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ASSESSMENT AND CLASSIFICATION OF MINERAL OIL CONTAMINATION IN FEED AND MILK IN RELATION TO LEGISLATIVE BENCHMARKS

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Abstract

Contamination of animal feed and food with mineral oil hydrocarbons (MOH), particularly the MOSH (saturated) and MOAH (aromatic) fractions, is becoming an increasingly important issue for food safety due to the absence of harmonized and binding legislative limits at the European level. This study aims to assess and classify MOH contamination in animal feed and milk in relation to current legislative benchmarks, combining a literature-based approach with an applied analysis. Different relevant references were reviewed to evaluate the current regulatory framework and its limitations. In addition, 32 feed samples and 16 milk samples collected from farms in North-Eastern Romania were analyzed for MOSH and MOAH contamination levels using previously validated LC-GC-FID methodology. The results were assessed in relation to existing guideline values and further interpreted through hypothetical regulatory scenarios. A classification framework for contamination levels was proposed, highlighting a high proportion of non-compliant samples. The findings emphasize the need for legislative measures and improved monitoring across the entire agri-food chain.

Key words*: contamination, food safety, legislative benchmarks, mineral oil.*

INTRODUCTION

The presence of mineral oil hydrocarbons (MOH) in a wide range of matrices, along with their potential toxicity for both animal and human organisms, has attracted increasing scientific attention across multiple fields, including food products, animal feed, and other consumer goods (Pirow et al., 2019; Nestola, 2022; Moret et al., 2025). Although MOH have been detected in the environment for more than three decades (Grob et al., 1991), their occurrence was initially not considered a major concern. However, as toxicological studies have highlighted their potential for bioaccumulation and possible carcinogenic effects, the perception of MOH has shifted, and they are now recognized as contaminants of growing concern (Grob, 2018).

In Europe, recent incidents involving MOH contamination have raised concern among consumers, particularly following the detection of mineral oil hydrocarbons in various food products (Foodwatch, 2019). However, uncertainties regarding actual exposure levels and associated health risks persist, highlighting the need for a more consistent legislative approach. MOH exhibit variable toxicity, with the aromatic fraction (MOAH) being of particular concern due to its potential genotoxic effects (Grob, 2018; Pirow et al., 2019; Nestola, 2022; Srbinovska et al., 2022).

Since 2008, following the identification of elevated levels of MOH contamination in certain food products and food contact materials, the perception of these contaminants has undergone important changes. A key event was the detection of MOH contamination in batches of sunflower oil exported from Ukraine to several European Union countries, which led to the introduction of temporary maximum limits of 50 mg/kg (Biedermann & Grob, 2009; EFSA, 2012). In response to such incidents, the European Food Safety Authority (EFSA, 2012) published in 2012 a scientific opinion on the presence of MOH in food, highlighting the need for further investigations and more effective control measures, particularly in the context of limited data for a comprehensive risk assessment (EC, 2017). This milestone marked

