Original Paper

Carcass quality and physico-chemical characteristics of meat of light lambs

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The quality of 40 carcasses of light lambs of synthetic population of the Slovak Dairy sheep from artificial rearing (AR) and traditional rearing (TR) systems was assessed on the basis of growth and carcass traits, and physico-chemical characteristics. Weights before starvation and at slaughter were similar in AR and TR lambs, respectively. The significant difference was found only in age. The significantly lower ($P < 0.01$) average daily gain was found in AR lambs (0.215 kg). Hot carcass weight, hot and cold dressing percentage was also lower in AR lambs (8.1 kg, 47.1 % and 45.7 %). Weights of internal organs were lower in TR lambs (except for testicles). Proportion of commercial joints in left carcass half was the same (anterior-rib 7.1 %), slightly lower (neck 5 %, loin 13.2 %), or slightly higher in TR lambs (breast plus flank 20.4 %, leg 34.5 %, shoulder 19.8 %). First and third quality meat percentages did not differ significantly; second quality meat percentage was significantly higher ($P < 0.01$) in TR lambs (26.9 %). Muscle percentage in left carcass half was significantly higher ($P < 0.001$) in TR lambs (63.5 %), whereas percentage of fat (11.4 %) and of bone (29.2 %) in left carcass half were almost significantly ($P = 0.065$) and significantly ($P < 0.01$) higher in AR lambs. Electric conductivity and water holding capacity were found significantly different ($P < 0.01$) between AR and TR lambs (lower values were found in *MLD* of TR lambs) as concerned physico-chemical characteristics which were measured on samples taken from *Musculus longissimus dorsi* (*MLD*). Protein content tended to be higher ($P = 0.0513$) in *MLD* of TR lambs (20.62 g 100 g^{-1}).

Keywords: light lambs, carcass traits, meat quality

1. Introduction

In dairy sheep, which is prevailing sheep industry in Mediterranean countries, lambs are weaned at an age of 30 to 45 days and are mainly sold on Easter and Christmas (Sanudo et al., 2000; Lanza et al., 2006; Sinanoglou et al., 2013). In Slovakia, light lambs with carcass weight less than 13 kg (Decree of the Ministry of Agriculture No. 206/2007 of 4 April 2007) are produced before Easter (to a greater extent) and Christmas (to a lesser extent). Most (about 80 %) are exported. Two lambs rearing systems can be found in Slovakia. First, artificial rearing based on a milk replacer available from an automatic feeding machine is applied in highly productive dairy breeds (due to higher revenues from sheep milk in first month of lactation in comparison to revenues from light lambs production). The number of farms with this rearing system is increasing at present. Second, traditional rearing often applied with nurseries is used in less productive dairy breeds (Margetín, 2007; Margetín et al., 2009). Milking of ewes begins when lamb weaning is finished; usually between the 30th and 45th day after parturition.

Small information on assessment of meat and carcass quality of light lambs with carcass weight less than 13 kg is available in Slovakia. No reference scale to express the composition of lamb carcass also exists in EU-countries although attempts to establish international reference procedures for carcass description and dissection to determine carcass composition were done (Fischer and Boer, 1994). The most similar classification of standardized commercial joints to that applied in Slovakia is given in study of Carrasco et al. (2009). To a lesser extent, similarities with study of Vacca et al. (2008) can be found. As far as quality of light lambs is related, not only good carcass traits are required, but also physico-chemical and sensory characteristics are of increasing importance (Martinez-Cerezo et al., 2005). Lamb meat is considered to be a highly nutritious, easy digestible and valued food with a positive fatty acid composition (Milewski, 2006; Nuernberg et al., 2008). Meat quality of light lambs and nutrition value of meat depends on feeding, quality of milk, roughage and concentrace consumed. Zygoyiannis et. al. (1985), Velasco et al. (2004) and Juárez et al. (2009) reported about the importance of milk consumed on quality of light lambs, mainly on the fatty acid profile of fat depots.

In spite of most Slovak lambs exported to EU countries, information on their quality is limited. Only growth and

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carcass traits of lambs from traditional rearing are mostly known; information from artificial rearing is less available (Margetín et al. 2006, 2009, 2010). Knowledge about physico-chemical and sensory characteristics of meat of light lambs is also limited (Margetín, 1993).

