Scientific assistance to assess the detoxification process for dioxins and PCBs in sunflower cake by hexane extraction

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Scientific assistance to assess the detoxification process for dioxins and PCBs in sunflower cake by hexane extraction

European Food Safety Authority (EFSA), Katleen Baert, Marco Binaglia, Matteo Lorenzo Innocenti and Luisa Ramos Bordajandi

Abstract

EFSA was requested to provide scientific assistance to the European Commission on a detoxification process for dioxins and polychlorinated biphenyls (PCBs) from sunflower cake by hexane extraction in an emergency situation, as specified in Article 7 of Commission Regulation (EU) 2015/786. The process entails hexane extraction of sunflower oil from the cake to remove dioxins (polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)) as well as dioxin-like (DL-) and non-dioxin-like (NDL-) PCBs. The data provided by the applicant were assessed with respect to the efficacy of the process, absence of solvent residues and on information demonstrating that the process does not adversely affect the nature and characteristics of the product. According to data provided, the process was effective in producing a sunflower meal that contained concentrations of PCDD/Fs and DL-PCBs, and NDL-PCBs (6 indicator PCBs) about 90% lower than in the sunflower cake. The data showed that it is possible to meet the current EU maximum levels with respect to these contaminants using this process. It is unlikely that hazardous substances (i.e. hexane) remain in the final product. The extraction of the oil from the sunflower cake produces sunflower meal, which has a different nutrient content and nutritional value than the original sunflower cake, but is suitable to be used in animal nutrition with no specific legal limitations in the use or the inclusion levels in the diets. The applicant indicated that the crude oil, as well as the co-products resulting of the processing of this oil, could only be used for technical purposes. No information was provided regarding the disposal or reuse of the hexane. EFSA concluded that the proposed detoxification process to remove PCDD/Fs and PCBs from sunflower cake by means of solvent extraction to produce sunflower meal, met the acceptability criteria provided in Commission Regulation (EU) 2015/786.

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**Keywords:** detoxification process, dioxins, PCDD/Fs, dioxin-like PCBs, non-dioxin-like PCBs, sunflower cake, sunflower meal

**Requestor:** European Commission

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed\(^1\) provides that the use of products intended for animal feed which contain levels of undesirable substances exceeding the maximum levels laid down in Annex I of that Directive is prohibited.

Directive 2002/32/EC provides also that Member States are to ensure that measures are taken to guarantee the correct application of any acceptable detoxification process on products intended for animal feed and the conformity of those detoxified products with the provisions of Annex I of that Directive.

In order to ensure a uniform assessment across the European Union of the acceptability of detoxification processes, acceptability criteria for detoxification processes have been established at Union level by Commission Regulation (EU) 2015/786 of 19 May 2015\(^2\) defining acceptability criteria for detoxification processes applied to products intended for animal feed as provided for in Directive 2002/32/EC of the European Parliament and of the Council.

The acceptability criteria for detoxification processes established by the Regulation shall ensure that the detoxified feed does not endanger animal and public health and the environment and that the characteristics of the feed are not adversely altered by the detoxification process. The Regulation furthermore provides that the compliance of a detoxification process with those criteria shall be scientifically assessed by the European Food Safety Authority (EFSA) on a request from the Commission.

Article 7 of Regulation (EU) 2015/786 provides that in case of an urgent need to decontaminate a large amount of feed with a detoxification process not yet assessed by EFSA, the Commission may request to EFSA on request of a competent authority to provide within a short period of time for an assessment of the detoxification process.

The Commission received a request from the competent authority of Spain on 18 July 2018 about a process to decontaminate a consignment of sunflower meal contaminated with dioxins and PCBs with a specific detoxification process.

1.1.2. Terms of Reference

In accordance with Art. 31 of Regulation (EC) No 178/2002, the European Commission asks the European Food Safety Authority to assess the detoxification process for dioxins and PCBs in sunflower meal.

