

## THE ANALYSIS OF THE MASS AND MORPHOLOGICAL COMPOSITION OF WASTE PRODUCED BY THE MEAT INDUSTRY

### Summary

In 2009, meat preserves were produced by approximately 2700 plants in Poland. Used in the process of production and processing of meat, raw materials are not fully utilized and this results in the formation of by-products in the form of remnants of unused raw materials and different types of waste (which is the consequence of the operation of machinery, buildings and devices). The ultimate purpose of the study was to analyze the mass and morphological composition of waste generated in the process of meat production and processing in the years 2011-2013. The analysis was carried out for the macroregion of Southern Poland (the Śląskie, the Świętokrzyskie, the Małopolskie and the Podkarpackie provinces). For the analyzed period of time information about the waste from around 300 companies involved in the meat industry which submitted a report to the Marshal's Office was obtained. These companies generated on average  $586 \pm 211$  Mg of waste per year. 1 Mg of produced meat generates over 290 kg of waste in the plants located in the analyzed area. The largest share of all generated waste comprises a group classified according to the Waste Catalogue as 02 02. Among the waste, the biggest, well over 40%, share is created by animal tissue waste.

**Key words:** meat industry, waste

## ANALIZA MASY I SKŁADU ODPADÓW POWSTAJĄCYCH W PRZEMYSLE MIĘSNYM

### Streszczenie

W 2009 roku w Polsce przetwory mięsne produkowano w około 2700 zakładów. Stosowane w procesach produkcji i przetwórstwa mięsa surowce nie są w pełni wykorzystywane, co skutkuje powstawaniem produktów ubocznych w postaci resztek niezwyżytych surowców oraz różnego rodzaju odpadów (będących konsekwencją eksploatacji maszyn, budynków i urządzeń). Głównym celem pracy była analiza masy i składu morfologicznego odpadów wytwarzanych w procesach produkcji i przetwórstwa mięsa w latach 2011-2013. Analizę wykonano dla makroregionu Polski Południowej (województw: śląskiego, świętokrzyskiego, małopolskiego i podkarpackiego). Dla analizowanego przedziału czasu uzyskano informacje o odpadach z około 300 firm działających w branży mięsnej, które złożyły sprawozdanie do Urzędu Marszałkowskiego. Firmy te generowały średnio  $586 \pm 211$  Mg odpadów w ciągu roku. W zakładach zlokalizowanych na analizowanym obszarze na 1 Mg produkowanego mięsa generowanych jest ponad 290 kg odpadów. Największą część wszystkich generowanych odpadów stanowi grupa klasyfikowana zgodnie z Katalogiem Odpadów jako 02 02. Wśród tych odpadów największy, ponad 40% udziału stanowi odpadowa tkanka zwierzęca.

**Słowa kluczowe:** przemysł mięsny, odpady

### 1. Introduction

The mass of meat processing products such as cold meats, sausages, canned meat, poultry, pork, beef and edible fats available on the Polish market grows steadily. CSO [9] reports that in 2011 there were more than 4000 thousand Mg, in 2012 - 4500 thousand Mg, in 2013 - 4670 thousand Mg, in 2014 - 4840 thousand Mg whereas in 2015 more than 5050 thousands Mg. The waste in the processes of production and processing of meat is generated at the stage of slaughtering and butchering, the assessment of quality of raw materials, curing, moulding, smoking and brewing. Depending on the product, it may also be generated while rough grinding, cooling or as a result of improper storage.

As a result of the slaughter of animals for slaughter, by-products (production residues) are obtained which are classified as edible, for example offal, natural intestines and inedible, ie. skin, hoofs and horns. Some by-products may fall into both edible and inedible categories, for example, blood, bone, pig skin or even glands [10]. Production residues are also generated in meat processing plants. Moreover, the waste which is produced can be completely useless

and typical of the given production branch such as the end of artificial intestines, foil forms, plastic casings and fine metal waste from the clipper [5].

In the literature, there is no single coherent classification of waste from the meat industry. In the guidelines of the Ministry of Agriculture and Rural Development [5] wastes are classified into production residues from a slaughterhouse and production residues in meat processing plants. In turn, in the Waste Catalogue [12] a group of wastes from the preparation and processing of food products of animal origin (0202) divided into wastes from washing and preparing raw materials (020201), animal tissue waste (020202), raw materials and products unfit for human consumption (020203), sludge from wastewater treatment plants (020204), animal tissue waste exhibiting hazardous properties (020280), animal tissue waste constituting material of special and high-risk including waste from the production of meat-and-bone animal feed other than those mentioned in 020280 (020281), waste from the production of fishmeal other than the one mentioned in 020280 (020282) and coded as 020299 - other not aforementioned waste can be distinguished. Rosik-Dulewska [11] divides

the waste from the meat industry into operating slaughter waste, waste containing chlorides, manure, sewage sludge, energy waste and municipal-economic waste.