a turning point in both research and regulatory approaches, prompting European authorities to initiate monitoring programs and to establish indicative, rather than binding, reference values.
Current European Union legislation and international recommendations provide guidance on acceptable levels of mineral oil hydrocarbons (MOH); however, their implementation remains largely at the discretion of individual Member States. As of July 2024, EU legislation concerning MOH, particularly MOAH, is still under development, with a preliminary draft regulation, indicative and non-binding in nature, proposed for MOAH in food, with the objective of its future integration into the European Union Contaminants Regulation (EU) 2023/915 (EC, 2023; Sante, 2025).
Although several European countries have attempted in recent years to implement stricter measures to control MOH contamination, most of these initiatives have faced many limitations and have not been translated into binding legislative standards, remaining instead as scientific references for future regulatory developments. The absence of clearly defined and enforceable limits restricts the ability of both producers and authorities to effectively prevent contamination, while the establishment of mandatory regulations could contribute to improved public health protection and support the maintenance of a safe and compliant agri-food sector. The MOSH/MOAH issue continues to evolve, particularly due to the involvement of key regulatory bodies such as the European Food Safety Authority and the European Commission. Since the publication of the EFSA scientific opinion in 2012 and its subsequent updates (EFSA, 2012; EFSA et al., 2019; EFSA 2023), legislative discussions have become more structured and application-oriented. However, many gaps remain, including the lack of maximum limits across all product categories and the inconsistency between recommended guideline values and enforceable legislation. Although MOH contamination may affect multiple stages of the agri-food chain, the present study specifically focuses on feed and milk contamination in relation to current legislative benchmarks.
This study addresses the issue of mineral oil hydrocarbon (MOH) contamination in the context of feed and food safety, with a particular focus on existing legislative limitations. The main objective is to provide an integrated approach combining a review of the current regulatory framework with an applied assessment of MOSH and MOAH contamination levels in feed and milk. Based on experimental data and existing legislative benchmarks, the study further aims to develop a classification framework for contamination levels, allowing for a structured interpretation of compliance and potential risk.

MATERIALS AND METHODS

This paper combines a literature review and an applied experimental evaluation aiming to provide a comprehensive perspective on mineral oil hydrocarbon (MOH) contamination and its legislative implications. The literature review focused on assessing the current regulatory framework and toxicological aspects related to MOH, based on specific scientific publications and institutional reports. Sources were systematically selected from the main scientific databases and official documents addressing MOH contamination in feed and food, as well as related risk assessment and legislative developments. Togheter, an applied study was conducted using contamination data obtained from selected samples along the feed and dairy sector. The experimental component aimed to assess the levels of MOSH and MOAH contamination in relation to existing legislative benchmarks.

Literature review

A comprehensive literature review was conducted to assess mineral oil hydrocarbon (MOH) contamination, with particular emphasis on toxicological aspects and current legislative limits. In order to capture regulatory developments and new legislative trends, specific studies and reference reports addressing MOH contamination in food and feed, as well as its implications for food safety, were selected (Figure 1).
The literature search covered publications and official documents published between 2008 and 2025, with particular attention given to studies published after the EFSA scientific opinion issued in 2012. The sources included scientific publications accessed through major online

databases such as PubMed, ScienceDirect, Web of Science, Scopus, CAB Direct or Google Scholar, as well as institutional resources from the association institution's documentary fund, such as the Anelis Plus Database.

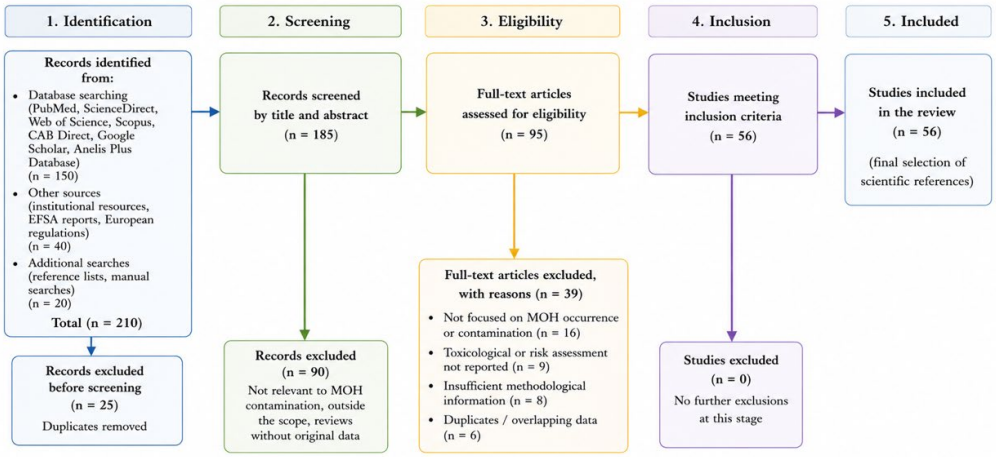

Figure 1. PRISMA flow diagram of the literature selection process addressing MOH contamination in food and feed (original)

In addition, authoritative documents such as the assessments issued by EFSA and other relevant European regulations were taken into account.

