



Article

PROCESSING OF ANIMAL-ORIGIN WASTE IN MEAT PRODUCTION

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SPRACOVANIE ODPADOV ŽIVOČÍŠNEHO PÔVODU V MÄSOVÝROBE



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ABSTRACT

The increase in population and improvement in living standards also lead to a rise in the consumption of meat and meat products. This reality is linked to the production of this type of waste – animal by-products (ABPs), with their processing (recovery and disposal) being managed by the producers or processors of the given commodity. Inappropriate or inefficient waste processing methods can negatively impact the environment. If there is no way to reduce the amount of waste, one option is to recover or dispose of it. Recycling brings economic and environmental benefits and helps to reduce the overall risk of adverse effects on human health. This paper provides basic information on the processing of animal-origin waste (animal by-products) under the conditions in the Slovak Republic and emphasises the importance of sustainable approaches that can bring economic and environmental benefits.

KEY WORDS: meat production, animal waste, animal by-products, waste management



ABSTRAKT

Zvyšovanie počtu obyvateľstva, či zlepšovanie životnej úrovne spôsobujú aj nárast spotreby mäsa a mäsových výrobkov. S touto skutočnosťou súvisí produkcia tohto typu odpadu – vedľajších živočíšnych produktov, pričom za jeho spracovaním (zhodnotením, zneškodnením) stoja výrobcovia či spracovatelia danej komodity. Nevhodné alebo neefektívne spôsoby spracovania odpadov môžu negatívne ovplyvniť životné prostredie. Ak neexistuje spôsob ako znížiť množstvo odpadu, je jednou z možností jeho zhodnotenie alebo zneškodnenie. Zhodnocovanie prináša výhody na ekonomickej a environmentálnej úrovni a pomáha znižovať celkové riziko nepriaznivých účinkov na zdravie ľudí. Tento príspevok poskytuje základné informácie o spracovaní odpadov živočíšneho pôvodu (vedľajších živočíšnych produktov) v podmienkach Slovenskej republiky a zdôrazňuje význam udržateľných prístupov, ktoré môžu priniesť ekonomické a environmentálne výhody.

KEÚČOVÉ SLOVÁ: mäsovýroba, živočíšne odpady, vedľajšie živočíšne produkty, nakladanie s odpadmi

INTRODUCTION

Meat consumption in Slovakia is nearly double the global average per capita, posing a significant challenge for the meat production sector. Given the open markets, Slovak meat producers and manufacturers must withstand fierce competition in the global market, facing pressure from major retail chains to keep prices low on one side, and rising quality expectations from consumers on the other.

During the production of any product, including in the meat industry, waste is generated. The impact of this waste extends beyond local boundaries, contributing to broader environmental concerns such as pollution, resource depletion, and greenhouse gas emissions, which are critical issues in the global effort to combat climate change.

Producers can choose to comply with only the necessary legislative requirements, opting for the “easier path,” or they can exceed these requirements by investing in modern technologies that enable better material processing and reduced waste production. By developing, adhering to, evaluating, and continually improving waste management plans, they can become not only high-quality producers but also socially responsible ones.

INTAKE AND PROCESSING OF MEAT IN MEAT PRODUCTION

In the meat production industry, companies can focus either on the butchering of meat (and possibly its subsequent sale to the end consumer) and/or on the production of various meat products. Their portfolio may include various soft meat products, durable meat products, cooked meats, roasted meats, salted meats, semi-preserved meats, and canned meats, as well as other meat products.

The processing of meat involves various procedures, from the reception of materials to their final processing, where it is crucial to adhere to established procedures and regulations. Slaughtered meat arrives at the intake area, where compliance with requirements is checked, not only based on the order and delivery note but also by inspecting the cleanliness and temperature of the vehicle used for transport, the sensory properties of the delivered meat, the meat temperature using a probe thermometer, and the pH of the meat, which should be around 5.5 – 6 [1].

At pH levels of 6.2 – 6.8, putrefactive processes occur, and if the pH is even higher, the meat is considered spoiled. The pH is measured either with a penetrating electrode directly in the muscle or in an aqueous extract from the meat [2].

Meat quality is assessed based on a set of characteristics, which can be divided into:

- **Sensory indicators**, including colour, taste, smell, brightness, tone, marbling, texture, consistency, and juiciness.



