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Influence of sex and the slaughtering season on water-holding capacity and carcass composition in Istrian lambs

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ABSTRACT

The aim of this study was to determine influence of sex and slaughtering season on water-holding capacity and carcass composition in Istrian lambs, raised in a traditional farming system in the Istrian region. The study was carried out on a total of 32 lambs (16 males and 16 females) of Istrian breed, raised on a family farm, during the slaughtering season in 2010, 2011 and 2012. Female lambs had a significantly higher cooking loss ($P \leq 0.05$) and proportion of loin-rib ($P \leq 0.05$), while male lambs had a significantly higher head proportion ($P \leq 0.05$). Regarding tissue composition, it was found that in the loin-rib, female lambs had significantly higher fat content ($P \leq 0.05$) and lower muscle content ($P \leq 0.05$) than males. Slaughtering season significantly affected proportions of neck ($P \leq 0.001$), shoulder ($P \leq 0.05$), anterior rib ($P \leq 0.001$), loin-rib ($P \leq 0.001$), breast ($P \leq 0.001$), hind leg ($P \leq 0.05$) and kidney knob ($P \leq 0.05$). Furthermore, slaughtering season significantly affected ($P \leq 0.05$) the composition of individual cuts, i.e. muscle proportion in the neck, loin-rib, breast and hind leg, bone proportion in the neck, shoulder, anterior rib and hind leg, and fat proportion in all cuts. The results of this study indicated that male and female Istrian lambs, reared under similar conditions, had very similar expression of the investigated traits. Slaughtering season affected most of the traits related to carcass composition. In order to provide more uniform carcasses on the market, it is necessary to ensure similar quality of feeds during the unfavourable seasons.

Key words: carcass composition, lambs, season, sex, water-holding capacity

Introduction

The Istrian sheep is an indigenous Croatian breed from the Istrian peninsula located at the north of the Adriatic Sea. The registered population size is 2,871 heads, which constitutes 6.96 % of the total sheep population included in an approved selection program led by the Croatian Agricultural Agency (CAA, 2014). The Istrian sheep is traditionally

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reared under a semi-extensive production system. During the days in the summer period, animals are free-range in natural pastures, while during the nights they are kept in a stable. During the winter period, animals are kept in stables, fed with hay and supplemented with concentrates. The Istrian sheep is predominately used for dairy production, which is accompanied in many husbandries by lamb meat production. The Istrian lamb production system is closely related to the production systems widely used for dairy sheep breeds in Mediterranean countries (D'ALESSANDRO et al., 2013). Namely, Istrian lambs are traditionally fed with dam's milk for their entire lives, additionally receiving hay and concentrates from 21-28 days of age to slaughter. They are usually slaughtered at the age of 60 to 90 days, when they achieve between 20 and 25 kg of slaughter weight (MIOČ et al., 2012; VNUČEC et al., 2014).

It is well known that the final appearance of the carcass is primarily the result of a biological process affected by genetic, environmental and management factors (SARI et al., 2012), while the purchase and consumption of meat is determined by consumer habits that are largely influenced by religion, tradition and customs (KEARNEY, 2010). Nowadays, more and more importance is given to meat quality (RODRIGUES et al., 2006). It has been proven that meat quality is one of the most important factors in the selection and purchasing of certain types of meat (FISHER et al., 2000). Although it is a polysemic and complex trait of meat, most authors believe that lamb meat quality and its acceptance by consumers are primarily determined by its physicochemical properties (TEJEDA et al., 2008). Information about carcass quality is an important factor in determining meat quality (RODRIGUES et al., 2006).

There are several studies that have investigated the carcass and meat quality traits of Istrian lambs (VNUČEC et al., 2010; 2012; 2014). However, to date there has been no information regarding the water-holding capacity, and the proportion of individual (their tissue distribution) and lower-priced carcass cuts in Istrian lambs. Since consumers have become more diet conscious, mainly being concerned with fat content and meat palatability, it is important to provide information about differences in carcass composition and meat quality (ABDULLAH and QUDSIEH, 2008). Therefore, the aim of this study was to determine whether the sex and slaughtering season affect the water-holding capacity and carcass composition in Istrian lambs, reared under common management and during the traditional period.

