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Economic consequences of pig and poultry mortality during transport

Ekonomiczne konsekwencje śmiertelności świń i drobiu podczas transport

Abstract. The purpose of the paper is to estimate the financial losses incurred by the Polish meat industry as a result of pigs and slaughter poultry mortalities in pre-slaughter handling. The analysis showed that the total financial losses resulting from the pigs' mortality during transport to an abattoir in 2005–2018 could be estimated at about PLN 178 million. In the case of slaughter poultry, the losses in the period analysed amounted to PLN 321 million. The results obtained indicate the need for improvement measures to reduce animal mortalities in pre-slaughter handling. The most important should be the reduction of transport time, compliance with loading standards, introduction of a ban on transporting animals in conditions that may cause thermal stress.

Key words: transport of pigs and poultry, animals' mortality, economic losses

Synopsis. Celem opracowania jest oszacowanie strat finansowych ponoszonych przez polski przemysł mięsny w wyniku upadków świń oraz drobiu rzeźnego w obrocie przedubojowym. Z przeprowadzonej analizy wynika, że łączne straty finansowe wynikające z upadków trzody chlewnej w czasie przewozu do uboju w latach 2005–2018 szacuje się na około 178 mln złotych. W przypadku drobiu rzeźnego straty w analizowanym okresie wynosiły 321 mln złotych. Uzyskane rezultaty wskazują na konieczność podjęcia działań doskonalących w celu redukcji upadków zwierząt w obrocie przedubojowym. Za najważniejsze należy uznać skrócenie czasu transportu, przestrzeganie norm załadunku, wprowadzenie zakazu przewozu zwierząt w warunkach mogących wywołać u nich stres termiczny.

Słowa kluczowe: transport świń i drobiu, upadki zwierząt, straty ekonomiczne

Introduction

Transport is an important element of agro-logistics. According to Klepacki [2011], it is an activity involving the organization, planning, control and an implementation of the flow of agro-food goods from the place of production of agricultural raw materials

through channels related to their purchase, storage, production and distribution up to the final recipient, whose goal is to meet market requirements while maintaining food security, minimal costs and minimal capital involvement. Animal transport has a special place in the food sector. This branch of transport connects individual production links, it concerns farm and slaughter animals. It is a complex and multi-stage process. It covers logistics activities and operations whose purpose is to transfer farm animals to a new place of use or slaughter animals to the slaughter sector. There are three types of utility animals transport: transport of breeding material of production and breeding animals, transport of slaughter animals and transport of other farm animals. The most numerous group in transport are slaughter animals for meat production. First, pigs and poultry from large-scale fattening farms, followed by fattening cattle, sheep, rabbits and culled animals. It is estimated that in Europe over 350 million large slaughter animals are transported to slaughter annually, including about 240 million pigs, 25 million cattle, 70 million sheep, 8 million goats, 300 thousand horses [Baltussen et al. 2011]. Around 2 billion slaughter poultry are also produced annually in the EU. According to Trojanowski [2018], transported animals are classified as sensitive loads. These goods require maintaining specific transport conditions. Loads of this nature can be sensitive to many different factors. In particular, animals during transport show sensitivity to: duration of transport, light, noise, temperature and humidity as well as their changes, mechanical energy, biochemical processes.

Literature review

Adaptation of animals for transport requires considerable physical effort and usually causes effects in the form of fatigue or exhaustion. As a result, this leads to quantitative and qualitative losses, which ultimately shape the value and technological suitability of slaughter raw material delivered to the processing sector. According to Pisula and Florowski [2008], two elements should be considered in the considerations of losses arising in the meat and meat products production chain. The first are transport and storage losses related to the ones of live weight, carcasses, elements of their basic cutting, cooking and processing meat, as well as preparations during their circulation and storage. The second is related to the deterioration of the quality of raw materials, semi-finished and finished products during the production cycle as a result of endogenous and exogenous bio-physico-chemical processes occurring in meat. It should be emphasized that the negative effects of transport are transferred to the next links of the processing process, which causes a serious reduction of its efficiency.

