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Review: Survey on the production conditions for animal fats as feed ingredients in Germany

Übersichtsarbeit: Erhebung zu Produktionsbedingungen von tierischen Fetten für Fütterungszwecke in Deutschland

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Summary

The feeding of animal fats to food producing animals was generally prohibited by law in Germany between 2001 and 2009. As a result, manufacturers of animal fats from Category 3 material, being principally suited for feed utilization according to Regulation (EC) No 1774/2002, had to find alternative consumers for their products, for instance in the oleochemical industry. The situation changed in July 2009, when animal fats were approved again for feeding of non-ruminant food producing animals. A description of the structure of the rendering industry and of established safety measures is an important factor for the risk assessment of animal fats for livestock. Therefore, a survey was performed pertaining to the raw materials, the setup, the processing and the workflow in the rendering and fat melting industry. Questionnaires were sent to rendering and fat melting plants throughout Germany. The aim was to obtain information about raw material flow, production processes, and hygiene measures for the assessment of product safety. Due to the relative small number of evaluable questionnaires, the validation of repeatability and coherence of the responses was not possible. The evaluation of 31 responses indicated that the plants had implemented measures as usage of defined raw materials, monitoring of critical control points and the control of purity, hygiene and quality of the end product animal fat. Several plants had separated processing lines, allowing the production of species specific animal fat and processed animal proteins for feed purpose. Latter is interesting in respect to a possible change in the European regulation, regarding the lifting of the feed ban for processed animal proteins, which is discussed by the European Commission. In conclusion, defined production lines are an interesting option for animal fat production. These could be arranged at least in part on the basis of the established infrastructure.

Keywords: animal by-products, Category 3 material, fat processing, feed safety

Zusammenfassung

Die Verfütterung von tierischen Fetten an lebensmittelliefernde Tiere war in Deutschland zwischen 2001 und 2009 gesetzlich verboten. Als Folge dieses Verbots fanden die Hersteller von tierischen Fetten aus Kategorie 3 Material, welche grundsätzlich geeignet sind, nach den Richtlinien der Verordnung (EG) 1774/2002 Fette für Fütterungszwecke zu produzieren, neue Distributionswege und Verwendungsmöglichkeiten für ihre Produkte, wie zum Beispiel in der Oleochemie. Im Juli 2009 änderte sich diese Situation, als das Verfüttern von tierischen Fetten an lebensmittelliefernde Tiere mit Ausnahme von Wiederkäuern wieder erlaubt wurde. Kenntnisse über die Struktur von Verarbeitungsbetrieben tierischer Nebenprodukte und von etablierten Sicherheitsmaßnahmen sind wichtig für die Risikobewertung von tierischen Fetten im Rahmen der Ernährung von Nutztieren. Vor diesem Hintergrund erfolgte eine Befragung in den verarbeitenden Betrieben bezüglich der Rohwaren, der Betriebsstruktur, der Arbeitsprozesse und –abläufe. Hierfür wurden Fragebögen an Verarbeitungsbetriebe tierischer Nebenprodukte und Fettschmelzen innerhalb Deutschlands versendet. Ziel dieser Befragung war es, Informationen über Rohmaterialflüsse, Produktionsabläufe und hygienische Aspekte für die Bewertung der Produktsicherheit zu erhalten. Aufgrund der relativ geringen Anzahl an auswertbaren Fragebögen war eine Prüfung der Wiederholbarkeit und der Richtigkeit der Antworten nicht möglich. Die Auswertung von 31 beantworteten Fragebögen zeigt, dass Produzenten von tierischen Fetten die geforderten Bedingungen wie die Verwendung von definiertem Rohmaterial, die Überwachung kritischer Kontrollpunkte sowie die Durchführung von Reinheits-, Hygiene- und Qualitätsana-

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lysen erfüllen. Mehrere Betriebe haben zusätzlich eine Trennung verschiedener Verarbeitungslinien etabliert, sodass die separate Herstellung speziespezifischer Fette sowie von tierischen Proteinen möglich ist. Letzteres ist im Hinblick auf eine von der Europäischen Kommission diskutierte Änderung der europäischen Gesetzgebung im Bezug auf eine Aufhebung des Verfütterungsverbots für proteinreiche Futtermittel tierischer Herkunft interessant. Schlussfolgernd ergibt sich, dass die Produktion von definierten tierischen Fettqualitäten für Fütterungszwecke für die Optimierung der Sicherheit in der Futtermittelproduktion eine interessante Option ist. Eine Umsetzung erscheint zumindest zum Teil auf der Basis der etablierten Strukturen und der gegebenen Bedingungen möglich.