The objective of this study was to assess the quality of light lambs on the basis of growth and carcass traits as well as on physico-chemical characteristics. Artificially and traditionally reared male and female lambs were considered.

2. Material and methods

2.1 Experimental design

The two groups of light lambs of synthetic population of Slovak Dairy sheep kept in the experimental farm of the Animal Production Research Centre Nitra (APRC Nitra) were included in the experiment. The first group consisted of 20 artificially reared (AR) lambs, of these 13 were males and 7 were females. Lambs were fed a commercial milk replacer (Profilamm, importer Milki, Ltd.). The milk replacer was available from an automatic feeding machine (producer Förster-Technik, importer Agrostar, Ltd.). Lambs were separated from their mothers during colostral period i.e. 2 to 4 days after parturition. Lambs were fed good quality lucerne-grass hay *ad libitum* and a compound feed ration (OV 02). The milk replacer consisted of 33 % dried whey, 24 % refined vegetable oil (coconut and palmic), 15% partly decarbohydrated dried whey, 10 % wheat protein concentrate, 5 % soybean protein concentrate, 5 % dried whey protein, 5 % wheat starch and 3 % additives (24 % NL, 24 % fat, 8.3 % ash, 1.8 % lysine, 0.5 % dietary fiber, 1.2 % Ca, 0.7 % P and 0.4 % Na). The supplemental compound feed ration (OV 02) consisted of barley, wheat, maize, soybean meal, dried whey, calcium carbonate and additives (18 % NL, 2.4 % fat, 4 % dietary fiber, 4 % ash).

The second (control) group consisted of 20 traditionally reared (TR) lambs; of these 13 were males and 7 were females as well. Lambs were housed with ewes; simultaneously, nurseries were applied. The access to mothers was gradually diminishing and separation of lambs from ewes in nurseries was increasing. Younger lambs were allowed to stay with ewes more often than older lambs (Margetín 2007; Margetín et al., 2009, 2010). The basic feed ration of ewes consisted of meadow and lucerne hay, and maize silage plus a compound feed ration (OV 05) with 150 g kg^{-1} NL at minimum, 100 g kg^{-1} diet fiber, 60 g kg^{-1} fat and 100 g kg^{-1} ash at maximum, 5.3 g kg^{-1} Na, 9.2 g kg^{-1} Ca, 7.1 g kg^{-1} P, 9.3 g kg^{-1} S and 2.8 g kg^{-1} Mg at minimum. Lambs in nurseries were allowed the same forage and concentrate feed as AR lambs.

2.2 Slaughter procedure

AR and TR lambs were slaughtered in the slaughter house of APRC Nitra. The average weight of lambs before starvation was 17.9±1.5 kg. The average age of lambs before starvation was 59.5±6.6 days. There were found no significant differences in lamb weight (Table 1). The differences in age, however, were significant (63.6 vs. 55.3 days in AR and TR lamb). Lamb carcasses were weighed 60 min after slaughter (hot carcass weight). The slaughter procedure was done according to the Slovak Technical Standard 466220 "Carcass sheep" (1999). Internal organs i.e. heart, lungs, liver, spleen, kidney and testicles were weighed till 15 min after slaughter. Dissection of left carcass half was done 24 hours after slaughter (according to Codex Alimentarius i.e. Decree of Ministry of Agriculture No. 12/2002 of 20 June 2002). The following joints were separated: neck, shoulder, anterior-rib, loin, breast plus flank and leg. This classification is most similar to that given in study of Carrasco et al. (2009) with the detailed image shown. The difference, in comparison to Carrasco et al. (2009), was the fact that neck and anterior-rib were separated between 5th and 6th chest vertebra (this study), and between 6th and 7th chest vertebra (study of Carrasco et al., 2009). Moreover, anterior-rib and loin were separated between 6th and 7th chest vertebra (this study), and between 5th and 6th chest vertebra (study of Carrasco et al., 2009). Because of high between- and within-breed variations in number and size of chest and lumbar vertebras (Donaldson et al., 2013), it is difficult to compare joints and their percentages between breeds and individuals. Thus, mainly leg, shoulder and neck are recommended to be compared.

