduction in coating, lead to false positive results. · Paraffin oils may be used as anti-foaming agents.	[17]
6	Paper/carton/ board	Secondary packaging	MOSH/MOAH	See tools: Primary packaging	Migration in secondary packaging made from corrugated board is relevant only if the primary packaging has no barrier properties. In this case, review the use of cartons based on recycling materials and the type of barrier.	[Expert]
7	Paper/carton/ board	Transport packaging, tertiary packaging	MOSH/MOAH	See tools: Primary packaging	Transport packaging includes several packagings for the purpose of transportation or storage. Transport packaging for the delivery of primary and secondary packaging or packaging components must be such as to exclude any influence. Where necessary, use barrier materials.	[Expert]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
8	Paper/carton/ board	Container linings/ liners	MOSH/MOAH	se of low mineral oil linings (so called dressings), in particular for sea transport	Container dressings for the transport of bulk and bagged goods in containers or open bulk goods should be free from mineral oils and free from waste paper substances or equipped with functional barriers. Concretise FCC guidelines.	[28] [29]
9	Paper/carton/ board	Container liners	MOSH/MOAH	se alternative materials for the absorption of moisture/humidity in transport containers	Refrain from using carton dressings made from waste paper or based on recycling materials.	[28]
10	Paper/carton/ board	Secondary packaging	MOSH/MOAH	No heat treatment of raw materials (e.g. melting) of raw materials or inter-mediate products inside the packaging (applies in particular to plastic or carton packagings). Remove packaging materials completely. Avoid open liners in closed cartons	Extraction of MOSH/MOAH levels from secondary packagings such as corrugated board with heat, e.g. warming or melting of fats or decontamination of powders.	[Expert]
11	Printing ink	Primary packaging	MOSH/MOAH	Use low migration and mineral oil free inks	Apply FFI/ECHMA and EuPIA recommendations with GMP guidelines.	[30] [6a] [6b]
12	Printing ink	Primary packaging	MOSH/MOAH	Prevent carry-over of mineral oil containing inks in the printing company	Carry-over of mineral oil containing inks from other printing processes during machine re-configuration in the printing company. Apply "Good Manufacturing Practice", consider GMP guidelines.	[Expert] [6a]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
13	Printing ink	Primary packaging	MOSH/MOAH	Use functional barrier with packaging with inside print	Use mineral oil free printing inks for inside printing as well Even mineral oil free printing inks may result in false-positive findings caused by concomitant substances with binding agents.	[Expert] [Expert]
14	Printing ink	Primary packaging	MOSH/MOAH	Avoid contact of printed surfaces with food contact material surfaces	Apply FFI/ECHMA and EuPIA recommendations Printing according to the stipulation of the GMP Regulation No 2023/2006 (Annex 1).	[13] [6a] [6b]
15	Adhesives	Primary packaging and secondary packaging	MOSH/MOAH MOSH analogues (MORE)	Request use of adhesives that release no or only minor amounts of low molecular hydrocarbons; use of seal/reseal adhesives that do not release any low molecular hydrocarbons	Hot melts, pressure sensitive adhesives, water-based adhesives, seal/reseal adhesives are sources for MOSH and MOSH analogues (PAO). Adhesives may release low molecular hydrocarbons that migrate.	[31] [32]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
16	Plastics	Primary packaging	MOSH analogues (POSH)	When using plastic materials as functional barriers, make sure that they have sufficient barrier properties; suitable layer thickness or composite design	Introduction of POSH from plastic layers is possible and inevitable. In particular PP/PE plastics may give false positive results through the migration of POSH. There is no way to separate MOSH and POSH analytically. Consider respective SML and total migration according to Regulation (EU) 10/2011. Multi-component materials or acryl lacquer may reduce migration of POSH; this refers to foil and composite packaging e.g. bags, Big Bags, PE liners, jerry cans, transport boxes, containers, sealing foil (foil on trays) and others. Possible increase in POSH levels with heat treatment, e.g. melting of fats in bags. Production oils (technical white oils) may be used in the production process, may be MOAH sources.	[33] [Expert]
17	Plastics	Secondary packaging	MOSH analogues (POSH)	Select materials with appropriate barrier properties	Barrier properties of the secondary packaging serves as protection against migration from transport and/or tertiary packaging, e.g. shrink foil, wrapping foil. But: for materials with absolute barrier properties, no discharge through "gassing" is possible.	[Expert]
18	Jute and sisal fibres	Bags	MOSH/MOAH	Request use of suitable jute bags according to IJP (food grade) and use of vegetable batching oils	Refers to e.g. transport of bulk goods such as cocoa beans, grains, spices in jute bags from countries of origin; no sufficient definition of "food grade quality". Comply with IJO Standards, no quality standards as regards MOSH/MOAH levels.	[28] [34] [35]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
19	Metal foil/metal sheets (lacquered/ laminated)	Primary packaging	MOSH analogues (MORE)	Avoid surface lubricants on MOH or MORE basis, if possible Do not allow inevitable residues of rolling oils or rolling emulsions Both sides in the case of rolled or stacked products Use MOSH/MOAH-free coatings and lacquers	Rolling oils or rolling emulsions are used for the production of metal foils, in general paraffin oils which may introduce MOSH analogues. In the case of lacquered or laminated applications, the foils/sheets must be annealed and the rolling oils used evaporated. Consider lacquer and laminating components because they may contain MOSH analogues (MORE). Consider printing ink specifications for printing and avoid contact with the inside of cans.	[Expert] [36] [44]
20	Composite materials Laminates	Primary packaging	MOSH/MOAH	Use suitable materials with respective layer thickness as barrier materials; for aluminium foil, a thickness of 6 µm is considered to be suitable depending on the other composite materials Review packaging tight-ness under consideration of the closing technology	Specify aluminium tightness (pin holes/defects) for aluminium foils and composite materials. For beverage cartons, a common layer thickness is 6.25 µm. Other than metal or aluminium foils, metal coatings, are in general not a barrier for MOSH/MOAH.	[24] [Expert] [44]
21	Laminated composite foils	Primary packaging	MOSH/MOAH MOSH analogues (POSH)	Use suitable carrier materials (plastics) with appropriate layer thickness	E.g. composite bag as inside bags. The requirements of the Plastics Regulation No. 10/2011 in combination with the declarations of compliance apply.	[Expert] [24]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
22	Metal foils/ sheets with non-lacquered/ non-laminated metal surfaces	Primary packaging and preliminary stages of primary packaging	MOSH/MOAH MOSH analogues (MORE)	Avoid residues of roller and mould oils (surface lubricants)	Foil for chocolate, uncoated food trays, cans. Rolling oils based on MORE are used for the production of metal foils or sheets instead of rolling emulsions. Usually they comply with the FDA purity requirements. In any case, a soft anneal process has to be applied prior to further processing in order to evaporate rolling oil residues from the roller process.	[Expert] [6] [37]
23	Wood	Secondary packaging	MOSH/MOAH	Combine with suitable primary packaging with barrier effect	Wooden boxes, e.g. used for decoration or transport, do not display barrier properties.	[Expert]