Schlüsselwörter: Tierische Nebenprodukte, Kategorie 3 Material, Fettverarbeitung, Futtermittelsicherheit

Introduction

Traditionally, animal fats have been an important ingredient of compound feed for farm animals in Germany as in other European countries. As a consequence of the occurrence of Bovine Spongiform Encephalopathy (BSE), the feeding of animal proteins such as meat and bone meal to livestock was prohibited by European (Regulation (EC) No 999/2001) and national legislation (Gesetz über das Verbot des Verfütterns, des innergemeinschaftlichen Verbringens und der Ausfuhr bestimmter Futtermittel (VerfverbG) vom 29. 3. 2001; Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch vom 1. 9. 2005). While other European countries continued to allow the feeding of animal fats, Germany prohibited animal fats for food producing livestock and horses, with the exception of fish oils to non-ruminants (Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch, 1. 9. 2005, § 18). As a result, the industry developed alternatives for the utilisation of rendered fats, such as their implementation as combustible material for energy production and their exploitation in the oleochemical industry. In July 2009, Germany repealed the prohibition and allowed animal fats as feed components to non-ruminants (Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch, 1. 9. 2005, changed by regulation of 3. 8. 2009).

Animal fat is a valuable ingredient of livestock feed due to its energy value, its provision of essential fatty acids and its positive effect on the product quality, which is mainly related to the higher amount of saturated fatty acids (Jeroch et al., 2008).

The amount of animal fat that can be used for feed production depends on adequate safety measures, the availability of defined raw materials, the competitive economic situation and the specific quality requirements of feed and finally food producers and retailers. While published data on animal fats give a good overview of their production yield and their utilisation in Germany (Niemann, 2007), the conditions in the rendering and fat melting industry and the specific raw material flow and processing in the plants have not been addressed. The aim of the present survey was to investigate these questions in specific regard to the processing of animal fats by rendering (end products: e.g. processed animal proteins and animal fat) and fat melting plants (end product: animal fats) in Germany, and to describe the structural aspects of the production of animal fats as well as the implications for animal fat as an ingredient in livestock feed, which requires high standards in terms of safety and quality.

Material and methods

Data collection on the production of animal fats in Germany

Data on the production of animal fats for the year 2006 were obtained from the STN (Servicegesellschaft Tierische Nebenprodukte mbH, Bonn, Germany). The data comprised the total amount of fat produced by the rendering plants, including the three Categories 1, 2 and 3 according to the "Animal By-Products Regulation" (Regulation (EC) No 1774/2002, Regulation (EC) No 1069/2009).

Category 1 material comprises e.g. animal by-products of animals suspected of being infected by a Transmissible Spongiform Encephalopathy (TSE), animals killed in the context of TSE eradication measures, specified risk material, as well as pets and zoo and circus animals. Materials of Category 2 are for example animal products containing residues of veterinary drugs and other listed contaminants, manure and digestive tract contents, and animals and parts of animals that died other than by being slaughtered for human consumption, including animals killed to eradicate epizootic diseases. Also all animals and animal products which are not listed for Category 1 or 3 belong to material of Category 2. Category 3 material comprises e.g. animal by-products of slaughtered animals which are suitable for human consumption but are not intended for human consumption for commercial purposes, parts of slaughtered animals which are rejected as unsuitable for human consumption but are not affected by any signs of diseases communicable to humans or animals, and other products of slaughtered animals such as skin, hooves, horn, porcine bristles, feathers and blood from non-ruminants.

Survey on rendering and fat melting plants using a structured questionnaire

In October 2007, a structured questionnaire was sent to 50 rendering and fat melting plants in Germany. All plants had implemented defined critical control points and regularly performed process controls. These control points were defined by the plant quality managers in accordance with the local authorities and therefore varied between plants. The process structure was generally comparable in all plants (Fig. 1).

