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SLAUGHTER CHARACTERISTICS AND WEIGHT LOSSES (SHRINKAGE) OF LAMBS FROM AN ORGANIC AND CONVENTIONAL SYSTEM

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Abstract: *The aim of the research was to determine the differences in slaughter characteristics, weight loss in transport and cooling, and the pH value of lamb meat grown in an organic and conventional system. The study included 120 lambs, 60 of which were bred in a conventional and 60 in an organic system for a period of 75 days. The established differences in the slaughter results (carcass weight, dressing percentage) and the proportion of internal organs relative to the weight of lamb before slaughter) among the lambs bred in an organic and conventional system are statistically not significant ($p>0.05$). Significant difference ($p<0.05$) is determined for total shrinkage (transport and shrinkagein lairage facility) between lambs of group I from the organic and conventional system and a significant difference from ($p<0.01$) between lambs of group II of the organic and conventional system. The discrepancies found in the cooling shrinkage of lamb carcases between groups from the organic and conventional system are significant ($p<0.01$). In the pH value measured 1 and 24 hours post-mortema statistically significant difference was found ($p<0.05$) between lamb meat from the organic and conventional system.*

Keywords: *quality, carcass, meat, breeding systems*

1. Introduction

With the increasing needs and interest in the domestic and foreign market for lamb, there are demands for increasing its quality, covered by the new EU regulations concerning the quality of the animals for slaughter [1]. In accordance with [2] there is no general model for breeding, which could be applied in all farms and in all conditions. There are different breeding systems in the world, which are conditioned by natural and economic factors, as well as from the tradition of countries or regions.In the conventional breeding system, the traditional way is popular, with a technology of early rejection of the lambs from 25 to 30 days, and intensive feeding with concentrated fodder mixtures and hay at will, up to a certain slaughter weight or age. The main objective of this method of breeding is to intensify sheep farming, by achieving solid weight gaining performance in earlier rejected lambs and getting bigger amount of milk per sheep [3]. Compared to conventional, organic sheep production is based on compliance with standards and legal regulations for controlling each stage of the production cycle, which contribute to respect for animal welfare and the production of safe products of animal origin. The cultivation of lambs in an organic system is carried out in accordance with the organic production rules, equivalent to the European Union Regulation 834/2007, according to which, in order to respect animal welfare, the lambs should be rejected at the 45 days old. The birth weight represents the basis

for the growth and development of lambs, [4]. Lambs grown in a conventional and organic system have similar production and slaughter yields, [5]. Long transport of animals, adverse conditions and improper handling of animals during transport negatively affect animals and the quality and sustainability of the meat. Transport shrinkage (loss of body mass), when transporting lambs to a slaughterhouse depends on the influence of several factors such as: breed, sex, health status of lambs, degree of nutrition, the treatment of the lambs before and after transport, mode of transport, length of transport, type of transport vehicle, and the season.

The shorter relation when transporting lambs from farm to slaughterhouse leads to a reduction in stress [6], [7]. The loss of body weight and the stress experienced during the transportation of lambs negatively affects the quality and sensory properties of the lamb, which means that the lambs should be placed in the slaughterhouse before the slaughter for the normalization of the physiological condition, and therefore be properly prepped for slaughter. With the rest in the slaughter shed many negative consequences caused by transport are eliminated or mitigated, i.e., the irritated vasomotor centres in the brain, ejection of harmful products from the metabolism and withdrawal of the bacteria from the blood. During the stay in the shed in the lambs, a loss of body mass occurs, primarily as a result of excretion of bodily fluids by evaporation, sweating, urination, etc. [8]. The weight of the lambs before slaughter affects the carcass weight of the lamb carcass, [9]. Slaughter characteristicsof the lamb carcass, i.e. the quantity and quality of the resulting meat vary depending on farming systems, [10]. When slaughtering the lambs, the dressing percentageis an important economic indicator that represents the relationship between the slaughter and the body weight of lambs before slaughter, expressed in percent. Dressing percentageof slaughter varies greatly and depends on the influence of several factors such as: breed, sex, age, health, manner of nutrition and degree of nutrition and weight of the lambs. The mass of the internal organs and parts of the lamb carcases is a parameter that is often used to evaluate the conformation of lamb carcasses. The loss in the mass of carcasses so called. Cooler shrink occurs because of the draining and evaporation of the lamb carcasses in the cooling chambers.