Negative effects of adaptation to transport conditions can take many forms, such as: animal mortality, fatigue and exhaustion, weight loss, skin injuries and injuries, wounds, muscle bruises, bone fractures. The following are the post-slaughter ones: slaughter output reduction, reduced post-slaughter bleeding, quality defects in meat, confiscation of slaughter raw materials [Tereszkiewicz et al. 2017]. Studies carried out so far show that the mentioned negative transport consequences usually occur in parallel and affect a significant number of animals. Numerous factors of different nature have the impact on the volume and type of losses incurred in transport. The main ones include: genetic factors (species, breed, susceptibility to stress, sex), internal environment factors (health, condition), exter-

nal environmental factors (noise, vibrations, weather conditions, transport conditions and time, transport distance), factors social environment (interaction between animals, interaction between animals and staff). The vast majority of negative consequences are the result of transport stress, which is of polyetiological nature. The main stressors during transport are: vehicle movement, noise, vibrations, change of light and thermal-humidity conditions, hunger, thirst, foreign social environment, limitation of living space, intensive driving out [Tereszkiewicz et al. 2017]. In transport, there may also be social stress defined as a state of disturbance of the body's internal balance caused by the behaviour of other individuals of the same species. Social stress is caused by territorial conflict or rivalry within the hierarchy [Kołacz and Dobrzański 2006]. A significant threat to transported animals is thermal stress, which causes hyperthermia. Malignant hyperthermia is particularly dangerous, manifested by an increase in the body's internal temperature to life-threatening levels. Pigs and poultry are particularly vulnerable to hyperthermia.

The most drastic manifestation of losses at the same time as a measurable indicator of an extreme breach of welfare principles during transport is the phenomenon of animal mortality. In spite of various actions taken, mortality in transport has not been eliminated. However, in recent years a significant reduction in the scale of their occurrence has been achieved. The analysis carried out by Baltussen et al. [2011] shows that in the EU in 2005–2010 there was a decrease of about 15% in the number of animals reported as "dead on arrival" (DOA indicator). A significant decrease in the mortality rate was recorded in long and very long transports. The phenomenon of mortality during transport occurs in all livestock species, however, with varying intensity (Fig. 1).

The interspecies differences in mortality in transport are primarily determined by the resistance of individual species to transport stress, anatomical and physiological differences, including the structure and efficiency of the respiratory and circulatory systems, and dehydration resistance. Pigs and poultry are the species that are particularly vulnerable to mortality during transport.

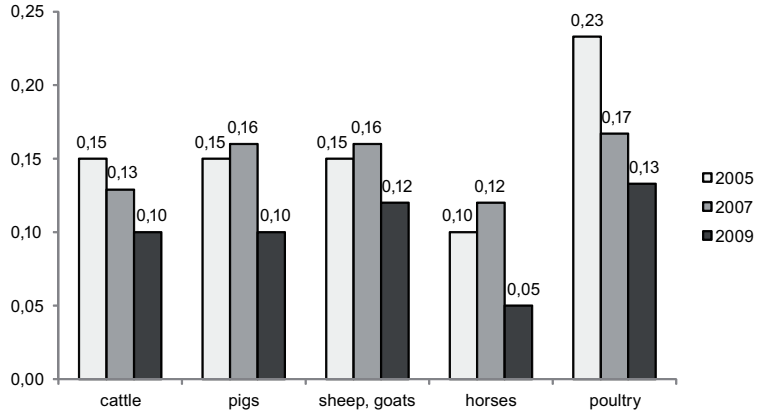

Figure 1. Mortality of animals in transport in the EU countries in 2005, 2007 and 2009
Rysunek 1. Śmiertelność zwierząt w transporcie w krajach UE w latach 2005, 2007 i 2009

Source: own study based on [Baltussen et al. 2011].