1.2. Interpretation of the Terms of Reference

EFSA received from the European Commission a request for scientific advice on the assessment in an emergency situation, as specified in Article 7 of Regulation (EU) 2015/786, of an application referring to a feed detoxification process. EFSA was requested to check whether the process is compliant with acceptability criteria specified in the Commission Regulation (EU) 2015/786 of 19 May 2015. In this context, the term detoxification is interpreted as either decontamination by removing the contaminants or by using chemical or (micro)biological processes able to reduce the toxicity of the contaminants present. This urgent request assesses the detoxification process of sunflower cake by the removal of dioxins (polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)), as well as dioxin-like (DL-) and non-dioxin-like (NDL-) polychlorinated biphenyls (PCBs) by extracting the contaminated sunflower oil to produce a sunflower meal. Since PCDD/Fs and PCBs mostly occur in the lipid fraction, this process should have the potential to reduce their presence in the final sunflower meal product. EFSA agreed that the Terms of Reference provided by the European Commission were clear and that the scientific report for the assessment of this physical detoxification process should mainly focus on data in order to:

- enable the assessment of the efficacy of the process to remove the contaminants from the feed batches to ensure compliance with the requirements of Directive 2002/32/EC, and

\(^1\) OJ L 140, 30.5.2002, p. 10.
\(^2\) OJ L 125, 21.5.2015, p. 13.
demonstrate that the detoxification process does not adversely affect the characteristics and the nature of the feed.

Information concerning the safe disposal of the removed part of the feed was also considered. Since hexane, an organic solvent, is used in a step of the process, EFSA was of the view that information about presence of its residues in the resulting sunflower meal should be evaluated.

EFSA noted the similarities with the detoxification process assessed in the 'Scientific Opinion on the assessment of a decontamination process for dioxins and PCBs from fish meal by hexane extraction and replacement of fish oil' (EFSA CONTAM Panel, 2018) and used this assessment as a starting point for the current evaluation. It should be noted that the current assessment was carried out in an emergency situation and is not a comprehensive assessment.

In this scientific report, sunflower cake was considered as the by-product resulting from the mechanical pressing (expelling) of sunflower seeds, while sunflower meal refers to the product resulting of the further processing of the cake by solvent extraction.

In this scientific report, NDL-PCBs refer to the six indicator PCBs (PCB-28, -52, -101, -138, -153 and -180) (ICES-6).

1.3. Additional information

The feed business operator has provided the European Commission with information referring to the proposed detoxification process and its effectiveness as laid down in Directive 2002/32/EC.

2. Data and methodologies

2.1. Data

The feed business operator has submitted information in support to its claim about the efficacy of the detoxification process consisting in the extraction of sunflower oil containing high levels of DL- and NDL-PCBs from the sunflower cake. A report was provided describing an experimental laboratory-scale set-up to examine the conditions of an industrial extraction using a simulation of a counter-flow extraction process with hexane. The report included information on the detoxification process and its steps, equipment and solvent used for the detoxification procedures, analytical data, some characteristics of sunflower meal, and on disposal of undesirable substances. In addition, analytical reports of the contaminated sunflower cake were provided.

EFSA based its assessment on the information provided (see section 'Documentation provided to EFSA'), the comprehensive assessment of the decontamination process for dioxins and PCBs from fish meal by hexane extraction (EFSA CONTAM Panel, 2018) and published literature, to address the Terms of Reference.

2.2. Methodologies

EFSA evaluated the acceptability of the proposed detoxification process as requested by the relevant regulations, specifically Directive 2002/32/EC and Commission Regulation (EU) 2015/786 with their Annexes. EFSA followed the same methodology as for the comprehensive assessment of the decontamination process for dioxins and PCBs from fish meal by hexane extraction (EFSA CONTAM Panel, 2018). The assessment was conducted in line with the principles described in the EFSA guidance on transparency in the scientific aspects of risk assessment (EFSA, 2009) and following the relevant existing guidance from the EFSA Scientific Committee.

3. Assessment

3.1. Method of analysis

The feed business operator submitted information on the analysis of PCDD/Fs, DL-PCBs and NDL-PCBs performed by two accredited laboratories (Dr. A. Verwey B.V., Rotterdam, the Netherlands and CARSO, Lyon, France).

The analytical methods to determine the concentration of PCDD/Fs and PCBs were based on or equivalent to the European Standard CEN – EN 16215 ‘Animal feeding stuffs – Determination of dioxins and dioxin-like PCBs by GC/HRMS and of indicator PCBs by GC/HRMS’. The method is suitable for the determination of PCDD/Fs, DL-PCBs and NDL-PCBs at the appropriate MRL in compound feed and ingredients.
3.2. Detoxification process

The feed business operator submitted information to assess the effectiveness of the procedure, including data on PCDD/Fs, DL-PCBs and NDL-PCBs. A scheme and description of the steps of the detoxification process of the sunflower cake were also provided.