Shrinkage of cooling depends on the influence of several factors, primarily on the time of the first measurement, which represents the basis for determining the shrinkage, the quality of the meat and the coverage of the body with fatty tissue that depends on the race of lambs and the diet, the speed of cooling of the carcasses, air circulation in the chambers and the relative importance of the air, [11]. pH value is one of the factors that determine the quality of the meat associated with biochemical processes during the transformation of the muscles in the meat. Measuring the pH value of the meat allows for monitoring of the intensity of changes occurring in the muscles in the *post-mortem* period which also affect the sensory properties of the meat, [12]. Lowering of the pH value of the meat must be gradual, [13]. If the animal is under stress immediately before slaughter, the glycogen reserves in the muscles are reduced and a sufficient amount of lactic acid is not generated, and the pH value of the meat remains high and causes the occurrence of DFD - Dark, Firm and Dry meat [14], while too rapid a decrease in pH value can lead to PSE - Pale, Soft, Exudative meat, [15]. The pH value of the meat is influenced by many factors such as breed, animal fatigue before slaughter, muscle glycogen content, carbohydrate-rich diet, acute starvation

before slaughter, and meat storage temperature, [16].

2. Matherials and methods

The study covered 120 lambs, 60 of which were grown conventionally and 60 in an organic system, over a period of 75 days. In the conventional system, two groups of 30 lambs were formed. The lambs of Group Imade up of crossbreeds of domestic breed refined with Virtemberg, and in Group II, the lambs were made up of crossbreeds of domestic breed refined with East-Friesian breed. The lambs of both groups in the conventional system were raised the traditional way, weaned on the 30th day and until the end of the breeding were fed with a commercial conventional fodder mixture. Two groups of 30 lambs were formed in the organic system, out of which the lambs in Group I made up of crossbreeds of domestic breed refined with Virtemberg, and in Group II, the lambs were made up of crossbreeds of domestic breed refined with East-Friesian breed, certified for organic production. Lambs from the organic system were breed according to organic production rules, according to which lambs were weaned on the 45^{th} day and by the end of the breeding were fed with a concentrated fodder mixture obtained from an organic produced and certified food from own production cycle.

Body mass control of the lambs from both systems was done every fifteen days starting from the first day (birth weight), to the 75th day when they were slaughtered. The transport of lambs from both systems to the slaughterhouse, which is 75 km away, was carried out in the same way, with special means of transport for animals. The last measuring of the weight of the lambs was done on the farm; just before loading them into the vehicle.After arriving and unloading them at the slaughterhouse, the lambs were measured on an electronic livestock scale and placed in a lairage facility. By calculating the difference in body mass before and after transport, the transport shrinkage of the lambs is determined. After the 7 hour stay at the lairage facility, the lamb shrinkage is determined in the same manner. The killing of the lambs was done with stunning, to humanize the procedure. After the slaughter of the lambs and the processing of the carcases, individual measurements of the internal organs, taken from the lamb carcass, were performed. After 24 hours in the cooling chambers at a temperature of 0°C, the carcases were individually weighted and on the basis of the difference in the weight of the warm and cold carcasses the loss in the mass during cooling was determined.

In determining the slaughter value, the following parameters for the dressing percentage of the lambs were determined: warm carcass with head and internal organs (R I), cold carcass with head and internal organs (R II), carcass with head without internal organs (R III), cold carcass without head and internal organs (R IV). The first measurement of the pH value of the meat was conducted one-hour *post mortem*, and the second measurement of the pH value was 24 hours after the stay in the cooling chambers at a temperature of 0°C.