The joints were weighed and their proportion in left carcass half as well as first quality meat (leg and loin), second quality meat (shoulder) and third quality meat (neck and breast plus flank) percentage were calculated. Also, tissues (muscle, fat and bone) in each joint were separated and weighed; their proportion was calculated. Muscle, fat and bone percentages (a) in left carcass half and (b) in shoulder separately were studied. The evaluation of shoulder tissue percentages was due to comparison purposes. In past, these often served as a basis for assessment of the whole carcass quality. Hot dressing percentage and cold dressing percentage are widely reported in literature; therefore, both are given.

2.3 Analysis of physico-chemical characteristics

To assess physical and chemical characteristics, meat samples (about 500 g) of light lambs were taken from *Musculus longissimus dorsi* (*MLD*). Samples were analysed as fresh meat i.e. were analysed after 48 hours of chilling in the laboratory of APRC Nitra. These were processed before the analysis (removal of surface fat) and grounded. Physical and chemical characteristics (moisture, fat, protein etc.) were analyzed afterwards, when no more changes in composition of meat were in progress. The apparatus Nicolet 6700 Spectrometer or the devices Infratec 1265 with application module for fat content assessment 1 to 10 % were used. The pH meter Toledo with combined stab

electrode was used to measure pH value. Water holding capacity was analyzed by Grau-Hamm method. Meat colour (*L**: lightness, *a**: redness and *b**: yellowness) were measured by the MiniScan XE plus and Spectrometer CM 2600. Electric conductivity was determined in the defined location of *MLD* using the apparatus PMV 51 in μS. The detailed description of equipment and methodology are given in study of Polák et al. (2012).

2.4 Statistical analyses

The analysis of variation was used to study the influence of rearing system (AR and TR), lamb sex (males and females) and interaction considered between rearing system and sex on growth and carcass traits as well as on physical and chemical characteristics. General Linear Model procedure as implemented in SAS application software was applied (2009).

3. Results and discussion

3.1 Growth and carcass traits

In accordance with expectations, the average daily gain from birth to slaughter were significantly ($P < 0.01$) lower in AR lambs (0.215 kg) than in TR lambs (0.248 kg) as shown in Table 1.

The lower daily gain in AR lambs accords with the earlier study of Margetín et al. (2009), although the authors reported a slightly higher daily gain in AR lambs (0.270 g) as well as in TR lambs (0.285 kg). The higher average daily gain ranging between 0.226 kg and 0.269 kg was also reported by Margetín et al. (2006), who studied an influence of various milk replacers on growth and carcass traits in AR lambs of three groups of purebred Tsigai breed. The authors reported almost the same average daily gain in TR lambs (0.258 kg) as was found in TR lambs included in this research (0.248 kg). It is generally known that growth intensity of suckling (light) lambs depends on quality of ewe's milk and of a milk replacer. Lanza et al. (2006) reported the average daily gain 0.159 kg (in lambs fed a milk replacer) and 0.189 kg (in lambs fed ewe's milk) till live weight of about 11 kg, respectively.

There were found no significant differences in most of carcass traits (Tables 1 and 2) between AR and TR lambs. However, hot dressing percentage (47.1 % in AR lambs vs. 49.2 % in TR lambs) and cold dressing percentage (45.7 % in AR lambs vs. 47.8 % in TR lambs), differed significatly ($P < 0.05$) between AR and TR lambs. Hot dressing percentage in TR lambs accords with study of Margetín et al. (1993), who found this trait equal to 47.1±0.7 % in 40 suckling lambs reared the same way as in this research. Margetín et al. (2006) found hot dressing percentage in AR lambs in the range from 46.8 to 47.4 %. Also, hot dressing percentage (49.06 %) in TR lambs was similar. No significant differences in hot dressing percentage and in cold dressing percentage between males and females were found. Lanza et al. (2006) reported the significantly higher dressing percentage in lambs fed ewe's milk (56.0 %) than in lambs on a milk replacer (54.6 %). The significant differences in dressing percentage of suckling lambs of Churra Tenzina in

Table 1 Growth intensity and carcass traits of light lambs by rearing system and sex