The mortality rate of pigs in transport varies widely and according to various sources [Voslarova et al. 2007, Ritter et al. 2009, Baltussen et al. 2011, Barton-Gade et al. 2012, Schwartzkopf-Genswein et al. 2012, Kephart et al. 2014, Vecerek et al. 2015] is estimated from 0.03 to 0.50%. In extreme individual cases, it can be higher and even exceed 1%. Pig mortality is characterized by a significant continental, national and regional diversity. In the EU countries, the mortality rate varies (Fig. 2) and ranges from 0.46% (Germany) to 0.03% (Denmark). However, there is no detailed statistical data showing the current scale of pig mortality in EU countries.

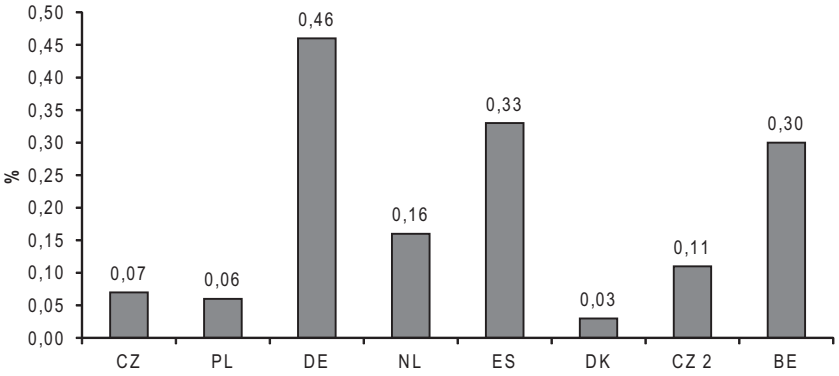

Figure 2. Mortality of pigs in pre-slaughter handling in selected EU countries in 2004–2009
Rysunek 2. Śmiertelność świń w postępowaniu przed ubojem w wybranych krajach UE w latach 2004–2009

Source: own study based on [Baltussen et al. 2011, Dos Reis et al. 2015, Vecerek et al. 2015].

Mortality is observed in all groups of pigs, with particular intensification in piglets, heavy pigs weighing over 120 kg and sows defective from breeding use [Voslarova et al. 2017]. The problem of pigs' mortality during their transportation on the largest scale occurs in the group of pigs. Particularly thorough and long-term studies devoted to the issue of slaughter pig mortality and its conditions are available in American literature. A compilation of these results by Ritter et al. [2009] shows that in the period from 1933 to 2006 the mortality rate in individual years was variable and throughout the whole period fluctuated within very wide limits. However, until 2002 it did not exceed 0.22%. As the main causes of such high mortality of pigs during this period, genetic changes in the population are indicated, which resulted in an increase in the population of the frequency of stress sensitivity gene, meat index, increase of slaughter weight of pigs for fattening [Ellis et al. 2003]. The negative impact of increasing production concentration and as a result of which it was necessary to transport pigs over longer distances was also indicated. Mortality of pigs can occur both during loading, transport and unloading of animals. According to Kołacz [2010], it most often occurs during transport at this stage about 70% of all deaths recorded in pre-slaughter handling are recorded. The remaining 30% occurs

during unloading or during pre-mortem storage. Previous studies [Murray and Johnson 1998, Guárdia et al. 2009] clearly indicate that the frequency of pig mortality in transport is associated with the occurrence of the mutated *RYR1* stress sensitivity gene, which is affected by about 10% of the pig population. This load is the cause of over 50% of pig mortality in transport as well as after its completion. Elimination of the stress sensitivity gene from the pig population results in a significant reduction in mortality during transport to slaughter. Particularly positive effects of such activities were noted in Denmark. According to Barton-Gade et al. [2012], successive actions aimed at eliminating from the population of pigs used in this country specimens loaded with the halothane sensitivity gene allowed reducing pig mortality in transport from 0.12% in 1980 to 0.016% in 2002. Currently, it is the lowest rate among European countries. Denmark is recognised as a world leader in the improvement of methods of handling animals before slaughter. In recent years, as a result of other actions, mainly of a legal and organisational nature, the problem of pig mortality has also been significantly reduced in other EU countries [Baltussen et al. 2011].