Solvent extraction has been described in the literature as being effective in extraction of edible oils. For sunflower oil, hexane is the most commonly used solvent (FAO, 2010; Heuze et al., 2016). The applicant uses hexane as solvent and reports that the residual content of oil in the sunflower meal following extraction is 1.6%. It is expected that the elimination of PCDD/Fs, DL-PCBs and NDL-PCBs should occur to a similar extent as these are present primarily in the oil fraction.

3.2.1. Description of the process

The proposed process is a counter-flow oil extraction with hexane. The process is based on the principle that PCDD/Fs and PCBs are lipophilic contaminants and will be associated with the oils found in sunflower products. Therefore, the defatted sunflower meal will have a considerably lower level of organic (lipophilic) contaminants such as PCDD/Fs and PCBs in comparison to the starting material.

In the laboratory-scale test, the cake (3 kg) was extracted with 4.2 L of hexane for a period of 10 min at 55°C. Each batch of cake was extracted four times and the ‘miscella’ (i.e. the mixture of oil and hexane) was re-used in a counter-flow system. Namely, the miscella resulting from the fourth extraction of the first batch was used for the third extraction of the second batch, followed by the second extraction of the third batch and the first extraction of the fourth batch. The first three miscella were not representative for the four steps counter-flow extraction and were discarded.

After the fourth extraction of a batch, the resulting meal was allowed to drain until the product was not dripping anymore and it was dried at ambient temperature under a fume hood. Finally, a thermal treatment was done in an oven at 100°C (time unspecified).

A distillation of the collected miscella was performed to separate the hexane from the oil.

3.2.2. Efficacy of the process

The detoxification process was tested once at the laboratory scale and the feed business operator provided analytical results of the contaminated cake (n = 3), the decontaminated meal (n = 5) and the crude oil (n = 5). Concentrations of PCDD/Fs, DL-PCBs and NDL-PCBs were reported for each sample and Table 1 shows a summary of the data provided. The required information to calculate the efficacy of the process was not provided. EFSA calculated instead, from the average concentrations in the contaminated cake and the decontaminated meal, the average reduction of the concentration as shown in Table 2. However, it should be noted that the meal and the cake have different compositions.

Table 1: Summary statistics of the concentration of PCDD/Fs and PCBs in sunflower cake, decontaminated sunflower meal and the crude oil

| Matrix                  | N  | PCDD/Fs<sup>(a)</sup> | DL-PCBs<sup>(a)</sup> | Sum of PCDD/Fs and DL-PCBs<sup>(a)</sup> | NDL-PCBs<sup>(b)</sup> |
|-------------------------|----|-----------------------|-----------------------|-------------------------------------------|------------------------|
|                         |    | Average | Range     | Average | Range     | Average | Range     | Average | Range     |
| Sunflower cake          | 3  | 0.16    | 0.110–0.186| 6.173   | 3.410–8.710| 6.334   | 3.595–8.896| 17.467  | 14.600–20.000|
| Decontaminated sunflower meal | 5  | 0.022   | 0.019–0.026| 0.542   | 0.410–0.710| 0.564   | 0.429–0.736| 1.660   | 1.400–2.000|
| Crude oil               | 5  | 1.08    | 0.98–1.10 | 57.2    | 55.0–59.0 | 58.28   | 56.10–59.98| 197     | 195.0–201.0|

N: number of samples; PCDD/F: polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans; DL-PCB: dioxin-like polychlorinated biphenyls; NDL-PCB: non-dioxin-like polychlorinated biphenyls (six indicator PCBs (PCB-28, -52, -101, -138, -153 and -180) (ICES-6)).

<sup>(a)</sup>: Expressed as ng WHO2005-TEQ/kg and relative to a moisture content of 12%.