II. Tools: KONTAMINATION

Systematic introduction is possible at all processing stages, e.g. from lubricants, compressed air or use of processing aids (e.g. defoaming agents) or from the processing environment (e.g. dust control agents). Sporadic introduction is possible in the case of damages/accidents or misuse of processing aids; substances present may introduce MOSH/MOAH and/or MOSH analogues while analytical separation and unique identification of sources is possible.

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
24	Lubricants in food processing (food grade ≙ incidental food contact)	Damage, contamination, continuous introduction	MOSH/MOAH MOSH analogues (PAO, MORE)	Use specified and internationally certified NSF lubricants (NSF-H1) or synthetic lubricants. Minimise technically inevitable introduction (instructions, staff trai-ning). Adhere to hygienic design of equipment (lubrication cup, motors etc.) by maintenance	"Food grade" lubricants for machines and equipment, use in food production without intended food contact. Lubricants on mineral oil basis may contain MOSH as well as MOAH. MOAH-free products are available; according to FDA: maximum residue of 10 mg "mineral oils"/kg food for H1 lubricants. PAO will deliver false positive results after damage. Synthetic lubricants are more homogeneous, not free from MOSH and PAO, free from MOAH.	[36] [37] [38] [39]
25	Lubricants – technical quality (no food contact)	Damage	MOSH/MOAH MOSH analogues (PAO, MORE)	No use of lubricants with technical quality (NFS-H2) in food production and if possible in the entire processing environment (e.g. drives) Damage concepts with maintenance measures/ provide for blockings	Lubricants in technical quality are less purified and may contain MOAH.	[28]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
26	Lubricants – technical quality	Compressed air Pneumatic plants	MOSH/MOAH MOSH analogues (PAO, MORE)	Check compressed air for oil penetration on a regular basis Use oil-free compressors, if possible, draw in zero-emission environmental air	Use of compressed air for spray drying, pneumatic conveying plants for the transport of granulates or powders (e. g. filling and emptying of silos); contact of food with compressed air in filling/packaging lines. The quality of compressed air is stipulated in the Standards DIN ISO 8573 ff. According to ISO 8573-1 a maximum residue oil level of 0.01 mg/sqm was defined for compressed air with food contact.	[Expert] [40; 41]
27	Technical lubricants	Continuous introduction through harvesters or damage	MOSH/MOAH MOSH analogues (PAO, MORE)	Avoid/reduce leaks that may result in the introduction of lubricants Use suitable lubricants (NSG-H1/NSF-H2) at all primary production levels, if possible	Use of harvesters e.g. combines, and conveyors in harvesters. Maintenance and damage concepts in the case of leaks and accidents.	[28]
28	Smoke, gases from drying/ combustion	Drying methods	MOSH/MOAH	Avoid direct drying of raw materials with combustion gases dependent on the energy source	Mainly introduction of volatile hydrocarbons and PAH, concerns drying processes, e.g. spices, grain products.	[Expert]