- **Hygienic and toxicological indicators**, which evaluate the presence of pathogenic and conditionally pathogenic microorganisms, and the content of additives and residues in the meat.
- **Nutritional indicators**, influenced by the chemical composition of the meat, mainly the content of proteins, fats, carbohydrates, minerals, and trace elements.
- **Technological and processing indicators**, such as consistency, structure, and water-binding capacity [3].

If the received meat meets the requirements, it is transferred from the reception area to the cold storage, where it is cooled and gradually taken to the butchering department, where it is cut at a temperature of 4 °C into meat intended for sale and for production purposes. Meat for sale is then sent to the packaging department and subsequently to the distribution section, while production meat goes to various production departments, then to the packaging section, and finally to distribution.

The entire meat processing flow maintains a unidirectional technological process, moving from the unclean area towards the clean area, with a separate waste collection area outside the technological flow to prevent cross-contamination.

WASTE IN MEAT PRODUCTION

Despite production being focused on optimising material use while meeting the highest quality and legislative standards, it is impossible to avoid the generation of various types of waste, particularly packaging waste, biodegradable waste, municipal waste, waste oils, and animal by-products (ABPs). ABPs include entire animal bodies or parts, animal-origin products, or other animal-derived products that are not intended for human consumption, including oocytes, embryos, and semen [4]. Based on the risk these by-products pose to humans and animals, as well as their impact on the environment, animal by-products are classified into:

- **Category 1 material:** This group includes animal bodies or parts with officially confirmed PSE (pale, soft, exudative meat, especially occurring in pigs as a result of breeding), pets, animals from zoos and circuses, animals used for scientific purposes that pose a risk, wild animals suspected of carrying transmissible diseases, ABPs containing excessive levels of substances and environmental contaminants, catering waste from international transport vehicles, and mixtures of Category 1 materials with other categories [4,5].
- **Category 2 material:** This category includes ABPs containing residues of approved substances exceeding permitted limits, manure, digestive tract contents, animals imported from third countries that do not meet veterinary requirements, animals killed for disease control purposes, and animals that died other than by slaughter, as well as mixtures of Category 2 and Category 3 materials.
- **Category 3 material:** This group comprises slaughtered animals inspected before and after slaughter that are unfit for human consumption but do not show signs of transmissible diseases. Examples include poultry heads, hides and skins including trimmings, horns and limbs, feathers, wool, hair, fur, and ABPs from the production intended for human consumption, such as bones, fat, eggs, blood, sludge from milk processing centrifuges or separators, and products or foodstuffs containing animal-origin products that are no longer intended for human consumption for commercial reasons but do not pose any risk to public or animal health [4].

COLLECTION AND TRANSPORT OF ANIMAL WASTE

Waste from ABPs generated in meat production is predominantly Category 3 material. It is collected in colour-coded containers and stored in a designated room called the rendering box, where a constant temperature of 4 – 6 °C is maintained. As in any production facility, a thermometer is



installed in the rendering box to measure the temperature, and compliance with the correct temperature is monitored at regular intervals in accordance with the developed HACCP directive (Hazard Analysis and Critical Control Points) and recorded in a logbook.

The rendering box is typically strategically located at the central junction of the production halls, with entrance doors from the corridor and exit doors to the yard, allowing easy access for vehicles transporting ABP waste.



Fig. 1 - Containers for Collecting ABPs (left), Vehicle for ABP Collection and Transport (right)

During the cleaning of individual production halls, water contaminated with fats is flushed into the drainage system, which is equipped with grease traps cleaned at specified intervals by an authorised company. The collection and transport of rendering waste are also carried out by authorised companies at regular intervals. After each collection, the containers are cleaned and returned to the production halls.

For each collection of ABPs, a "Collection Record" is completed, which includes, among other details, the information of the employee conducting the waste collection, the vehicle registration number, the date, the destination, a description of what was collected (e.g., Category 3 ABP material), specifying the type of material, the source of the material, and the weight of the collected material. The signed and confirmed collection record then forms part of the invoice.

A similar procedure is followed for the cleaning of grease traps, for which a document titled "Record of Delivery and Receipt of Completed Work under Act No. 513/1991 Coll." is completed. This document includes, among other details, the client and contractor, the start and end times of the work, the location of the work, a description of the tasks carried out (e.g., grease trap cleaning), the number of traps cleaned and the volume of material cleaned, any assessment of issues, the worker's signature, and the vehicle registration number. This document also forms part of the invoice.

