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Impact of Selected Factors On Poultry Death During Transportat And Implications In The Form of Financial Losses.

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Abstract

Animal welfare during processing of poultry is one of the most important aspects contributing to quality of the acquired meat. During transportation of animals to slaughterhouses animals are subjected to various environmental factors such as temperature extrema during summer and winter months. The travel distance between breeding place and slaughterhouse is other important factor responsible for poultry mortality during transport. To ensure provision of optimal transportation conditions it is important to understand which factors have statistically significant impact on the welfare of poultry identified based on dead on arrival indicator. In this research five variables e.g., transportation month, quarter of the year, temperature, travel distance and transportation vehicle were investigated whether they have impact on dead on arrival indicator. Moreover financial implications of poultry deaths on arrival were estimated.

Keywords: Animal Transport, Poultry Deaths, DOA Indicator

Itroduction

Poultry industry has become more and more important source of nutrients for human diet. Already in 2012, Food and Agriculture Organization (FAO) presented data that estimed the global chicken meat production to be about 103.5 million tons, which is more than 34% of global meat production Pawar et al. (2016). The quality of the processed meat depends on the animal welfare during birds processing. At the pre-slaughter stage of animal resources processing e.g., handling and transport of birds to slaughterhouse, a number of poultry organisms can die. The mortality rates increase along with the transportation time. Other qualitative changes, such as mass loss may also occur depending on transport conditions, which results in reduction of financial effectiveness of the whole process Petracci et al. (2005).

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In order to tackle the issue of animals loss in general, it is important to understand environmental factors responsible for mortality of poultry during pre-slaughter phase of poultry industry production e.g., at the stage of transport from farms to processing plants. A major factor affecting their condition is thermal stress. In limited space of the containers, where birds are transported, the birds ability to use thermoregulatory mechanisms in impaired Warriss et al (2005). Thermal stress can cause a reduction in birds growth and decrease in the production of eggs. It was reported that broilers exposed to heat stress, eat less and have lower body mass Niu et al. (2009) and Lara and Rostagno (2013). Moreover, it was reported that under heat stress the chemical composition of poultry meat changes. It was shown that during exposure of birds to heat stress the protein content is reduced and the fat tissue content increased Lara and Rostagno (2013). Data on the negative impact of thermal stress on birds welfare and quality of meat produced improve awareness of consumer who are more and more interested in improving birds production conditions. Therefore, an intensive research is conducted aiming of investigation of mechanisms responsible for reaction to thermal stress of poultry Lara and Rostagno (2013). Warriss et al., in 2005 showed that the mortality of birds is growing during summer season, when the average and peak temperatures are the highest. Vecerek et al (2006) showed that mortality rates increase both in summer and in winter months, which are characterized by temperature ex trema. St-Pierreet al. (2003) reported that exposure of livestock to heat stress in USA causes high financial loses in livestock handling industry amounting between 1.69 and 2.36 billion USD. Poultry industry alone accounts for 128 up to 165 milions USD. Indywidua which are dead on arrival (DOA) present a total loss and amount for up to 0.5% of total processed organisms Warriss et al. (1999) [8]. Wariss et al (2006) reported that over 120 milions of birds die yearly during transportation between farms and processing plants.

In this study five variables e.g., transportation month, quarter of the year, temperature, travel distance and transportation vehicle were investigated whether they have impact on dead on arrival indicator. Moreover financial implications of poultry deaths on arrival were estimated. The goal of the conducted research was the veryfication wchich factors have impact on the dead on arivial indicator.

