foodwatch

Project-report December 2021

International tests of various food products for their contamination by mineral oil hydrocarbons (MOSH/MOAH)

A project of

foodwatch international (Berlin and Brussels) with foodwatch offices in Germany, France, Netherlands and Austria.

Executive summary

Within the framework of an international product test, various food products were tested for their content of mineral oil hydrocarbons (MOSH/MOAH).
The selected products were purchased in the 5 different countries: Germany, France, the Netherlands, Austria and Belgium.

Method

In total, 152 different food products were analysed for their content of mineral oil hydrocarbons (MOSH/MOAH).
The analytical methods used for the determination (online LC/GC-FID) and verification of the results (GC*GC-MS) correspond to the recommendations of the Technical Guidance of the European Commission, Joint Research Centre (JRC) for the current EU-wide monitoring for the determination of MOSH/MOAH in foodstuffs. [7] The chemical analysis of the products was carried out in 2 different laboratories in order to guarantee the highest possible and feasible precision of the analytical results. The verification and identification of the marker compounds of the results was performed by GC*GC-TOF technique after fractionation of the corresponding samples.

Results

MOAH:
Positive levels of MOAH were found in **19 out of 152 samples (12 %).**
The levels found ranged from 0,63 mg/kg to 82 mg/kg.

MOSH/POSH:
In **140 from 152 (92 %)** tested products MOSH/POSH were detected above the limit of quantification of 0.5 mg/kg.
The values range from 0,5 mg/kg up to 1152 mg MOSH/POSH/kg of product.

The limit of quantification (LOQ) for the method used (online LC/GC-FID) was usually 0.5 mg/kg. For a few samples with a problematic matrix and interferences, the LOQ was 1.0 mg/kg.

Conclusion/Evaluation of the results

The results clearly demonstrate that the MOAH percentage in the positively tested products is an indication that they are contaminated with a mineral oil which is insufficiently purified.
Food grade mineral oil saturated hydrocarbons (MOSH) (white oils) are reported to contain less than 1 % of MOAH [7].
The analytical verification of the positive results for corresponding marker substances and substance groups was carried out using a technically sophisticated procedure (GC*GC-TOF). These tests proved the mineral, fossil origin of the detected mineral oil contamination.

It is not possible to make a statement about the potential source of the mineral oil contamination. Contamination can occur during the whole production chain, as well as through the packaging material.

In 133 products (87,5%) no MOAH could be determined. This means that it is technically possible to produce products without detectable content of MOAH. However, in order to comply with the minimisation principle (ALARA), actions should be taken immediately to ensure that the products concerned meet these requirements, which means that no MOAH should be detectable.

foodwatch demands:

foodwatch calls on all manufacturers / private brand retailers to:

1. immediately initiate public product warnings in all Member States where their **MOAH-contaminated products** are sold and immediately withdraw the products from sale;
2. prevent any contamination with MOAH mineral oil components suspected of being carcinogenic as well as to publicly commit to selling only food products that do not contain detectable MOAH.

foodwatch calls on all relevant authorities at national and EU level, to

1. clarify by law that the analytical detection of MOAH in accordance with the relevant JRC guideline will result in the product not being marketable in the sense of Article 14 of the General Food Law (178/2002).

2. establish immediately corresponding requirements for MOAH in the EU contaminants legislation for all food categories and not to allow any exceptions.
3. lay down immediately requirements for MOSH in the EU contaminants legislation for all food categories which, in accordance with the ALARA principle, only allow deviations from a regular maximum level of 2 mg MOSH / kg food if there is a scientifically justified need for this. The exceptions are to be defined as narrowly as possible with regard to both the food categories and the exception for exceeding 2 mg MOSH/kg food.

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1. Project target

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- Comparison and evaluation of the results of different EU Member States (**Germany, France, Netherlands, Austria and Belgium**)
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    - 27 products from Netherland
    - 39 products from Germany
    - 36 products from Austria
    - 20 products from Belgium
- Comparison and evaluation of the results in the products
- Summary and publication of results

2. Introduction

Mineral oils have been found in numerous foods such as rice, pasta, chocolate and edible oils, but can also be found in packaging, children's toys, animal feed and cosmetics. [1]
Packaging materials made of recycled paper can transfer mineral oils to food either through direct contact with the food or in a gaseous phase, i.e. through so called migration.
In addition, mineral oils can enter foodstuffs at all stages of the processing chain, from harvesting, through further processing, to packaging. In the environment there can also be a certain background pollution.
But mineral oils are also used specifically by the food industry, for example, as dust binders, lubricants in production machines, as release agents, as polishing agents (on fruits) or in adhesives in packaging.