<sup>(b)</sup>: Expressed as µg/kg and relative to a moisture content of 12%.
The data provided by the feed business operator showed that the detoxification process resulted in the production of a sunflower meal that had concentrations of PCDD/Fs and DL-PCBs (ng WHO2005-TEQ/kg, expressed as ‘toxic equivalent’) and NDL-PCBs that were approximately 90% lower than in the original sunflower cake. For PCDD/Fs alone, the concentration was on average 86% lower.

Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed and its updates sets action thresholds and maximum limits. Thresholds of action are needed in order to keep the presence of specific undesirable substances in products intended for animal feed as low as possible in order to reduce their presence in the food chain. Where such action thresholds are exceeded, investigations must be carried out to identify the sources of the undesirable substances and steps taken to reduce or eliminate such sources. As shown in Table 3, the action threshold applicable to sunflower cake/meal for PCDD/Fs is 0.5 ng WHO2005-TEQ/kg and the maximum permitted level is 0.75 ng WHO2005-TEQ/kg. For DL-PCBs, the action threshold is 0.5 ng WHO2005-TEQ/kg while the maximum level for the sum of PCDD/Fs and DL-PCBs is 1.5 ng WHO2005-TEQ/kg and for NDL-PCBs 10 μg/kg.

EFSA noted that the absence of hexane in the final product was not analytically verified. It is indicated in the information provided by the applicant that a thermal treatment was simulated by heating a sample of 500 g meal at 100°C (time not specified). Upon request from EFSA, the applicant provided additional information on this step. It was clarified that the elimination of the residual hexane in the sunflower meal would be carried out in a vertical and hermetic cylindrical equipment (toaster), in which evaporation of the solvent is achieved by heating the meal (80–105°C) and steam distillation under atmospheric pressure. Considering that hexane has a boiling point <70°C, heating the sunflower meal to 100°C for an appropriate time should be sufficient to ensure that residues of hexane are not left in the finished product.

Table 2: Average concentration of PCDD/Fs and PCBs in sunflower cake and decontaminated sunflower meal and calculated mean reduction of the concentrations

| Matrix                      | N | PCDD/Fs (a) | DL-PCBs (a) | Sum of PCDD/Fs and DL-PCBs (a) | NDL-PCBs (b) |
|-----------------------------|---|-------------|-------------|--------------------------------|--------------|
| Sunflower cake              | 3 | 0.16        | 6.173       | 6.334                          | 17.467       |
| Decontaminated sunflower meal| 5 | 0.022       | 0.542       | 0.564                          | 1.660        |
| Mean reduction (%)          |   | 86          | 91          | 91                             | 90           |

N: number of samples; PCDD/F: polychlorinated dibeno-p-dioxins and polychlorinated dibenzofurans; DL-PCB: dioxin-like polychlorinated biphenyls; NDL-PCB: non-dioxin-like polychlorinated biphenyls (six indicator PCBs (PCB-28, -52, -101, -138, -153, and -180) (ICES-6)).

(a): Expressed as ng WHO2005-TEQ/kg and relative to a moisture content of 12%.

(b): Expressed as μg/kg and relative to a moisture content of 12%.

The data provided by the feed business operator showed that the detoxification process resulted in the production of a sunflower meal that had concentrations of PCDD/Fs and DL-PCBs (ng WHO2005-TEQ/kg, expressed as ‘toxic equivalent’) and NDL-PCBs that were approximately 90% lower than in the original sunflower cake. For PCDD/Fs alone, the concentration was on average 86% lower.

Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed and its updates sets action thresholds and maximum limits. Thresholds of action are needed in order to keep the presence of specific undesirable substances in products intended for animal feed as low as possible in order to reduce their presence in the food chain. Where such action thresholds are exceeded, investigations must be carried out to identify the sources of the undesirable substances and steps taken to reduce or eliminate such sources. As shown in Table 3, the action threshold applicable to sunflower cake/meal for PCDD/Fs is 0.5 ng WHO2005-TEQ/kg and the maximum permitted level is 0.75 ng WHO2005-TEQ/kg. For DL-PCBs, the action threshold is 0.5 ng WHO2005-TEQ/kg while the maximum level for the sum of PCDD/Fs and DL-PCBs is 1.5 ng WHO2005-TEQ/kg and for NDL-PCBs 10 μg/kg.