To ensure comprehensive coverage of the topic, various combinations of keywords were used during the search process, such as: "feed and food safety", "mineral oil hydrocarbon", food "contaminant", "MOSH", "MOAH", "exposure and risk assessment". The inclusion criteria considered studies focused on MOH occurence, toxicological assessment, food and feed contamination, risk asessment, and legislative aspects related to the feed and milk production chain. Duplicate publications, studies lacking sufficient methodological informationm and papers not directly related to MOH contamination were excluded from the final selection. Following the processes of identification, screening and evaluation, a total of 56 scientific references were selected and included in this study.

Data sources and analytical methodology

An applied study was conducted on a total of 32 feed samples and 16 milk samples collected from different crop farms and dairy farms in North-Eastern Romania (Table 1). The samples were analyzed to determine the levels of MOSH and MOAH contamination in order to assess their compliance with current indicative legislative limits. The sampling procedures and analytical methods applied for both feed and milk followed the protocols described in previous studies. The contamination data used in the present study were derived from experimental investigations previously carried out by the authors. Detailed information on the origin of the samples, sampling techniques and analytical procedures have been reported in previous works (Matei & Pop, 2023; Matei et al., 2024a; 2024b) and were adapted to the objectives of the present study.

Table 1. Identification and coding of the analyzed feed and milk samples

Samples					
Name	Code	Name	Code	Name	Code
Feed samples				Milk samples	
Mountain pasture F-MP	F-MP-A	Corn grains F-C	F-C-A	Milk 1	M1-A
	F-MP-B		F-C-B		M1-B
Natural hay F-NH	F-NH-A		F-C-C	Milk 2	M2-A
	F-NH-B		F-C-D		M2-B
Alfalfa hay F-AH	F-AH-A	Triticale F-T	F-T-A	Milk 3	M3-A
	F-AH-B		F-T-B		M3-B
	F-AH-C	Soya F-S	F-S-A	Milk 4	M4-A
	F-AH-D		F-S-B		M4-B
Corn silage F-CS	F-CS-A		F-S-C	Milk 5	M5-A
	F-CS-B		F-S-D		M5-B
	F-CS-C	Sunflower meal F-SS	F-SS-A	Milk 6	M6-A
	F-CS-D		F-SS-B		M6-B
Alfalfa silage F-AS	F-AS-A	Combined feed F-CF	F-CF-A	Milk 7	M7-A
	F-AS-B		F-CF-B		M7-B
Brewer's spent grain F-BSG	F-BSG-A		F-CF-C	Milk 8	M8-A
	F-BSG-B		F-CF-D		M8-B

Data interpretation and classification approach

The results obtained from previous experimental studies were compared with currently available reference values. In order to better assess the potential impact of future legislative developments, this analysis was based on hypothetical scenarios that consider the potential tightening of proposed legislative limits at European Union level (Bratinova & Hoekstra, 2019; Bratinova et al., 2023). These scenarios enabled the identification of non-compliant samples and the estimation of the proportion of samples that would require additional control measures. Based on this comparative analysis, a classification framework for MOH contamination levels was developed. The proposed classification consists of grouping the analyzed samples into distinct contamination ranges, based on their relative position with respect to existing legislative reference values. This classification allows a structured interpretation of contamination severity, facilitating the differentiation between compliant, borderline and non-compliant samples.

The classification system can support both risk assessment and decision-making processes by providing a practical tool for assessing contamination levels in feed and milk. Additionally, it enables the extrapolation of current results under more stringent regulatory scenarios, providing insight into potential future compliance challenges.