NO.	SOURCE	ROUTE OF	SUBSTANCES	TOOL	NOTES/EXAMPLES	REFERENCE
29	Transport container with direct contact	Transport containers contaminated with mineral oil	MOSH/MOAH	Check proper cleaning (if necessary certificate), exclude critical previous cargos	Containers that are used for raw materials and food, e.g. liquid, pasty products (oils, fruit pulps) or powders (e.g. milled grain products).	[Expert]
30	Technical lubricants	Transport chain	MOSH/MOAH MOSH analogues (PAO)	Prevent/minimise introduction of lubricants. All pneumatic and belt conveyors are relevant. Use H1 lubricants within the entire transport chain, if possible	Even when using H1 lubricants, MOSH and PAO may be introduced, e.g. conveyors, fork lifts, contaminated transport containers or carriers (e. g. returnable pallets).	[Expert] [28]
31	Technical lubricants	Damage or systematic contamination	MOSH/MOAH MOSH analogues (PAO)	No contact between raw materials and storage areas/floors contaminated with lubricants No raw materials from contaminated cultivation areas	Handling of raw materials in the country of production (e. g. drying) or during transportation (e. g. loading platforms).	[Expert]
32	Exhaust gases	Environmental air ventilation	MOSH/MOAH	Avoid introduction through exhaust gases. Check vehicle fleet, check external air inlets	Prevent trucks from backing up to the storage, etc., turn off motors.	[Expert] [27]

III. Information on introduction from additives and processing aids

The notes provided here within the scope of the Toolbox are no "tools" as defined previously. The information is provided in order to complete the information on potential route of entry in food products and to explain possible findings.

However, this does not aim at replacing or the elimination of technologically required food additives or processing aids.

The same applies to all production processes for any type of packaging material or other food contact materials. The description of the required processing aids and additives that may potentially introduce MOSH analogues would go far beyond the scope of this Toolbox.

Food additives and technical processing aids are usually used as approved and technically inevitable for the conditioning of ingredients, raw materials, processing conditions, materials and for the provisioning of equipment. They are applied based on Good Manufacturing Practice (GMP).

In the final product there is no way currently to analytically separate mineral oil hydrocarbons and so called analogues with common analysis methods. Food additives which may give false positive results as MOSH analogues and which are used in accordance with Regulation (EC) No 1333/2008 amongst others include anti-caking agents, edible glazing agents, anti-foaming agents or ingredients according to the "quantum satis" principle (q.s.) such as: [42]

–	Microcrystalline waxes/hard paraffins	E 905
–	Carnauba wax	E 903
–	Candelilla wax	E 902
–	Beeswax	E 901
–	Siloxane	E 900
–	Oxidised polyethylene wax	E 914

Information on paraffin/paraffin oils/hard paraffin

Paraffins are crude oil products that consist of mixtures of alkanes (saturated hydrocarbons) and thus correspond to the definition of MOSH. Depending on the mixture and additives, paraffins are distinguished as liquid, viscous/pasty and solid paraffins.

White oils are paraffin oils with so called „technical" white oil that in general contains MOAH and medical white oil which is MOAH free [36]. For white oils with medium to high viscosity, the EFSA established an average daily intake (ADI) of 12mg/kg body weight/day in 2013. [43]

The range of application of paraffin-based processing aids or additives in food processes at all stages from the growing/production to the processing of food raw materials and foods as well as for the manufacture of food contact materials is broad:

- Lubricants (food grade and technical)
- Bases for technical protection and release/anti-caking agents
- Maintenance products for machines and equipment
- Maintenance products in animal husbandry
- Lubricants for movable equipment parts or food contact materials (e. g. artificial casings)
- Production oils, rollers, release and form oils for food contact materials, as food additives and others, glazing agents, release agents or coating agents
- Animal drug components (by-products in vaccines)
- Pesticides (as adhesives or active agents)
- Anti-freeze agents in crop cultivation