Materials and methods

The study was carried out on a total of 32 lambs (16 males and 16 females) of the Istrian breed. They were raised on a family farm located in the Istrian region, during the slaughtering season in 2010, 2011 and 2012. According to the Croatian Bureau of Statistics, average monthly air temperatures during the slaughtering season in 2010 ranged

from 1.4 to 5.8 °C, in 2011 from 3.2 to 7.0 °C and in 2012 from 1.8 to 8.8 °C. Average precipitation rates during the slaughtering season in 2010 ranged from 44.3 to 131.0 mm, in 2011 from 13.5 to 122.0 mm and in 2012 from 0.3 to 20.4 mm. Animals included in the study were raised in accordance with a traditional farming system. Throughout the year, the sheep grazed on natural pastures and were supplied with alfalfa hay. During the last month of gestation and the first two months of lactation, they were supplemented with concentrates, based on corn and barley (200-300 g per day). Lambs were born at the beginning of January and kept with their dams almost until the end of March. During the first 4 weeks, the lambs were penned and suckled milk from their dams. After that they were raised throughout the day with their dams continuously on a pasture, and at night in the stable. Throughout that period the lambs suckled milk and were supplied with alfalfa hay and small amounts of corn. At the average age of 83 days, lambs were randomly selected from the flock. Transport to a commercial slaughterhouse and manipulation of the lambs was performed according to Croatian regulations with regard to animal welfare rules (OG 135/06, 37/13, 125/13, 14/14, 92/14). Slaughter and dressing methods followed the standard commercial procedures in Croatia (OG 30/10, 83/11). The lambs were electrically stunned and slaughtered by cutting the arteries and the jugular vein in the neck region. Immediately after bleeding, the non-carcass components (skin, feet, lungs and trachea, liver, hearth, spleen, pancreas, gastro-intestinal tract, diaphragm and testicles) were removed from the carcasses. After that, the carcasses were carefully halved throughout the dorsal midline and chilled at 4 °C for 24 h in a conventional chill cooler.

Drip loss and cooking loss were evaluated in the *longissimus dorsi* muscle of the right half-carcass, using the method described by HONIKEL (1998). For determination of drip loss, the samples were weighed, placed in netting and then suspended separately in an inflated polyethylene bag. After a storage period of 24 h and 48 h at 4 °C in a refrigerator, the samples were dried with paper towels and reweighed. Drip loss was calculated separately after 24 h and 48 h, as weight loss expressed as a percentage of the initial sample weight. In order to measure cooking loss, refrigerated meat samples were weighed, placed in polyethylene bags and then cooked in a boiling water-bath. When the endpoint temperature of 75 °C had been attained, the samples were removed from the water-bath, cooled in ice slurry and held in chill conditions (3 °C) until equilibrated. The samples were then taken from the polyethylene bags, blotted dry and weighed. Cooking loss was calculated as weight loss before and after cooking, expressed as a percentage of the initial sample weight.

After 24 h of chilling, the left half-carcasses were separated into lower-priced and individual cuts. The lower-priced cuts (head, tail, kidney, kidney knob and channel fat) were removed from the left half-carcasses and weighed. Each of them was expressed as a proportion of lower-priced cuts and was excluded from the calculations related to whole

carcass composition. Next, the left half-carasses were separated according to COLOMER-ROCHER et al. (1988) into individual cuts: shoulder, belly, hind leg, neck, anterior rib and loin-rib (Fig. 1). Each individual cut was weighed and dissected into muscle, bone and fat (FISHER and DE BOER, 1994).

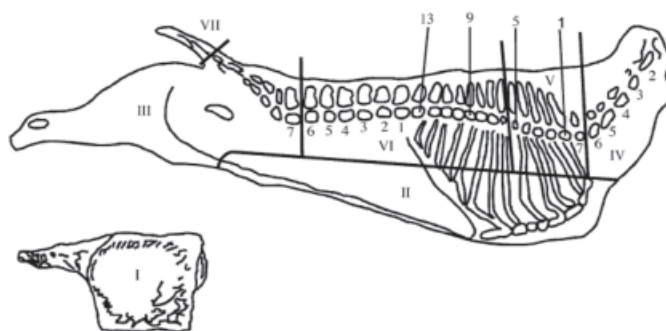


Fig. 1. Half lamb carcass with cuts; I-shoulder; II-belly; III-hind leg; IV-neck; V-anterior rib; VI-loin-rib; VII-tail (COLOMER-ROCHER et al., 1988)

All investigated traits were analysed by the MIXED procedure of the SAS/STAT software package (SAS Inst. Inc., 2008). The following linear model was applied

$$y_{ijk} = \mu + S_i + P_j + e_{ijk}$$

where y_{ijk} = dependent variable, μ = overall mean, S_i = fixed effect of sex (i = male, female), P_j = fixed effect of the slaughtering season (j = 1, 2, 3) and e_{ijk} = residual error.

The t -test was applied to assess the effect of the sex, whilst Scheffe's test was applied to assess the effect of the slaughtering season. Differences in the last-square means determined at level $\alpha = 0.05$ were considered as statistically significant.