3. Health risks

According to the European Food Safety Authority (EFSA) and the German Federal Institute for Risk Assessment (BfR), MOSH and MOAH have different toxicological potential. [1, 2]
MOSH can be easily assimilated by the body and accumulate in fatty tissue. In experiments with rats, these led to damage in certain organs. Depending on the chain length and viscosity, MOSH can accumulate in organs of the human body, some fractions are of concern according to the EFSA. However, only MOSH with a chain length greater than C16 are accumulated. [1]

The intake of MOAH should generally be avoided as "a possible carcinogenic potential [...] cannot be excluded" [2].
Since, in addition, no toxicological data are available for evaluation so far, no tolerable intake has been derived to date. [2]
A final risk assessment by EFSA is still pending. However, in January 2017, the European Commission adopted a recommendation for the monitoring of "mineral oil hydrocarbons in foods and materials and articles intended to come into contact with foods". The resulting data will then be made available to EFSA for evaluation. [4]

According to the German Federal Institute for Risk Assessment (BfR), it cannot be ruled out that carcinogenic substances may be present in this fraction of MOAH. The Federal Institute for Risk Assessment (BfR) therefore demands the greatest possible minimisation for MOAH in foodstuffs (ALARA principle: "As Low As Reasonably Achievable"). [1]
The opinion of the BfR is also shared by EFSA. [2]

Given the genotoxic and mutagenic nature demonstrated for certain MOAHs, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) [10] believes that priority should be given to reducing the contamination of food by these compounds. ANSES recommends limiting consumer exposure to MOHs, and to MOAHs in particular, by acting initially on the main sources of mineral oils in paper and cardboard packaging. ANSES recommends the use of barriers to limit the migration of MOHs from packaging into foods.

In July 2019, a study by the Dutch National Institute for Public Health and the Environment (RIVM) was published, for which new toxicological data since the last EFSA-Opinion in 2012 were evaluated and linked to consumption data. The RIVM concluded that dietary exposure to MOSH had no health effects on the Dutch population. In addition, the migration of MOSH from recycled packaging into food contributes only to a small extent to the overall dietary exposure.

The focus should be on exposure to MOAH, as substances contained in this fraction may have a carcinogenic effect. However, this does not mean that all mineral oils containing MOAH are also carcinogenic, but rather that a distinction must be made between the sources. Those containing potentially carcinogenic MOAH compounds should be minimised. [5]

For the risk assessment of MOAH found in food, it is important to distinguish between different sources of MOAH. MOAH derived from crude oils or oils not sufficiently purified, as well as MOAH from combusted (or heated) mineral oils are carcinogenic and therefore, these contaminations should be avoided as much as possible.
The risk assessment of the entire group of Mineral Oil Hydrocarbons (MOH) is subject to gaps of knowledge. The toxicological relevance of effects shown for MOSH in rats for humans is questioned. For MOAH, with a possible mutagenic and carcinogenic potential, there are no dose response data available.[5]
Methods to discriminate between different MOAH in mixtures are currently not available. That is why it is important to distinguish between the different sources of contamination for MOAH, as some contain harmful MOAH, where others do not.[5]

Benchmark levels for mineral oil hydrocarbons (MOH) in foods" in Germany

In June 2018, in Germany the **Consumer Protection Consortium of the Federal States** (LAV) and the **Food Industry Federation Germany** ("Lebensmittelverband") launched a joint project to derive so-called „Benchmark levels for mineral oil hydrocarbons (MOH) in foods". [6]

Based on a comprehensive data collection, the first list of benchmark levels for three food categories was published in March 2019. This was updated twice (June 2020 and August 2021) and supplemented by other additional product categories. In the latest version (August 2021), eight product categories are listed and the values represent the state of good manufacturing and packaging practice.

- For **MOAH**, in Germany **food control authorities and food industry have agreed** that the **analytically achievable limit of quantification** (LOQmax according to the JRC technical guidance) **is applicable for each of the eight product categories** listed. [6]
- "Due to insufficient data" oils/fats obtained from tropical plants (e.g. coconut oil) have up to now not been included in that list. [6]
- For **MOSH** there are **differentiated benchmark levels** which vary in a range from 4 mg/kg (for example for nuts, oilseeds, coconut, peanuts and dried fruit) up to 22 mg/kg (milk and milk products).

LAV and Lebensmittelverband: Common MOH-Benchmark levels (UPDATE August 2021)				
No.	**Product group Food category (consumer products)[2]**	**MOSH and analogues [mg/kg] C_{10}-C_{50}**	**MOAH [mg/kg] C_{10-C50}**	**Notes on the application** Notes on the food groups covered/on products not covered and delimitations/on justifications or other special features (see footnotes, if applicable). **MOH orientation values are always to be applied in conjunction with the definition described.**
1	Vegetable oils and fats (such as rapeseed oil, sunflower oil, soya oil, linseed oil, olive oil and margarines) (excluding oils/fats of tropical plants)	13	n.q.[3]	not for use with oils/fats obtained from tropical plants. (e.g. coconut oil)[5]
2	Bread and biscuits, fine pastries, cereal products and cereal-based products, cereals, rice, pasta	6	n.q.[4]	not to raw commodities or raw doughs
3	Confectionery (sugar confectionery except chewing gum), chocolate and cocoa-based confectionery	9	n.q.[4]	
4	Nuts, oilseeds, coconut, peanuts and dried fruit, including mixtures thereof	4	n.q.[4]	
5a	Desserts (ready-to-eat) and ice cream (except category 5b)	4	n.q.[4]	
5b	Ice cream with fat-based coatings, glazes and couvertures (whether or not in pieces on / in ice cream, on / in wafers)	10	n.q.[4]	
6	Meat, meat preparations and meat products (including sausages)	9	n.q.[4]	not for firm raw sausages with cheese, with cheese or pepper coatings; not for meat preparations in oil-based marinades.
7	Fish and fish products (including canned fish in aqueous infusion/own juice)	4	n.q.[4]	not for canned fish and fish products in oil or oil-based sauces and dips; not for crustaceans and molluscs and products thereof
8	Milk and milk products (such as cream, butter, yoghurt, cheese) including preparations thereof	22 mg/kg milk fat	n.q.[3/4]	assessment is made in all milk products and preparations in relation to the milk fat content [6]; not for mixed spreadable fat products

n.q. - not quantifiable, i.e. contents < limit of quantification (here: LOQ_{max} in mg/kg in accordance with the JRC Guidance on sampling, analysis and data reporting for monitoring of mineral oil hydrocarbons in food and food contact materials, Valid as of 2019)

