

Carcass traits and meat colour of lambs from diverse production systems

Ivan Vnučec¹, Valentino Držaić^{1*}, Boro Mioč¹, Zvonimir Prpić¹,
Vesna Pavić¹, and Zvonko Antunović²

¹Department of Animal Science and Technology, Faculty of Agriculture, University of Zagreb, Croatia

²Department of Animal Science, Faculty of Agriculture, University of J. J. Strossmayer, Osijek, Croatia

VNUČEC, I., V. DRŽAIĆ, B. MIOČ, Z. PRPIĆ, V. PAVIĆ, Z. ANTUNOVIĆ:
Carcass traits and meat colour of lambs from diverse production systems. *Vet. arhiv*
84, 251-263, 2014.

ABSTRACT

Sheep production in Croatia is primarily based on indigenous breeds and different production systems determined by specific environmental conditions and tradition. The aim of this research was to determine the influence of sex on birth weight, daily gain, pH value, and meat colour as well as the slaughter and carcass traits of lambs derived from three different sheep production systems. For that purpose a total of 306 lambs from three breeds reared in three production systems with different production goals were randomly selected: I - milk production, Pag sheep (total 112 lambs: 66 males and 46 females); II - lamb meat production, Dalmatian Pramenka (total 96 lambs: 52 males and 44 females), and III - milk and lamb meat production, Istrian sheep (total 98 lambs: 54 males and 44 females). Sex only had a significant influence on daily gain and age ($P < 0.01$), and weight at slaughter ($P < 0.05$) in production system III. The effect of sex on slaughter characteristics between the investigated breeds was variable. The highest pH value of m. longissimus dorsi (MLD) was determined in production system III, while the L^* value of the same muscle differed ($P < 0.001$) between all three production systems and the b^* value was significantly lower in production system II. The highest value of L^* and b^* parameters of m. rectus abdominis (MRA) was determined in production systems III and I, respectively. Sex significantly affected the b^* parameter of MRA in production system I, L^* parameters of MLD and MRA in production system II, and pH value and L^* parameter of MLD in production system III. The results of this study indicate that in a rather small geographical area the possibilities exist for the production of lamb carcasses with specific quality characteristics.

Key words: lamb, meat, production system, carcass, pH value, meat colour

*Corresponding author:

Valentino Držaić, mag. ing. agr., Department of Animal Science and Technology, Faculty of Agriculture, University of Zagreb, Svetošimunska c. 25, 10000 Zagreb, Croatia, Phone: +385 1 239 3900; Fax: + 385 1 239 3901; E-mail: vdrzai@agr.hr

Introduction

Sheep production systems in Croatia, as well as in other Mediterranean countries, are quite diverse and determined by specific environmental conditions and tradition, which affect the choice of breed, housing system, nutrition, age and weight of lambs at slaughter. Consumer preferences for a specific carcass weight are very diverse, so in countries of southern Europe consumers prefer light lamb carcasses: 8 kg in Portugal (SANTOS et al., 2007), 9 kg in Italy (CIFUNI et al., 2000), 11 kg in Spain (RIPOLL et al., 2008), while in countries of northern Europe heavier carcasses from 16 to 23 kg prevail (BERIAIN et al., 2000).

In Croatia, the age and body weight of lambs at slaughter are primarily the result of traditional sheep husbandry, production goals and consumer demand, so they are very variable. On the island of Pag very young (from 28 to 40 days of age) and light (from 7 to 15 kg body weight) suckling lambs are slaughtered (VNUĆEC, 2011; MIOČ et al., 2013). The main production goal of Pag sheep is the milk which is processed into the famous Pag cheese. For that reason the average slaughter weight of Pag sheep lambs is very similar to other breeds from the European Mediterranean. Istrian sheep are mainly used for milk production, as Pag sheep, but lambs are fed longer with mother's milk and solid feed such as concentrates and alfalfa hay. Their lambs are usually slaughtered at an age from 60 to 80 days and between 20-25 kg of slaughter weight, so they belong to the higher weight class. Dalmatian Pramenka sheep are farmed under an extensive production system and are used only for meat production, i.e. lambs carcasses for spit roasting, from 8 to 12 kg carcass weight (VNUĆEC et al., 2011). For that purpose lambs are slaughtered at 20-25 kg of slaughter weight and from 90 to 120 days of age (MIOČ et al., 2007).

The aim of this research was to determine the influence of sex on lamb birth weight, daily gain, pH value, and meat colour. Also the aim was to determine the influence of sex on the slaughter and carcass traits of lambs derived from three different sheep production systems.

Materials and methods

The study was conducted on 306 randomly selected lambs from three different production systems with different production goals. All lambs were raised according to traditional system from birth until slaughter, with age and slaughter weight being defined by sheep production system of the specific breeding area and purpose of the flock. System I focused on sheep milk production and is based on the Pag sheep breed. Pag sheep are traditionally kept on natural pastures all year, but during winter, when vegetation is scarce, they are fed with 1.3 - 1.5 kg of hay per day. During the last month of gestation and the first two months of lactation, the sheep are fed corn meal (150 and 500 g per day, respectively). Mating takes place in the late summer while lambing occurs between 15th December and 15th January. Pag lambs are reared with their mothers on pasture and in

our study a total of 112 lambs (66 males and 46 females) were slaughtered at an average age of 33 days.