3. Results and discussion

The established average values for the birth and body weight of the lambs, on the 75th day of the breeding, before the transport of the lambs to the slaughterhouse are presented in Table 1. The determined birth weight of the lamb's fromGroup Iof the organic system is 3.991kg, i.e. 4,189kg of Group II from the organic system. A similar birth weight of 4.226 kgand 4.338 kg, it was found in the

lambs of Group I and II from the conventional system. The difference in the birth weight between lambs of Group I from the organic and conventional system, as well as the difference between Group II lambs from the organic and conventional system, is statistically not significant ($p>0.05$) [17].

Table 1

Birth and body weight of lambs from breeding systems

Birth weight	$\bar{x}$	S_d	cv	$S_{\bar{x}}$
O (I)	3.991	0.522	13.08	0.095
O (II)	4.189	0.566	13.52	0.103
C (I)	4.226	0.615	14.55	0.112
C (II)	4.338	0.561	12.95	0.102
Body weight (75^{th} day)	$\bar{x}$	S_d	cv	$S_{\bar{x}}$
O (I)	17.995	1.812	10.07	0.331
O (II)	18.363	2.161	11.77	0.395
C (I)	18.480	2.447	13.24	0.452
C (II)	19.149	2.339	12.22	0.428

Similar value results for the birth weight of the lambs were stated [18]. On the 75^{th} day, i.e. at the end of the breeding the highest body weight of 19.149 kg was established in lambs from Group IIfrom the conventional system, and the lowest body mass of 17.995 kg of Group I lambs from the organic system. The difference in body weight of lambs found at the end of breeding (75 days), between groups in the same system, as well as the established differences between the same groups of different systems (organic and conventional system) is statistically not significant ($p>0.05$), [17]. Results for the body weight of lambs from the organic system at the end of the breeding can be compared with the results obtained by [19].

Figure 1 presents the total shrinkage of lambs (transport and shrinkage in a lairage facility) of both groups of organic and conventional system breeding.

From the data presented in Figure 1, it can be stated that the total shrinkage (transport and lairage facility shrinkage) in lambs in the organic system is significantly lower, compared to the total shrinkage in lambs of the conventional system.

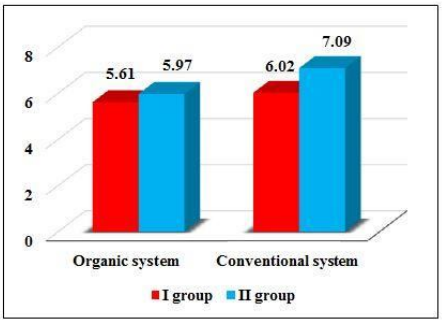

Fig.1 Total shrinkage (loss) ofthe weight of the lambs

The total shrinkage in the organic system for lambs of Group I is 5.61% and 5.97% for lambs of Group II. In the conventional system, total shrinkage in Group I lambs is 6.02% and 7.09%. Differences in the total shrinkage of lambs between Group I from the organic and Group I from the conventional system, as well as the difference between Group II in the organic and Group II in the conventional system, are statistically significant at the level of ($p<0.05$), that is, ($p<0.01$), respectively.

From the above it can be concluded that apart from the breeding system, the breed of the lambs, as well as the stress during transport has a certain influence on the total shrinkage.