Results

Table 1 shows the influence of sex and slaughtering season on drip loss and cooking loss in Istrian lambs. There was no statistically significant difference in drip loss between females and males. Contrary to that, cooking loss was influenced by gender. Cooking loss was significantly higher ($P \leq 0.05$) in females than in males, i.e. meat from females expelled a higher percentage of liquid during cooking than that of males (16.32 % vs. 12.99 %). Neither drip loss nor cooking loss were significantly affected by the slaughtering season.

Table 1. Influence of sex (S) and slaughtering season (SS) on drip loss (%) and cooking loss (%) in Istrian lambs

Trait	Sex (LSM ± SE)		S ¹	Slaughtering season (LSM ± SE)			SS ¹
	Male	Female		2010	2011	2012	
	n = 16	n = 16		n = 11	n = 11	n = 10	
Drip loss 24	0.78 ± 0.13	0.64 ± 0.13	NS	0.69 ± 0.16	0.60 ± 0.15	0.82 ± 0.18	NS
Drip loss 48	1.45 ± 0.20	1.35 ± 0.20	NS	1.47 ± 0.22	1.32 ± 0.23	1.48 ± 0.18	NS
Cooking loss	12.99 ± 1.28	16.32 ± 1.33	*	15.33 ± 1.09	15.42 ± 1.49	15.89 ± 1.14	NS

¹ Significance level: NS = not significant; *P≤0.05

Table 2. Influence of sex (S) and slaughtering season (SS) on slaughter weight (kg), individual and less-priced cuts (%) in Istrian lambs

Trait	Sex (LSM ± SE)		S ¹	Slaughtering season (LSM ± SE)			SS ¹
	Male	Female		2010	2011	2012	
	n = 16	n = 16		n = 11	n = 11	n = 10	
Slaughter weight	23.04 ± 0.45	22.87 ± 0.49	NS	22.93 ± 0.57	23.52 ± 0.65	23.41 ± 0.50	NS
Neck	8.65 ± 0.25	8.66 ± 0.28	NS	9.54 ± 0.32	9.28 ± 0.37	7.13 ± 0.28	***
Shoulder	17.01 ± 0.31	16.80 ± 0.34	NS	16.19 ± 0.40	17.38 ± 0.46	17.22 ± 0.35	*
Anterior rib	6.66 ± 0.28	6.20 ± 0.31	NS	7.59 ± 0.36	5.07 ± 0.41	6.62 ± 0.31	***
Loin-rib	13.55 ± 0.27	14.54 ± 0.30	*	15.30 ± 0.34	13.71 ± 0.40	13.12 ± 0.30	***
Breast	14.32 ± 0.37	14.00 ± 0.41	NS	12.75 ± 0.47	13.84 ± 0.54	15.90 ± 0.41	***
Hind leg	29.09 ± 0.30	28.63 ± 0.33	NS	27.89 ± 0.38	29.65 ± 0.44	29.04 ± 0.34	*
Less-priced cuts	10.72 ± 0.18	11.17 ± 0.20	NS	10.74 ± 0.23	11.07 ± 0.27	10.97 ± 0.21	NS
Head ²	81.80 ± 1.07	80.97 ± 1.08	*	81.60 ± 1.35	81.81 ± 1.56	81.71 ± 1.19	NS
Tail ²	9.82 ± 0.36	9.78 ± 0.39	NS	9.83 ± 0.45	9.79 ± 0.52	9.58 ± 0.40	NS
Kidney ²	7.45 ± 0.26	7.97 ± 0.28	NS	7.59 ± 0.33	7.32 ± 0.38	7.89 ± 0.29	NS
Kidney knob ²	0.58 ± 0.06	0.78 ± 0.07	NS	0.65 ± 0.08	0.66 ± 0.09	0.33 ± 0.07	*
Channel fat ²	0.35 ± 0.03	0.50 ± 0.04	NS	0.33 ± 0.04	0.42 ± 0.05	0.49 ± 0.04	NS

¹Significance level: NS = not significant; *P≤0.05; ***P≤0.001; ²Expressed as a proportion of a less-priced cuts

The influence of sex and slaughtering season on slaughter weight, individual and less-priced cuts in Istrian lambs is presented in Table 2. The differences determined for the slaughter weight between male and female lambs were not statistically significant. Regarding dissected cuts, it was found that females had a significantly higher proportion of loin-rib (P≤0.05), while males had a significantly higher proportion of head (P≤0.05).