RESULTS AND DISCUSSIONS

MOH in feed and milk

The presence of mineral oil hydrocarbons (MOH) in the feed and milk production chain is a major concern, having been reported in both plant and animal-derived products (Srbinovska et al., 2023; EFSA, 2012). Contamination can occur at several stages of the production and processing chain of feed and milk, either through direct anthropogenic sources or through migration from materials used during processing (Lăpușneanu et al., 2023; Ciobotaru et al., 2024; Gucianu et al., 2023; Manoliu et al., 2024), transport or packaging (Van Heyst et al., 2020). According to the scientific literature, MOH levels and composition vary considerably depending on the food matrix and the source of contamination (Bratinova & Hoekstra, 2019). Animal products, such as milk and meat, are considered particularly vulnerable due to the potential transfer of MOH from contaminated feed (Bauwens et al., 2022). In addition, vegetable oils, fish products and cereals have also been identified as among the most affected categories, with direct implications for food safety and public health (EFSA, 2012).

Recent studies indicate that air pollution is an important source of MOH contamination, resulting from industrial, agricultural and urban activities (Van Heyst et al., 2020). However, evidence regarding the exclusive contribution of environmental sources to food contamination remains limited, especially for the MOAH fraction, which tends to undergo rapid oxidation when exposed to atmospheric conditions (Menegoz Ursol et al., 2022). Many of the observed contamination patterns may also be influenced by technological factors, including processing conditions and material interactions. Previous studies have shown that technological interventions, such as the incorporation of artificial additives, can alter the physicochemical properties of food products, indirectly affecting their safety profile (Flocea et al., 2024; Gucianu et al., 2024). These findings are consistent with previous research highlighting the influence of technological factors on the quality and safety of animal-derived products (Ciobotaru et al., 2024). In addition to environmental and technological sources, food contact materials, particularly packaging systems, represent an important pathway for contamination. Recent advances in food product development (Manoliu et al., 2025; Coșarcă et al., 2025) and smart packaging technologies have been increasingly focused to improve food safety and traceability. Innovative approaches, such as the development of functional food products and the implementation of smart packaging systems, contribute to enhanced product stability and consumer protection (Anchidin et al., 2024a; 2024b). However, these technological advancements may also introduce new challenges related to material composition and potential contaminant migration (Davidescu et al., 2025).

In terms of animal production, due to their lipophilic nature, MOH have the ability to

accumulate in the adipose tissues of animals, while feeding contaminated feed is considered a primary route of exposure (Grob, 2018). In addition, the MOSH fraction is known to accumulate in the liver and other organs, while MOAH present carcinogenic potential due to their structural similarity to polycyclic aromatic hydrocarbons (PAH) (Nestola, 2022). The presence of contaminants in animal derived products is not limited to MOH, as previous studies have reported the accumulation of various toxic elements in animal tissues, emphasizing the broader context of food safety risks (Boișteanu et al., 2023; Boișteanu et al., 2024; Ciobanu et al., 2020).

Since 2011-2012, the potential toxicity of mineral oil hydrocarbons (MOSH and MOAH) has attracted the attention of regulatory authorities, leading to the initiation of investigations into their presence in the food sector (EFSA, 2012). In the absence of sufficient data to support a comprehensive risk assessment, regulatory bodies established temporary reference limits. These limits have been periodically recommended and updated, and are referred to in documents such as the European Union Recommendation 2017/84 (EC, 2017); guidelines issued by the German Federal Ministry for Food, Agriculture and Consumer Protection (BMEL, 2020), as well as proposals from the Consumer Protection Consortium of the Federal States (LAV) and the German Food Federation (BLL, 2022).

Germany has been one of the most active countries in addressing MOH contamination. In 2011, the German Federal Ministry of Food and Agriculture (BMEL) and the German Federal Institute for Risk Assessment (BfR) published legislative proposals and scientific opinions on the risk assessment associated with MOSH and MOAH, highlighting the need for a clearer regulatory framework.