The main goal of system II is lamb meat production and this system is based on the Dalmatian Pramenka sheep breed. Dalmatian Pramenka sheep are kept on natural rangelands all year (extensive production system). During the winter the animals are feed with alfalfa hay (1 kg per day) and corn meal during last month of gestation and the first two months of lactation (150 g and 300 g per day, respectively). Mating takes place during the period from September until December, and lambing is between 1st March and 30th May. Dalmatian Pramenka lambs were reared with their mothers on pasture and total 96 lambs (52 males and 44 females) were slaughtered within average age of 105 days.

System III is focused on sheep milk and lamb meat production and is based on the Istrian sheep breed. Istrian sheep are kept in a more intensive production system: grazing all year on natural pastures while during the cold winter and hot summer days they are housed in barns and fed alfalfa hay (1.5-2.0 kg per day). During the last month of gestation and first two months of lactation the sheep are fed corn and barley meal (250 and 600 grams per day, respectively). The sheep mate during the late summer (July - August) and lambing is in January. During the first 3 - 4 weeks of their life the lambs suckle their mothers' milk and after that alfalfa hay, corn and barley are added to their diet. In our study a total of 98 Istrian lambs (54 males and 44 females) were slaughtered at the age of 60 days.

The lambs were slaughtered at authorized slaughterhouses, following the conventional dressing procedure in Croatia (stunning, bleeding, removing skin, lower limb parts (cut off at the carpal, i.e. tarsal joints) and the abdominal (forestomachs, stomach, spleen, intestines and liver) and thoracic (trachea, lungs with heart) cavity organs. Immediately after slaughter, the carcasses, individual internal organs and skin with lower limb parts were weighed and the dressing percentage was calculated afterwards. The carcass measurements (carcass length, chest width, chest depth, and hind limb length and buttock width) were recorded using the method developed by FISCHER and DE BOER (1994). The pH was measured at the m. longissimus dorsi (MLD) between the 12th and 13th rib 45 minutes after slaughter, using a pH meter IQ 150 with puncture electrode 56/57-SS. Meat colour was assessed by L*, a* and b* systems (CIE, 1986) using a Minolta Chroma Meter CR-410, with a colour measuring area of 50 mm and standard meat illumination D65. Meat colour was measured on the fresh section (between 12th and 13th rib) of the m. longissimus dorsi (MLD) and m. rectus abdominis (MRA) after fascia removing.

The data were analysed using the GLM procedure of SAS/STAT software (SAS, 2008) with a model that included sex (male, female) and production system (system I, II and III) as fixed effects. Effects were considered significant if $P < 0.05$. The results are presented as the least square means (LSM) \pm standard error (SE).

Results

Table 1 shows the influence of sex on the birth weight, daily gain, slaughter weight and age of lambs from the three different production systems. Sex only had a significant influence on daily gain, age ($P<0.01$) and slaughter weight in production system III while in the other two production systems the influence of sex on the investigated parameters was not significant. Higher slaughter weight, daily gain and age at slaughter were determined in males compared to female lambs from production system III. Although in all the investigated production systems male lambs had higher birth weight than females, the differences were not statistically significant.

Table 1. The influence of sex on birth weight, slaughter weight, daily gain and age of lambs (LSM \pm SE)

Parameters	Sex		Level of significance
	Male	Female	
Production system I (Pag sheep)			
Birth weight (kg)	3.60 \pm 0.01	3.54 \pm 0.05	NS
Slaughter weight (kg)	11.61 \pm 0.23	10.94 \pm 0.27	NS
Daily gain (g)	239.73 \pm 5.59	230.20 \pm 6.60	NS
Age (days)	34.00 \pm 0.86	32.40 \pm 1.01	NS
Production system II (Dalmatian Pramenka)			
Birth weight (kg)	1.93 \pm 0.04	1.91 \pm 0.04	NS
Slaughter weight (kg)	17.49 \pm 0.43	17.23 \pm 0.49	NS
Daily gain (g)	179.49 \pm 6.51	182.26 \pm 7.62	NS
Age (days)	87.27 \pm 3.25	85.30 \pm 3.81	NS
Production system III (Istrian sheep)			
Birth weight (kg)	4.31 \pm 0.10	4.18 \pm 0.12	NS
Slaughter weight (kg)	20.59 \pm 0.38	19.32 \pm 0.42	*
Daily gain (g)	263.07 \pm 8.05	209.65 \pm 9.24	**
Age (days)	64.17 \pm 1.74	74.27 \pm 2.00	**

* $P<0.05$; ** $P<0.01$; NS - not significant

Slaughter characteristics were differently influenced by sex depending on each production system, i.e. breed (Table 2). Male lamb carcasses from production system I were heavier ($P<0.05$) as were their lungs with heart ($P<0.001$) compared to female lambs. In production system II, females had significantly higher dressing percentage compared to males (58.5 : 54.6%) probably because male lambs have heavier stomachs and intestines ($P<0.05$). The carcass weight, dressing percentage and weight of all the internal organs of lambs in production system III were similar for both sexes and only the skin and lower legs were significantly ($P<0.05$) heavier in male lambs.