Source data indicate that particularly high rates of mortality in pre-slaughter handling concern poultry, especially chicken and turkey broilers. The death of the poultry most often occurs as a result of acute stress reaction, suffocation, trampling, cardiac arrest. Numerous studies [Bremer and Johnston 1996, Petracci et al. 2006, Voslarova et al. 2007] show that the average death rate of poultry during transport in the EU is 0.35% and in selected EU countries it ranges from 0.16% (the United Kingdom) to 0.47% (The Czech Republic) – Figure 3. A higher mortality rate is found among turkeys.

Some publications state that poultry mortality may be more severe. According to Nijdam et al. [2004], the DOA rate may be 0.57%, and exceptionally it may exceed

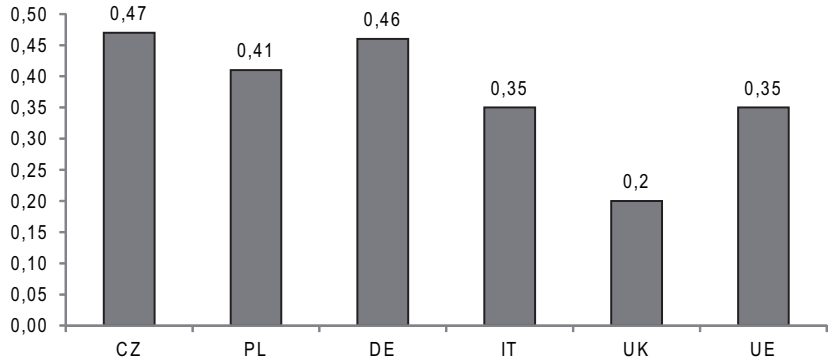

Figure 3. Mortality of slaughter poultry in pre-slaughter handling in selected EU countries in 2004–2009

Rysunek 3. Śmiertelność drobiu rzeźnego w postępowaniu przed ubojem w wybranych krajach UE w latach 2004–2009

Source: own study based on [Petracci et al. 2006, Voslarova 2007].

even 1%. According to Warriss [2006], the main factor contributing to the mortality of poultry during transport is the microclimate, and especially the high temperature. As the author shows, the temperature up to 17°C is considered to be the level of thermal safety during poultry transport. On the other hand, a higher temperature causes a significant increase in the incidence rate. Transporting poultry at temperatures above 23°C is particularly risky due to mortality. The relationship between the level of DOA indicator and transport temperature in studies on very large animal material was also confirmed by Petracci et al. [2006]. These studies show that the most poultry mortality during the summer months, with the highest mortality rates for broiler chickens observed in July and August, while the most turkeys mortality during transport carried out in June. Different results were obtained by Voslarova et al. [2007], who showed a much higher rate of mortality in the winter months when poultry was transported at a temperature not exceeding 10°C.

The global meat industry bears measurable financial losses as a result of the mortality of slaughter animals in pre-slaughter handling. According to Fitzgerald et al. [2008], animal mortality in transport is particularly severe as it affect animals when they gained market value. The economic effects of animal mortality identified in numerous studies at the stage of their transport for slaughter are characterized by considerable regional and national diversity. Brazilian studies have shown that sector losses due to mortality of pigs in the supply chain are estimated at around USD 160 thousand. Kephart et al. [2014] showed that losses due to the mortality of fattening pigs in the US in 2011 amounted to more than USD 29 million. Assuming an average mortality rate of fattening pigs in EU countries of 0.07% with an annual production of around 250 million pigs, the meat sector losses can be estimated at around EUR 26 million. Similarly, transport losses in the poultry sector, with a mortality rate of 0.35% in the EU, amount to around EUR 98 million.