The differences in other dissected cuts between genders were found to be not statistically significant. The slaughtering season significantly affected the proportion of neck ($P \leq 0.001$), shoulder ($P \leq 0.05$), anterior rib ($P \leq 0.001$), loin-rib ($P \leq 0.001$), breast ($P \leq 0.001$), hind leg ($P \leq 0.05$) and kidney knob ($P \leq 0.05$).

Table 3. Influence of sex (S) and slaughtering season (SS) on the composition of individual cuts (%) and of the total carcass (%) in Istrian lambs

Trait		Sex (LSM \pm SE)			Slaughtering season (LSM \pm SE)			SS ¹
		Male	Female	S ¹	2010	2011	2012	
		n = 16	n = 16		n = 11	n = 11	n = 10	
Neck	Muscle	48.72 \pm 1.19	48.73 \pm 1.31	NS	45.89 \pm 1.51	48.74 \pm 1.73	49.06 \pm 1.32	*
	Fat	25.28 \pm 1.51	25.56 \pm 1.66	NS	29.90 \pm 1.91	27.99 \pm 2.19	21.94 \pm 1.67	**
	Bone	26.00 \pm 1.26	25.71 \pm 1.38	NS	24.21 \pm 1.59	23.27 \pm 1.83	29.00 \pm 1.39	**
Shoulder	Muscle	61.09 \pm 0.99	60.63 \pm 1.09	NS	59.76 \pm 1.25	62.70 \pm 1.44	60.12 \pm 1.10	NS
	Fat	13.16 \pm 0.86	13.51 \pm 0.95	NS	14.89 \pm 1.09	9.69 \pm 1.25	16.93 \pm 0.95	***
	Bone	25.75 \pm 0.63	25.86 \pm 0.69	NS	25.35 \pm 0.79	27.61 \pm 0.91	22.95 \pm 0.70	**
Anterior rib	Muscle	54.47 \pm 1.01	54.45 \pm 1.21	NS	55.00 \pm 1.39	54.48 \pm 1.60	55.30 \pm 1.22	NS
	Fat	15.94 \pm 1.64	15.99 \pm 1.85	NS	16.92 \pm 1.07	11.66 \pm 1.38	22.50 \pm 1.82	**
	Bone	29.59 \pm 1.15	29.56 \pm 1.35	NS	28.08 \pm 1.70	33.86 \pm 1.13	22.20 \pm 1.37	**
Loin-rib	Muscle	47.31 \pm 1.10	46.30 \pm 1.21	*	49.35 \pm 1.39	42.78 \pm 1.60	51.26 \pm 1.22	**
	Fat	20.37 \pm 1.03	21.37 \pm 1.13	*	17.96 \pm 1.30	26.59 \pm 1.50	18.03 \pm 1.14	***
	Bone	32.32 \pm 1.12	32.33 \pm 1.23	NS	32.69 \pm 1.42	30.63 \pm 1.63	30.71 \pm 1.24	NS
Breast	Muscle	51.83 \pm 1.12	51.66 \pm 1.23	NS	54.65 \pm 1.41	53.10 \pm 1.63	48.97 \pm 1.24	*
	Fat	23.12 \pm 1.21	23.18 \pm 1.34	NS	20.82 \pm 1.54	21.58 \pm 1.77	27.05 \pm 1.35	*
	Bone	25.05 \pm 0.83	25.16 \pm 0.92	NS	24.53 \pm 1.05	25.32 \pm 1.21	23.98 \pm 0.92	NS
Hind leg	Muscle	61.95 \pm 0.97	61.81 \pm 1.07	NS	63.39 \pm 1.23	63.59 \pm 1.41	58.66 \pm 1.08	*
	Fat	10.23 \pm 0.66	10.46 \pm 0.73	NS	11.76 \pm 0.83	8.23 \pm 0.96	12.55 \pm 0.73	**
	Bone	27.82 \pm 0.60	27.73 \pm 0.66	NS	24.85 \pm 0.76	28.18 \pm 0.87	28.79 \pm 0.67	*
Total muscle		50.11 \pm 0.50	49.70 \pm 0.56	NS	50.09 \pm 0.64	50.52 \pm 0.74	49.11 \pm 0.56	NS
Total fat		14.72 \pm 0.51	15.54 \pm 0.57	NS	14.81 \pm 0.65	14.79 \pm 0.75	15.69 \pm 0.57	NS
Total bone		24.57 \pm 0.40	23.62 \pm 0.44	NS	24.27 \pm 0.50	23.62 \pm 0.58	24.50 \pm 0.44	NS

¹Significance level: NS = not significant; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

The influence of sex and slaughtering season on the composition of individual cuts and of the total carcass in Istrian lambs is presented in Table 3. The composition of individual cuts was not affected by gender, except for loin-rib, where females had significantly higher fat content ($P \leq 0.05$) and lower muscle content ($P \leq 0.05$) than males. The proportions of the total muscle, bone and fat between male and female carcasses were not significantly different. Composition of individual cuts was significantly affected by the slaughtering season ($P \leq 0.05$), except for muscle content in the shoulder and anterior rib, and bone content in the loin-rib and breast. Contrary to this, total carcass composition (muscle, fat and bone content) was not significantly affected by the slaughtering season.