The questionnaire consisted of two parts, one relating to the raw materials and the other relating to the structure and the processing and workflow in the rendering and fat melting plants. Some of the questions covered statistical data published by the STN and will not be considered in

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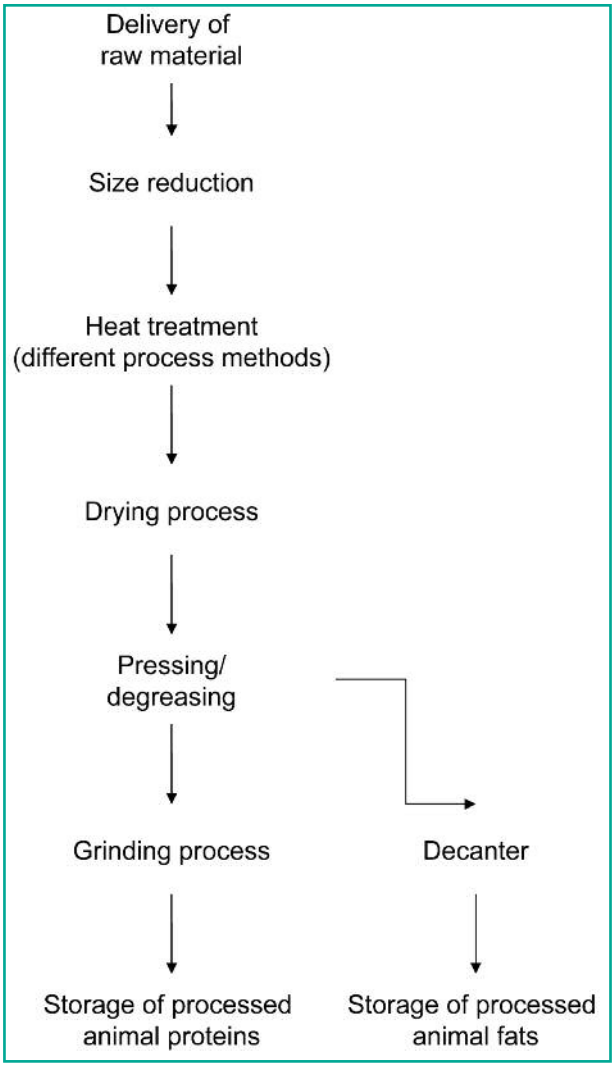

FIGURE 1: *General process structure of rendering and fat melting plants.*

this paper. A total of eleven questions were used in the evaluation:

1. **Which processing lines do you have in your plant?** (multiple answers possible)
   - ☐ Category 1 processing plant
   - ☐ Category 2 processing plant
   - ☐ Category 3 processing plant
   - ☐ Fat processing plant

2. **From which animal species did you obtain your raw material in 2006?** (multiple answers possible)
   - ☐ Pig ☐ Cattle ☐ Horse ☐ Chicken
   - ☐ Turkey ☐ Goose ☐ Duck ☐ Rabbit
   - ☐ Companion animals ☐ Others

   Please add the amount of raw material defined by the weight in tons.

3. **Which end products did you produce in 2006 and in what amount (in tons)?** (multiple answers possible)
   - ☐ Animal meal (Category 1 and 2)
   - ☐ Meat and bone meal ☐ Meat meal
   - ☐ Greaves meal ☐ Blood meal
   - ☐ Animal fat ☐ Others

4. **How was the disposition of the end products in 2006?** (multiple answers possible)
   - ☐ Oleochemicals ☐ Fertiliser ☐ Biodiesel
   - ☐ Incineration[1] ☐ Combustion[2]
   - ☐ Pet food industry ☐ Storage ☐ Others

   Please add the amount (in tons/2006) and the end product.

   [1]Incineration without using thermal energy.
   [2]Incineration for self supply and for thermal utilisation.

5. **Do you have an established division of processing lines for each animal species or categories over the whole working process?**
   - ☐ Yes ☐ No

   If not available, would a division be possible?
   - ☐ Yes ☐ No

6. **What kind of processing system do you have in your plant?**
   - ☐ Continuous system ☐ Batch system

7. **Time, temperature and pressure of heat treatments.** (Describe all steps if several heating processes are used).

8. **Which are your critical control points?** (multiple answers possible)
   - ☐ Particle size ☐ Temperature
   - ☐ Pressure ☐ Processing time
   - ☐ Processing rate
   - ☐ Analysis for the presence of *Clostridium perfringens*
   - ☐ Analysis for the presence of *Salmonella*
   - ☐ Analysis for the presence of *Enterobacteriaceae*
   - ☐ Others

9. **Do you control the incoming raw material in your plant?**
   - ☐ Yes ☐ No

   If yes, how do you perform it?

10. **Please give suggestions for an optimised localisation of sampling to control the product safety and quality of rendered fats.**

11. **Which analysis of the rendered fats do you perform in your plant?**
    - ☐ Remaining total insoluble impurities
    - ☐ Fatty acids ☐ Protein residues
    - ☐ Iodine number ☐ Peroxide number
    - ☐ Melting point ☐ Others

The response options to the questions were determined according to expert opinions. The response option "others" found in some questions provided the opportunity to give additional, specific information.

