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EXCUTIVE SUMMARY:

MOH CONTAMINATION IN THE JUTE BAG SUPPLY CHAIN USED FOR PACKING COCOA BEANS -A SPECIFICATION LEVEL CONCEPT

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Project Supported By:

Members of the Technical Working Group on Mineral Oil Hydrocarbons (MOH TWG[1])

contributing to the MOH Sampling Project

[1] MOH TWG includes stakeholders from the cocoa and jute sectors.
The project was kindly sponsored by some of the members of the TWG, namely (in alphabetical order): Barry-Callebaut, Cargill, Guittard, Mars, Mask Associates , Nederland, ofi, Premchand Jute and Storck

ABSTRACT

Mineral oil hydrocarbons (MOH) are ubiquitous contaminants, mainly composed of two fractions, saturated hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH), that have raised significant concern in the last years. The European Union is currently drafting a regulation for maximum limits for MOAH, with indicative action levels for MOSH, in a number of foods including cocoa products, and is also encouraging the Codex Alimentarius Commission to consider MOH as an emerging food safety issue. Jute bags have been identified in a previous project to be important contributors to MOH contamination in cocoa, though not all bags are contaminated to the same extent. This work was commissioned to gain an insight into the causes of variability, assess entry points of contamination, determine if the current International Jute Standard is adequate to prevent the use of MOSH/MOAH contaminated jute bags in the cocoa supply chain and, if not, to propose new specifications that will help minimize the risk that cocoa products will not meet the anticipated EU limits due to contamination arising from contact with jute packaging.

KEY FINDINGS:

- Evaluation of industry data suggests mineral oil hydrocarbon (MOH) contamination of jute bags sampled in recent years is still a concern, whether the bags are labelled as food-safe (vegetable oil treated, VOT) or not (mineral oil treated, MOT) with no significant differences found between MOSH and MOAH levels in VOT vs MOT bags

- Higher levels of MOH found in "(re)-used" bags suggesting that further contamination can occur during transport and storage.

- Analysis of samples taken from points along the jute production line shows that whilst contamination from sources including raw jute fibre, vegetable batching oils and printing inks cannot be ruled out, other sources including cross-contamination from mineral oil batched jute produced in the same factory are implicated
- Reliance on the IJO 98/01 criteria for food-safe jute, based on a maximum level for unsaponifiable material (USM), cannot provide assurance that bags are not contaminated with MOSH/MOAH since no correlation between MOAH and USM, and only a weak correlation between MOSH and USM, was found.

- Based on a model to predict the impact of exposure to MOH contamination from jute on compliance of cocoa products to anticipated EU regulatory limits, the following maximum limits are proposed (with a safety margin to take account of exposure to MOH contamination from other sources

  - **MOAH: max. 25 mg/kg**

  - **MOSH: max. 250 mg/kg**

RECOMMENDATIONS

- Further investigation and action to address the root causes of MOH contamination in jute bag manufacturing (a risk assessment template is provided)

- Awareness raising of the proposed specifications and their use advocated for any jute used in cocoa supply chains as a first step in reducing MOH contamination.

- Proposed specifications to be kept under review in the context of the changing regulatory landscape, in particular in the eventuality of international regulatory limits for MOH in food contact materials

- Engage stakeholders and identify standardization bodies(s) to establish specifications in a standard which can be enforced, for example a revised standard for food grade bags for use in the jute sector and an optional clause in FCC cocoa contracts

Mineral oil hydrocarbons (MOH) are ubiquitous contaminants, mainly composed of two fractions, saturated hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH), that have raised significant food safety concerns in recent years (EFSA, 2023). The European Union is currently drafting a regulation for maximum limits for MOAH, with indicative action levels for MOSH, in a number of foods including cocoa products, and is also encouraging the Codex Alimentarius Commission to consider MOH as an emerging food safety issue.

Previous studies have shown that cocoa products can be exposed to MOH contamination at various points in the supply chain from the farm to the final product delivered to the consumer. Potential contamination sources include poorly designed/badly maintained artificial dryers which do not prevent fuel or fumes coming into contact with cocoa beans, exposure to lubricants, tyre debris or road bitumen, and contact with contaminated packaging materials (see BDSI Toolbox MOSH_MOAH). A study supported by the CAOBISCO/ECA Joint Cocoa Research Fund (JRF, 2021) found that cardboard, and in particular, the jute sacks used during the transportation of cocoa were important sources of contamination though there was considerable variability in the samples tested. This current work was commissioned to investigate the sources of this variability in the jute sacks, and to develop criteria that could be used in the cocoa supply chain to assess whether or not a bag is suitable for use in transporting cocoa.

A survey of data provided by CAOBISCO/ECA members on MOH levels in jute bag samples (VOT and MOT, new and used bags), batching oils, and printing inks was carried out, and results from 148 samples analysed by different laboratories between 2014 and 2023 were evaluated. Although levels of MOSH were found to be generally lower in the VOT jute bag samples, this was not the case for MOAH levels. Nevertheless, in all cases, **the differences between MOSH and MOAH in VOT vs MOT bags were not significant ($p>0.05$)**. The highest levels of MOSH were found in used bags, whether VOT or MOT, suggesting poor handling/exposure to additional contamination during transport and storage.