Table 2. The influence of sex on slaughter characteristics of lambs (LSM \pm SE)

Traits	Sex		Level of significance
	Male	Female	
Production system I (Pag sheep)			
Carcass weight (kg)	6.65 \pm 0.12	6.27 \pm 0.15	*
Dressing percentage (%)	57.63 \pm 0.52	57.41 \pm 0.61	NS
Stomach and intestines (kg)	1.83 \pm 0.07	1.66 \pm 0.08	NS
Lungs with heart (kg)	0.33 \pm 0.01	0.29 \pm 0.01	***
Liver (kg)	0.24 \pm 0.01	0.22 \pm 0.01	NS
Spleen (kg)	0.05 \pm 0.01	0.04 \pm 0.01	NS
Skin and lower legs (kg)	1.75 \pm 0.04	1.65 \pm 0.04	NS
Production system II (Dalmatian Pramenka)			
Carcass weight (kg)	9.55 \pm 0.30	10.12 \pm 0.34	NS
Dressing percentage (%)	54.58 \pm 0.84	58.53 \pm 0.96	**
Stomach and intestines (kg)	4.09 \pm 0.11	3.66 \pm 0.12	*
Lungs with heart (kg)	0.46 \pm 0.01	0.46 \pm 0.02	NS
Liver (kg)	0.36 \pm 0.01	0.35 \pm 0.36	NS
Spleen (kg)	0.08 \pm 0.01	0.08 \pm 0.01	NS
Skin and lower legs (kg)	2.20 \pm 0.08	2.26 \pm 0.09	NS
Production system III (Istrian sheep)			
Carcass weight (kg)	10.76 \pm 0.23	10.19 \pm 0.25	NS
Dressing percentage (%)	52.26 \pm 0.45	52.61 \pm 0.51	NS
Stomach and intestines (kg)	5.28 \pm 0.15	4.85 \pm 0.17	NS
Lungs with heart (kg)	0.61 \pm 0.01	0.60 \pm 0.01	NS
Liver (kg)	0.37 \pm 0.01	0.35 \pm 0.01	NS
Spleen (kg)	0.06 \pm 0.01	0.06 \pm 0.01	NS
Skin and lower legs (kg)	2.76 \pm 0.06	2.52 \pm 0.07	*

* P<0.05; ** P<0.01; *** P<0.001; NS - not significant

The effect of sex on carcass measurements is presented in Table 3. Sex significantly (P<0.05) affected the chest depth of lambs in production system I, the chest width of lambs in production system II, and the buttock width of lambs in production system III.

Table 3. The influence of sex on carcass measurements of lambs (LSM \pm SE)

Traits	Sex		Level of significance
	Male	Female	
Production system I (Pag sheep)			
Carcass length (cm)	50.37 \pm 0.37	50.34 \pm 0.37	NS
Thoracis width (cm)	10.59 \pm 0.10	10.30 \pm 0.11	NS
Thoracis depth (cm)	17.71 \pm 0.16	17.22 \pm 0.19	*
Hind limb length (cm)	20.73 \pm 0.15	20.58 \pm 0.18	NS
Buttock width (cm)	10.86 \pm 0.10	10.82 \pm 0.12	NS
Production system II (Dalmatian Pramenka)			
Carcass length (cm)	60.74 \pm 0.62	61.79 \pm 0.71	NS
Thoracis width (cm)	10.75 \pm 0.14	11.19 \pm 0.16	*
Thoracis depth (cm)	21.88 \pm 0.18	21.45 \pm 0.20	NS
Hind limb length (cm)	23.29 \pm 0.18	23.06 \pm 0.21	NS
Buttock width (cm)	12.93 \pm 0.13	13.15 \pm 0.15	NS
Production system III (Istrian sheep)			
Carcass length (cm)	61.96 \pm 0.42	62.54 \pm 0.47	NS
Thoracis width (cm)	11.77 \pm 0.17	11.67 \pm 0.17	NS
Thoracis depth (cm)	21.35 \pm 0.16	20.92 \pm 0.17	NS
Hind limb length (cm)	23.75 \pm 0.21	23.50 \pm 0.24	NS
Buttock width (cm)	12.96 \pm 0.13	12.47 \pm 0.15	*

* P<0.05; NS - not significant

Table 4. Values of pH and colour parameters of lamb meat (LSM \pm SE)