PROCESSING (RECOVERY, DISPOSAL) OF WASTE FROM MEAT PRODUCTION

Depending on the type and category of ABPs, they can be processed in various ways – either recovered or disposed of. Animal by-products (ABPs) are processed or disposed of industrially based on their category, which determines the level of risk and applicable usage restrictions. Legislation classifies them into three main categories:

- **Category 1:** This includes the highest-risk materials, such as animal carcasses suspected of carrying transmissible diseases and materials with excessive levels of contaminants. These products must be disposed of by direct incineration or pressure sterilisation. They may subsequently be used solely for technical purposes, such as fuel or additives in industry.



- **Category 2:** This category includes materials with a lower risk than Category 1, such as animals that died other than by slaughter or digestive tract contents. After pressure sterilisation, these products can be recovered as fuel, composted, or processed into biogas. Meat-and-bone meal from Category 2 materials can be used as fertiliser but must be treated to prevent its use as animal feed.
- **Category 3:** This includes the lowest-risk materials, such as slaughtered animal carcasses deemed unfit for human consumption but without signs of transmissible diseases. These products can be used to produce animal feed (excluding fur animals) or organic fertilisers after processing according to safety requirements. Category 3 materials may also be utilised in compliance with Decree 148/2012 Coll., §10(5), which allows for animal-origin products that are no longer intended for human consumption for commercial reasons to be offered for free to pet owners at retail stores, provided specific conditions are met. Such products, including bones and trimmings of soft items, must originate from registered or approved establishments, be stored separately, properly labelled, and protected from contamination. Before distribution, samples must be sent for rapid microbiological testing to the Regional Veterinary and Food Administration. These products must be safely stored and accompanied by a commercial document as outlined in Annex 2 of the Decree of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 148/2012 Coll., ensuring safety and regulatory compliance [6].

In addition to these traditional methods, modern practices are being adopted to enhance sustainability and economic value.

Comprehensive Utilization for Sustainability: Animal waste can be transformed into valuable products such as feed, fuel, fertiliser, and biogas, promoting a circular economy and reducing environmental impacts. This approach also emphasises the combination of animal by-products with plant-based sources for enhanced utilisation [7].

Energy Production and Economic Viability: Waste from meat processing, particularly fats and offal, can be converted into polyhydroxyalkanoate biopolyesters, showing potential as an economically feasible and sustainable resource for biopolymers and biofuels [8].

Biogas and Energy Recovery: Anaerobic digestion of waste from meat processing, such as manure and slaughterhouse by-products, can produce significant amounts of biogas, contributing to renewable energy solutions and reducing greenhouse gas emissions [9].

Mineral Recycling: Innovative methods, such as thermal recycling of animal by-products, convert waste into mineral fertilisers, providing a dual benefit of waste reduction and agricultural resource replenishment [10].

Grease Trap Sludge Processing: Grease trap sludge is partially processed directly in the vehicles of the company responsible for its collection and processing. The grease is drawn into a sludge chamber by a suction pump and moved to a separation chamber with a flocculant, which binds solid particles and separates them from the water. The filtered water is reused for cleaning the separator, while the dewatered sludge can be used as fertiliser after lime sanitisation, composted, disposed of in wastewater treatment plants, used as fuel in industry, or stored in a landfill [11].

Challenges and Environmental Considerations: The meat industry generates considerable organic waste that, if not processed adequately, poses environmental and health risks. Efforts in waste management emphasise minimising these effects through advanced waste processing technologies and eco-friendly disposal methods [12].



CONCLUSION

The management of animal by-products in the meat production industry plays a vital role in addressing environmental challenges and promoting sustainable practices. Traditional waste processing methods provide a necessary framework for safe disposal and utilisation.

However, embracing modern, sustainable technologies can elevate the industry's approach to waste management, contributing to both economic growth and environmental stewardship. Innovative methods such as biogas production, energy recovery from fats and offal, and the conversion of waste into mineral fertilisers exemplify the shift towards a circular economy.

These practices reduce the overall environmental footprint, mitigate greenhouse gas emissions, and create valuable resources from what would otherwise be waste. To effectively tackle global waste issues, continuous investment in technology and commitment to sustainable development are crucial.

This integrated approach ensures that waste management in the meat production sector aligns with global efforts to reduce pollution and conserve resources, fostering a healthier planet for future generations.

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