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[1] The analytical methods are being continuously optimized and the limits of quantification for mineral oil hydrocarbons (MOSH/MOAH) are being reduced. This is represented in the *Standard Method of the German Society for Fat Science (DGF) C-VI 22 (20)* "Mineral oil constituents, saturated hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH) with online coupled LC-GC-FID method for low limits of determination" published in December 2020. **With this method it is possible to quantify mineral oil hydrocarbons with improved precision and comparability up to a value of 0. 5 mg/kg or 1.0 mg/kg in various foods or oils and fats.**

The LOQ-t is the analytically achievable quantification limit for the majority of matrices of each food category, whereas the LOQ-max should not be exceeded for any analytical methods used in MOSH or MOAH analysis. [7]
foodwatch demands that in the future the identification of the maximum acceptable MOAH content as “non quantifiable” (”n.q.”) has to make use of the achievable limits of determination (LOQ-t).

In 2019, immediately after foodwatch's publication of MOAH-findings in infant formula, EFSA published a new "Technical Report: Rapid risk assessment" on the potential risk to public health from contamination of infant formula and follow-on formula by aromatic mineral hydrocarbons. It concludes that hazard characterisation is not possible due to the lack of relevant dose-response data and the absence of information on the presence of the more harmful 3- to 7-ring MOAH [11].

4. Sampling

The sample purchases of the products took place in parallel in all five countries from the first week of August 2021 to the last week of October 2021.

The investigations and verification of the results have been carried out from August 2021 to December 2021.

5. Test procedure and analytical methods

Quantitative determination and verification of analytical results is an essential and important part of product testing.

In order to ensure that the product test has the highest possible precision, reproducibility and validity, the quantitative determination of the products was carried out in 2 different laboratories.

This means that for all products with MOAH contents above 0.5 mg/kg (= Limit of Quantification) the determinations were analysed in another laboratory to verify the MOSH and MOAH results.

The following requirements had to be met by the participating laboratories:

- The participating laboratories needed to have a substantial experience in the field of the analysis of mineral oil hydrocarbons.
- The laboratories must certify a validated method and periodically participate in proficiency tests and interlaboratory comparisons for mineral oil (MOSH/MOAH) analysis.

- The quantification of the MOSH/POSH and MOAH should be performed in all laboratories using the Online-LC/GC-FID method. This is the method of choice recommended by the European Commission, Joint Research Centre (JRC) Technical Guidance for the current EU-wide monitoring for the determination of MOSH/MOAH in food. [1,2,7,8,9]
- Sample preparation MOSH fraction: Determination after extraction or digestion, saponification of product and a) clean up with aluminium oxide or b) without clean up step.
- Sample preparation MOAH fraction: Extraction or digestion, saponification of the products with subsequent clean-up of the extract with epoxidation.

The verification of positive results to determine typical markers and substances for MOSH and MOAH fractions are performed by mass specific detection. For this step the method of choice is two-dimensional gaschromatographic separation and mass specific detection, see [7, 8, 9]. This verification and identification of markers was performed using GC*GC-TOF.

6. Test results

All products were analysed to determine which products were contaminated with mineral oil. Products with amounts above 0.5 mg/kg MOAH were analysed in a second replicate analysis. In addition, for samples with amounts above 0.5 mg/kg MOAH, another sample from a different batch was purchased if possible and analysed.

To be sure that there is no cross contamination, from all of the products with MOAH contents above 0,5 mg/kg a second container of the same batch was analysed.

Verification with GCxGC-TOF: In addition, a confirmatory analysis of these products was carried out in another laboratory. For all products with positive MOAH results, the verification of the results and the test for markers was performed in two laboratories using GC*GC-TOF technology.

The results of laboratory 1 for all products are shown in Tables 1 to 5[2].