Muscle	Trait	Production system			Level of significance
		I.	II.	III.	
m. longissimus dorsi	pH	6.35 \pm 0.03 ^b	6.34 \pm 0.03 ^b	6.56 \pm 0.03 ^a	*
	L*	44.07 \pm 0.22 ^a	44.47 \pm 0.25 ^b	47.03 \pm 0.24 ^c	***
	a*	17.87 \pm 0.11	17.61 \pm 0.13	16.63 \pm 0.12	NS
	b*	3.97 \pm 0.13 ^a	2.34 \pm 0.15 ^b	3.23 \pm 0.14 ^a	***
m. rectus abdominis	L*	51.42 \pm 0.43 ^a	51.12 \pm 0.28 ^a	54.21 \pm 0.37 ^b	***
	a*	20.93 \pm 0.34	20.36 \pm 0.22	19.32 \pm 0.29	NS
	b*	3.73 \pm 0.22 ^a	2.02 \pm 0.15 ^b	1.94 \pm 0.19 ^b	*

*P<0.05; ***P<0.001; NS - not significant

Table 5. The influence of sex on pH and colour of lamb meat (LSM \pm SE)

Muscle	Trait	Sex		Level of significance
		Male	Female	
Production system I (Pag sheep)				
m. longissimus dorsi	pH	6.33 \pm 0.04	6.37 \pm 0.05	NS
	L*	44.29 \pm 0.28	43.91 \pm 0.33	NS
	a*	17.91 \pm 0.12	17.79 \pm 0.14	NS
	b*	4.11 \pm 0.14	3.82 \pm 0.17	NS
m. rectus abdominis	L*	51.74 \pm 0.45	51.08 \pm 0.46	NS
	a*	20.54 \pm 0.35	21.34 \pm 0.36	NS
	b*	3.32 \pm 0.25	4.17 \pm 0.26	*
Production system II (Dalmatian Pramenka)				
m. longissimus dorsi	pH	6.45 \pm 0.04	6.40 \pm 0.04	NS
	L*	45.03 \pm 0.34	43.73 \pm 0.39	*
	a*	17.53 \pm 0.18	17.71 \pm 0.21	NS
	b*	2.32 \pm 0.18	2.37 \pm 0.21	NS
m. rectus abdominis	L*	51.70 \pm 0.37	50.35 \pm 0.43	*
	a*	20.21 \pm 0.31	20.54 \pm 0.36	NS
	b*	2.14 \pm 0.19	1.86 \pm 0.22	NS
Production system III (Istrian sheep)				
m. longissimus dorsi	pH	6.48 \pm 0.04	6.64 \pm 0.46	*
	L*	47.46 \pm 0.30	46.48 \pm 0.34	*
	a*	16.53 \pm 0.18	16.75 \pm 0.20	NS
	b*	3.38 \pm 0.24	3.03 \pm 0.27	NS
m. rectus abdominis	L*	54.69 \pm 0.57	53.71 \pm 0.58	NS
	a*	19.39 \pm 0.44	19.25 \pm 0.45	NS
	b*	1.85 \pm 0.30	2.02 \pm 0.31	NS

* P<0.05; NS - not significant

The meat pH and colour values related to the production system are presented in Table 4. Although lambs from production systems I and II had similar pH values of MLD, lambs from production system III had significantly (P<0.05) higher pH values of the same muscle. The highest L* value of MLD was determined in lambs from production system III, it was significantly lower in lambs from production system II, while the lowest value of the investigated parameter was determined in lambs from production system I (P<0.001). There was no significant difference in a* values of MLD between lambs from different production systems. The value of parameter b* of MLD was significantly lower

in lambs from production system II compared to lambs from production systems I and III. The highest value of L* parameter of MRA was determined in lambs from production system III ($P < 0.001$). There was no statistical difference between a* values of MRA between lambs from different production systems ($P > 0.05$). Lambs from production system I had the highest b* value of MRA, while the lambs from production system III had the lowest value of this parameter.

The effect of sex on pH and meat colour parameters is presented in Table 5. In lambs from production system I, sex only had a significant influence on the b* parameter of MRA so that female lambs had higher values compared to male lambs. Parameter L* of MLD and MRA in lambs from production system II was higher ($P < 0.05$) in male lambs than in females. A lower pH value and higher L* value of MLD were determined in male lambs from production system III compared to females.