Various measures aimed at establishing maximum acceptable levels of MOH contamination have been initiated over time, one of the most notable being the Joint Research Centre (JRC) Guidance Document. This document, developed by Bratinova & Hoekstra (2019), proposed a procedural, step-by-step set of measures necessary to maintain acceptable level of MOSH and MOAH contamination in different products. However, despite these coordinated efforts, several challenges persist, including the lack of harmonisation of analytical protocols, the absence of validated and standardised methods and variability in data interpretation. These limitations complicate the integration of analytical results and undermine the reliability of contamination control (Bratinova et al., 2023).

Legislative proposals and expert opinions regarding reference levels for MOSH and MOAH contamination, presented in Table 1, reflect the evolution of regulatory actions over time. Although some of these proposals have not been officially implemented, more recent initiatives, such as the JRC Guide (Bratinova & Hoekstra, 2019) or documents developed at the level of the European Commission (2022) and EFSA (2023), continue to be used as reference models for establishing safety limits. The data presented in Table 2 were processed based on the work of Menegoz Ursol (2022).

Between 2011 and 2017, the German Federal Ministry of Food and Agriculture (BMEL) issued three additional legislative ordinances proposing various recommended maximum limits for MOSH and MOAH contamination in food. In parallel, the European Union, through Commission Recommendation 84/2017, requested the collection of additional data, with a particular focus on the most toxic MOAH fractions. According to the scientific literature, an important milestone in the development of legislative criteria for MOSH and MOAH was reached in 2019 with the publication of the JRC technical reports (JRC Guidelines), prepared by Bratinova & Hoekstra (2019) under the auspices of the European Commission. This guideline included recommendations for the detection and quantification of MOH, along with indicative limits, and has since become a reference framework for monitoring these contaminants.

In Germany, control authorities within the Working Group of the Federal States on Consumer Protection, together with the Food Federation, suggested the use of reference safety levels developed as part of a joint data collection project initiated in 2016. Although these limits were not based on toxicological data or exposure assessments, they were considered sufficiently protective for a wide range of food products (Menegoz Ursol, 2022).

In May 2022, the Standing Committee on Plants, Animals, Food and Feed, Section Novel Foods

and Toxicological Safety of the Food Chain of the European Commission issued specific recommendations on the maximum levels of MOAH permitted in food, setting limits raging from 0.5 mg/kg to 2 mg/kg, depending on the fat content of the products (EC, 2022). Although the Commission recommends the withdrawal or recall of products exceeding these limits, these requirements are not legally binding and remain at the discretion of Member States in terms of their application (Srbinovska et al., 2023; EC, 2022; Bratinova et al., 2023).