[2] Method: Online-LC/GC-FID;
MOSH: Saponification of sample, if necessary cleanup step, removal of natural alkanes with Aluminiumoxide;

Table 1: Test results France

No.	Product name	Batch number	Expiration date	MOSH/POSH (C10-C50)	MOAH (C10-C50)
1	Vigean huile de Coco France	# 20-062A	02.03.22	1,4 mg/kg	< 0,5 mg/kg
2	Pate à tartiner Bio Lucien Georgelin	# 16:13J	12/05/2024	3,8 mg/kg	< 0,5 mg/kg
3	Nutella Pate à tartiner aux noisettes et au cacao 200 g France	# L076RV	02/2022	3,0 mg/kg	< 0,5 mg/kg
4	Vahiné Noix de coco rapée	#L1097	07/04/22	5,6 mg/kg	< 0,5 mg/kg
5	Monoprix Poudre instantanée gout choco	# L1090	03.2023 11:54	1,4 mg/kg	< 0,5 mg/kg
6	Maggi Bouillon Kub Volaille France	# 10610364	03.2022	2,7 mg/kg	< 0,5 mg/kg
7	Lotus Biscoff the original speculoos	# L1141309	21.06.2022	3,0 mg/kg	< 0,5 mg/kg
8	Lidl Choco Nussa	# RA 800912 30125548	16.09.22	5,5 mg/kg	< 1,0 mg/kg
9	Knorr Bouillon de légume sans sel	# L11450D098	06/2022	417 mg/kg	44 mg/kg
10	Jardin Bouillon cube légumes sans sel	# 100822	10/08/2021	36 mg/kg	5,3 mg/kg
		# 221110	10/11/2022	64 mg/kg	5,0 mg/kg
11	Kara Creme de Coco France	# CB0212 4	12/08/22	< 0,5 mg/kg	< 0,5 mg/kg
12	Knorr Bouillon aux herbes et avec de l'huile de olive	# L11650U098	12/2022	369 mg/kg	40 mg/kg
		# L11670U098	12/2022	574 mg/kg	48 mg/kg
13	Creme de coco legere Bjorg France	# I:201030	30-10-21 16:19:50	< 0,5 mg/kg	< 0,5 mg/kg

MOAH: Saponification, cleanup step and removal of interferences with epoxidation

Total Amount Result calculated to DGF method C-VI-22, Dec. 2020

14	Banania l'original	# L1141	05 2023	1,3 mg/kg	< 0,5 mg/kg
15	Auchan Pouce Bouillon de boeuf deshydraté	# 0950H0	01/2023	15 mg/kg	2,5 mg/kg
		# 0205Y1	03/2023	26 mg/kg	2,0 mg/kg
16	Nesquik All natural 350 g	# 10530835U1A	11/2021	4,8 mg/kg	< 0,5 mg/kg
17	Oréo original - 220g	#OVI0511921	31/05/2022	2,3 mg/kg	< 0,5 mg/kg
18	SuzyWan Creme de Coco France	# 5A601 103C18GF99	13/04/2022	< 0,5 mg/kg	< 0,5 mg/kg
19	Chocapic de Nestlé	# L1148083800E1	05/2022	< 0,5 mg/kg	< 0,5 mg/kg
20	Cruesli Chocolat Noir France	# 153B 1R	05 03 22	3,8 mg/kg	< 0,5 mg/kg
21	Kellogg's Extra Chocolat Noir et noisettes grillées	# SA 2SN	05/07/22	2,3 mg/kg	< 0,5 mg/kg
22	Chabrior Muesli Crisp chocolat au lait France	# 13:14 L1	28/05/2022	3,5 mg/kg	< 0,5 mg/kg
23	Danette Chocolat	# Z8225	22/09	0,5 mg/kg	< 0,5 mg/kg
24	Herta Trésor de Grand-mère feuilletée	# 1232001900 E0	21/09/2021	2,0 mg/kg	< 0,5 mg/kg
25	MARQUE REPÈRE (E.LECLERC) La sablée - tablier blanc	# D20432339	03/10/21	0,7 mg/kg	< 0,5 mg/kg
26	CARREFOUR Pâte feuilletée Classic	# 00 JT234/1836H	22/09/2021	1,8 mg/kg	< 0,5 mg/kg
27	Fruit d'or- oméga 3	# L120404098	05/11/2021	5,4 mg/kg	1,0 mg/kg
		# L125904098	30/12/2021	38 mg/kg	1,9 mg/kg
28	Pate brisée- Monoprix	# D2_0257325	18/09/21	2,3 mg/kg	< 0,5 mg/kg
29	LIDL Pâte brisée - Toque du chef	# 59UH232/3443H	09/09/2021	1,4 mg/kg	< 0,5 mg/kg
30	CROUSTIPATE Feuilletée avec de la farine de riz	# L/RD 18/09/21	18/09/21 02:54	1,0 mg/kg	< 0,5 mg/kg