Discussion

The birth weight of lambs from different production systems in this study was dependent on the average body weight of adult animals of the investigated breeds, which is lowest in Dalmatian Pramenka (ŠIRIĆ et al., 2009), higher in Pag sheep (PAVIĆ et al., 2006) and the highest in Istrian sheep (MIKULEC et al., 2007). The dominant effect of breed on lamb's birth weight has been determined in many scientific researches (FAHMY et al., 1992; BERIAIN et al., 2000; MIOČ et al., 2003). The birth weight of Istrian sheep lambs reported in this research is considerably higher than that stated by RAKO (1957) for the same breed. The birth weight of Pag sheep lambs was in agreement with MIOČ et al. (2007), while the birth weight of Dalmatian Pramenka lambs has not been the subject of previous research work. Daily gain of suckling lambs depends on their mothers' milk production; therefore Pag sheep lambs from production system I and Istrian sheep lambs from production system III had higher daily gain compared to Dalmatian Pramenka lambs from production system II. Pag sheep lambs had a higher average daily gain than suckling lambs of the Italian Barbaresca breed (189 g) at 40 days of age (LANZA et al., 2006), and considerably lower average daily gain than lambs of the Assaf breed (307) at 18.3 days of age (RODRÍGUEZ et al., 2007). Lambs of Dalmatian Pramenka sheep achieved lower average daily gain than Kupres pramenka lambs (190 g) and lambs of the Spanish Churra Tensina (261 g) and Talaverana (270 g) breeds of equal age and from similar production systems (PAVIĆ et al., 1996; CARRASCO et al., 2009; DÍAZ et al., 2002). The average daily gain of Istrian sheep lambs was almost the same as the daily gain of Manchego lambs (242 g) at 80 days of age from a similar production system (VERGARA et al., 1999) and considerably lower than the average daily gain of Churra Tensina lambs (299 g) at the age of 66 days (CARRASCO et al., 2009). The experimental lambs of higher average birth weights (Istrian sheep lambs and Pag sheep lambs) achieved a higher average daily

gain, which is in agreement with SINGH et al. (2006). Although some studies emphasize the importance of gender influence on birth weight and daily gain (SINGH et al., 2006; EYDURAN et al., 2008) there was no significant difference in those parameters between the male and female lambs overall ($P>0.05$) in our research.

The dressing percentage of young, suckling lambs of different breeds is within the range from 50.0% to 56.0% (SAÑUDO et al., 1997), which is somewhat in accordance with the present study. Thus, the dressing percentage of Pag sheep lambs from production system I was higher than the dressing percentage of Portuguese Churra de Terra Quente lambs (50.0%; SANTOS et al., 2007) and Italian Barbaresca lambs (56.02%) of similar age and slaughter weight (LANZA et al., 2006). The values of the dressing percentage of Istrian sheep lambs and Dalmatian Pramenka lambs from production systems III and II, respectively, were higher than those from some Spanish breeds of similar age and slaughter weight (VERGARA et al., 1999; CARRASCO et al., 2009). The significant influence of production system on dressing percentage in grazing compared to indoor concentrate feed in Churra Tensina lambs was pointed out by JOY et al. (2008b). Although some authors (VERGARA et al., 1999; JOHNSON et al., 2005) confirm that female lambs had a higher dressing percentage than male lambs, this was only confirmed in production system II. Sex did not have a significant effect on the dressing percentage of Pag sheep lambs and Istrian sheep lambs which is in agreement with PÉREZ et al. (2002) and PEÑA et al. (2005). The greater weight of the organs which are not part of the carcass was determined in Istrian sheep lambs (8.81 kg) and Dalmatian Pramenka lambs (7.09 kg) compared to Pag sheep lambs (4.09 kg).

Istrian sheep lambs with the highest slaughter weight (20.03 kg) had the greatest carcass length (66.22 cm), hind limb length (23.64 cm) and chest width (11.72 cm). Compared to lambs of some Spanish breeds (Churra, Castellana, Manchega) slaughtered at the age of one month (SAÑUDO et al., 1997) Pag sheep lambs had 2.5 cm shorter hind limb length and almost the same chest depth. Istrian sheep lambs and Dalmatian Pramenka lambs had almost the same hind limb length and chest depth when compared with lambs of Spanish Segureña breed slaughtered at 19-25 kg of live weight (PEÑA et al., 2005), but greater carcass length and chest depth, and narrower chest and buttock when compared to Apenninica lambs of equal live weight (RUSSO et al., 2003).

The pH values reported in this study for the investigated sheep lambs overall were higher than the pH values of typical Mediterranean lambs breeds of similar age and slaughter weight. Compared to Pag sheep lambs (6.35) DÍAZ et al. (2003) reported lower (6.04) pH values of MLD in Manchego lambs 60 minutes after slaughter, while SANTOS et al. (2008) reported higher pH values (6.60) in MLD of Churra da Terra Quente suckling lambs. The pH value in two Portuguese breeds (average slaughter weight of 16.0 kg), measured 60 minutes after slaughter, was 6.20 (TEIXEIRA et al., 2005) which is lower than in Dalmatian Pramenka lambs (6.34). However, the pH value of the MLD of Istrian sheep

lambs (6.56), 45 minutes after slaughter, was 0.5 lower than in Manchego lambs (6.03) of similar slaughter weight (VERGARA et al., 1999). Pag sheep lambs and Dalmatian Pramenka lambs had an almost identical pH value of MLD 45 minutes *post mortem*, while Istrian sheep lambs had a significantly higher pH value. These differences in pH value could be influenced by different slaughter weight (SAÑUDO et al., 1996). Sex did not have a significant influence on pH value in the breeds in our study, which is in agreement with the results from other authors (VERGARA et al., 1999; RODRÍGUEZ et al., 2007).