Trait	Lambs rearing		P	Sex		P	Interaction	SEM	R^2
	AR	TR		male	female		P		
Weight at birth in kg	4.2	4.13	0.777	4.3	4.0	0.119	0.011	0.58	0.218
Weight before starvation in kg	17.8	17.6	0.588	18.5	16.9	0.028	0.887	1.50	0.228
Age before starvation in days	63.6	55.3	0.001	59.7	59.2	0.842	0.929	6.62	0.310
Average daily gain in kg	0.215	0.248	0.008	0.243	0.220	0.052	0.895	0.035	0.257
Weight at slaughter in kg	17.1	16.9	0.633	17.8	16.2	0.002	0.807	1.48	0.243
Hot carcass weight in kg	8.1	8.3	0.396	8.7	7.7	0.001	0.784	0.81	0.264
Hot dressing percentage in %	47.1	49.2	0.028	48.6	47.7	0.296	0.381	2.72	0.151
Cold dressing percentage in %	45.7	47.8	0.019	47.1	46.3	0.368	0.459	2.63	0.161
Weight of left carcass half in kg	3.9	4.0	0.281	4.2	3.8	0.003	0.949	0.42	0.241
Heart in kg	0.084	0.078	0.052	0.084	0.078	0.025	0.490	0.008	0.209
Lungs in kg	0.444	0.417	0.136	0.442	0.419	0.210	0.995	0.053	0.104
Liver in kg	0.361	0.327	0.032	0.350	0.338	0.446	0.508	0.046	0.134
Spleen in kg	0.034	0.032	0.475	0.035	0.031	0.189	0.475	0.008	0.084
Kidney in kg	0.038	0.036	0.224	0.038	0.036	0.108	0.713	0.004	0.106
Testicles in kg	0.024	0.025	0.955	–	–	–	–	0.116	0.001

AR: artificial rearing, TR: traditional rearing

Table 2 Proportion of commercial joints and tissues (meat, fat, bone) in left carcass half of light lambs by rearing system and sex

Trait	Lambs rearing		P	Sex		P	Interaction	SEM	R^2
	AR	TR		male	female		P		
Weight of left carcass half in kg	3.9	4.0	0.281	4.2	3.8	0.003	0.949	0.42	0.241
Neck in %	5.8	5.0	0.045	5.7	5.0	0.087	0.196	1.17	0.180
Anterior-rib in %	7.1	7.1	0.991	7.4	6.8	0.015	0.662	0.78	0.159
Loin in %	14.0	13.2	0.012	13.6	13.7	0.762	0.459	0.94	0.163
Breast plus flank in %	19.7	20.4	0.110	19.7	20.4	0.111	0.084	1.31	0.166
Leg in %	34.2	34.5	0.377	34.1	34.6	0.180	0.425	1.08	0.099
Shoulder in %	19.2	19.8	0.022	19.5	19.6	0.850	0.137	0.75	0.153
First quality in %	48.2	47.7	0.221	47.7	48.3	0.156	0.202	1.22	0.113
Second quality in %	26.3	26.9	0.005	26.9	26.3	0.004	0.199	0.61	0.337
Third quality in %	25.4	25.3	0.807	25.4	25.4	0.946	0.499	1.15	0.019
Muscle in shoulder in %	66.5	67.1	0.501	66.1	67.6	0.077	0.311	2.46	0.131
Fat in shoulder in %	6.6	6.8	0.822	7.4	6.1	0.203	0.207	2.92	0.085
Bone in shoulder in %	26.9	26.1	0.216	26.6	26.4	0.710	0.516	1.86	0.048
Muscle in left carcass half in %	59.4	63.5	<0.001	60.6	62.3	0.081	0.157	2.80	0.471
Fat in left carcass half in %	11.4	9.5	0.065	11.3	9.63	0.120	0.034	3.11	0.289
Bone in left carcass half in %	29.2	27.0	0.004	28.1	28.1	0.976	0.192	2.13	0.217
Kidney fat in left carcass half in %	1.71	1.33	0.051	1.45	1.60	0.432	0.140	0.577	0.211

AR: artificial rearing, TR: traditional rearing

dependence on rearing system were reported by Carasco et al. (2009). The authors reported the slightly higher cold dressing percentage in TR lambs (49.7 % vs. 47.8 % found in TR lambs included in the presented research).