A second objective of the project was to examine entry points of MOH contamination in jute bag production, focusing on VOT jute bags. Thirty-nine samples were selected for analyses using LC-GC-FID for MOSH and MOAH, with further analysis of some samples using GC×GC-MS for confirmation purposes. The three samples of raw jute analysed showed highly variable levels of MOSH (1, 15, and 86 mg/kg); while the MOAH levels were < 5 mg/kg, 8 and 9 mg/kg, whilst the one sample of vegetable batching oil tested contained unexpectedly high levels of MOAH most likely due to the presence of interfering compounds. Analysis of further samples of batching oils/raw jute, together with further information on their source, would be needed to draw firm conclusions on their respective roles as potential entry points for MOH contamination. Similarly, although no significant differences were found between levels of MOSH/MOAH from samples taken before and after

printing (sewing stage and final bags, respectively), some samples from printed bags did contain notably higher levels of both MOSH and MOAH. These limited results suggest that although it is likely that some MOH originates from the raw jute material, it is likely that the subsequent steps in producing and handling the bags are critical in controlling contamination, with further research and controls placed on batching oils, emulsifiers, printing inks and prevention of contamination from non-food grade lubricants for equipment and cross-contamination from MOT bags produced in the same factory advocated.

The third objective of this work was to establish whether the current criteria used to determine the suitability of jute bags for use in the cocoa supply chain, provide adequate assurance that they are not contaminated with MOSH/MOAH. Jute bags for cocoa should conform to a standard for food-safe jute adopted by the International Jute Organisation (IJO, 1998) which specifies that the batching oil used during jute manufacture shall only contain non-toxic ingredients and sets a maximum limit for the presence of unsaponifiable material (USM) of 1250 mg/kg jute fibre (as determined using IUPAC method WG 1/90) to distinguish VOT from MOT bags. Thirty-six samples of the jute bags mentioned above were analysed for USM in addition to MOSH/MOAH. Although there was some correlation between MOSH and USM levels (R^2=0.4137), there was no correlation between MOAH and USM (R^2=0.0001) (Table and Figures below) indicating that **USM determination is unsuitable for assessing whether bags are contaminated with MOAH.**

Table 2.3. correlation Matrix

	Total MOH	*Total MOSH / POSH (C10-C50)*	*Total MOAH (C10-C50)*	*USM mg/kg*
Total MOH	1			
Total MOSH (C10-C50)	0.99	1		
Total MOAH (C10-C50)	0.29	0.14	1	
USM mg/kg	**0.62**	**0.64**	**-0.01**	**1**

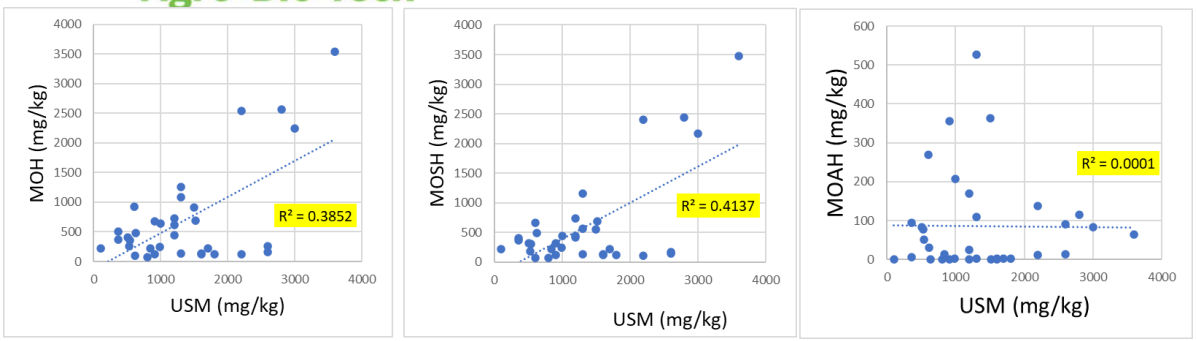

Figure 1. correlation between MOH, MOSH, and MOAH vs USM

The final objective of this work was to develop guidance on the maximum levels of MOSH and MOAH in jute bags that would still be suitable for use in cocoa supply chains as a pragmatic first step in the process of minimizing MOH contamination in cocoa products. A model was developed, based on the previous study of the migration of mineral oil contaminants from jute into cocoa shells and nibs (JRF, 2021) and the anticipated EU regulatory limits. Although a limited number of time points are available, a migration curve was built to evaluate the migration function and a worse-case scenario applied whereby all of the MOH contaminants in the jute migrate into the cocoa cotyledon of the cocoa beans over a 12 month period. To give a conservative estimate, calculations were based on the migration of total MOSH/MOAH, with no differentiation based on the C-fraction, although it is known that the migration is favored on the light fraction for volatility reasons. Based on this model, the following specification levels for jute bags are proposed to assure[GP1] that cocoa beans stored in the sacks, and their derived products, would not exceed the regulatory limits for MOH that are expected to be set in the EU with a safety margin for potential MOH contamination at other stages in the cocoa bean supply chain.