Białecka [2], on the basis of the analyses, concludes that the wastes from the Agro-industry are dispensed for recycling (92.0%) by selling them for animal feed, fertilizers or components for the production of compost. These wastes are processed into meat and bone meal and fat and then incinerated or used as a soil conditioner. Some of the wastes go to a biogas plant [8]. It is assumed that the remaining waste is stored (5%) or disposed of (3%). Sludge from on-site wastewater treatment plant is also utilised by composting.

According to the data in Best Available Techniques in the Food, Drink and Milk Industries [4], solid wastes coming from production of ham, sausages and meat preservation amount to 35 - 50 kg·Mg<sup>-1</sup> of end product whereas the wastes from production of canned products come to 20 - 30 kg·Mg<sup>-1</sup> of end product.

The final report on the work of the Thematic Network AWARENET informs that while slaughtering, waste constitutes as many as 31-52% of the batch and the canning process generates even a greater share (30-75%) of waste [1]. Daniel *et al.* [3] reports that agricultural production and the Agro-Industry in Poland generate more than 10 million Mg of waste every year. The unambiguous determination of the actual mass of waste generated in agriculture and in the Agro-industry is not likely mainly due to the lack of such data in reports submitted by companies to Marshal Offices [3]. The mass of waste generated during the processing of meat, depending on the source data, is very diverse and ranges from 1.5 million Mg according to Eurostat [13] to as many as 113 million Mg by Rosik-Dulewska [11]. The problem of significant discrepancies in data is also noted by Jędrzak [7]. In the years 2002-2008 the difference in mass of produced and developed waste which is biodegradable between the data provided by the Central Statistical Office and the Central Waste System amounted even to 70% [7].

This paper attempts to characterize the waste generated in the meat industry. The analysis concerns the morphological structure (composition) and the mass of waste generated in the process of production and processing of meat as well as the changes that occurred in the structure in the years 2011-2013. The study was conducted for the macroregion of Southern Poland that is the Śląskie, the Świętokrzyskie, the Małopolskie and the Podkarpackie provinces. The assumed aim of the research resulted from the absence of such analyses in the available national literature. The data utilised in the study were obtained from provincial reports provided by the Marshal Offices of the selected provinces.

## 2. Material and methods

The data for the study were obtained in the form of a database on waste from the years 2011- 2013 from the Marshal Offices of selected provinces (in \*.pdf or \*.docx formats). Each database contained information about the holder of the waste (that is the manufacturer), tax identification number (NIP), National Business Registry Number, the type of business according to Polish Classification of Activity and the types (and codes) of waste generated in individual enterprises as well as the produced mass of different types of waste in Mg. The analyses involved selecting re-

ports from provincial plants which over the years 2011-2013 produced the code 02 02 waste classified according to the Waste Catalogue [12] as that coming from the preparation and processing of food products of animal origin. On the basis of the obtained information a new database with information about waste producers, mass and morphological composition of the waste generated was compiled for each company. The chosen companies were subject to selection by checking each of them in the National Court Register for codes of Polish Classification of Activity, the European Classification of Activities and the classification of economic activities SIC (Standard Industrial Classification). As a result of the verification, plants that did not operate in the analyzed years in the meat industry, for example, restaurants, shops and supermarkets, bakeries and veterinary clinics were removed from the database. The deleted enterprises accounted for more than 20% of companies for each of the analyzed years. These companies were removed from the database primarily due to the fact that their inclusion would result in distortion of the morphological composition of waste generated in the meat industry. These companies, in fact, generate significant quantities of other types of waste related to the basic role of their market functioning. The database allowed us to determine the number of plants involved in the production and processing of meat and the mass and the morphological composition of waste generated in the meat industry for the analysed region. The morphological composition was determined on the basis of the waste groups classified according to the Waste Catalogue [12].

## 3. Results

Fig. 1 shows the number of companies which submitted summary reports of the generated waste to the Marshall Offices for the years 2011-2013 and for whom meat processing was the main source of income. The greatest number of entrepreneurs was identified in the Śląskie province and the Małopolskie province, and the smallest number in the Świętokrzyskie province. A significant phenomenon is the systematic reduction in the number of plants observed in each of the provinces.