Discussion

The water-holding capacity, i.e. the ability of meat to retain its water during application of external forces, such as cutting, heating, grinding or pressing, is an important attribute of meat quality (SEN et al., 2011). According to SANTOS-SILVA and PORTUGAL (2001) the level of water-holding capacity is closely related with low ultimate pH values, and its accelerated decline during the development of rigor mortis. The non-significant differences in drip losses between female and male Istrian lambs are consistent with those found by MORBIDINI et al. (2001) and ÇELİK and YILMAZ (2010), and in contrast to those obtained by DÍAZ et al. (2003). However, it must be considered that the differences in drip loss reported by DÍAZ et al. (2003) were related primarily to pH values. They determined that lower pH values in females reduced water holding capacity, i.e. increased drip loss. Since we did not find significant differences in the pH values between males and females (data are not shown), absence of a difference in drip loss was somehow expected.

The available information concerning the influence of sex on cooking loss are contradictory. Some authors report that this trait was not affected by sex (RODRÍGUEZ et al., 2007; SEN et al., 2011) while others report that males had significantly higher cooking loss than females (MORBIDINI et al., 2001; DAWSON et al., 2002). These results were mainly explained by the differences in fatness, pH values, Warner-Bratzler shear force, and the method used for determination of shear force and live-weight gain from birth to slaughter. In contrast to this, in the present study it was found that females had significantly higher cooking loss (Table 1). Since the pH values between males and females did not differ and the other parameters mentioned above associated with cooking loss were not investigated, our result is quite complex to explain. According to the above mentioned parameters, which are primarily related to water-holding capacity, it was expected that neither drip loss nor cooking loss in Istrian lambs would be affected by the slaughtering season.

The size and quality of individual and lower-priced cuts are among the most important quality attributes of a sheep carcass, and depend on many physical, chemical and biochemical factors (SHIRIMA and MTENGA, 2012). The sex of the animal, and the

type and amount of feeds are some of the factors contributing to different sizes and compositions of carcass cuts (DÍAZ et al., 2006; SHIRIMA and MTENGA, 2012).

In the present study, females had a significantly higher proportion of loin-rib, because they mature earlier than males and the loin area is a late maturing tissue (ÁLVAREZ-RODRÍGUEZ et al., 2008). A significantly higher proportion of loin-rib was also found in suckling female Manchego lambs slaughtered at 10, 12 and 14 kg (DÍAZ et al., 2006). According to DÍAZ et al. (2006) the loin area is one of the cuts with the highest fat content, but fatness appears later. However, it must be taken into account that besides the greater loin-rib in females, male Manchego lambs had a greater proportion of anterior rib, shoulder and neck. In contrast, PEÑA et al. (2005) only found statistically significant differences in Segureña lambs in the proportion of neck and back, which were more developed in males. These lambs were reared in a similar system and slaughtered at comparable weights as the lambs in our study. The results of the studies mentioned above vary considerably. These differences could be due to different rearing conditions and the growth rates of each breed, or, in the case of Segureña lambs, different dissection methodology, i.e. different positions of anatomical cuts. In the lower-priced cuts, only the head was significantly different, with higher yields in male Istrian lambs (Table 2). This result is consistent with those reported by PÉREZ et al. (2007) for Suffolk Down and Merino Precoz Aleman lambs, Suffolk Down x Corriedale and Suffolk Down x Merino Precoz Aleman crossbreds.

Studies on carcass and meat quality are generally conducted under optimal production conditions, while there has been relatively little research conducted under more natural conditions (RAMÍREZ-RETAMAL and MORALES, 2014). As a result of this and the increasing demand for more 'natural' meat products, it is necessary to consider systems in which production conditions are more restricted, such as grazing in natural or semi-natural grasslands.

The influence of the slaughtering season on the carcass composition of lambs has been attributed to undefined environmental factors, such as: differences in feed supply and its composition, rearing systems, day light/dark ratio, etc. (KREMER et al., 2004). According to the available data from the Croatian Bureau of Statistics, the hydro-meteorological conditions of the Istrian sheep breeding area differed substantially between the slaughtering seasons. These differences in climate conditions indirectly caused higher or lower physical activity in the animals and their food supply throughout vegetation development. Therefore, it is assumed that most of the differences in kidney knob and all individual carcass cuts arose primarily from different climatic conditions.