EFSA noted that the absence of hexane in the final product was not analytically verified. It is indicated in the information provided by the applicant that a thermal treatment was simulated by heating a sample of 500 g meal at 100°C (time not specified). Upon request from EFSA, the applicant provided additional information on this step. It was clarified that the elimination of the residual hexane in the sunflower meal would be carried out in a vertical and hermetic cylindrical equipment (toaster), in which evaporation of the solvent is achieved by heating the meal (80–105°C) and steam distillation under atmospheric pressure. Considering that hexane has a boiling point <70°C, heating the sunflower meal to 100°C for an appropriate time should be sufficient to ensure that residues of hexane are not left in the finished product.

Table 3: Action thresholds and maximum levels for PCDD/Fs, DL-PCBs and NDL-PCBs applicable to sunflower cake/meal according to Directive 2002/32/EC and its amendments

| Contaminant          | Action thresholds (a) | Maximum levels (a) |
|----------------------|-----------------------|--------------------|
| PCDD/Fs              | 0.5                   | 0.75               |
| DL-PCBs              | 0.5                   | –                  |
| Sum of above         | –                     | 1.5                |
| NDL-PCBs             | –                     | 10.0               |

PCDD/F: polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans; DL-PCB: dioxin-like polychlorinated biphenyls; NDL-PCB: non-dioxin-like polychlorinated biphenyls (six indicator PCBs (PCB-28, -52, -101, -138, -153, and -180) (ICES-6)); – not set in regulation.

(a): Values expressed in ng WHO2005-TEQ/kg (PCDD/Fs and DL-PCBs) or μg/kg (NDL-PCBs); moisture content of 12%.

3.3. Characteristics and nature of the sunflower meal

The characteristics and nature of the sunflower meal from the decontaminated batch was not described. Therefore, a direct comparison of the same batch before (sunflower cake) and after (sunflower meal) the decontamination by means of, e.g. evaluation of the fatty acids profile and other key characteristics was not possible.

EFSA noted that the process described by the applicant seems to be in line with the industrial process to extract oil from seeds, including sunflower seeds. On a first step, the seeds are ground and...
pressed to remove the oil. This results in sunflower oil and as by-product the so-called sunflower cake, with an average oil content of 10–14% (range from 7% to > 20%); the cake can be processed further by solvent extraction, to result in sunflower meal, with an oil concentration of approximately 1.8–2.3% (Heuzé et al., 2016). The applicant reported an oil content in the initial sunflower cake and in the resulting sunflower meal after hexane extraction of 8.46% and 1.64%, respectively. These values are in line with those described above.

EFSA considers that the extraction of the oil from the sunflower cake as reported by the applicant produces sunflower meal, a different product than the original sunflower cake. Sunflower meal has a different nutrient content (e.g. crude fat and crude protein concentration) and nutritional value than sunflower cake, but it is also used in animal nutrition with no specific legal limitations in its use or its inclusion levels in the animal diets (Heuzé et al., 2016). Therefore, the resulting sunflower meal from the detoxification process described by the applicant is suitable to be used for animal feed.

3.4. Disposal of the removed materials

The crude sunflower oil and hexane were separated by distillation. The applicant indicated that the crude oil, as well as the co-products resulting of the processing of this oil, could only be used for technical purposes.

No information was provided regarding the disposal or reuse of the hexane.

3.5. Discussion

EFSA assessed the information made available in the documents submitted by the feed business operator and was of the view that sufficient information was available to assess, in an emergency situation, the proposed detoxification process for PCDD/Fs, DL- and NDL-PCBs present in sunflower cake.

A description of the process with its different steps was provided. The process resulted in the production of a sunflower meal that had concentrations of PCDD/Fs and DL-PCBs, as well as NDL-PCBs that were on average 90% lower than in the original sunflower cake. The concentrations of PCDD/Fs, DL- and NDL-PCBs remaining in the feed after the detoxification process, complied with the maximum levels reported in the Annex I of Directive 2002/32/EC (Table 3). However, it was noted that the concentration of DL-PCBs in the decontaminated meal was close to or above the action threshold. However, it should be noted that the measurement uncertainty was not specified.

EFSA concluded that it is possible to meet the current EU maximum levels for sunflower meal with respect to these contaminants after removal of oil with PCDD/Fs, DL- and NDL-PCBs.