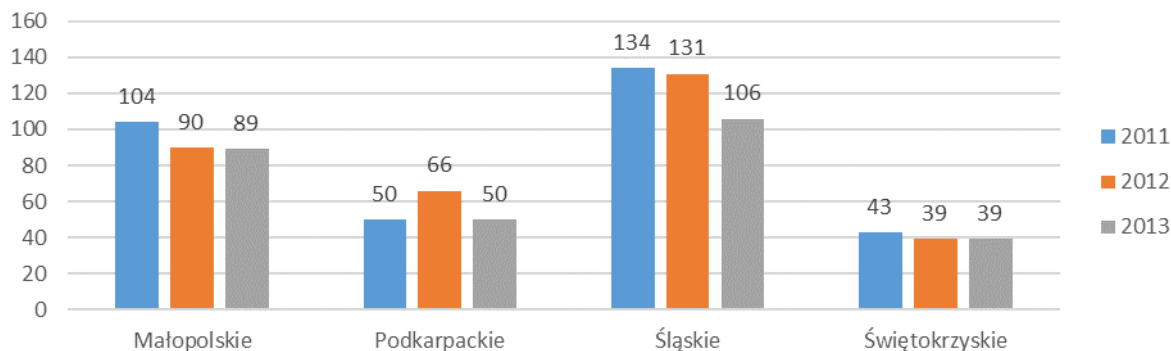
The meat industry in the study area of Poland generates annually on average  $176 \pm 48$  thousand Mg waste, approximately  $586 \pm 211$  Mg per plant (Table 1). Assuming that the production of animals for slaughter, which according to the Statistical Yearbook of Agriculture [6] amounted for the analyzed region of Poland in the years 2011, 2012 and 2013 to 619, 628 and 534 thousand Mg respectively, it can be estimated that at least 290 kg of waste is generated approximately out of 1 Mg of produced meat and its products. A sudden drop in the mass of waste generated in the Małopolskie province in 2013 results primarily from the absence of the report on waste from SOKOŁÓW SA company and from the Meat Processing Plant in Jarosław which during the previous year had produced nearly 10 thousand Mg of residues and from a considerable reduction in the mass of waste produced by companies such as CEDROB SA and SYSTEM-DRO S.J.

As a result of the analyses as many as 75 different types of waste generated by the meat industry were identified. The average share of individual types of waste over the three years in question is presented in Fig. 2. The composition of waste from the meat industry is dominated by ani-

mal-tissue waste (02 02 02) which constitutes 42% of all residues. A significant share (8%) is comprised by sludge from wastewater treatment plants (02 02 04), paper and cardboard packaging - 7% (15 01 01), the other not aforementioned waste from 02 02 group - 6% (02 02 99) and plastic packaging - 5% (15 01 02) as well as slag, ash and boiler dust - 4% (10 01 01).

The remaining 69 types of waste comprise 28%. Among them animal tissue waste (020102), printing toner waste (08 03 18), fly ash and dust from liquid fuelled boilers

(10 01 04), mineral engine oils, gear and lubricating non-chlorinated oils (13 02 05), other engine, gear and lubricating oils (13 02 08), packaging waste (15 01 group) including metals and composite packaging, electrical and electronic equipment waste (16 02 group), iron and steel (17 04 05), screenings (19 08 01), grease and oil mixture from oil / water separation containing only edible oils and fats (19 08 09) can be distinguished. In addition, the meat industry also produces batteries, accumulators, used tires and equipment containing chlorofluorocarbons.



Source: own work / Źródło: opracowanie własne

Fig. 1. The number of analysed companies that produce waste from the meat industry

Rys. 1. Liczba analizowanych zakładów przetwórstwa mięsnego

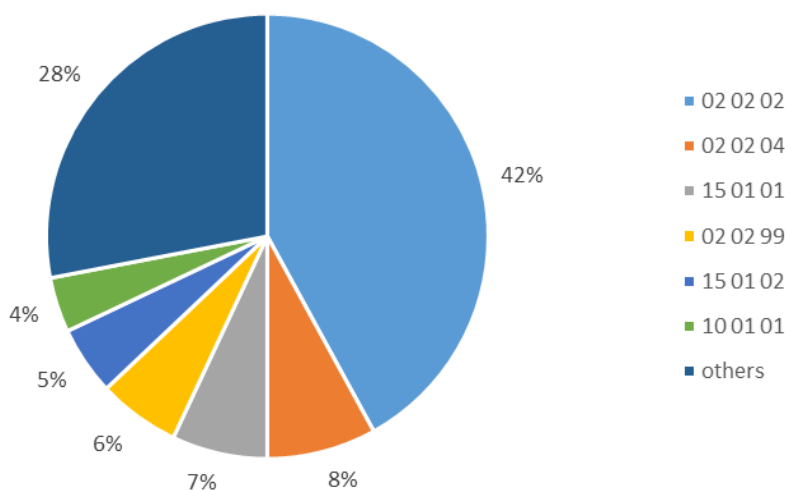
Table 1. Mass of generated waste produced in the meat industry per one plant