Table 2: Test results Netherland

No.	Product name	Batch number	Expiration date	MOSH/POSH (C10-C50)	MOAH (C10-C50)
1	LU Prince Start Naturel Cookies 300 g	# OHF4012312 2 19:22	31.03.2022	3,2 mg/kg	< 0,5 mg/kg
2	Bolletje SCHUDDEBUIKJES Speculaas 300 g	# L018278B 18:41	01-01-2022	3,7 mg/kg	< 1,0 mg/kg
3	De Ruijter Vlokfeest 300 g	# L22 03:05	08-2022	3,3 mg/kg	< 1,0 mg/kg
4	BE-KIND Caramel Almond & Sea salt Bars	# 121E22GU01 16:49	28.08.2022	< 0,5 mg/kg	< 0,5 mg/kg
5	Knorr Groente bouillon	# L11270R098 14:43	11/2022	609 mg/kg	36 mg/kg
		# L11660D098 14:44	12/2022	1152 mg/kg	58 mg/kg
6	Maggi Kippen bouillon	# 11100364 13:33	04/2022	4,8 mg/kg	< 0,5 mg/kg
7	Liga Milkbreak Melk Biscuits	# OHT091 221 13-7 00:40	28/02/2022	1,6 mg/kg	< 0,5 mg/kg
8	AH Bouillon, Bospaddenstoel	# 15.04.2023	15.04.2023	< 0,5 mg/kg	< 0,5 mg/kg
9	Sultana Naturel Fruit Biscuits	# LZ11956 03:26	03/2022	< 0,5 mg/kg	< 0,5 mg/kg
10	Kellog's Tresor Melkchocolade	#L1167 034510 12:13	12/04/22	1,2 mg/kg	< 0,5 mg/kg
11	Calvé Pindakaas 350 g	# L118900A69 05:31	03/04/2022	< 0,5 mg/kg	< 0,5 mg/kg
12	Nutella Hazelnootpasta met cacao	# L161RV--C09:46	10/06/2022	3,8 mg/kg	< 0,5 mg/kg
13	Lotus Biscoff THE ORIGINAL speculoos	# L1186409/1925	05/08/2022	2,9 mg/kg	< 0,5 mg/kg
14	Kellog's Froot Loops Mixed	#L1 160 034510 12:29	9-6-21	0,80 mg/kg	< 0,5 mg/kg
15	Calvé Pindakaas 350 g	# L120300A69	18/04/22	0,56 mg/kg	< 0,5 mg/kg

16	Trek Protein Havermout Repen	# L5 18-07-2022	18-07-2022	1,9 mg/kg	< 0,5 mg/kg
17	Jumbo Groente Bouillon	# 62517-1017	11-09-2022	1,8 mg/kg	< 0,5 mg/kg
18	Cruesli Kids Chocolate Flavour	# 153C 22:12 2R	05-03-2022	9,7 mg/kg	1,4 mg/kg
19	Bladergeeg op een rol Albert Heijn	#8718907453196	06/10/2021	3,4 mg/kg	< 0,5 mg/kg
20	Danerolles croissants classic	# 06:25 02	21/09/21	1,9 mg/kg	< 0,5 mg/kg
21	VioLife Greek White	# 21175A	24/04/2022	6,7 mg/kg	< 0,5 mg/kg
22	AH Plantaardige plakken	#SN1792E	25/12/2021	6,5 mg/kg	< 0,5 mg/kg
23	AH Verse original croissants	#0222920:35 s1	25/10/21	3,6 mg/kg	< 0,5 mg/kg
24	Oatly! Romige haver spread	# AA000379	08-12-2021	2,3 mg/kg	< 0,5 mg/kg
25	Jumbo Bladerdeeg met bakpapier	# 121114006	16-09-2021	2,1 mg/kg	< 0,5 mg/kg
26	Koopmans Bladerdeeg Origineel	# L454121131 10:16	11-2022	4,0 mg/kg	< 0,5 mg/kg
27	Consenza Puff Pastry	# 30-05-22	30-05-22	1,0 mg/kg	< 0,5 mg/kg

Table 3: Test results Germany

No.	Product name	Batch number	Expiration date	MOSH/POSH (C10-C50)	MOAH (C10-C50)
1	BEN & JERRY'S Cookie Dough	# L1168BM020	12/2022	2,1 mg/kg	< 0,5 mg/kg
2	Rapunzel Tiger Creme	# 4000010105A	19.10.2022	1,5 mg/kg	< 0,5 mg/kg
3	Alnatura Haselnuss-Nougat	# 4000009445	01.09.2022	4,6 mg/kg	< 0,5 mg/kg
4	Gut & Günstig Frischer Blätterteig	# 32323	14.09.21	2,8 mg/kg	< 0,5 mg/kg
5	Henglein Frischer Blätterteig	#32323 06:14	14.09.21	3,5 mg/kg	< 0,5 mg/kg
6	Veganz Geniesserstück	# 608527051	18.12.2021	4,1 mg/kg	< 0,5 mg/kg
7	Bedda Scheibenkäse	# 22.12.2021	22.12.2021	1,0 mg/kg	< 0,5 mg/kg
8	Smarties Pop up Eis	# L-AR1070A1	03/2023	1,3 mg/kg	< 0,5 mg/kg
9	Simply V Natur	#13120120	18.10.2021	2,4 mg/kg	< 0,5 mg/kg
10	Knack & Back Sonntagsbrötchen	#0200 15:5052	03/10/2021	< 0,5 mg/kg	< 0,5 mg/kg
11	Rewe Bio Vegan Mozzarisella	#284	20/10/2021	12 mg/kg	< 0,5 mg/kg
12	Schöller Kaktus 4 Friends	#LFE 1133 22FR	05/2023	6,1 mg/kg	< 0,5 mg/kg
13	Rewe Beste Wahl Blätterteig	#31333	21.09.21	4,3 mg/kg	< 0,5 mg/kg
14	Nestle Nesquik Snack	# L12092	01.10.21	2,5 mg/kg	< 0,5 mg/kg
15	Knorr Feinschmecker Sauce Hollandaise	# L11380D803	11/2022	3,7 mg/kg	< 0,5 mg/kg
16	De Beukelaer Prinzenrolle	# 174V1	01.04.22	4,6 mg/kg	< 0,5 mg/kg
17	Knorr Helle Soße	# L1131	11/2022	3,4 mg/kg	< 0,5 mg/kg