Hard paraffins, micro-crystalline waxes and their mixtures with beeswax, waxes, resins or plastics are used in the production of food contact materials such as adhesives, paper coatings and certain coatings not intended for human consumption. [45]

Surface lubricants, rolling oils and rolling emulsions are needed in processes for the manufacture and processing of metallic materials. Their use is technically required and inevitable. These products are generally based on paraffins; they comply with the internationally acknowledged requirements of the US Code of Federal Regulation (CFR) 21 § 178.3570 (Lubricants for incidental food contact), § 178.3620 (Mineral Oil), and § 178.3910 (Surface lubricants used in the manufacture of metallic articles) in particular in terms of established purity criteria. According to these specifications, rolling oils and surface lubricants contain MOH which may be relevant analytically as MOSH analogues.

In the manufacturing process of e.g. aluminium foils, trays or tubes and similar products, which are intended to be used as food contact materials, the primary metal foils and sheets are subjected to a soft anneal process in order to evaporate the rolling oil from the rolling process. Surface lubricants are also used in the manufacture of tinplate cans. If the lubricants remain on the surface, they have to be approved for food contact (CFR 21 § 178.3570) or otherwise removed after mechanical processing for subsequent lacquering.

NO.	SOURCE	ROUTE OF ENTRY/ CAUSE	SUBSTANCE	NOTES/EXAMPLES	REFERENCE
a	Release agent	Microcrystalline waxes used as - wrappers - coatings - glazing agents - coatings	MOSH analogues (MORE)	Use in e.g. waxed papers or coatings for meat products. Abrasion of microcrystalline waxes results in the migration of compounds predominantly from the MOSH fraction, which delivers false positive results as MOSH analogues. Consider SML according to Regulation (EC) No 10/2011 and conditions of use according to Regulation (EC) No 1333/2008. Where necessary, check process temperature for wrappers. Where necessary, review alternatives: - wrapper coatings based on vegetable esters - quantum satis (q.s.) use.	[33] [42]
b	Release agent	Hard paraffin or microcrystalline waxes	MOSH analogues (PAO, MORE)	Use with e.g. confectionery, fruits. Is harmless when used as approved; however, relevant to analysis as MOSH analogues. Where necessary, use alternative waxes such as carnauba wax or beeswax, which are also relevant as MOSH analogues in analysis.	[Expert]
c	Glazing agents, release waxes, coating agents	Surface treatment	MOSH analogues (PAO, MORE)	Use with e.g. confectionery, sausage casings or food contact materials. Where necessary review product formulation. Alternatively use suitable glazing agents based on vegetables, where necessary . Introduction of saturated hydrocarbons as MOSH analogues.	[Expert] [42]
d	Dust control agents	Spraying of mineral-oil based oils	MOSH/MOAH	Use with dusting bulk goods that are food raw materials such as soya beans, grains, rape seeds and other oil seeds. Alternative use of mineral oil-free dust control agents based on vegetable oils. For dusting food such as flours or powders, only use dust control agents on a vegetable oil basis or substances according to Regulation (EC) No 1333/2008.	[2]

NO.	SOURCE	ROUTE OF ENTRY/ CAUSE	SUBSTANCE	NOTES/EXAMPLES	REFERENCE
e	Release agents Anti-sticking agents	Paraffin oils or white oils for machine maintenances or as release oils for bakery moulds and sheets	MOSH/MOAH MOSH analogues (MORE)	Use of medicinal white oils; in the case of predicable food contact, only vegetable oils or substances according to Regulation (EC) No 1333/2008 are permitted.	
f	Parchment papers for baking or release	Processing aids, release agents with direct food contact	MOSH analogues (PAO, MORE)	Use with baking and heating processes. Composition may result in the introduction of MOSH analogues.	[17]
g	Defoaming agents	Silicone oils Paraffin oils	MOSH/MOAH MOSH analogues (MORE)	Are often used in food processing: washing water, frying processes. Technical use in paper production, for paper recycling, in the production of adhesives. Where necessary, use of vegetable oils as components in defoaming agents.	[42]
h	Pesticide formulations	Use of pesticides based on paraffin oil	MOSH/MOAH MOSH analogues (MORE)	Use and presence as MOSH analogue within the area of vegetable raw materials possible.	
i	Maintenance greases	Based on paraffin	MOSH/MOAH MOSH analogues (MORE)	Use with food producing animals; quantum satis use, prevention of damages.	

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