Tab. 1. Masa odpadów generowanych przez zakłady przetwórstwa mięsnego w przeliczeniu na jeden zakład produkcyjny

Province	2011		2012		2013	
	Mass of waste produced [Mg·enterp. <sup>-1</sup> ]	Mass 020202 [Mg·enterp. <sup>-1</sup> ]	Mass of waste produced [Mg·enterp. <sup>-1</sup> ]	Mass 020202 [Mg·enterp. <sup>-1</sup> ]	Mass of waste produced [Mg·enterp. <sup>-1</sup> ]	Mass 020202 [Mg·enterp. <sup>-1</sup> ]
Małopolskie	923.3	383.2	978.4	417.9	374.6	223.1
Podkarpackie	585.5	281.9	502.2	228.5	482.9	196.4
Śląskie	382.3	224.9	391.3	247.4	394.2	205.0
Świętokrzyskie	671.2	412.3	778.7	456.8	567.0	178.1
<b>Avarage</b>	<b>620.5</b>	<b>307.6</b>	<b>622.2</b>	<b>315.7</b>	<b>427.4</b>	<b>205.5</b>

\*enterp. – enterprise

Source: own work / Źródło: opracowanie własne



Source: own work / Źródło: opracowanie własne

Fig. 2. Morphological structure of waste generated in the meat industry

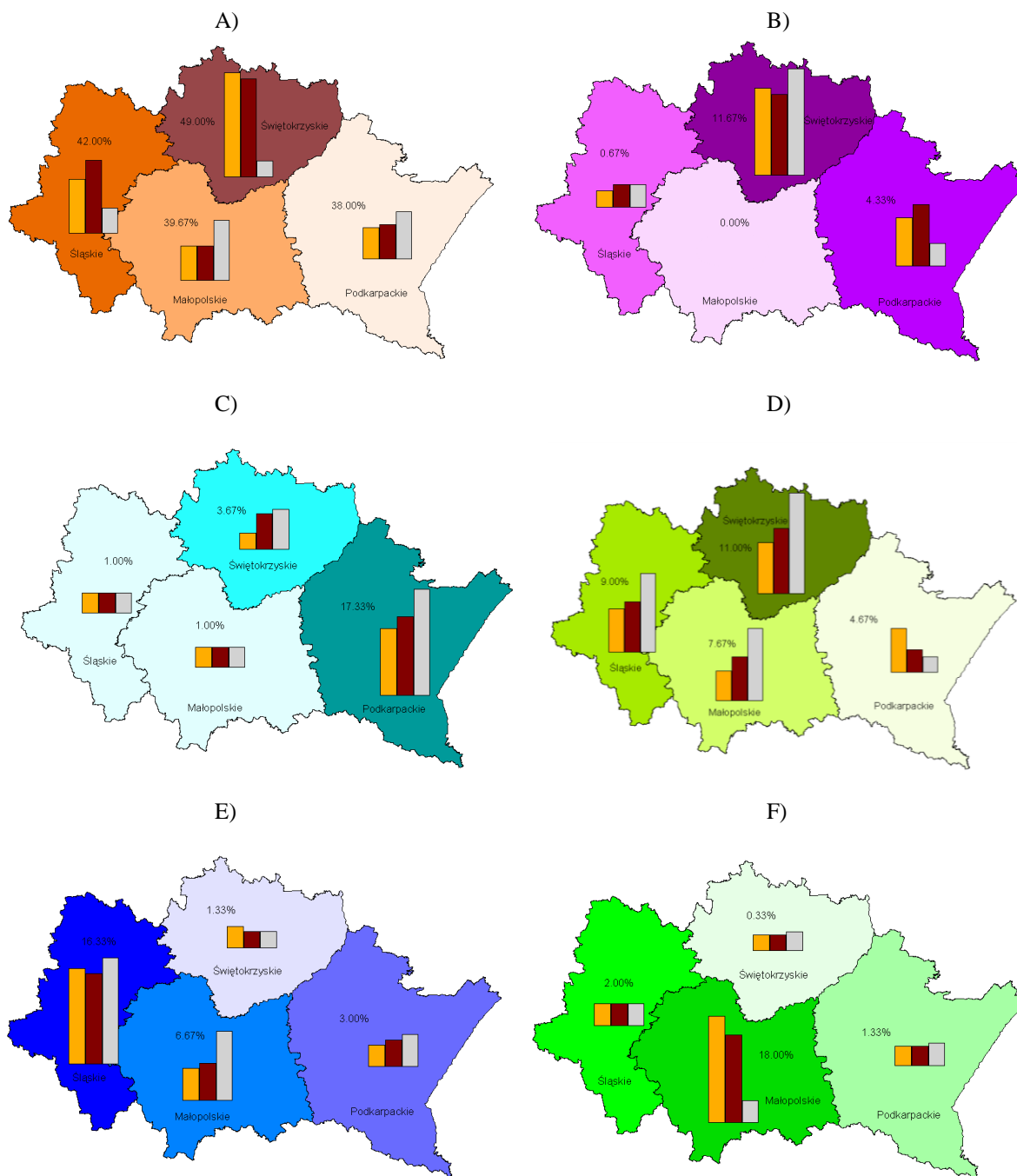
Rys. 2. Skład morfologiczny odpadów wytwarzanych w przemyśle mięsnym