The meat of young suckling lambs has high L* (44-56) and low a* (8-17) value of meat colour with b* value in a range from 4 to 10 (TEIXEIRA et al., 2005; LANZA et al., 2006; RODRÍGUEZ et al., 2007). An increase in the slaughter weight of lambs reduces L* (lightness) and increases a* (redness) value (VERGARA et al., 1999) and the meat becomes darker and more red. The parameter L* (44.07) of MLD in Pag sheep lambs was almost identical to that of Assaf (43.07) suckling lambs (RODRÍGUEZ et al., 2007), but was slightly lower than in Churra de Terra Quente lambs (45.20) of similar slaughter weight (SANTOS et al., 2007). Compared to the previously mentioned study, Pag sheep lambs had a slightly higher a* value but a considerably lower b* value of MLD. Dalmatian Pramenka lambs had slightly higher L* (44.5) and a* (17.6), but considerably lower b* (2.3) colour parameters measured on MLD than those reported by TEIXEIRA et al. (2005) for the longissimus dorsi of lambs of two Portuguese breeds reared in a similar production system (L* = 41.5, a* = 16.5, b* = 9.5). The values of colour parameters (L* = 47.03, a* = 16.63 and b* = 3.23) measured on MLD determined in Istrian sheep lambs were lower than those measured on MLD of Manchego lambs (L* = 49.46, a* = 22.60 and b* = 9.07) from a similar production system (VERGARA et al., 1999). BERIAIN et al. (2000) and DÍAZ et al. (2003) reported lower a* and higher b* values of MRA in Spanish suckling lambs compared to Pag sheep lambs, and similar differences were found when Dalmatian Pramenka lambs were compared with Spanish lambs from a similar production system (JOY et al., 2008a). Male lambs in this study had a slightly, but significantly higher L* values than females, while the values of a* and b* parameters between the sexes did not differ significantly. This is in accordance with the results of TEIXEIRA et al. (2005), while JOHNSON et al. (2005) and RODRÍGUEZ et al. (2007) did not find any significant effect of sex on meat colour.

Conclusions

The birth weight and daily gain of the investigated lambs were influenced by the breed of sheep, while age and slaughter weight were determined by the breeding area, sheep tradition, production technology and consumer demands. The influence of sex was only evident in some slaughter characteristics, as well as in some carcass measurements. The highest pH value was determined in Istrian sheep lambs, while Pag sheep lambs and Dalmatian Pramenka lambs had almost the same pH value of the MLD. Colour

parameters (L^* , a^* and b^*) were very variable between different production systems and sexes. Despite the differences in some colour parameters, lamb meat from all three production systems belongs to same qualitative category.

References

- BERIAIN, M. J., A. HORCADA, A. PURROY, G. LIZASO, J. CHASCO, J. A. MENDIZABAL (2000): Characteristics of Lacha and Rasa Aragonesa lambs slaughtered at three live weights. *J. Anim. Sci.* 78, 3070-3077.
- CARRASCO, S., G. RIPOLL, A. SANZ, J. ÁLVAREZ-RODRÍGUEZ, B. PANEA, R. REVILLA, M. JOY (2009): Effect of feeding system on growth and carcass characteristics of Churra Tensina light lambs. *Livest. Sci.* 121, 56-63.
- CIE (1986): Colorimetry (2nd ed.). CIE Publications 15.2 Commission Internationale de l'Eclairage, Vienna, Austria.
- CIFUNI, G. F., F. NAPOLITANO, C. PACELLI, A. M. RIVIEZZI, A. GIROLAMI (2000): Effect of age at slaughter on carcass traits, fatty acid composition and lipid oxidation of Apulian lambs. *Small Rumin. Res.* 35, 65-70.
- DÍAZ, M. T., S. VELASCO, C. PÉREZ, S. LAUZURICA, F. HUIDOBO, V. CAÑEQUE (2003): Physico-chemical characteristics of carcass and meat Manchego-breed suckling lambs slaughtered at different weights. *Meat Sci.* 65, 1085-1093.
- DÍAZ, M. T., S. VELASCO, V. CAÑEQUE, S. LAUZURICA, F. RUIZ DE HUIDOBRO, C. PÉREZ, J. GONZÁLES, C. MANZANARES (2002): Use of concentrate or pasture for fattening lambs and its effect on carcass and meat quality. *Small Rumin. Res.* 43, 257-268.
- EYDURAN, E., K. KARAKUS, S. KESKIN, F. CENGİZ (2008): Determination of factors influencing birth weights using regression tree (RT) method. *J. Appl. Anim. Res.* 34, 109-112.
- FAHMY, M. H., J. M. BOUCHER, L. M. POSTE, R. GRÉGOIRE, G. BUTLER, J. E. COMEAU (1992): Feed efficiency, carcass characteristics, and sensory quality of lambs, with or without prolific ancestry, fed diets with different protein supplements. *J. Anim. Sci.* 70, 1365-1374.
- FISCHER, A. V., H. DE BOER (1994): The EAAP standard method of sheep carcass assessment. Carcass measurements and dissection procedures, Report of the EAAP Working Group on Carcass Evaluation, in cooperation with the CIHEAM Instituto Agronomico Mediterraneo of Zaragoza and the CEC Directorate General for Agriculture Brussels. *Livest. Prod. Sci.* 38, 149-159.
- JOHNSON, P. L., R. W. PURCHAS, J. C. MCEWAN, H. T. BLAIR (2005): Carcass composition and meat quality differences between pasture-reared ewe and ram lambs. *Meat Sci.* 71, 383-391.
- JOY, M., J. ALVAREZ-RODRÍGUEZ, R. REVILLA, R. DELFA, G. RIPOLL (2008a): Ewe metabolic performance and lamb carcass traits in pasture and concentrate-based production systems in Churra Tensina breed. *Small Rumin. Res.* 75, 24-35.
- JOY, M., G. RIPOLL, R. DELFA (2008b): Effects of feeding system on carcass and noncarcass composition of Churra Tensina light lambs. *Small Rumin. Res.* 78, 123-133.