Materials and Methods

Research material consisted of data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob). The analysis was based on data acquired vetween 1 Jun 2018 and 31 May 2019. Data concerned transports, during which 20 689 592 poultry were transported. The analysis was performed for hen broilers belonging to the Ross 308 breed, whose age was in the range of 35-42 days. Animals for slaughter were transported in a container system using three types of vehicles: a classic solo truck, a truck with a trailer and a truck with a semi-trailer. The birds were transported from farms located within a radius of 500 km. The number of dead animals was determinated during unloading the birds in the slaughterhouse. In order to determine the influence of the analyzed factors on the DOA indicator during the transport, the data were analyzed taking into account month and quarter of the year of the transport, transport temperature (temperature from -3.4 to 31.6 °C in range of every 5 °C) and transport distance (from under 50 km up to 500 km in intervals of 50 km) and the type of truck. The financial losses during transportation were estimated based on the DOA indicator and previous publication by Tereszkiewicz et al (2019). In this research the callculation of financial losses were based on curent seeling proces of poultry, the amass of birds and doa indicator. In order to verify the combined effects of transportation vehicles and the travel distance of poultry deaths two-factor analysis of variance (Fisher-Snedecor F test) with the level of significance $\alpha = 0.05$ was adopted. Other observations are based on the Analysis of variance (ANOVA) and post hoc analysis.

Results

The data acquired from consignment notes were analyzed, processed and presented in Tables 1 to 5. It was shown that the average DOA indicator was 0.60%. The obtained results were characterized by high standard deviation values. The analysis of the data contained in Table 1 indicates that the number of deaths varied significantly depending on the month in which the transport was carried out. It was found that most (0.83%) of broilers died during transports that were carried out in August. The statistical analysis showed that the value of the DOA indicator recorded in August was significantly higher compared to the DOA indicator recorded in January, March, April, October and December. In those months the DOA indicator did not exceed the value of 0.5%, and the lowest value of 0.41% was observed in December. The mortality rate recorded in December was more than twice lower than in August (see Table 1). On the other hand, a high mortality rate (0.71) of birds transported for slaughter occurred in February. The mortality rate in that month was statistically significantly higher than the that recorded in April, October and December.

Tab 1. Mortality rate of chickens and value of financial losses during the transportation in following months of the year

Months (statistical code)	number broiler chicken transported	the number of broiler chicken that died in transport	percentage of broiler chicken that died during transport mean/sd		mass of dead birds [t]	value of dead birds [thousand Euro]	Significance of differences
January (a)	2 000 431	10 032	0.50	0.79	24.49	19.34	a:h
February b	1 468 828	10 605	0.71	1.16	25.88	20.44	b:djl
March c	2 061 162	10 900	0.49	0.94	26.59	21.01	c
April d	1 589 250	7 600	0.47	0.49	18.54	14.65	d:hi
May e	2 188 717	13 936	0.62	0.74	34.00	26.86	e:l
June f	2 204 799	15 141	0.66	0.84	36.94	29.18	f:djl
July g	2 111 027	16 607	0.76	0.84	40.52	32.01	g:djl
August h	502 012	7 101	0.83	0.75	17.33	13.69	h:acdjl
September i	2 070 913	14 822	0.69	0.78	36.16	28.57	i:djl
October j	1 792 057	7 872	0.44	0.38	19.21	15.17	j:bfeghik
November k	1 191 934	8 191	0.64	0.83	19.97	15.79	k:jl
December l	1 508 462	6 237	0.41	0.43	15.22	12.02	L:befghi
Sum/Mean	20 689 592	129 044	0.60	0.78	314.85	248.73	

Data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob)

The analysis of the collected data showed that the highest DOA indicator was recorded in the third, and the lowest in the fourth quarter of the year. The deaths rate in the third quarter was significantly higher than in the remaining quarters (see Table 2).

Tab. 2 : Mortality rate of chickens and value of financial losses during the transportation in following quarters of the year

Quarter	number of broiler chicken transported	the number of broiler chicken died in transport	percentage of broiler chicken that died during transport mean/sd		mass of dead birds [t]	value of dead birds [thousand Euro]	Significance of differences
I a	5 530 421	31537	0.55	0.96	76.95	60.79	a:d
II b	5 982 766	36677	0.60	0.73	89.48	70.70	b:d
III c	4 683 952	38530	0.74	0.80	94.01	74.27	c:d
IV d	4 492 453	22300	0.48	0.56	54.41	42.97	d:abc
Sum/Mean	20 689 592	129044.0	0.59	0.78	314.85	248.73	