The share of individual types of wastes as well as their mass varies greatly over time. Fig. 3 (a-f) illustrates their shares in individual years, divided into the above-mentioned groups. The card diagrams also depict the average share of the code for each of the provinces.

The waste which dominates in all of the four provinces is animal tissue waste (020202). The largest average share of this type of waste (49%) is dominant in waste from the Świętokrzyskie province whereas the most modest share is observed in the Podkarpackie province (38%). The share of the waste declined significantly in 2013 (Fig. 3a). Fig. 3b

shows the percentage of sludge from industrial waste water treatment plant (020204). The largest share of this type of waste occurred in the Świętokrzyskie province (11%) and the most modest in the Podkarpackie province (about 5%). In the provinces of Silesia, Małopolskie and Świętokrzyskie a steady increase in the proportion of waste in the morphological structure is observed.

The other not aforementioned waste from 02 02 group described with 020299 code constituted a little over 1% in the Świętokrzyskie, the Małopolskie and the Śląskie provinces.



Source: own work / Źródło: opracowanie własne

Fig. 3. Share of different waste groups: A – 02 02 02 (animal tissue waste), B – 02 02 04 (sludge from wastewater treatment plants), C – 02 02 99 (others, not aforementioned), D – 10 01 01 (slag, ash and boiler dust), E – 15 01 01 (paper and cardboard packaging), F – 15 01 02 (plastic packaging)

Rys. 3. Udział różnych rodzajów odpadów: A – 02 02 02 (odpadowa tkanka zwierzęca), B – 02 02 04 (osady z zakładowych oczyszczalni ścieków), C – 02 02 99 (inne nie wymienione z grupy 02 02), D – 10 01 01 (żuźle, popioły paleniskowe i pyły z kotłów), E – 15 01 01 (opakowania z papieru i tektury), F – 15 01 02 (opakowania z tworzyw sztucznych)

However, in the Podkarpackie province the share of such waste was up to 17.33% (Fig. 3c). Slag, ash and dust from boilers (10 01 01) not classified in 0202 group are among others the waste produced in large quantities. The largest share was observed in the Świętokrzyskie province and amounted to almost 12% and the most modest one occurred in the Śląskie province (approx. 1%). The waste did not occur in the Małopolskie province at all. The paper and cardboard waste (150101) was produced in almost 100% of the analyzed companies. The largest share was observed in the Śląskie province (over 16%) and the most modest in the Świętokrzyskie province (approx. 1%). Plastic packaging waste (150102) was produced mainly in the Małopolskie province (18%), however from the year 2013 its share was very modest. In the remaining provinces low proportion of the waste (0.3-2.0%) was reported.

#### 4. Conclusions

The analyses lead to a conclusion that the number of plants producing waste which come from 0202 group steadily decreases in the studied region. The largest amount of waste is produced in the Małopolskie and Śląskie provinces, which is associated with a significant number of companies in the region. In the studied region the meat industry generates an average of 176.5 thousand Mg of waste that is approximately  $586 \pm 211$  Mg of waste per 1 plant. The largest amount of waste per 1 plant is produced in the Małopolskie province (except the year of 2013) and in the Świętokrzyskie province. 1 Mg of produced meat generates over 290 kg of waste in plants located in the analysed area. Animal tissue waste comprises the largest, more than 40%,

share in the stream of the total waste generated by the analysed section of the Agro-industry.

#### 5. References

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