Table 2. Legislative proposals on MOSH/MOAH reference levels

YEAR	AUTHORITY / LEGISLATIVE PROPOSAL	MAXIMUM LIMIT (mg/kg)	REFERENCES
2011	Ordinance I of the German Federal Ministry of Food and Agriculture (BMEL)	MOSH < 0.6 MOAH nd (< 0.15)	Menegoz Ursol, 2022; Luisi, 2019
2011	Opinion of the German Federal Institute for Risk Assessment (BfR)	MOSH $C_{10–16}$ < 12.0 MOSH $C_{16–20}$ < 4.0	
2012	European Food Safety Authority (EFSA)	-	EFSA, 2012
2013	Ordinance II of the German Federal Ministry of Food and Agriculture (BMEL)	MOAH nd (< 0.15)	Menegoz Ursol, 2022; Luisi, 2019
2014	Ordinance III of the German Federal Ministry of Food and Agriculture (BMEL)	MOSH $C_{20–35}$ < 2.0 MOAH $C_{16–35}$ < 0.5	
2017	Ordinance IV of the German Federal Ministry of Food and Agriculture (BMEL)	MOAH < 0.5	
	Provisions of the Scientific Committee of the Belgian Federal Agency for the Safety of the Food Chain (FASFC) on action thresholds	MOSH $C_{16–35}$ = 5.0 – 150.0 MOAH $C_{16–35}$ < 0.5	
2019	JRC Technical Reports "Guidance on sampling, analysis and reporting of data for the monitoring of mineral oil hydrocarbons in food and food contact materials"	MOSH & MOAH 0.5 mg/kg (< 4 % CF) 1.0 mg/kg (> 4 % CF) 2.0 mg/kg (fats)	Bratinova & Hoekstra, 2019
2020	Provisions of the German Food Federation (BLL) on reference levels	MOSH = 4.0–13.0	Menegoz Ursol, 2022
	Ordinance V of the German Federal Ministry of Food and Agriculture (BMEL)	MOAH < 0.5	
2021	State Working Group for Consumer Protection (LAV) & German Food Federation (BLL)	MOSH = 13.0 MOAH < LOQ	
2022	European Commission, Standing Committee on Plants, Animals, Food and Feed, Section Novel Foods and Toxicological Safety of the Food Chain	MOSH & MOAH 0.5 mg/kg (< 4 % CF) 1.0 mg/kg (> 4 % CF) 2.0 mg/kg (fats))	EC, 2022; Bratinova et al., 2023
2023	European Food Safety Authority (EFSA) European Commission (EC) ▪ draft regulation aimed at integrating MOAH limits into the European Regulation on food contaminants (EU) 2023/915	MOSH & MOAH 0.5 mg/kg (< 4 % CF); 1.0 mg/kg (> 4 % CF; ≤ 50 % CF) 2.0 mg/kg (fats) > 50 % CF)	EFSA, 2023
2025	Revision 7 of the SANTE PLAN 2023/2345 (draft not adopted or endorsed by the European Commission) released by the Directorate-General for Health & Food Safety	specific limits of 2 mg/kg are planned for cocoa beans and cocoa mass	Sante D.G., 2025
2027		1 mg/kg MOAH, cocoa powder 4 mg/kg MOAH, cocoa butter (Jan. 1st, 2027)	
2028		2 mg/kg MOAH, cocoa beans and mass (Jan. 1st, 2028)	
2030		2 mg/kg MOAH, cocoa beans and mass (Jan. 1st, 2030)	

CF=crude fat.

On the other hand, in 2023, the European Food Safety Authority (EFSA, 2023) published a draft scientific opinion on the risk assessment of mineral oil hydrocarbons. The limited availability of information on the occurrence of MOAH in food led to the development of two predictive scenarios. EFSA continued to classify MOAH as having a potential toxicological risk, while MOSH were not considered hazardous to human health (EFSA, 2023). EFSA also emphasized the importance of collecting additional data on MOAH and their long-term effects on feed and food safety, as well as human health. The assessment was carried out through a public consultation process and is intended to support the development of stricter and better-founded future legislation. The scientific opinion provided is expected to support EU Member

States in the correct management of associated risks.

More recently, regulatory efforts have intensified. However, many of these provisions remain under discussion and have not yet been formally adopted. Current draft scenarios suggest the introduction of specific maximum levels for certain food matrices, with progressively stricter limits planned over time, reflecting an ongoing process of regulatory consolidation (Sante, 2025).

For the analysis of the research results, a classification system was developed to categorize contamination levels into five ranges for MOSH (normal, low, moderate, high, very high) and four ranges for MOAH (normal, low, moderate, high). Although current recommendations generally indicate a maximum acceptable level of 0.5 mg/kg for MOH contamination, a more detailed classification may provide a clearer understanding of the distribution and severity of contamination in feed and milk. It is important to note that values exceeding the threshold of 0.5 mg/kg can be considered "non-compliant" from the perspective of current recommendations. These ranges allow for a more nuanced characterization of contamination levels and a more precise assessment of contamination trends. In this way, we not only distinguish between compliance or non-compliance, but also supports the possibility of assessing potential risks.