The return rate of the questionnaires was 36/50 (72 %). The responses of five plants were excluded from the evaluation because the plants were either storehouses for animal by-products, or they solely produced food for human consumption according to Regulation (EC) No 853/2004 and were not additionally registered according to Regulation (EC) No 1774/2002, or the excluded units were administrative headquarters. The evaluation therefore refers to 31 responses. The response rate was 69 % (31/45) under the condition that the excluded plants were not

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considered to be rendering plants. Two responses (2/31) were from fat melting plants which produced animal fats for human products and for animal feed according to the Regulations (EC) No 853/2004 and (EC) No 1774/2002.

Two plants refused to fill out the questionnaire without giving further statements, one plant didn't exist anymore and eleven plants didn't respond at all, even after a reminding phone conversation.

Results

The statistical data of the year 2006, collected from the STN (Servicegesellschaft Tierische Nebenprodukte mbH, Bonn, Germany), revealed that a total of 319 446 t of animal fat were produced in Germany (Niemann, 2007). Thereof, 146 814 t belonged to Category 1, 27 981 t to Category 2 and 144 671 t to Category 3, according to the Animal By-Products Regulation (EC) No 1774/2002 (Tab. 1). Only animal fats belonging to Category 3 can be used as ingredients in feed production. About 6.7 % (9758 t) of the animal fats (Category 3 material) were utilized by the pet food industry and more than 90 % of the Category 1 material was used for combustion, for instance in steam generators operating directly in the plants (Tab. 1). Many processing plants modified their heating systems to be able to derive energy from the animal fats. Interestingly, in the year 2006, no animal fats were incinerated without using thermal energy. The majority of the Category 2 and 3 animal fats (21 623 and 132 621 t, respectively) were used for technical purposes, especially for the production of oleochemicals such as glycerine and fatty acids (Tab. 1).

Most rendering plants (23/31) had one processing line, five plants processed two categories of raw material or processed Category 3 materials and had a fat melting plant. In three plants, material of all three categories was utilized (Tab. 2).

In total, most rendering plants utilized Category 1 material (19/31), seven plants processed Category 2 material, 14 plants used Category 3 material, and two were fat melting plants.

Based on the information from 28 rendering and fat melting plants, the major source of raw material used in the year 2006 was from pigs (356 575 t). Other animal by-products were from cattle (153 937 t), poultry (65 842 t) and horses (9233 t) (Tab. 3). The majority of raw materials (482 891 t) was summarised as "others", and included various sources including small ruminants as sheep and goats, rabbits, companion animals, forest and wild animals, or it originated from other animal by-products, such as bones, fat or blood. Three plants did not respond to this question.

Most of the rendering and fat melting plants were producing more than one type of end product, concerning both, animal fat and processed animal proteins. In total, 28 out of 31 plants produced animal fats. These represented the majority (269 044 t) of end products in 2006, followed by animal meal from the Categories 1 and 2 (220 434 t), meat and bone meal (112 352 t), meat meal (74 976 t), blood meal (16 302 t), greaves meal (6600 t) and 180 615 t of other products (biogas, meat paste, liquid feed, poultry meal, duck meal, used cooking oil and fat from the food industry). In total, 880 323 t of the end products obtained from animal by-products were produced in 2006, based on the information provided by 30/31 plants. The 269 044 t of animal fats could be further divided into 116 732 t of fat of Categories 1 and 2 raw material and 116 479 t, which originated from Category 3 raw material (Tab. 4). An amount of 35 833 t, which relates to 13.3 %, was not further specified and contained animal

TABLE 4: *Distribution of the animal fats produced in 2006 (in tons and percent), based on 31 returned questionnaires.*

End product animal fat	Tons	%
Animal fats of Categories 1 and 2	116 732	43.4
Animal fats of Category 3[1]	116 479	43.3
Not specified[2]	35 833	13.3
Total	269 044	100

[1]Summarised animal fats of Category 3 processing lines and fat melting plants. [2]Includes material of the categories 1, 2 and 3 and belongs, according to Regulation (EC) No 1774/2002, to Category 1.

TABLE 1: *Utilisation of different categories (Regulation (EC) No 1774/2002) of animal fats (in tons and percent) produced in Germany in 2006[1].*

	Category 1		Category 2		Category 3	
	Tons	%	Tons	%	Tons	%
Pet food production	–	–	–	–	9 758	6.7
Technical utilisation	11 315	7.7	21 623	77.3	132 621	91.7
Combustion	135 484	92.3	6 358	22.7	1 068	0.7
Storage	15	<0.1	–	–	1 224	0.9
Total	**146 814**	**100**	**27 981**	**100**	**144 671**	**100**

[1](Niemann, 2007).