In table 2 are presented relative participation of internal organs and parts of the lamb carcass

Table 2

Relative participation of internal organs and parts of the lamb carcass

System/group	O(I)		O(II)		C(I)		C(II)	
indicators	kg	%	kg	%	kg	%	kg	%
live weight	16.987	100	17.267	100	17.368	100	17.79	100
head	728.0	4.28	760.0	4.40	755.0	4.35	790.0	4.44
liver	380.0	2.24	400.0	2.32	405.0	2.33	425.0	2.39
lung	320.0	1.88	350.0	2.08	340.0	1.96	370.0	2.08
heart	90.0	0.52	100.0	0.57	95.0	0.54	105.0	0.59
tallow	103.9	0.61	106.2	0.62	111.5	0.61	119.6	0.67
tonsils	158.0	0.93	166.6	0.96	169.0	0.97	176.0	0.99
stomach with intestines	3.890	22.89	3.905	23.25	3.995	23.31	4.230	23.77
skin	1.950	11.48	2.038	11.80	2.020	11.70	2.115	11.89
feet	530.0	3.12	557.0	3.23	546.0	3.14	586.0	3.29

With lambs of Group I from the organic system, the body weight before slaughter is 16.987kg, that is, 17.267 kg for lambs of Group II, while the weight before slaughter in lambs of Group I in the conventional system is 17.368 kg, or 17.792 kg in lambs of Group II. The observed differences in body mass before slaughter of lambs from the groups in the systems are statistically not significant ($p>0.05$). The percentage share of skin in lambs of Group I from the organic system is11.48% i.e. 1.80% in lamb's fromGroup II, i.e 11.70% in Group I and 11.89 in lamb's from Group II from the conventional system. Similar results were obtained by [11]. The percentage share of the liver in lambs from Group I and II of the organic system is 2.24%, i.e. 2.32% and in the conventional system 2.33%, i.e. 2.39%. The percentage share of the the lungs in the lambs from Group I and II of the organic system is 1.88%, i.e. 2.08, while and in the conventional system in Group I and II with 1.96%, i.e. 2.08%.

The heart accounts for 0.52% in lambs from Group I and 0.57% in lambs from Group II in the organic system, while and in the conventional system the heart accounts for 0.54% in Group I and 0.59% in Group II. Similar results to ours were obtained by [20], for the percentage of liver 2.20±0.05, for the lungs 2.06±0.09, for the heart 0.46% and for the head 4.97, [21],obtained almost the same values as ours, for the percentage of the liver weight in male lambs from 0.23 ± 0.01 kg, i.e. 0.22 ± 0.01 kgin female lambs, i.e. 1.91% in unweaned lambs and 1.60% in weaned lambs and percentage shareof the heart of 0,52% in unweaned and 0.48% in weaned lambs.The differences in relative share of the internal organs of lambs from Group I of the organic and conventional system and Group II of the organic and conventional systems are not significant ($p>0.05$), which is understandable because the weight of the lambs from the organic and conventional breeding system before the slaughter is approximate in lambs from both breeding systems.

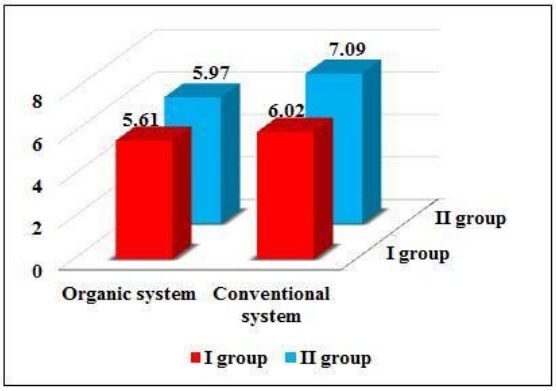

Fig 2 Mass losesof lamb carcasses in cooling chambers

The differences in the average values for cooling shrinkage in lamb carcases between groups of the organic and conventional system are significant ($p<0.01$). The discrepancy found is understandable and stems from the influence of several factors such as: the time of the first weighing, which represents the basis for determining the shrinkage, the quality of the meat and the coverage of the body with fatty tissue that depends on the breed of lambs and the diet, the speed of cooling of carcasses, circulation and the relative importance of air in the chambers [11].