The results on MOSH and MOAH contamination levels were presented separately for roughage and for concentrate and compound feeds (Figure 2 a,b). This separate visualization allowed highlighting the variations in contamination levels depending on the type of feed, considering the specific characteristics of each category. Roughage (e.g. hay, silage) and concentrate and compound feeds differ in both composition and technological processing. These technological and compositional differences may influence their susceptibility to contamination, as reported in previous studies (Matei et al., 2024; Matei & Pop, 2022).

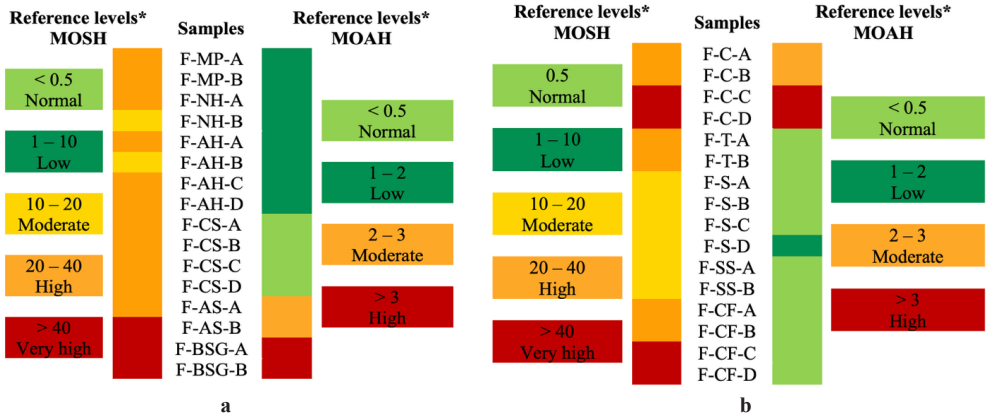

Figure 2. Proposed classification system for MOSH and MOAH contamination levels: a-bulk feeds; b-concentrated and compound feeds
(*current proposals; EU-RL=European Commission Recommended Limits (ScoPAFF) for foods with ≤ 4% fat; performance criteria for MOSH/MOAH analysis: LOQ < 0.5 mg/kg; values are the average of 2 replicates/sample)

The results of the analysis of feed samples indicate an alarming situation regarding MOSH contamination. Over 75% of the samples showed moderate to high levels of contamination, while more than 20% were classified as highly contaminated, far exceeding the current reference limits (0.5 mg/kg). Very high levels of contamination were particularly evident in samples from the F-BSG (brewer's grain) and F-CF (compound feed) categories, suggesting that the technological processes involved in their production and handling may be major sources of contamination. Samples from the F-CS (corn silage), F-AH (alfalfa hay) and F-C (corn grains) categories also showed high levels of contamination. These findings could be associated with the use of agricultural

machinery, as well as inadequate storage conditions, which may facilitate the transfer and accumulation of contaminants.

Regarding the MOAH fraction, the majority of the samples analyzed fell within the reference limit of 0.5 mg/kg, which is encouraging, given the higher toxicological concern associated with this fraction. Over 75% of the bulk feed samples showed normal (25%) or low contamination limits, ranging between 1-2 mg/kg (50% of the samples). At the same time, approximately 70% of the concentrate feed samples recorded normal contamination levels, below the reference limit of 0.5 mg/kg. Although the majority of the samples fell within the recommended limits, approximately 25% were classified as marginally non-compliant, exceeding the threshold of 2 mg/kg. These findings indicate the need for further investigations to identify and eliminate potential sources of contamination, although the indications point more towards technological contamination of these feeds. Feed contamination is a multifactorial issue, involving not only chemical contaminants such as MOH, but also microbiological hazards and mycotoxins. Previous studies have highlighted the presence of aflatoxins in feed obtained in feed mills, emphasizing the importance of control measures throughout the feed production chain (Lăpușneanu et al., 2024).