Of internal organs, the significant difference (P <0.05) in liver weight was found (0.361 kg in AR lambs vs. 0.327 kg in TR lambs). The difference in heart weight (0.084 kg in AR lambs vs. 0.078 kg in TR lambs) tended to be significant and might be a result of a higher age of AR lambs. Weight of each internal organ was found higher in males. Heart weight differed significantly; the differences in spleen and liver weights tended to be significant. This might be a result not only of the fact that males are generally heavier, but also of the fact that metabolism between males and females differs. Weights of internal organs found in the presented research were similar to those reported by Nuernberg et al. (2008), who found heart weight equal to 104±3 g, lungs weight equal to 397±29 g and liver weight equal to 377±16 g in suckling lambs supplementary fed concentrate and slaughtered at carcass weight of 25 kg. Table 2 also shows proportion of commercial joints and tissues (muscle, fat and bone) in dependence on lamb rearing and sex. TR lambs had higher shoulder percentage than AR lambs (P < 0.05). In contrast, AR lambs had higher neck and loin percentages (P < 0.05). The only significant difference in anterior-rib percentage between males and females was found (P < 0.05). Anterior-rib percentage was higher in males than in females. Pena et al. (2005) found leg percentage equal to 34.0±0.2 % and shoulder percentage equal to 20.2±0.1 % in suckling lambs of Segurena breed (carcass weight ranged between 8.1 to 10 kg) i.e. both values were similar to those found in this study.

Vacca et al. (2008) found lower leg percentage (32.8±2.1 %) and shoulder percentage (18.8±1.94 %) in suckling lambs of Sarda breed (carcass weight 10.5 kg). With respect to meat quality (first, second and third), more shoulder muscle can be found in TR lambs than in AR lambs. The differences in muscle, fat and bone in shoulder of AR and TR lambs were not significant. Muscle percentage in shoulder were high (66.5 % in AR lambs vs. 67.1% in TR lambs); whereas, fat percentage in shoulder were low (6.6 % in AR lambs vs. 6.8 % in TR lambs). Wachira et al. (2002) found muscle percentage in shoulder equal to 58.5 %, fat percentage in shoulder equal to 7.2 % and bone percentage in shoulder equal to 24.4 % in heavy lambs of Friesian breed. These findings accord with findings of the presented research and with findings about lamb ontogenesis. When comparing muscle, fat and bone percentages in left carcass half, the significant differences between AR and TR lambs were found. Muscle percentage in left carcass half was significantly higher (P < 0.001) in TR lambs (59.4 % in AR lambs vs. 63.5 % in TR lambs). Bone percentage in left carcass half

was significantly higher ($P < 0.01$) in AR lambs (29.2 % in AR lambs vs. 27.0 % in TR lambs). Similar muscle, fat and bone percentages were found by Pena et al. (2005), in suckling lambs (carcass weight ranging between 8.1 and 10 kg). The authors reported muscle percentage equal to 54.5±0.5 %, fat percentage equal to 2.5±0.1 % and bone percentage equal to 20.3±0.20%. Vacca et al. (2008) reported muscle percentage equal to 58.1± 4.3 %, fat percentage equal to 14.5±4.7 % and bone percentage equal to 27.4±3.3 % in left carcass half of suckling Sarda lambs. In the presented research, no statistically significant differences in muscle, fat and bone percentages in left carcass half between males and females were found, although the difference in muscle percentage tended to be significant. Pena et al. (2005) found the significant difference in bone percentage in left carcass half; the authors also found the higher bone percentage in males (20.9 % in males vs. 19.2 % in females). Kidney fat percentage in left carcass weight tended to be higher ($P = 0.051$) in AR lambs (1.71 % in AR lambs vs. 1.33 % in TR lambs). The percentages of kidney fat were higher than those found by Margetín et al. (1993), who analysed 40 suckling lambs with average carcass weight of 16.3 kg, but lower than those found Pena et al. (2005), who analysed Spanish suckling lambs (2.3 %).

3.2 Physical and chemical characteristics

The influence of rearing systems and lamb sex did not significantly affect most of physico-chemical characteristics in light lambs (Table 3).