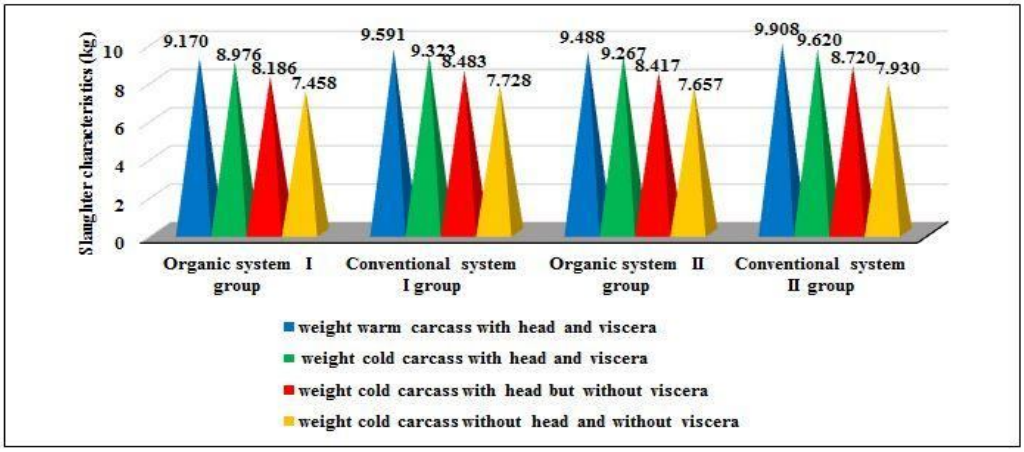

Fig 3 Slaughter values of the lambs of I and Group II from the organic and conventional system

Differences in carcass weight among groups in the systems are not statistically significant ($p>0.05$), which is understandable because the live weight before slaughter is approximate in lambs between both breeding systems.