In the case of milk, MOSH contamination levels were generally acceptable, as approximately 94% of the samples analyzed fell within normal (6.25%) or low (87.5%) categories. A more concerning situation was observed for MOAH contamination, where only 50% of the samples fell within the normal (25%) or low (25%) categories. Meanwhile, 12.5% of the samples exhibited moderate contamination levels, and 37.5% showed high levels of contamination.

Milk contamination with MOSH and MOAH reflects a mixed situation in relation to established food safety limits. In the case of the MOSH fraction, the majority of the samples analyzed (94%) fell within the safety limits: 6.25% of the samples recorded normal contamination levels, while 87.5% showed low levels (Figure 3).

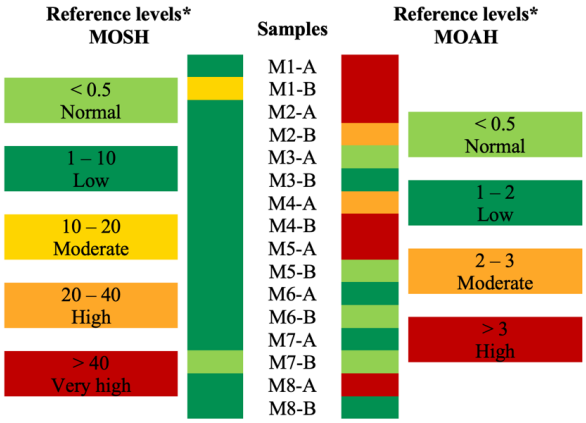

Figure 3. Proposed classification system for MOSH and MOAH milk contamination levels:
(*current proposals; EU-RL=European Commission Recommended Limits (ScoPAFF) for foods with ≤ 4% fat;
performance criteria for MOSH/MOAH analysis: LOQ < 0.5 mg/kg; values are the average of 2 replicates/sample)

In contrast, for the MOAH fraction, the situation was more concerning. Only half of the samples fell within the normal (25%) or low (25%) categories. At the same time, 12.5% of the samples showed moderate contamination levels, and 37.5% exceeded the thresholds considered acceptable and were classified as highly contaminated. Given the higher toxicity associated with MOAH and their potential to cause adverse health effects, these results may highlight a considerable risk to food safety. These findings are consistent with previous studies highlighting the vulnerability of dairy products to contamination and quality variations. Analyses of RASFF notifications over the past two decades have demonstrated the recurrent occurrence of contamination incidents in dairy products, emphasizing the importance

of risk management (Postolache et al., 2020). In addition, farm management systems have been shown to significantly influence the hygienic quality of milk, which may also impact their susceptibility to contamination (Rațu et al., 2023).

CONCLUSIONS

The consistent exceedance of the reference limits established for MOSH and MOAH in the majority of the samples analysed suggests an urgent need for intervention at both regulatory and agricultural practice levels, underlining the importance of harmonising legislative standards at European level to reduce associated risks.

The results highlight an alarming situation for feed safety, with potentially severe implications for animal and consumer health. Given the high proportion of non-compliant samples, it is essential to prioritize stricter legislative measures, as well as investments in technological solutions to reduce contamination.

The contamination distribution observed for the MOAH fraction shows that contamination levels are relatively better controlled compared to MOSH. However, given the toxicological concern associated with this fraction, even low contamination levels may require strict monitoring and maintenance of rigorous control measures. The results obtained from milk analysis also highlight the need for stricter preventive measures throughout the production, storage and processing chain to limit sources of MOAH contamination.

In order to improve food safety and effectively control MOH contamination, it is essential to establish clear and legally binding limits for the MOSH and MOAH fractions, based on the latest toxicological data. It is also recommended to implement a monitoring and reporting system across the entire agri-food sector, with a focus on reducing technological sources of contamination. International collaboration to harmonize regulations, support research into innovative methods to reduce contamination and educate consumers are also necessary measures that could contribute to reducing public health risks and increasing confidence in food safety.

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