18	Knorr Sauce Hollandaise	# L 107802777	14/12/2021	6,0 mg/kg	< 0,5 mg/kg
19	Kölln Knusper Klassik Hafer Müsli	# L1273	07.06.2022	1,8 mg/kg	< 0,5 mg/kg
20	Vitalis Schoko Müsli	#L208	08.22	1,1 mg/kg	< 0,5 mg/kg
21	Pfanni Kartoffelklöße	# L 108810805	06.2022	< 0,5 mg/kg	< 0,5 mg/kg
22	Storck Toffifee	#MB34M	01.03.22	1,1 mg/kg	< 0,5 mg/kg
23	Ferrero Yogurette	# L175RG-37	05.01.2022	2,1 mg/kg	< 0,5 mg/kg
24	Ferrero Nutella	# L089RG 19:41	30.03.2022	14 mg/kg	2,3 mg/kg
		# L272RG--18:23	29.09.2022	9,8 mg/kg	< 1,0 mg/kg
25	Zentis Nusspli Nuss Nougat Creme	# 18:44 16.09.2022	16.09.2022	6,5 mg/kg	1,1 mg/kg
		# 21:41 19.11.2022	19.11.2022	8,0 mg/kg	1,2 mg/kg
26	Ritter Sport Knusperkeks	# H2P128060 08:44	28.04.2022	1,3 mg/kg	< 0,5 mg/kg
27	Leibniz Pickup!	# F1302	01.08.22	3,5 mg/kg	< 0,5 mg/kg
28	Güldenhof Geflügelsalami mit Pflanzenfett geräuchert	# 14.10.2021	14.10.2021	1,6 mg/kg	< 0,5 mg/kg
29	Lindt Lindo Milch Vollmilch-Chocolade mit zartschmelzender Füllung	# L5701 13 007/2022	07/2022	5,5 mg/kg	< 0,5 mg/kg
30	Choceur Keks Milchcreme	# L41292B 30.04.2022	30.04.2022	1,4 mg/kg	< 0,5 mg/kg
31	Le Gusto Klare Hühner Brühe	# 03.09.2022	03.09.2022	< 0,5 mg/kg	< 0,5 mg/kg
32	ja! NussNougat Creme	# L122164 10/2022	10-2022	4,0 mg/kg	< 0,5 mg/kg
33	Nusskati Nuss Nougat Creme	# N1 07:06 30.06.2022	30.06.22	6,4 mg/kg	< 0,5 mg/kg

34	nussetti Nuss Nougat Creme	#L1215506/0131	03.09.2022	6,5 mg/kg	< 0,5 mg/kg
35	Biscoteria Pausenschnitte	#17:12 B L136940	30.05.2022	4,0 mg/kg	< 0,5 mg/kg
36	Carat Klare Gemüsebrühe	#29.10.2021	29.10.2021	4,0 mg/kg	< 0,5 mg/kg
37	Knorr Fette Brühe	# L221CH816x05	02.2022	325 mg/kg	22 mg/kg
		# L1014CH816x22	07.2022	465 mg/kg	28 mg/kg
38	Knorr Bratensaft Basis	# L01600C098 06:50	12/2021	813 mg/kg	52 mg/kg
		# L03360A098 11:04	06/2022	516 mg/kg	82 mg/kg
39	Maggi Fette Brühe	# 0342070F 14:25	02.2022	4,0 mg/kg	< 0,5 mg/kg

Table 4: Test results Austria

No.	Product name	Batch number	Expiration date	MOSH/POSH (C10-C50)	MOAH (C10-C50)
1	Billa Bio Nuss-Nougat-Creme	#12621E 17:31	07/2022	2,8 mg/kg	< 0,5 mg/kg
2	Nutella Nuss-Nougat-Creme	# L146RV--C 10:54	26/05/2022	4,1 mg/kg	< 0,5 mg/kg
3	Milky Way Cocoa + Milk duo creme	L21056 1WL	25.02.2022	9,9 mg/kg	3,1 mg/kg
4	Milka Haselnusscreme 350 g	#2B00911134/0002	17.12.2021	11,0 mg/kg	< 0,5 mg/kg
5	Knorr Goldaugen	#L1113AQ816 *07	10 2022	66 mg/kg	6,4 mg/kg
		#L1218AR816 *08	02 2023	102 mg/kg	7,0 mg/kg
6	Maggi Rindfleischsuppe	#10470824E1	02-2022	11 mg/kg	< 0,5 mg/kg
7	Knorr Bio Gemüse Bouillon Pulver	# L10891N809	09/2022	1,8 mg/kg	< 0,5 mg/kg
8	Suchard Express Kakao	# L 0331 08:13	02 02 2023	5,3 mg/kg	< 0,5 mg/kg
9	S Budget Instant Kakao	#L 1301 09:02	05 2023	1,1 mg/kg	< 0,5 mg/kg
10	Natur Pur Bio-Trink-Kakao	# L1381	05 2023	2,7 mg/kg	< 0,5 mg/kg
11	Ja! Natürlich Bio Trinkkakao	# L3580	06 2022	0,91 mg/kg	< 0,5 mg/kg
12	Benco Trinkkakao	# ZBL07117 42 B	28.04.23	1,8 mg/kg	< 0,5 mg/kg
13	Nestle Nesquik	# 10900973 T	09 2022	2,5 mg/kg	< 0,5 mg/kg
14	Soyananda Frisch Vegan Cheese "Creme Chesse"	# 10.09.21	10.09.21	7,4 mg/kg	< 1,0 mg/kg
15	MozzaRisella Klassisch Vegan Cheese "Mozzarella"	#261	03/10/2021	16 mg/kg	< 0,5 mg/kg
16	Violife Greek White Vegan Cheese "Feta"	# 21159 B	08/04/2022	5,2 mg/kg	< 0,5 mg/kg