TABLE 2: *Number of process lines of the rendering plants using animal by-products from categories 1, 2 and 3 according to Regulation (EC) No 1774/2002 and fat melting plants (FMP) according to Regulations (EC) No 1774/2002 and No 853/2004 in Germany in 2006, based on 31 returned questionnaires.*

	Number of process lines in the plant								
	1				2				3
Processed categories	1	2	3	FMP	1 and 2	2 and 3	1 and 3	3 and FMP	1 and 2 and 3
	12	3	7	1	1	0	3	1	3
Total	**23**				**5**				**3**

TABLE 3: *Distribution of the animal species from which the raw material was derived in 2006 (in tons and percent), based on 28 returned questionnaires.*

Animal species	Swine	Cattle	Poultry[1]	Horses	Others[2]
Tons	356 575	153 937	65 842	9 233	482 891
%	33.4	14.4	6.2	0.9	45.2

[1]Summarised data of chickens, turkeys, ducks, geese and poultry for human consumption. [2]Animal by-products, bones and fat of Category 3 material, pork and mixed blood, goats, sheep, forest and wild animals, companion animals, rabbits, fish, donkeys, unspecified animal cadavers (four plants did not differentiate the animal species).

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fats of Categories 1, 2 and 3 and belongs therefore, according to Regulation (EC) No 1774/2002, to Category 1.

The majority (407 518 t) of the produced animal by-products was used for combustion, 116 183 t of which were rendered fats. Great amounts (61 558 t) of fats were directly used for in-house energy production in the processing plants. The remainder of the animal fat fraction was used for the production of oleochemicals (49 200 t), as ingredient in the pet food industry (23 066 t), for biodiesel production (13 294 t) and for other, non-specified technical purposes (19 000 t) (Tab. 5).

Setup of the rendering and fat melting plants and working process

Nine plants out of thirty-one processed using an animal species or category separation (Tab. 6). The majority of the rendering plants (21) did not process species or categories separately (Tab. 6). Two thirds of these plants (14/21) stated that a physical separation would also not be possible in the future (Tab. 7), whereas eleven processed only one category of raw material and three of this 14 plants processed more than one category. In four plants, separated production lines would be feasible. In two plants, reconstructions were necessary to produce in separated lines, and in one plant, only the separation of Category 3 material would be possible (Tab. 7).

The thermal processes of the plants were designed either for continuous or batch production. Most of the plants (14) were equipped with a continuous system, twelve with batch systems and five worked with both systems (Tab. 8).

The majority of the plants (25/31) sterilized the raw material over 20 minutes at 133 °C and a pressure of 3 bar.

TABLE 5: *Destination of the total end products from rendering and fat melting plants (e. g. processed animal proteins, animal fats) in 2006 and proportion of animal fats, based on 31 returned questionnaires.*

Destination of the end products	Total amount of end products (t)	Animal fats (t)[1]
Oleochemicals	49 200	49 200[3]
Fertiliser	82 801	0
Biodiesel	13 294	13 294[4]
Combustion	407 518	116 183[5,6]
Pet food industry (Total amount)	121 409	23 066
Storage	3 615	0[7]
Others[2]	114 706	19 000
Total	**792 543**	**210 692**

[1]Based on the responses of 30/31 plants. [2]In total: 69 519 t for the production of biogas, 13 128 t of material for the mink industry, 19 000 t of animal fats for the food industry and 13 059 t for non-specified purposes. [3]Thereof 1697 t bone fat. [4]Thereof 1 704 t bone fat and 2 200 t used cooking oil. [5]Two plants did not provide information about the end products, it is assumed that a total of 10 051 t corresponds to animal fats. [6]Thereof 61 558 t were directly used for in-house energy production. [7]Some (≤ 45 t) animal fats were stored, the precise amount was not provided however.