- LANZA, M., M. BELLA, A. PRIOLO, D. BARBAGALLO, V. GALOFARO, C. LANDI, P. PENNISI (2006): Lamb meat quality as affected by a natural or artificial milk feeding regime. *Meat Sci.* 73, 313-318.
- MIKULEC, D., V. PAVIĆ, V. SUŠIĆ, B. MIOČ, K. MIKULEC, Z. BARAĆ, Z. PRPIĆ, I. VNUČEC (2007): Exterior characteristics of different categories of Istrian sheep (in Croatian). *Stočarstvo* 61, 13-32.
- MIOČ, B., D. JURKOVIĆ, A. IVANKOVIĆ, V. PAVIĆ, Z. BARAĆ (2003): Some reproduction traits of Solčavsko-jezerska sheep in Croatia (Croatian). Book of abstracts, 38th Croatian Symposium on Agriculture with International Participation, Opatija, 495-468.
- MIOČ, B., V. PAVIĆ, V. SUŠIĆ (2007): Sheep husbandry (in Croatian), Hrvatska mljekarska udruga. Zagreb. pp. 64-65.
- MIOČ, B., V. DRŽAIĆ, I. VNUČEC, Z. PRPIĆ, Z. ANTUNOVIĆ, Z. BARAĆ (2013): Some slaughter and meat traits of lambs and kids from an extensive production system. *Vet. arhiv* 83, 263-274.
- PAVIĆ, V., B. MIOČ, Z. BARAĆ, I. VNUČEC, V. SUŠIĆ, N. ANTUNAC, D. SAMARDŽIJA (2006): Exterior characteristics of Pag sheep (in Croatian). *Stočarstvo* 59, 83-90.
- PAVIĆ, V., B. MIOČ, N. STIPIĆ (1996): Some production traits of the Kupres sheep (in Croatian). *Poljoprivredna znanstvena smotra* 61, 251-253.
- PEÑA, F., T. CANO, V. DOMENECH, M. A. J. ALCALDE, J. MARTOS, A. GARCÍA-MARTINEZ, M. HERRERA, E. RODERO (2005): Influence of sex, slaughter weight and carcass weight on "non-carcass" and carcass quality in Segureña lambs. *Small Rumin. Res.* 60, 247-254.
- PÉREZ, P., M. MAINO, G. TOMIC, E. MARDONES, J. POKNIAK (2002): Carcass characteristics and meat quality of Suffolk Down lambs. *Small Rumin. Res.* 44, 233-240.
- RAKO, A. (1957): Istrian dairy sheep (in Croatian). *Stočarstvo* 11, 423-429.
- RIPOLL, G., M. JOY, F. MUÑOZ, P. ALBERTÍ (2008): Meat and fat colour as a tool to trace grass-feeding systems in light lambs production. *Meat Sci.* 80, 239-248.
- RODRÍGUEZ, A. B., R. LANDA, R. BODAS, N. PRIETO, A. R. MANTECÓN, F. J. GIRÁLDEZ (2007): Carcass and meat quality of Assaf milk fed lambs: Effect of rearing system and sex. *Meat Sci.* 80, 225-230.
- RUSSO, C., G. PREZIUSO, P. VERITÀ (2003): EU carcass classification system: carcass and meat quality in light lambs. *Meat Sci.* 64, 411-416.
- SANTOS, V. A. C., S. R. SILVA, E. G. MENA, J. M. T. AZEVEDO (2007): Live weight and sex effects on carcass and meat quality of "Borrego terrincho-PDO" suckling lambs. *Meat Sci.* 77, 654-661.
- SANTOS, V. A. C., S. R. SILVA, J. M. T. AZEVEDO (2008): Carcass composition and meat quality of equally mature kids and lambs. *J. Anim. Sci.* 86, 1943-1950.
- SAÑUDO, C., M. M. CAMPO, I. SIERRA, G. A. MARÍA, J. L. OLLETA, P. SANTOLARIA (1997): Breed effect on carcass and meat quality of suckling lambs. *Meat Sci.* 46, 357-365.