EFSA was of the view that in principle the use of lipid extraction with organic solvent (hexane) should not lead to any detrimental changes in the quality of the sunflower final product. However, it should be noted that the process as proposed results in sunflower meal, a different feed product with different nutrient content and nutritional value compared to the original product (sunflower cake). Since sunflower meal is also used in animal nutrition with no specific legal limitations in its use or its inclusion levels in the animal diets, the resulting product from the detoxification process described by the applicant is suitable to be used for animal feed, and should be identified as such.

Limited information was provided regarding the disposal of the removed materials. The applicant indicated that ‘the crude oil could only be used for technical use - the co-products resulting from the processing of this oil also could only be recovered in technical use’. Considering that according to Directive 96/59/EC3, Member States should have taken the necessary measures to ensure that used PCBs are disposed of, it is unclear for which ‘technical purposes’ the oil and its co-products will be used.

According to the information provided to EFSA about the detoxification process, there is no analytical confirmation that the solvent (hexane) used to extract the oil, has been removed from the final product. From the additional information received from the applicant, it is foreseen to heat the sunflower meal in a so-called toaster at temperatures ranging from 80 to 105°C. Heating the sunflower meal at these temperatures for an appropriate time should be sufficient to minimise the residues of hexane in the sunflower meal.

EFSA noted that it is the responsibility of the Member State to ensure that measures are taken to guarantee the correct application of the detoxification process assessed on products intended for

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3 Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT). OJ L 243, 24.9.1996, p. 31–35.
animal feed and the conformity of those decontaminated products with the provisions included in the Commission Regulation (EU) 2015/786 and its Annexes.

3.6. Uncertainty analysis

The method used relies on the ability of an organic solvent (hexane) to extract the oil fraction from the sunflower cake. Based on the limited evidence provided by the business operator, it appears that the process will be effective in removing lipophilic contaminants such as PCDD/Fs and PCBs from the product.

EFSA noted that all provided information related to an experimental laboratory-scale set-up to examine the conditions of an industrial extraction using a counter-flow extraction. The experiment was carried out once. No information was provided regarding possible efficacy changes due to the up-scaling of the process. Therefore, and as part of an ongoing process to ensure compliance with EU legislation, the compliance of the final product with the Directive 2002/32/EC and its amendments should be checked before using the sunflower meal in animal feed.

4. Conclusions

In relation to the request for scientific advice on the assessment in an emergency situation, as specified in Article 7 of Regulation (EU) 2015/786, of an application referring to a feed detoxification process of sunflower cake by the removal of PCDD/Fs, DL-PCBs and NDL-PCBs (six indicator PCBs) by extraction with hexane, EFSA concluded that:

On the basis of the information submitted by the feed business operator, the proposed detoxification process is effective in producing a sunflower meal that contains lower concentrations of PCDD/Fs and DL- and NDL-PCBs than were contained in the sunflower cake from which it was produced. The levels of these compounds in the sunflower meal complied with the maximum levels laid down in Directive 2002/32/EC and subsequent amendments.

The sunflower oil extraction from the original sunflower cake leads to sunflower meal, a different feed product with different nutrient content and nutritional value. Sunflower meal is a suitable feed product commonly used as animal feed, with no specific legal limitations in its use or its inclusion levels in the animal diets.

Therefore, the proposed detoxification process assessed meets the acceptability criteria provided in Commission Regulation (EU) 2015/786.

The use of this detoxification process on a wider scale for an undetermined period of time is only allowed after EFSA has performed a comprehensive scientific assessment with favourable outcome.

Documentation provided to EFSA

1) Information provided by Saipol (Groupe Avril) – Spain regarding the detoxification of a sunflower press cake batch by simulating a counter-flow extraction with hexane; received on 20 July 2018.

2) Additional information submitted by Saipol (Groupe Avril) – Spain in response to a request from EFSA; received on 24 July 2018.

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Abbreviations

DL-PCBs  dioxin-like polychlorinated biphenyls
GC/HRMS  gas chromatography/high-resolution mass spectrometry
NDL-PCBs non-dioxin-like polychlorinated biphenyls
PCBs     polychlorinated biphenyls
PCDDs    polychlorinated dibenzo-p-dioxins
PCDD/Fs  polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans
PCDFs    polychlorinated dibenzofurans
TEQ      Toxic equivalents
WHO      World Health Organization