- MOAH: max. 25 mg/kg
- MOSH: max. 250 mg/kg

Based on the results from the current study, 45% of the jute bags tested are below the proposed maximum MOAH level, and 55% are below the proposed MOSH level (Figure 1). Since the samples evaluated in this study come from a diverse range of sources, it is likely that this specification is already widely achievable.

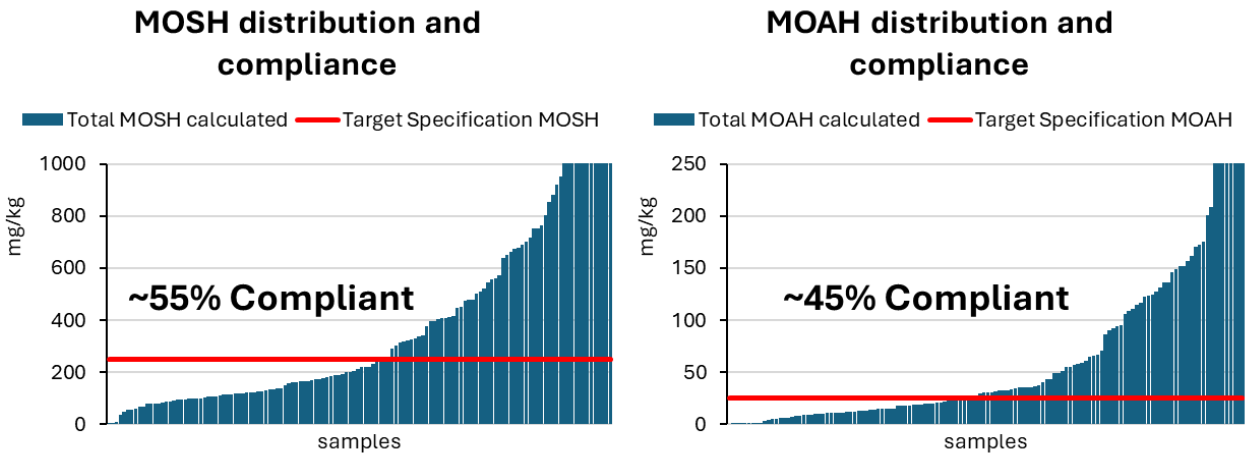

Figure 2 The distribution of MOSH and MOAH in the 169 jute bags ordered from the lowest to the highest value and in relation to the proposed specification.

Recommendations:

- Further investigation and action to address the root causes of MOH contamination in jute bag manufacturing (a risk assessment template is provided in Annex 1 to help identify potential reduction steps).
- Awareness raising of the proposed specifications and their use advocated for any jute used in cocoa supply chains. The specification levels proposed should be seen as a first step in a pragmatic approach to minimizing MOH contamination from the jute bags used in the cocoa supply chain. However, it is advised to review the specification levels in the context of the changing regulatory landscape, and following the ALARA principle, as and when required. Indeed, these current specifications may become obsolete once regulatory limits for MOH in food contact materials are introduced with international coverage, including possible Codex limits.
- It is necessary to engage stakeholders and identify standardization bodies(s) to establish specifications in a standard which can be enforced, for example a revised standard for food grade bags for use in the jute sector and an optional clause in FCC cocoa contract

ANNEX I: Sampling table/ risk assessment table (Also available in excel format)

Sample

Date

Batching oil 2.x

Process step	Sample	Type of machine lubricants/ oil/ ink used during process step	Details of oil/ ink/ lubricant	Food grade Y/N	Risk of contamination taking place	Likelihood of cross contamination to product (1 very low, 5 very high)	Additional comments
Explanation		Purpose of oil : for instance hydraulic oil, gearbox oil, lubricant, heating oil etc etc.	Describe the technical name of the lubricant for instance Casside GL 220 fluid gearbox	In the MSDS of the lubricant used it should be clear if the lubricant are food grade or not, bear in mind if risk of contact is very low or not possible a food grade lubricant might not be required	Describe how possible contamination can occur, for instance lubricants for joints coming in contact with jute fibres	If lubricant cannot come in contact with jute the likelihood is very low, if lubricant will likely be in directy contact the likelhood is very high	
Raw jute	1.x						
Assortment and Hackling							
Batch Selection							
Softening of emulsion							
Conditioning or pilling	3.x						
Carding							
Drawing							

			Spinning						
			Winding	4.x					
			Beaming and singeing						
			Weaving						
			Finishing						
			Cutting and Sewing	5.x					
Printing Ink	6.x	→	Printing	7.x	Printing Ink				
Secondary packaging	8.x	→	Packing						