Material and methods

The study attempts to estimate the financial losses incurred by the Polish meat industry as a result of mortality in poultry and slaughter pigs in pre-slaughter handling. To estimate the economic losses associated with the mortality of pigs and poultry in transport, data on the purchase of live slaughter animals in live weight published by the Statistics Poland (Główny Urząd Statystyczny – GUS) were used. It was assumed that the losses in the transport of pigs resulting from their mortality amounted to 0.137% (the average level of losses from published data for selected EU countries was taken into account – Figs. 1 and 2), while in the case of broiler chickens, the mortality rate was 0.35% [Petracci et al. 2006, Voslarova 2007]. For turkey broilers the mortality rate of 0.40% was used in the study [Petracci et al. 2006, Voslarova 2007]. To calculate the value of incurred losses, the average current purchase prices of slaughter animals published by the Statistics Poland were adopted.

Results

When analysing the purchase of pigs for the years 2005–2018 (Table 1), the value of losses for this period calculated in current prices was PLN 178 million. Assuming the improvement of pig transport conditions in Poland and the reduction of mortality during transport to the level of 0.10% (Fig. 1) and maintaining this level of the indicator, the value of losses for the analysed period would amount to PLN 129,942.8 thousand, which would give a benefit of PLN 48,778.8 on a national scale, i.e. 27% less loss.

Table 1. Economic losses resulting from mortality in transport of fattening pigs in Poland in 2005–2018

Tabela 1. Straty ekonomiczne wynikające ze śmiertelności w transporcie tuczników w Polsce w latach 2005–2018

Year	Purchase of slaughter animals for live weight – pigs (t)	Losses resulting from fattening pigs mortality (t)	Value of losses resulting from the mortality of fattening pigs (current prices) (PLN thous.)	Value of losses resulting from the mortality of broiler chickens with a mortality rate of 0.1% (current prices) (PLN thous.)
2005	1 944 447	2 663.9	10 176.1	7 427.8
2006	2 178 621	2 984.7	10 625.6	7 755.9
2007	2 228 942	3 053.7	10 565.6	7 712.1
2008	1 940 221	2 658.1	10 659.0	7 780.3
2009	1 767 687	2 421.7	11 043.1	8 060.7
2010	1 988 329	2 724.0	10 596.4	7 734.6
2011	2 085 918	2 857.7	12 916.8	9 428.3
2012	1 853 569	2 539.4	13 712.7	10 009.3
2013	2 017 210	2 763.6	14 895.7	10 872.8
2014	2 203 796	3 019.2	14 552.5	10 622.3
2015	2 250 382	3 083.0	13 257.0	9 676.6
2016	2 314 969	3 171.5	14 842.7	10 834.1
2017	2 255 405	3 089.9	15 604.0	11 389.8
2018	2 374 609	3 253.2	14 574.4	10 638.2
	Total			
	29 404 105	40 283.6	178 021.6	129 942.8

Source: own calculations based on data from the Statistics Poland.

A similar analysis was carried out for slaughter poultry – broiler chickens and turkeys. In the case of the broiler chickens, the adopted mortality rate during transport (0.41%) for the period analysed was over PLN 321 million (Table 2), while for the turkeys it was over PLN 36 million (Table 3). When adopting the assumption of improving the conditions for the transport of slaughter poultry and even a slight reduction in the losses rate would contribute to a significant reduction in the costs

Table 2. Economic losses resulting from mortality in transport of chicken poultry in Poland in 2005–2018

Tabela 2. Straty ekonomiczne wynikające ze śmiertelności w transporcie drobiu drobiowego w Polsce w latach 2005–2018