- SAÑUDO, C., M. P. SANTOLARIA, G. MARIA, M. OSORIO, L. SIERRA (1996): Influence of carcass weight on instrumental and sensory lamb meat quality in intensive production systems. *Meat Sci.* 42, 195-202.
- SINGH, D., R. KUMAR, B. L. PANDER, S. S. DHAKA, S. SINGH (2006): Genetic parameters of growth traits in crossbred sheep. *Asian. Austral. J. Anim. Sci.* 19, 1390-1393.
- ŠIRIĆ, I., B. MIOČ, V. PAVIĆ, Z. ANTUNOVIĆ, I. VNUĆEC, Z. PRPIĆ (2009): Exterior characteristics of Dalmatian Pramenka sheep (in Croatian). *Stočarstvo* 63, 263-273.
- TEIXEIRA, A., C. BATISTA, R. DELFA, V. CADAVEZ (2005): Lamb meat quality of two breeds with protected origin designation. Influence of breed, sex and live weight. *Meat Sci.* 71, 530-536.
- VERGARA, H., A. MOLINA, L. GALLEGO (1999): Influence of sex and slaughter weight on carcass and meat quality in light and medium weight lambs produced in intensive systems. *Meat Sci.* 52, 221-226.
- VNUĆEC, I. (2011): Carcass characteristics and meat quality of lambs from diverse production systems. Doctoral thesis, University of Zagreb, Faculty of Agriculture, Zagreb (in Croatian).
- VNUĆEC, I., B. MIOČ, Z. PRPIĆ, V. PAVIĆ, Z. BARAĆ (2011): Slaughter traits and carcass measurements of lambs and kid raised under extensive production system (in Croatian). *Proceedings, 46th Croatian and 6th International Symposium on Agriculture, Opatija, 899-903.*

Received: 4 March 2013

Accepted: 19 December 2013

VNUĆEC, I., V. DRŽAIĆ, B. MIOČ, Z. PRPIĆ, V. PAVIĆ, Z. ANTUNOVIĆ: Svojstva trupa i boja mesa janjadi iz različitih sustava proizvodnje. *Vet. arhiv* 84, 251-263, 2014.

SAŽETAK

Ovčarska proizvodnja u Hrvatskoj primarno se temelji na izvornim pasminama i različitim sustavima proizvodnje te je određena tradicijom i specifičnim uvjetima okoliša. Cilj ovog istraživanja bio je utvrditi utjecaj spola na porođajnu masu, dnevni prirast, pH vrijednost i boju mesa kao i klaoničke pokazatelje te odliku trupova janjadi iz tri različita sustava ovčarske proizvodnje. Za tu svrhu nasumično je odabrano ukupno 306 janjadi triju pasmina uzgajane u tri različita proizvodna sustava: I. – proizvodnja mlijeka, paška ovca (ukupno 112 janjadi: 66 muške i 46 ženske); II. – proizvodnja janječeg mesa, dalmatinska pramenka (ukupno 96 janjadi: 52 muške i 44 ženske) i III. – proizvodnja mlijeka i janječeg mesa, istarska ovca (ukupno 98 janjadi: 54 muške i 44 ženske). Spol je značajno utjecao na dnevni prirast i dob ($P < 0,01$) te tjelesnu masu prije klanja ($P < 0,05$) samo u proizvodnom sustavu III. Utvrđen je varijabilan utjecaj spola na klaoničke pokazatelje janjadi istraživanih pasmina. Najviša pH vrijednost *m. longissimus dorsi* (MLD) utvrđena je u proizvodnom sustavu III namijenjenom proizvodnji mlijeka i mesa. L^* vrijednost MLD-a razlikovala ($P < 0,001$) se između sva tri proizvodna sustava, dok je b^* vrijednost bila značajno niža u proizvodnom sustavu II. Najviša vrijednost L^* pokazatelja *m. rectus abdominis* (MRA) utvrđena je u proizvodnom sustavu III, a najviša vrijednost b^* pokazatelja MRA-a u proizvodnom sustavu I. Spol je značajno utjecao na b^* pokazatelj MRA u janjadi paške ovce, L^* pokazatelj MLD-a i MRA u janjadi dalmatinske pramenke te pH vrijednost i L^* pokazatelj MLD-a u proizvodnom sustavu III. Rezultati ovog istraživanja sugeriraju da unutar malog zemljopisnog područja postoje mogućnosti za proizvodnju janječih trupova sa specifičnim kvalitativnim karakteristikama.

Ključne riječi: janje, meso, proizvodni sustav, trup, pH vrijednost, boja mesa