Gender did not significantly affect the tissue composition of the analysed cuts, except for loin-rib (Table 3). In contrast to our results, DÍAZ et al. (2006) and SANTOS et al. (2007) observed that the tissue composition of carcass cuts was highly influenced by gender. DÍAZ et al. (2006) found that, compared to females, male Manchego lambs (slaughtered

at 10, 12 and 14 kg) had a higher bone proportions in the leg, loin-rib, anterior rib, shoulder and flank, a higher muscle proportion in the shoulder and neck, and a lower fat proportion in the leg, loin-rib, shoulder, flank and neck. SANTOS et al. (2007) found that female Churra da Terra Quente lambs (slaughtered at <8 kg, 8-11 kg and >11 kg) had a significantly higher muscle proportion in the leg, chump, loin and neck than males. On the other hand, no differences were found between the genders in intramuscular fat and, except for the shoulder, in bone proportions. Nevertheless, it must be considered that it is difficult to compare the results of the present study with these, primarily due to different slaughter weights and dissection methodology.

The carcass composition of Istrian lambs was not significantly affected by gender (Table 3). The non-significant differences observed between the genders in carcass composition may be explained by the low slaughter age or weight, and more evident differences might be expected at advanced slaughter age or weight.

The composition of individual cuts of Istrian lambs was significantly influenced by the slaughtering season (Table 3). According to JOY et al. (2008) and CARRASCO et al. (2009) carcass tissue composition may be altered throughout different rearing systems and feeds. JOY et al. (2008) investigated differences in carcass tissue composition in grazing and concentrate fed Churra Tensina lambs. Compared to concentrate fed lambs in drylot, the ones that grazed on pastures had lower fat content in the leg, shoulder and breast, lower muscle content in the ribs and breast, and higher bone content in the loin. CARRASCO et al. (2009) investigated differences in carcass tissue composition between Churra Tensina lambs, reared under different systems (grazing, grazing with supplement, drylot lambs with rationed grazing-ewes and drylot lambs with ewes fed in confinement). Grazing lambs had lower fat content in the pelvic limb, loin-rib, anterior rib and breast, and higher bone content in the loin-rib than the lambs reared under the other regimes investigated. The greater proportion of muscle in the breast observed in grazing lambs was significantly different only to drylot lambs, while the other regimes had intermediate values. According to these authors, the influence of the rearing and feeding system on the carcass tissue composition was probably due to the pattern of tissue maturation (bone-lean-fat), the physical activity of the animals and their average daily energy intake, sufficient to meet requirements for tissue accretion. Although in the present study the rearing system was not changed, we assume that different climate conditions within the investigated period affected vegetation development. Consequently, these changes were reflected in the different energy availability in feed and physical activity of the animals (in search for food), and finally had an influence on the composition of individual cuts.

Conclusions

It may be concluded that male and female Istrian lambs, reared under similar conditions, had very similar expression of the investigated traits (except for cooking loss, proportion and tissue composition of the loin-rib). The slaughtering season affected most of the traits related to carcass composition. In order to provide more uniform carcasses of Istrian lambs on the market, it is necessary to ensure similar feed quality even during unfavourable seasons. Due to the increasing demand for more 'natural' meat products, we recommend that it is necessary in future to conduct more detailed studies, with consumers included.