Year	Purchase of slaughter animals for live weight – poultry in total (t)	Purchase of slaughter animals in a live weight – chicken poultry in total* (t)	Losses resulting from chicken poultry mortality (t)	Losses resulting from mortality (current prices) (PLN thous.)	Value of losses resulting from the mortality of broiler chickens with a mortality rate of 0.35% (current prices) (PLN thous.)
2005	1 309 310	1 188 031	4 158	11 434.8	9 801.3
2006	1 268 794	1 152 730	4 035	10 086.4	8 645.5
2007	1 305 362	1 202 551	4 209	13 342.3	11 436.3
2008	1 486 394	1 366 099	4 781	15 156.9	12 991.6
2009	1 632 275	1 475 108	5 163	17 450.5	14 957.6
2010	1 814 344	1 667 862	5 838	18 680.1	16 011.5
2011	1 919 268	1 764 824	6 177	22 916.2	19 642.5
2012	2 099 515	1 882 792	6 590	25 436.5	21 802.7
2013	2 225 317	2 017 334	7 061	27 324.8	23 421.2
2014	2 504 521	2 276 591	7 968	29 481.8	25 270.2
2015	2 680 806	2 442 462	8 549	29 920.2	25 645.9
2016	2 949 389	2 690 836	9 418	31 455.9	26 962.2
2017	3 144 219	2 892 131	10 122	34 112.7	29 2394
2018	3 153 894	2 832 122	9 912	34 396.1	29 482.4
	Total				
	29 493 408	26 851 473	93 980	321 195.2	275 310.2

*The level of purchase of slaughter animals in a live weight for chicken poultry was estimated on the basis of the share of chicken poultry in the total poultry.

Source: own calculations based on data from the Statistics Poland.

incurred by poultry meat processing plants. Assumptions for reducing the poultry mortality rate by 0.05 p.p. would reduce losses for the broiler chickens by PLN 45,885 thousand (i.e. 14.3% lower level of losses), and in the case of the turkey broilers by PLN 4,517.5 thousand (i.e. 12.5% lower loss level).

Table 3. Economic losses resulting from mortality in transport of turkeys in Poland in 2005–2018
Tabela 3. Straty ekonomiczne wynikające ze śmiertelności w transporcie indyków w Polsce w latach 2005–2018

Year	Purchase of slaughter animals for live weight – turkeys* (t)	Losses resulting from turkeys mortality (t)	Value of losses resulting from mortality (current prices) (PLN thous.)	Value of losses resulting from the mortality of broiler chickens with a mortality rate of 0.35% (current prices) (PLN thous.)
2005	52 428	210	813.7	712.0
2006	70 776	283	1 030.5	901.7
2007	64 974	260	1 211.1	1 059.7
2008	76 151	305	1 288.5	1 127.4
2009	109 371	437	2 121.8	1 856.6
2010	93 811	375	1 726.1	1 510.4
2011	103 078	412	2 341.9	2 049.2
2012	153 263	613	3 322.7	2 907.4
2013	140 641	563	3 296.6	2 884.5
2014	155 437	622	3 655.9	3 198.9
2015	157 615	630	3 7512	3 282.3
2016	168 753	675	3 5236	3 083.1
2017	177 513	710	3 656.8	3 199.7
2018	225 394	902	4 399.7	3 849.7
	Total			
	1 749 204	6 997	36 140.1	31 622.6

*The level of purchase of slaughter animals in a live weight for chicken poultry was estimated on the basis of the share of chicken poultry in the total poultry.

Source: own calculations based on data from the Statistics Poland.

Conclusions

The analysis shows that the total financial losses resulting from the pigs' mortality during transport to an abattoir in 2005–2018 could be estimated at about PLN 178 million. In the case of slaughter poultry, the losses in the period analysed amounted to PLN 321 million. The losses shown in the results in the research are particularly bitter because they relate to animals that reached required slaughter parameters and have become an element of trade. Generating losses at this stage may evoke difficulties in determining

the subject responsible for them. The results obtained indicate the need for improvement measures to reduce the animals' mortality in pre-slaughter handling. The most important ones should include the reduction of transport time, compliance with loading standards, an introduction of a ban on transporting animals in conditions that may cause thermal stress.

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