TABLE 6: *Situation in rendering plants with strict animal species or category separation, based on 31 returned questionnaires.*

Animal species or category separation	Number of plants	%
Separation existing	9	29.0
No separation	21	67.7
No answer	1	3.2

TABLE 7: *Establishment of an animal species or category separation in 21 plants.*

Possibility of animal species or category separation	Number of plants	%
Possible	4	19.0
Possible after reconstruction	2	9.5
Possible if only for processing of Category 3 material	1	4.8
Not possible	14	66.7

TABLE 8: *Processing systems of the plants, based on 31 returned questionnaires.*

Processing system	Number of plants	%
Continuous system	14	45.2
Batch system	12	38.7
Continuous and batch system	5	16.1

TABLE 9: *Heat treatment of the raw material in the rendering and fat melting plants, based on 31 returned questionnaires[1] (multiple answers possible).*

Heat treatment (time, temperature, pressure)	Number of plants
20 minutes, 133 °C, 3 bar[2]	25
15 minutes, 90 °C	1
At least 60 minutes, >70 °C	1
At least 118 °C, 1 bar	1
Method 4[3]	1
90 minutes, 130 °C	1
2 minutes, 108 °C	1
3.5 minutes, 105 °C	1
No answer	1

[1]Two plants indicated two different heat treatments. [2]Meets the requirements of processing method 1 of Regulation (EC) 1774/2002. [3]Method 4 of Regulation (EC) 1774/2002: >100 °C for at least 16 minutes, >110 °C for at least 13 minutes, >120 °C for at least 8 minutes and >130 °C for at least 3 minutes.

Two plants heated the raw material at 90 °C for 15 minutes. Six further plants described "other" heat treatments (Tab. 9).

Critical control points in the rendering plants

According to Regulation (EC) No 1774/2002, Article 25, in accordance with the principles of the system of hazard analysis and critical control points (HACCP), operators and owners of intermediate and processing plants are requested to identify critical control points (CCP) in their plant and to establish and implement methods for monitoring such CCP. CCP were established and monitored in all plants. One processing plant did not disclose information about the localisation of the CCP. Most of the plants (29) were consistently measuring and controlling the process temperature. The majority (26) of the participating plants controlled the particle size of the raw material and 24 plants continuously controlled the pressure and the processing time (Tab. 10). The hygienic status was controlled by 21 processing plants for Salmonella and Enterobacteriaceae contamination of the end products. In 20 plants, the concentration of *Clostridium perfringens* was controlled regularly. The material processing rate was named as a CCP by two plants and nine plants added further CCP (the

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inspection of incoming goods, occasional controls of the hygienic status by quantifying concentrations of *Clostridium perfringens,* Salmonella and Enterobacteriaceae, disinfection of bins and vehicles, sorting conveyor, and sieves), which are included as "others" in Table 10.

While the inspection of incoming goods was defined as a CCP in only two processing plants, controls were regularly conducted in 30/31 plants. Only one plant did not use specific protocols to control the incoming material. In 28 plants, the control was a visual inspection of the incoming material during unloading. In five plants, the visual control was performed by the driver of the delivery vehicle. Further procedures such as the checking of documents or weighing of the material are listed in Table 11.

In the questionnaires, the quality managers of the rendering and fat melting plants were asked to provide suggestions on how to improve the screening procedures for product safety and quality in the process line for the production of animal fats. More specifically, the inquiry was aimed at determining additional useful and practicable control points in the processing line. Response options for this question were therefore not provided to avoid biased comments. The recommended localisations of additional control points are summarised in Table 12.

An important control point is the characterisation of the end products. All 31 processing plants performed additional analyses of the rendered fats. Different analytical procedures were used for the assessment of product quality and safety. Most (21) plants analysed the amount of total insoluble impurities, and 17 plants analysed the fatty acid spectrum of the products. Six plants determined the iodine number, five the peroxide number and four the melting point of the rendered fat. Protein residues were quantified by three plants. Three plants did not specify the type of analysis (Tab. 13).

TABLE 10: *Critical control points in the rendering and fat melting plants, based on 31 returned questionnaires (multiple answers possible).*

Critical Control Points	Number of plants	%
Temperature (heat treatment)	29	93.5
Particle size (after size reduction)	26	83.9
Pressure (heat treatment)	24	77.4
Processing time	24	77.4
Material flow (processing rate, only in continuous systems)	2	6.5
Others[1]	9	29.0
No answer	1	3.2

[1]Inspection of incoming goods, and occasional determination of the hygienic status by quantifying concentrations of *Clostridium perfringens, Salmonella* and *Enterobacteriaceae,* disinfection of bins and vehicles, sorting conveyor, sieves.

TABLE 11: *Spectrum of control procedures for incoming goods in rendering and fat melting plants, based on 31 returned questionnaires (multiple answers possible).*

Inspection of incoming goods	Number of plants	%
Visual control	28	90.3
Visual control by driver	5	16.1
Control of documents/delivery note	2	6.5
Weighing	2	6.5
Customer audits by HACCP[1] manager	2	6.5
Others[2]	4	12.9
No data/information	1	3.2

[1]Hazard Analysis and Critical Control Points. [2]Registration in the office, analyses, measurement of blood conductance and temperature, retaining of samples.