17	Wilmersburger Pizzaschmelz Vegan Cheese	# 179-2101	06.09.2021	9,3 mg/kg	1,7 mg/kg
		# 221-2101	18.10.2021	7,3 mg/kg	1,8 mg/kg
18	Clever Blätterteig Puff Pastry	# 121112103	28.08.2021	2,2 mg/kg	< 0,5 mg/kg
19	Tante Fanny Frischer Blätterteig verfeinert mit Butter	#121112976	06.09.2021	2,0 mg/kg	< 0,5 mg/kg
20	S Budget Bätterteig	#121112826	05 09 21	2,5 mg/kg	< 0,5 mg/kg
21	Penny Ready Frischer Blätterteig	#121113278	08 09 2021	2,4 mg/kg	< 0,5 mg/kg
22	Oreo Original Cocoabiscuits filled with Vanillacream	# OPA6112132 L4	31/05/2022	2,2 mg/kg	< 0,5 mg/kg
23	Lindt Lindor Milch	# L4971	30.11.3021	47 mg/kg	3,3 mg/kg
		#L3741	31.05.2022	10 mg/kg	0,98 mg/kg
24	Milka MMMAX Schoko&Keks	# 00V0812362	12.06.2022	3,2 mg/kg	< 0,5 mg/kg
25	Manner Haselnuss Mignon	# L15881139	19.08.2022	4,3 mg/kg	< 0,5 mg/kg
26	De Beukelaer Prinzen Rolle	# 081 T2	01.02.22	1,7 mg/kg	< 0,5 mg/kg
27	Napoli Dragee Keksi Classic	# L57521118	28.04.2022	3,4 mg/kg	< 0,5 mg/kg
28	Niemetz Schwedenbomben	# L212161	31.08.21	8,2 mg/kg	< 0,5 mg/kg
29	Kinderschokolade	# L151RG--08	11.01.2022	1,8 mg/kg	< 0,5 mg/kg
30	Alnatura Bio Hühner Bouillon	# 18.04.2022	18.04.2022	117 mg/kg	12 mg/kg
		# 27.07.2022	27.07.2022	121 mg/kg	7,7 mg/kg
31	Lindt Lindor Dunkel	# 5851	31.01.2022	8,6 mg/kg	< 0,5 mg/kg

32	Manner Weihnachtssterne Nougat	# L51801223	03 2022	6,6 mg/kg	< 0,5 mg/kg
33	Casali Tor Nusskugeln	# L51171253	03 2022	2,9 mg/kg	< 0,5 mg/kg
34	Kufferle Schoko Schirmchen	#11 L6671	06 2022	6,8 mg/kg	< 0,5 mg/kg
35	Betthupferl Pischinger Dark Chocolate	# L243	31.05.2022	5,6 mg/kg	< 0,5 mg/kg
36	ILDEFONSO Weihnachtsbehang	# L51171190	03 2022	92 mg/kg	10 mg/kg

Table 5: Test results Belgium

No.	Product name	Batch number	Expiration date	MOSH/POSH (C10-C50)	MOAH (C10-C50)
1	Madeleine Chocolat	# 29/10/2021 G	29/10/2021	3,9 mg/kg	< 0,5 mg/kg
2	Venz Flocons de crocodile	# L191824	04.2022	2,8 mg/kg	< 0,5 mg/kg
3	KWATTA puur fondant	# L1152209/1203	07.2022	5,9 mg/kg	< 0,5 mg/kg
4	Delhaize Bio cookies chocolate chip	# 21170	19.02.2022	2,4 mg/kg	< 0,5 mg/kg
5	Knorr Groenten Legumes Bouillon	#L104700N32	08.2022	1,9 mg/kg	< 0,5 mg/kg
6	Knorr Finesse Groenten Legumes Boullion	# L1069A8816*07	09.2022	95 mg/kg	6,4 mg/kg
		# L1069A8816*06	09.2022	123 mg/kg	8,4 mg/kg
7	Delhaize Pate a tartiner aux noisette (bio)	# C02-21054-G-18: 12-054	23.08.2022	7,7 mg/kg	0,71 mg/kg
		# C02-21060-G-20: 55-060	29/08/2022	7,5 mg/kg	0,63 mg/kg
8	Whole Earth peanut choco hazelnut spread	# 98123 02:15D	02.06.2022	1,3 mg/kg	< 0,5 mg/kg
9	Penotti Praline spread	#L106733	05.2022	6,5 mg/kg	< 0,5 mg/kg
10	Delhaize Speculoos spread	# L103528	04.04.2022	2,6 mg/kg	< 0,5 mg/kg
11	DelHaize Bladerdeeg- Pate Feuilletee	#D 4G0719338	02/10/21	2,7 mg/kg	< 0,5 mg/kg
12	DelHaize Kruimeldeeg- Pate Brisee	#D2_1357344	08/10/21	1,1 mg/kg	< 0,5 mg/kg
13	DelHaize Bladerdeeg- Pate Feuilletee- Blaetterteig bio	# 01P08 V 09:29D	28/9/21	1,2 mg/kg	< 0,5 mg/kg
14	Violife Greek White	# 21176 A 08:17	25/4/2022	6,2 mg/kg	< 0,5 mg/kg
15	Violife Mozzerrella flaveroured grated	#21145B 17:53	25/01/2022	2,3 mg/kg	< 0,5 mg/kg