Protein content tended to be lower ($P = 0.0513$) in *MLD* of AR lambs (20.16 g 100 g^{-1} in AR vs. 20.62 g 100 g^{-1} in TR lambs). In contrast, fat content tended to be higher ($P = 0.1218$) in *MLD* of AR lambs (4.52 g 100 g^{-1} in AR lambs vs. 3.70 g 100 g^{-1} in TR lambs). The higher fat content corresponds with the higher fat percentage and kidney fat percentage in left carcass half of AR lambs (Table 2). Lanza et al. (2006) found no significant differences in protein content between TR (20.26 %) and AR lambs (20.41 %) and found significantly higher fat content in *MLD* of TR lambs (1.92 %) than in *MLD* of AR lambs (0.89 %). The non-significantly higher moisture and significantly higher ($P < 0.01$) water holding capacity was found in *MLD* of TR lambs (29.93 g 100 g^{-1} in AR lambs vs. 34.72 g 100 g^{-1} in TR lambs). Moreover, the significantly higher ($P < 0.01$) electric conductivity was found in *MLD* of TR lambs (0.659 µS in AR lambs vs. 0.950 µS in TR lambs). Lanza et al. (2006) also did not found significant differences in moisture between TR lambs (76.43 %) and AR lambs (77.08 %). Moisture (74.67 g.100 g^{-1}), protein content (20.62 g.100 g^{-1}) and water holding capacity (34.72 g.100 g^{-1}) found in *MLD* of TR lambs included in the presented research accord with values given in study of Margetín et al. (1993), who reported moisture (76.31 g.100 g^{-1}), protein content (20.69 g 100 g^{-1}) and water holding capacity (28.92 g 100 g^{-1}) in *MLD* of TR lambs. Similarly, Vacca et al. (2008) reported moisture equal to 74.1 % and protein content equal to 22.0 % in *MLD* samples taken from light lambs slaughtered at an age of 40 days. Fat content in *MLD* from TR lambs (3.70 g.100 g^{-1}) was higher than Margetín et al. (1993), Lanza et al. (2006) and Vacca et al. (2008) reported. Of these studies, the highest value of intramuscular fat (2.8±0.43 %) was found by Vacca et al. (2008). Fat content in *MLD* of AR lambs included in the presented research was also high (4.52 g 100 g^{-1}). Martinez-Cereso et al. (2005) found intramuscular fat ranging between 1.28 and 2.79 % in lambs of three Spanish breeds of three weight categories (10 to 12 kg, 20 to 22 kg and 30 to 32 kg), with the lowest value found in lightest lambs. The lower intramuscular fat was found by Tejeda et al. (2008), who reported values between 0.93 and 1.16 g 100 g^{-1} in lambs with live weight ranging between 24 and 29 kg. Lanza et al. (2006) also reported lower fat content than found in the presented research. In this study, fat content varied to

Table 3 Physico-chemical characteristics of meat in *Musculus longissimus dorsi* (*MLD*) of light lambs

Trait	Lambs rearing		P	Sex		P	Interaction	SEM	R^2
	AR	TR		male	female		P		
Moisture in g 100 g^{-1}	74.32	74.67	0.4027	74.61	74.38	0.5841	0.8930	1.272	0.028
Protein in g 100 g^{-1}	20.16	20.62	0.0513	20.45	20.34	0.6127	0.3816	0.698	0.109
Fat in g 100 g^{-1}	4.52	3.70	0.1218	3.93	4.29	0.5636	0.6171	1.568	0.076
Energy value in KJ 100 g^{-1}	508.09	484.87	0.1931	490.9	502.1	0.5245	0.7150	52.82	0.057
pH 48 hour post mortem	5.38	5.36	0.8257	5.38	5.36	0.7197	0.8809	0.197	0.005
Electric conductivity in µS	0.659	0.950	0.0013	0.858	0.751	0.2085	0.2853	0.250	0.278
Colour *L** lightness	41.34	40.28	0.4057	41.15	40.47	0.5961	0.7173	3.819	0.027
*a** redness	7.32	7.20	0.7403	7.52	6.99	0.1477	0.9178	1.086	0.061
*b** yellowness	7.89	7.92	0.9117	8.28	7.53	0.0324	0.5153	1.011	0.132
Water holding capacity in g.100 g^{-1}	29.93	34.72	0.0014	32.39	32.26	0.9253	0.2515	4.151	0.252

AR: artificial rearing, TR: traditional rearing

a greater extent (SEM equal to 1.57 g 100 g^{-1}, minimum equal to 1.30 g 100 g^{-1}, maximum equal to 10.40 g 100 g^{-1}, R^2 = 0.076) and may be influenced by additional genetic and non-genetic effects. As a difference to study of Lanza et al. (2006), AR and TR lambs were not only on milk feeding (either ewe's milk or a milk replacer), but also on roughage and concentrate feed. No significant differences in moisture, protein and fat content in *MLD* were found between males and females (Table 3).