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References

- ABDULLAH, Y. A., R. I. QUDSIEH (2008): Carcass characteristics of Awassi ram lambs slaughtered at different weights. *Livest. Prod. Sci.* 117, 165-175.
- ÁLVAREZ-RODRÍGUEZ, J., A. SANZ, M. JOY, S. CARRASCO, G. RIPOLL, A. TEIXEIRA (2008): Development of organs and tissues in lambs raised on Spanish mountain grassland. *Can. J. Anim. Sci.* 89, 37-45.
- CAA (2014): Breeding of sheep, goats and small animals. In: Annual Report 2013 (Croatian Agricultural Agency, Ed.), Croatian Agricultural Agency, Križevci, pp. 11-12.
- CARRASCO, S, G. RIPOLL, B. PANEA, J. ÁLVAREZ-RODRÍGUEZ, M. JOY (2009): Carcass tissue composition in light lambs: Influence of feeding system and prediction equations. *Livest. Prod. Sci.* 126, 112-121.
- ÇELİK, R., A. YILMAZ (2010): Certain meat quality characteristics of Awassi and Turkish Merino x Awassi (F₁) lambs. *Turk. J. Vet. Anim. Sci.* 34, 349-357.
- COLOMER-ROCHER, F., R. DELFA, I. SIERRA (1988): Método normalizado para el estudio de los caracteres cuantitativos y cualitativos de las canales ovinas producidas en el área mediterránea según los sistemas de producción. *Cuadernos INIA* 17, 19-41.
- D'ALESSANDRO, A. G., G. MAIORANOB, M. RAGNIA, D. CASAMASSIMAB, G. MARSICOA, G. MARTEMUCCI (2013): Effects of age and season of slaughter on meat production of light lambs: Carcass characteristics and meat quality of Leccese breed. *Small Ruminant Res.* 114, 97-104.
- DAWSON, L. E. R., A. F. CARSON, B. W. MOSS (2002): Effects of crossbred ewe genotype and ram genotype on lamb meat quality from the lowland sheep flock. *J. Agr. Sci.* 139, 195-204.
- DÍAZ, M. T., S. VELASCO, C. PÉREZ, S. LAUZURICA, F. HUIDOBRO, 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., J. DE LA FUENTE, C. PÉREZ, S. LAUZURICA, I. ÁLVAREZ, F. RUIZ DE HUIDOBRO, S. VELASCO, V. CAÑEQUE (2006): Body composition in relation to slaughter weight and gender in suckling lambs. *Small Ruminant Res.* 64, 126-132.
- FISHER, A. V., H. DE BOER (1994): The EAAP standard method of sheep carcass assessment. Carcass measurements and dissection procedures, Report of the EAAP Studying 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.
- FISHER, A. V., M. ENSER, R. I. RICHARDSON, J. D. WOOD, G. R. NUTE, E. KURT, L. A. SINCLAIR, R. G. WILKINSON (2000): Fatty acid composition and eating quality of lamb types derived from four diverse breed x production systems. *Meat Sci.* 55, 141-147.
- HONIKEL, K. O. (1998): Reference methods for the assessment of physical characteristics of meat. *Meat Sci.* 49, 447-457.
- JOY, M., G. RIPOLL, R. DELFA (2008): Effects of feeding system on carcass and non carcass composition of Churra Tensina light lambs. *Small Ruminant Res.* 78, 123-133.
- KEARNEY, J. (2010): Food consumption trends and drivers. *Phil. Trans. R. Soc. B.* 365, 2793-2807.
- KREMER, R., G. BARBATO, L. CASTRO, L. RISTA, L. ROSÉS, V. HERRERA, V. NEIROTTI (2004): Effect of sire breed, year, sex and weight on carcass characteristics of lambs. *Small Ruminant Res.* 53, 117-124.
- MIOČ, B., V. PRPIĆ, Z. BARAC, I. VNUČEC (2012): Istrian sheep as a Croatian indigenous breed (in Croatian). *Hrvatski savez uzgajivača ovaca i koza, Zagreb*, pp. 45-48.
- MORBIDINI, L., D. M. SARTI, P. POLLIDORI, A. VALIGI (2001): Carcass, meat and fat quality in Italian Merino derived lambs obtained with „organic“ farming system. *Options Méditerranéennes* 46, 29-31.
- OG 135/06 (2006): Animal Protection Act. Official Gazette, No. 135. (in Croatian).
- OG 30/10 (2010): Ordinance on the quality of sheep carcasses. Official Gazette, No. 30. (in Croatian).
- OG 83/11 (2011): Ordinance on the protection of animals during killing. Official Gazette, No. 83. (in Croatian).
- OG 37/13 (2013): The Law on amendments to the Animal Protection Act. Official Gazette, No. 37. (in Croatian).
- OG 125/13 (2013): The Law on the implementation of the EU Regulation on animal protection. Official Gazette, No. 125. (in Croatian).
- OG 14/14 (2014): The Law on amendments to the Law on the implementation of the EU Regulation on animal protection. Official Gazette, No. 14. (in Croatian).
- OG 92/14 (2014): The Law on amendments to the Law on the implementation of the EU Regulation on animal protection. Official Gazette, No. 92. (in Croatian).