TABLE 12: *Suggestions of the processing plant operators for additional useful and practicable sampling localisations to control the product safety and quality of rendered fats, based on 31 returned questionnaires (multiple answers possible).*

Localisation for sampling	Number of suggestions
Out of silo/storage tank	9
After purification of fat	6
While loading	6
After separator	4
After degreasing	3
In process (before storage)	2
End product	2
Raw material	1
After decanter	1
Intermediate storage	1
Pump for fat loading	1
Delivery reservoir	1
No data	2

TABLE 13: *Additional analyses performed by the rendering and fat melting plants in the products prior to delivery, based on 31 returned questionnaires (multiple answers possible).*

Analyses of the rendered fats	Number of plants
Remaining total insoluble impurities	21
Fatty acids	17
Protein residues	3
Iodine number	6
Peroxide number	5
Melting point	4
Others[1]	44
No answer	3

[1]Water (7); content of dirt and nitrogen (both 4); ash and chlorine (both 3); oxide ash, heavy metals, volatile fatty acids, saponification number, microbiology (each 2); ELISA (not further specified), sulphur, dioxins, polychlorinated biphenyls, polyethylene, caloric value, colour, sediment, density, total volatile material, kinetic viscosity, intermittent by suspicion of impurities, others (some of these analyses are specific tests in addition to remaining total insoluble impurities).

Discussion

The present report summarises information provided by 31 of 45 rendering and fat melting plants in Germany in a survey. While most rendering and fat melting plants in Germany were included in the survey, the data obtained are not complete, but allow to assess the situation in animal fat processing. Due to the small sample size, a validation of the repeatability of the responses and validity control was not possible as usually performed in survey studies including

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big sample sizes. A visit of three plants took place and gave some insights into the production processes, critical control points and some quantitative data about raw material and end products. A general validation of the quality and coherence of the answers was not possible. The survey was conducted in 2007 and is relevant in relation to the ongoing discussion about the use of animal fats in livestock and also about the possible reintroduction of processed animal proteins. The German Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch was recently (24 July, 2009) modified to again allow the feeding of animal fats of warm-blooded animals and fish to non-ruminant livestock according to § 18.

After the initial prohibition of the feeding of animal fats to farm animals, processing plants adapted to the new economic circumstances by implementing the rendered fats, in particular Category 3 material, as energy and fuel sources, and, as before, for the production of pet food. The abrogation of the ban in 2009 may cause a considerable shift of the raw material and product flow. The feed industry is again becoming an important buyer, as animal fats are of significant value for the nutrition of non-ruminant livestock (Jeroch et al., 2008). Animal fats continue to be of great interest for the oleochemical industry as well as the rendering and fat melting plants themselves, as these have adapted their heating systems for the combustion of animal fats, which is of economic importance and an important factor when considering future use of animal fats for technical or nutritional purposes. From the ecological aspect it seems preferable to use high quality fats fulfilling the quality and safety requirements as feed ingredients instead of combustion.

In addition to the economic and ecological aspects, the safety aspects of using animal fats must be considered. An important safety measure would be the separation of the different animal species and the establishment of category-specific processing lines. As only Category 3 material has feed quality, a separation from the other categories is essential for feed purposes. A separation of rendering processing lines appears to be feasible, as 29 % of the plants already have established species or category separation, and 22.6 % stated that a separation would be possible after changing the process line design. Eleven out of 14 plants which stated, that a separation would not be possible at all, produced only Category 1 or 2 material, respectively. This indicated a possible category division but no species division. In total only three plants, processing Category 3 material, are not able to separate processing lines. An appropriate model, as already postulated shortly after the ban (Kamphues et al., 2001; Kamphues, 2002), should be established to control the strict separation of animal species and categories to ensure the purity of Category 3 material. In this concept, it is mandatory to establish traceability and tracking concepts covering the complete process line from the slaughterhouse to the end product. This may include document controls, especially on the way from the slaughterhouse to the rendering and fat melting plant, and analyses of the end products.