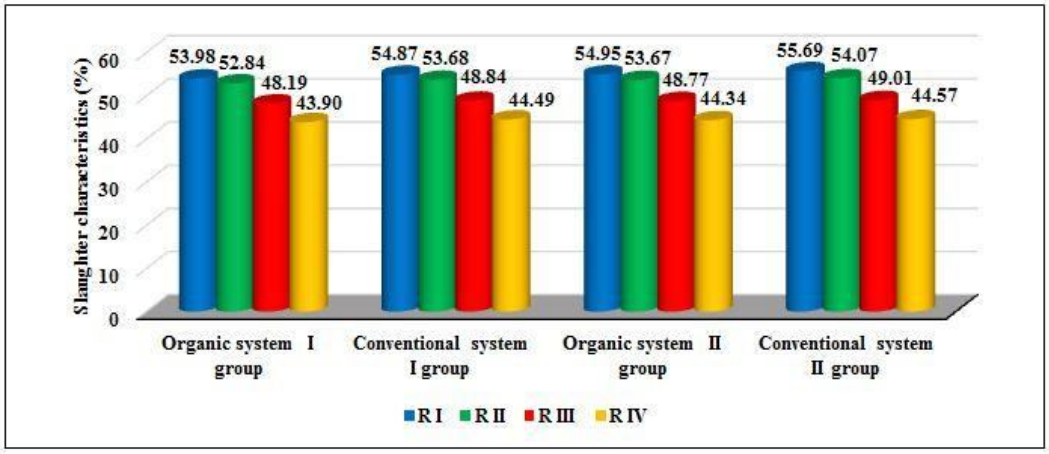

Fig 4 Dressing percentage of lambs from an organic and conventional system

The dressing percentage of slaughter is very variable and dependent of the influence of several factors such as: breed, sex, age, diet, fat, etc. During the research a difference is determined between lambs from Group I of the organic and conventional system, in the dressing percentagefrom: (RI-0.89%; RII-0.84%; R III-0.65% and R IV-0.59%), as well as a difference in the dressing percentagebetween lambs from Group II from the organic and conventional system of (RI-0.74%; RII-0.40%; RIII-0.24% and RIV-0.23%). The observed differences in the average value of dressing percentage in Group I lambs from the organic and conventional system and Group II of the organic and conventional system in all cases are statistically not significant ($p>0.05$) which is understandable, because the live weight of the lambs and the slaughter weight of the lamb carcasses from the organic and conventional system is similar [17]. Similar results for dressing percentage of a warm carcass in lambs grown in an organic system of 51.66% i.e. 48.90% in lambs of the control group were found [19]. The smaller dressing percentage of the organic system, is probably due to quicker weaning, changes in diet of the lambs as well as stress during transport [22], determined values fordressing percentage of a warm carcass that deviate from our results for the lambs from the conventional system from 49.27±0.607, i.e. 49.36±0.525 in lambs from the organic system. In the research ofslaughter characteristicsof Creska lambs [21] stated similar results of ours in the carcass weight of the lambs 19.04 ± 0.22 and dressing percentage of slaughter 50.50 ± 0.60.

The average pH_1 and pH_2 values of meat from lambs of both groups in the organic and conventional system are shown in Figure 5, where by it can be stated that the pH value of meat from lambs from the organic system has characteristic values for the normal course of post-mortem glycolysis. The established difference in the pH value of the lamb between the groups of the organic and conventional system is significant ($p<0.05$).

Identical results were obtained by [23], [24], whereby the average pH value after 45 minutes from the slaughter was 6.15, i.e. 5.55 after 24 hours. Similar results to ours for the pH value, 1 and 24 hours after the slaughter were obtained by [25].

Results from our research coincide with the data obtained for the pH value of lamb, 1 and 24 hours after the slaughter of the lambs from [10], [11], [26].

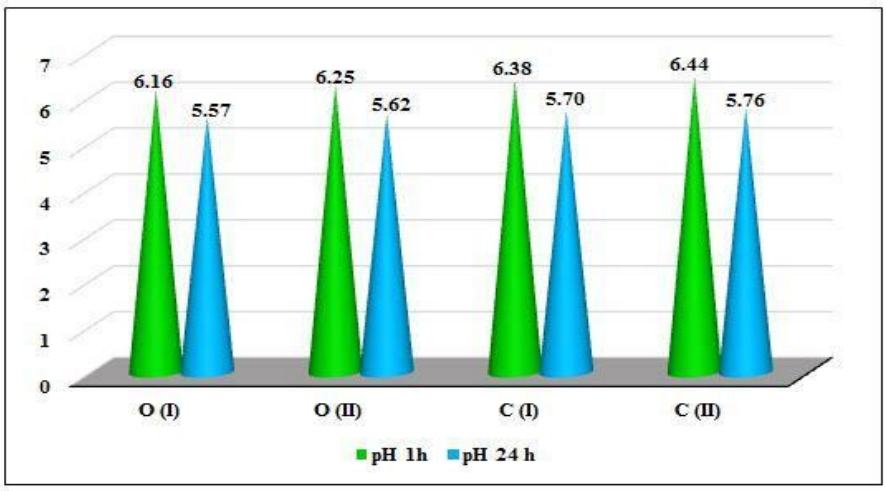

Fig 5 pH value of lamb from organic and conventional system

4. Conclusion

The study did not determine statistically significant ($p>0.05$) influence of the system on the breeding of lambs (organic and conventional one) on production and slaughtering results. The statistically significant influence of the breeding system, but also partly on the racial characteristics, was established in some of the investigated parameters: totalshrinkage (transport andlairage facility shrinkage) between Group I of the organic and Group I of the conventional system at the level of ($p<0.05$) and between Group II of Organic and Group II of the conventional system at the level of ($p<0.01$), the cooling shrinkagebetween lamb carcasses from the groups in the organic and conventional system ($p<0.01$). Significant difference ($p<0.05$) was determined for the pH value of lamb meat between groups of the organic and conventional system.

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