Data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob)

The analysis of the data also shows that the birds were transported under various thermal conditions of the environment, and the statistical analysis revealed a significant impact of the thermal factor on the DOA indicator. It was found that the lowest mortality rate was recorded for transports carried out in sub-zero temperatures. Under these conditions, the DOA index ranged from 0.42% to 0.51% (see Table 3). A low (0.46%) rate of deaths was also recorded during transports carried out in the temperature range of 11.6-16.6 ° C. The percentage of dead birds increased significantly at temperatures above 16.6 ° C. The fall rate exceeded 0.62% and reached the highest average level of 0.74% during transports at 26.6-31.6 ° C (see Table 3).

Tab. 3 : Mortality rate of chickens and value of financial losses during the transportation in particular temperature and the value of financial losses.

Temperature	number of broiler chicken transported	the number of broiler chicken died in transport	percentage of broiler chicken that died during transport mean/sd	mass of dead birds [t]	value of dead birds [thousand Euro]	Significance of differences

Below -3.4 a	1 477 858	6703	0.45	0.45	16.35	12.92	a:efg
-3.4 -1.6 b	577 507.0	2509	0.42	0.50	6.12	4.83	b:defg
-1.6 6.6 c	613 7328	32114	0.51	0.79	78.35	61.90	c:de
6.6 11.6 d	3 598 601	22442	0.58	0.80	54.76	43.26	d:abc
11.6 16.6 e	3 974 781	32373	0.46	0.41	78.99	62.40	e:dbc
16.6 21.6 f	3 371 000	21985	0.62	0.70	53.64	42.38	f:ab
21.6 26.6 g	1 427 612	10382	0.71	0.84	25.33	20.01	g:ab
26.6 31.6 h	124 905.0	536	0.74	0.92	1.30	1.03	h
Sum	2 0689 592	129044.0	0.59	0.78	314.85	248.73	

Data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob)

The birds for slaughter were transported from a distance within the radius of 500 km, and the most (over 4 and a half a million) animals were delivered from farms distant by 251-300 km. Animals obtained from producers located more than 350 km away had a much smaller share in the structure of supplies (see Table 4). The research showed statistically significant dependence of the DOA indicator on the distance of bird transport. The highest DOA value of as much as 1.12% was recorded for birds delivered to the processing plant from a distance of 401-450 km. The trend of the increase in DOA indicator along with the distance over which the birds were transported could be observed: from 0.34% for transports over 50 km to 1.12% for distances of 401-450 km (see Table 4). It was also noted that in transports up to 200 km, the fall rate did not exceed 0.40% (See Table 4).

Tab. 4: Mortality rate of chickens and value of financial losses during the transportation on particular distance and the value of financial losses.

Distance [km]	**broiler chicken transported**	**the number of broiler chicken died in transport**	**percentage of broiler chicken that died during transport mean/sd**		**mass of dead birds [t]**	**value of dead birds [thousand Euro]**	**Significance of differences**
below 50 a	1938870	6396	0.34	0.70	15.60	12.33	a:ergi
51-100 b	2605547	9576	0.37	0.46	23.36	18.46	b:fgi
101-150 c	2072760	7833	0.38	0.42	19.11	15.09	c:ergi
151-200 d	2491914	9729	0.39	0.44	23.75	18.75	d:ergi
201-250 e	3156914	21540	0.67	0.93	52.55	41.52	e:acd
251-300 f	4530507	36536	0.77	0.87	89.15	70.99	f:abcd
301-350 g	2577814	23938	0.86	0.87	58.41	45.14	g:abcd
351-400 h	328702	3219	0.92	0.93	7.85	6.20	h:abcd
401-450 i	711222	7965	1.12	1.39	19.05	15.05	i:abcd
451-500 j	275342	2147	0.78	0.78	6.02	4.75	J
Sum	20 689 592	128 789	0.60	0.78	314.85	248.73	

Data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob)

In the study, three types of means of transport were used in order to deliver birds to the slaughterhouse. Most of the animals were transported with the use of semi-trailers. The research shows, that the type of means of transport used to transport the birds did not significantly affect the DOA indicator. However, that the lowest number (0.49%) of fatalities was recorded in transports with a solo vehicle (see Table 5). Furthermore the dependence of the mortality rate on the distance and type of car was analyzed (see Table 6).