- PEÑA, F., T. CANO, V. DOMENECH, M. 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 Ruminant Res.* 60, 247-254.
- PÉREZ, P., M. MAINO, M. S. MORALES, C. KÖBRICH, C. BARDON, J. POKNIAK (2007): Gender and slaughter weight effects on carcass quality traits of suckling lambs from four different genotypes. *Small Ruminant Res.* 70, 124-130.
- RAMÍREZ-RETAMAL, J., R. MORALES (2014): Influence of breed and feeding on the main quality characteristics of sheep carcass and meat: A review. *Chil. J. Agric. Res.* 74, 225-233.
- RODRIGUES, S., V. CADAVEZ, A. TEIXEIRA (2006): Breed and maturity effects on Churra Galega Bragançana and Suffolk lamb carcass characteristics: Killing-out proportion and composition. *Meat Sci.* 72, 288-293.
- 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.
- 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-SILVA, J., A. V. PORTUGAL (2001): The effect of weight on carcass and meat quality of Serra da Estrela and Merino Branco lambs fattened with dehydrated lucerne. *Anim. Res.* 50, 289-290.
- SARI, M., A. R. AKSOY, M. TILKI, İ. KAYA, S. İŞİK (2012): Effect of different fattening methods on slaughter and carcass characteristics of Tuj male lambs. *Arch. Tierz.* 55, 480-484.
- SAS Inst. Inc. (2008): The SAS System for Windows. Version 9.2. Cary, NC. SAS Institute.
- SEN, U., E. SIRIN, Z. ULUTAS, M. KURAN (2011): Fattening performance, slaughter, carcass and meat quality traits of Karayaka lambs. *Trop. Anim. Health Prod.* 43, 409-416.
- SHIRIMA, E. J. M., L. A. MTENGA (2012): Comparative analysis of retail cuts, muscle physico-chemical properties and meat tenderness of indigenous castrate sheep finished off under feedlot conditions. *Research Journal of Science & IT Management* 1, 65-73.
- TEJEDA, J. F., R. E. PEÑA, A. I. ANDRÉS (2008): Effect of live weight and sex on physico-chemical and sensorial characteristics of Merino lamb meat. *Meat Sci.* 80, 1061-1067.
- VNUČEC, I., B. MIOČ, Z. PRPIĆ, V. PAVIĆ (2012): The effect of sex on slaughter traits and meat quality of Istrian sheep lambs (in Croatian). *Stočarstvo* 66, 187-200.
- VNUČEC, I., B. MIOČ, Z. PRPIĆ, V. PAVIĆ, V. SUŠIĆ, Z. ANTUNOVIĆ (2010): Chemical and mineral composition of m. longissimus dorsi of Istrian sheep lambs (in Croatian). *Proceedings of the 45th Croatian and 5th International Symposium on Agriculture*, 15-19 February, Opatija, Hrvatska, pp. 1092-1096.
- VNUČEC, I., V. DRŽAIĆ, B. MIOČ, Z. PRPIĆ, V. PAVIĆ, Z. ANTUNOVIĆ (2014): Carcass traits and meat colour of lambs from diverse production systems. *Vet. Arhiv* 84, 251-263.

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SAŽETAK

Cilj ovog istraživanja bio je utvrditi utjecaj spola i proizvodne sezone na sposobnost zadržavanja vode i sastav trupa janjadi istarske ovce. Janjad istarske ovce uzgojena je u skladu s tradicijskim načinom na obiteljskom poljoprivrednom gospodarstvu u Istarskoj županiji tijekom 2010., 2011. i 2012. godine. Za tu je svrhu nasumično odabrano 32 janjadi (16 muške i 16 ženske). U trupovima ženske janjadi utvrđen je značajno veći udio leđa (P≤0,05) i udio leđa s rebrima (P≤0,05), dok je u trupovima muške janjadi utvrđen značajno veći udio glave (P≤0,05). Uz to, utvrđeno je da trupovi ženske janjadi u leđima s rebrima imaju značajno veći udio masnog tkiva (P≤0,05), dok trupovi muške janjadi imaju značajno veći udio mišićnog tkiva (P≤0,05). Proizvodna sezona je značajno utjecala na udio vrata (P≤0,001), ramenog dijela (P≤0,05), prednjeg dijela rebra (P≤0,001), leđa s rebrima (P≤0,001), grudi (P≤0,001), buta (P≤0,05) i bubrežnog masnog tkiva (P≤0,05). Nadalje, proizvodna sezona je značajno utjecala na sastav janječeg trupa (P≤0,05), odnosno na udio mišića u vratu, leđima s rebrima, grudima i butu sa zdjeličnim dijelom, udio kosti u vratu, ramenom dijelu, prednjem dijelu rebra i butu te udio masti u svim dijelovima trupa. Rezultatima predmetnog istraživanja je utvrđeno da janjad istarske ovce koju se uzgaja u podjednakim uvjetima neovisno o spolu ima gotovo neznatne razlike u većini istraživanih svojstava. Proizvodna sezona je značajno utjecala na veći dio sastava janječeg trupa. Stoga je, u cilju pružanja ujednačenih janječih trupova na tržištu, potrebno osigurati podjednaku kakvoću krme i tijekom nepovoljnih proizvodnih sezona.

Ključne riječi: sastav trupa, janjad, sezona, spol, sposobnost zadržavanja vode