The difference in pH measured 48 hours *post mortem* between AR and TR lambs was non-significant (Table 3). This can indicate that AR and TR lambs respond to stress before slaughter similarly. Lanza et al. (2006) found pH (24 hours *post mortem*) in lambs from natural rearing and in lambs from artificial rearing equal to 5.77 and 5.68, respectively. Nuernberg et al. (2008) found pH (also 24 hours *post mortem*) in lambs of Skudde breed (25 kg of live weight at slaughter) equal to 5.7±0.02.

Similarly to Tejeda et al. (2008), no significant differences in meat colour characteristics between AR and TR lambs were found (Table 3). Lightness (L^*) was found equal to 41.43 in AR lambs and was found equal to 40.28 in TR lambs. The values accord with findings of Tejeda et al. (2008) and Martinez-Cerezo et al. (2005). Tejeda et al. (2008) reported L^* in the range from 43.39 to 43.68, redness (a^*) in the range from 12.73 to 13.73 and yellowness (b^*) in the range from 8.73 to 9.31. Martinez-Cerezo et al. (2005) found L^* in the range from 39.24 to 42.05 in lambs of three Spanish breeds (live weight between 20 and 22 kg). Lanza et al. (2006) found significantly higher L^* (i.e. lighter meat) in lambs from natural rearing (47.54) than in lambs from artificial rearing (45.69). In accordance with Lanza et al. (2006), the non-significantly higher L^* found in AR lambs included in the presented research may be a result of the higher content of intramuscular fat. It is generally known that suckling lambs have lighter meat; with an increasing live weight meat lightness decreases. The same was confirmed by Nuernberg at al. (2008), who found L^* equal to 30.3 and 34.5 in lambs fed concentrate and on pasture (from 18 kg of live weight) and slaughtered at an age of 233 and 214 days, respectively.

The lower redness (a^*) was found in AR (7.32) and TR lambs (7.20) than that reported by Martinez-Cerezo et al. (2005), who found a^* ranging between 10.51 and 12.01 in light lambs (10 to 12 kg) and by Lanza et al. (2006), who found a^* equal to 9.95 and 10.85 in lambs from natural rearing and from artificial rearing, respectively. The higher a^* was also found by Tejeda et al. (2008). According to Martínez-Cerezo et al. (2005), heavier lambs have higher a^* as a result of changed feeding (from milk to concentrate). Although redness in Slovak lambs was low, the values of a^* can be considered favourable.

Yellowness (b^*) is a very variable characteristics. In the presented research, b^* in AR and TR lambs (a) was lower than Tejeda et al. (2008) reported, (b) was almost the same as Martinez-Cerezo et al. (2005) reported and (c) was higher than Jerónimo et al. (2009) reported. According to colour characteristics, meat in AR and TR lambs included in the presented research was light and of the lower redness when comparing with characteristics reported in literature. The significant difference ($P < 0.05$) in b^* between males and females was found (8.28 vs. 7.53). The influence on lamb sex on the remaining meat colour characteristics was found insignificant.

Water holding capacity significantly differed between AR and TR lambs (Table 3). More liquid was expelled from *MLD* of TR lambs (29.93 g 100 g^{-1} in AR lambs vs. 34.72 g 100 g^{-1} in TR lambs). Díaz et al. (2002) reported water holding capacity equal to 19.6 and 18.3 % in lambs with weight at slaughter 24 and 28 kg, respectively.

4. Conclusions

The assessment of 40 carcasses of light lambs from artificial and traditional rearing was done. Artificially reared lambs had the lower daily gain, hot and cold dressing percentage, muscle percentage and the higher bone percentage in left carcass half than traditionally reared lambs. According to findings related to fat content in *MLD* and kidney fat percentage in left carcass half, artificially reared lambs tended to store more fat depots than traditionally reared lambs. The higher protein content, electric conductivity and water colour capacity was found in *MLD* of TR lambs. The complex assessment of quality of lamb carcasses is needed including analyses of fatty acids profiles, mainly as far as essential and health promoting acids (CLA, EPA) as well as SFA, MUFA, PUFA, BCFA and n-6/n-3 PUFA ratio is related.

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6. References

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