Tab. 5: Mortality rate of chickens and value of financial losses during the transportation in particular car type and the value of financial losses.

Car	number broiler chicken transported	the number of broiler chicken died in transport	percentage of broiler chicken that died during transport mean/sd		mass of dead birds [t]	value of dead birds [thousand Euro]
Truck with a semi-trailer	19125060	118726	0.59	0.78	289.69	228.85
Truck with a trailer	1441835	9774	0.67	0.91	23.83	18.84
Solo vehicle	122697	544	0.49	0.64	1.33	1.04
Sum	20 689 592	129044	0.60	0.78	314.85	248.73

Data acquired from consignment notes which included information on transport of broilers slaughtered in poultry processing company (Rzeszowskie Zakłady Drobiarskie Res Drob)

Tab. 6: Dependence of the mortality rate on the distance and type of car (summary of the analysis of variance)

Efect	F	P
Distance	37.51	0.000
Car type	0.05	0.825
Distance *car type	4.13	0.000

- Distance is a factor that significantly differentiates the mortality rate (p<0,05)
- Statisticaly important is interaction: distance * car type (p<0.05)

Discussion

Transport temperature remains one of the main determinants of animal welfare. The thermal comfort zone for broiler chickens is in the range of 17-20 °C. Exceeding the lower or upper critical temperature is a factor disturbing the body's thermoregulatory system, causing symptoms of thermal stress. According to many authors, thermal stress, especially exceeding the upper critical temperature, is one of the main factors that may cause animals deaths during transport. Pigs and poultry are particularly sensitive to the effects of thermal stress.
We emphasize that low-temperature transport may cause an increase in the number of dead birds as a result of massive suffocation of animals, which are crowded in a defensive reaction to excessive heat loss. Voslarova et al (2007) showed a significant increase in the death rate during transports at low temperatures. The authors found that at an average temperature of - 2.6 °C (SD, 1.9 °C), the average DOA indicator of birds in transport was as high as 1.22%. Moreover, in the study by Vecerek et al. in 2006, the authors noted the highest levels of birds deaths in the winter months (January, December).

Analysis of the level of the DOA indicator in individual months showed that particularly high values were recorded in the summer months, especially in July and August, and in the winter period (February - 0.71%). The obtained results are partially consistent with the data published by Vecerek et al (2006), especially with the scale of mortality rate in July and August. The cited authors indicate a high level of mortality of the transported birds in the winter months, especially in January and December, which was not confirmed in this study.

We acquired the mortality data for birds, which were transported to slaughter over various distances, and as indicated in the results section, a distance in range of 251-300 km dominated. The estimated transport time was 6-7 hours. According to Warriss et al (1992) the average transport time of broilers to slaughter in British conditions is 3.3 hours. According to the authors, the largest share, over 50%, was observed for birds transported during over 2 hours, and only 6% of birds were transported during more than 6 hours. In other studies Warriss et al (1999) it was found that transports longer than 4 hours increased the DOA indicator by about 80%. In this research, the share of birds transported longer than 6 hours was definitely higher and amounted to about 40% of all transported birds, that relatively long transport time could have contributed to the high level of the DOA indicator, which averaged as much as 0.60%. Our research confirmed the results obtained by other authors (Voslarova et al 2007, Bianchi et al 2016, Teke 2019), showing the relationship between time (transport distance) and the DOA indicator. Bianchi et al (2016) found that poultry losses during transport lasting less than 3.5 hours are statistically significant and nearly twice lower compared to deaths recorded over time for long and medium distance transports. Teke (2019) reports that the mortality rate of broilers transported over a distance of 101-200 km was on average 0.664 and was significantly higher than that of deaths recorded at distances of 51-100 km and below. Also, Voslarova et al (2007) indicated a clear increase in the DOA indicator along with the increase in the distance of transport of birds, while the authors recorded deaths of as much as 1.638% in the case of transport over a distance of 201-300 km Voslarova et al (2007). In the our own research, the highest mortality rate was recorded in the group of birds transported at a distance of 401-450 km.