Established control measures for rendered fats at processing plants are plant-specific and range from visual controls of the raw material over monitoring of the rendering processes to the analyses of the end products. A visual control of the raw material was performed by the driver of the delivery vehicle in 5/31 (16.1 %) plants. This procedure seems to be questionable, at least in Category 3 processing plants, if it is the only control procedure for incoming goods. A further control of incoming goods in regard to raw material from Categories 1 and 2 is not necessary, because it has be disposed of or processed as defined by Regulation (EC) No 1774/2002 or Regulation (EC) No 1069/2009, respectively, and is not allowed to be used as feed ingredient. The differentiation of animal species within separated processing lines, from which the rendered fats are obtained, may be problematic if these are highly purified or heat treated. However, as a result of the production process, high amounts of protein rich by-products (e. g. greaves) accumulate, which may be a suitable substrate for an adequate analysis. The processing plants provided heterogeneous suggestions for control points for products to ensure for instance species identity and quality of the produced material. One important aspect is the reduction of proteinaceous impurities. Animal fats with a residual of proteins were considered as having comparatively high risk potential for the transmission of BSE (Kamphues et al., 2001; Zentek et al., 2002). Rendered fats derived from ruminants are not allowed to contain more than 0.15 % of residual total insoluble impurities (Regulation (EC) No 1774/2002, Annex VII, Chapter 4). A threshold value for proteinaceous impurities was not defined in this regulation. In the year 2007, the analysis of residual total insoluble impurities was performed by 21/31 (67.7 %) of the processing plants. Eight out of twelve (66.7 %) Category 3 material processing and fat melting plants analysed the insoluble impurities. Protein residues were quantified only by 3/31 (9.7 %) of the plants. Two of these plants processed raw material of category 3. In order to improve process control and safety measures, it would be advisable to implement both analyses in all Category 3 processing plants.

The majority of the evaluated responses indicated that the production of animal fat used for livestock feed in Germany occurs at a high level of implemented safety measures. Concerning the heat treatment of the processed material, it can be noted, that about 81 % (25/31) of the rendering and fat melting plants performed a pressure sterilisation (20 minutes, 133 °C, 3 bar). One plant processed the material according to method 4 of Regulation (EC) 1774/2002. One plant didn't answer the question and about 13 % (4/31) used other heat treatments with differing pressure conditions. Considering these findings, it can be concluded that safety measures established for animal fats from many processing plants allow to produce feed ingredients for non-ruminant livestock in accordance with feed safety standards.

An important option would be the separation of processing lines, which was reported to be possible in about half of the plants. The strict separation of processing lines is also an important aspect regarding the discussion on the potential re-introduction of processed animal proteins (meat and bone meal, MBM) into the feed of non-ruminant livestock. This mainly concerns processed animal proteins from pork and poultry, as these species are not considered to be at risk for TSE transmission (European Commission, 2010). In contrast, the situation with MBM from ruminants is clearly different as a result of the risk of transmission of BSE, and the public health aspect concerning the spread of TSE to humans, which is believed to result in a 'new variant' Creutzfeldt-Jakob disease (Bruce et al., 1997; Ritchie et al., 2009). For this obvious reason, a strict separation of raw material from ruminants is crucial. In addition, the aspect of "cannibalism" (intra-species recycling in the practice of

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feeding poultry with MBM from poultry and feeding swine with MBM from swine, respectively) must be taken into account (European Commission, 2010) or is already seized in article 11 of Regulation (EC) No 1069/2009 which is repealing Regulation (EC) No 1774/2002, respectively. In the future, it can be expected that the separation of processing lines could be the crucial criterion for the re-introduction of processed animal proteins into the feed of non-ruminant livestock and this will also have an impact on the production of animal fats. A recent report of the European Food Safety Authority (EFSA) introduced the development of a new model (EFSA QRA PAP model) to study the magnitude of the total BSE infectivity in processed animal proteins and in ruminant feed (EFSA, 2011). Referring to this opinion and due to limitation of analytical methods the detection limit of processed animal proteins is still considered to be 0.1 %.

While it is believed that in addition to the feed industry, several industries are competing as potential buyers of produced animal fats, the extent of this competition can not be estimated using the present data. It will probably depend on the price the different industries are willing or able to pay. Consumers of animal fats of Category 3 origin are the oleochemical industry, the biodiesel industry and the feed industry. The price for animal fats of a defined quality will be probably the same independently of the intended use. The price in the end of September 2010, e. g. for animal fats of Category 3 with a content of maximal 15 % free fatty acids, was about 560 EUR/ton (Niemann, personal communication).

In conclusion, due to the high nutritional value of animal fats for livestock, it can be expected that animal fats will be increasingly utilized again in feed for food producing animals as it was traditionally used before the ban. The establishment of species specific production lines is an interesting option for animal fat and processed animal protein production. This would support the idea of transparency and traceability in the feed chain and the production of safe and genuine feed ingredients.

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