16	Nurishh Mozzerella flaveroured grated	# SN1831E 06:56	30/10/2021	2,9 mg/kg	< 0,5 mg/kg
17	ALPRO cooking coconut	# BA 2416 17:20	14/03/2022	< 0,5 mg/kg	< 0,5 mg/kg
18	Boerinneke sans lactose gluten (bio)	# L1179	28.09.2022	2,9 mg/kg	< 0,5 mg/kg
20	Nutella	L250RV --C 12:47	07/09/2022	4,1 mg/kg	< 0,5 mg/kg

7. Interpretation and discussion

MOSH/POSH :

- For food products there are currently no agreed acceptable values of contamination published on EU-level.[3]
- All products, however, show a wide range of contamination from MOSH/POSH ranging from non-detectable (below 0,5 mg/kg) to 1152 mg/kg.

MOAH:

- For food products there are currently no agreed acceptable values of contamination published on EU-level.
- The MOAH contents in all products show a wide range of contamination. They vary from non-detectable (below 0,5 mg/kg) to 82 mg/kg.

[3] Due to the persisting lack of legal maximum values all over Europe the German competent authorities together with the food industry published "Benchmark levels for mineral oil hydrocarbons (MOH) in foodstuffs" (Update August 2021). For all food groups covered any verification of MOAH is not accepted. And it appears remarkable for comparison reasons that the sum of MOAH (C10-C50) in 19 out of 152 samples is **above** the "benchmark level" of 0.5 mg/kg, i.e. level of quantification for the specified different matrices.

In all products with MOAH contents above 0.5 mg/kg, the percentage of the MOAH fraction to the total mineral oil content was calculated. These proportions are all in the range from 4,7% MOAH to 23,8% MOAH.
Food grade mineral oil saturated hydrocarbons (MOSH) (white oils) are reported to contain less than 1 % of MOAH. [7]
For the majority of the products tested positively for MOAH (> 0.5 mg/kg), a second different batch was tested. In most of the products of the second batch tested, the content of MOAH was confirmed.

However, it also showed that in the products of Nutella (Germany), the first batch had a MOAH content of 2.3 mg/kg and in the second batch no MOAH content could clearly be identified in the range of < 1.0 mg/kg. Similarly, Lindt Lindor milk (Austria), here the first batch had a MOAH content of 3.3 mg/kg and the second with 0.98 mg/kg. Thus, lower MOAH contents could be determined in other batches.

Typical marker substances could be identified in the MOSH and MOAH fractions of all these products.

Conclusion:

- The results of the ratio between MOSH and MOAH (MOAH content in whole mineral oil) of the products tested positive for MOAH is an indication that the products are contaminated with a mineral oil which is insufficiently purified.
- The verification of the positively tested products (MOAH above 0,5 mg/kg) by using GC*GC-TOF all showed typical markers and typical compound classes in both the MOSH and MOAH fraction. The results for MOAH here should be evaluated according to the ALARA (*As Low As Reasonably Achievable*) principle. It would be good practice from both manufacturers and distributors/retailers of the products to ensure that the concentration of contaminants in foodstuffs is as low as reasonably possible. 88 % of the products were able to comply with this principle, as they have a MOAH content below detectable levels (LOQ=limit of quantification).

- Considering the Limit of Quantification for this method with 0.5 mg MOAH /kg all 19 products with results above this value do not meet the requirement of ALARA.
- It is not possible to make a statement about the possible source of mineral oil contamination in the corresponding samples. Contamination can occur throughout the entire production chain, i.e. from the harvesting of the raw materials to the mechanical processing of the products in the manufacturing process and through to contamination from the packaging used. Different and also multiple input sources are conceivable. However, since no MOAH was found in 88% of the products, it seems technically feasible to produce “free” from MOAH.

8. Appendix

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[4] COMMISSION RECOMMENDATION (EU) 2017/84 of 16 January 2017
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[12] https://www.foodwatch.org/fileadmin/-INT/mineral_oil/documents/2019-10-24_Projectreport_babymilk_FINAL.pdf (last visit: 03.12.2021)
[13] SUMMARY of the Roundtable Workshop on the Determination of MOAH in Infant Formula 5 December 2019 Conference Centre Albert Borschette - Brussels This Roundtable Workshop on the determination of mineral oil aromatic hydrocarbons (MOAH) in infant formula (IF)
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