Modern broiler transport systems use means of transport with high load capacity. These are mainly semi trailers and trailers. In our own research, most birds were transported with the use of semi trailers. It is worth noting however, that despite the lack of a statistically confirmed impact of the type of means of transport on the DOA indicator, its lowest value (0.49%) was recorded for animals transported by solo vehicles. According to the organization system and transport plans, vehicles of this type were used to collect final batches of livestock from farms.

The research conducted by Bianchi et al (2016) indicate that poultry transport can negatively affects not only the animal welfare but also it may result in measurable finacial losses as a consequence of birds deaths and the reduction of the animal suitability for further processing including the occurrence of bruises and mass reduction.

Thermal stress causes significant financial effects for the livestock industry which, according to Lara and Rostagno (2013) in the US, are estimated at USD 1.69-2.36 trillion. Of these, 128-165 million are related to the poultry industry.

This research showed that the mortality rate in the analyzed plant was on the average level, in relation to the data reported in the literature. The DOA index recorded in the Czech Republic was at an average level of 0.247% Vecerek et al (2006). On the other hand, Vloslarowa et al (2007) provides data, that the DOA indicator in the Czech Rebublic within years 1997-2004 was 0.92% and was dependant on the travel distance and transportation month. In turn Haslam et al (2008) showed an average mortality rate of 0.12% in the range (0-0.64%). Ritz et al (2015), citing data published in Agri Stats, determined the annual DOA rate in the USA at 0.35-0.37%. Aside to measurable financial losses, a high DOA level may indicate the need for better handling of animals during the transport process.

Tereszkiewicz et al (2019) stated that the total value of poultry losses in transport in Poland is about 30 million PLN (6.81 mln Euro) and has an upward trend. The mortality rate is around 0.5% and does not have a significant impact on the overall performance of the poultry sector. However, those losses due to the deaths of animals at the stage of transport to slaughter are of measurable value, because they concern animals that have reached their processing value. With a low level of profitability, the search for any reserves of additional revenues, including those related to the DOA indicator, is important from an financial point of view.
In our research the total financial losses amounted about 250 thousands Euro and were dependant on the average DOA indicator in relations to the analyzed factors (transportation month and quarter and temperature during transportation. Additional calculation based on the determination of the amount of financial losses in relations to thousand of transported birds showed that the highest losses in the relations to transportation month were observed in February and amounted 13.92 Euro per thousand of transported animals. The average loses in the first quarter were 10.99 Euro. Taking the transportation temperature into consideration it was observed that the highest loses amounting 8.26 Euro per thousand of animals were observed in the temperatures between 26.6 and 31.6 C°.

Taking into account the transport distance, the highest recorded losses were recorded for travel distances of over 400 km and it amounted up to 21.16 Euro per thousand birds transported. According to the authors of these studies, financial losses are particularly acute in the case of animals transported over long distances (Warriss et al 1992 and Bianchi et al 2016).

Conclusios

As presented within this manuscript some factors may have impact on the animals survivability during transportation of poultry. Certain conditions of animal transport and the travel distance are responsible for high financial losses especialy due to the fact that the losses concern the birds wchich have already achieved the processing potential and are removed at the last stage of the processing cycle. Already in 2019 the financial losses caused by poultry deaths at the stage of transportation to slaughterhouses amounted about 6.81 mln Euro. The analysis carried out confirms that the mortality of chickens and the amount of financial losses during the transport of these animals to the slaughterhouse are very strongly influenced by the temperaturę stress and long distance (which i salso related to the lengh of time these animals have to spend on trucks) during transportation.

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