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THE EFFECT OF PRODUCTION SYSTEM AND WEANING ON LAMB CARCASS TRAITS AND MEAT CHARACTERISTICS OF AUTOCHTHONOUS JEZERSKO-SOLČAVA BREED

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ABSTRACT

Thirty-two Jezersko-Solčava lambs were used in a 2X2 factorial design to evaluate the effect of production system (fattening in stable with hay and cereals ad libitum or on the pasture) and weaning (suckling or weaned lambs) on carcass and meat traits of lambs. Suckling lambs were slaughtered at 125 days of age (30 kg of live weight) and weaned lambs were slaughtered at 165 days (38 kg of live weight). No significant differences in daily gain and dressing percentage compared to the production system or weaning were observed. Lambs from pasture had greater percentage of liver, heart and spleen. They had longer and wider carcasses and lower carcass fatness as indicated by lower percentage of kidney fat (1.16 vs. 1.99) and lower percentage of fat in leg than lambs from stable. They also had higher percentage of shoulder and leg and lower percentage of back, loin and rib with flank. Production system also affected meat color. Lambs from pasture had higher CIE L, a and b values of Longissimus dorsi muscle. Mostly, weaning influenced carcass fatness and related traits. Suckling lambs had lower fatness score (4.94 vs. 6.25), lower percentage of kidney fat and fat in leg (8.66 vs. 10.31) and lower percentage of rib with flank than weaned lambs. Meat from suckling lambs was also of lighter colour. There was no significant interaction between production system and weaning on studied carcass or meat traits.

Key-words: lamb, production system, weaning, carcass traits, carcass cuts, meat quality

INTRODUCTION

The main production system used by Slovenian breeders of autochthonous Jezersko-Solčava sheep is grazing lambs with their dams on the pasture till they reach 25 to 30 kg. They are slaughtered then. In winter, breeders wean lambs at around 50 to 60 days and fatten them with hay and commercial concentrates or cereals *ad libitum* till they reach 30 to 35 kg. However, lamb carcasses and meat quality may vary according to the production system (Diaz et al., 2002). Therefore, lambs fattened on pasture generally have less subcutaneous fat than sheepfold lambs. Pasture lambs have greater energy requirements compared to their stable coevals because of an increased basal metabolism due to herbage in their diet and increased activity associated with grazing. One method of lamb meat production involves the weaning of lambs and feeding them on quality pasture or in a stable with commercial concentrates or cereals up to slaughter. The second method is slaughtering suckling lambs of meat breeds such as Jezersko-Solčava at approx. 30 kg of live weight. This study was undertaken to determine the effects of grazing on mountain pasture vs. feeding lambs in a stable with hay and cereals *ad libitum* on carcass traits, some meat characteristics and on the percentage of non-carcass components and carcass cuts in lambs fed to 34 kg. The effect of weaning was also determined to find possible differences in mentioned observations between suckling (30 kg live weight) and weaned (38 kg live weight) lambs.

MATERIAL AND METHODS

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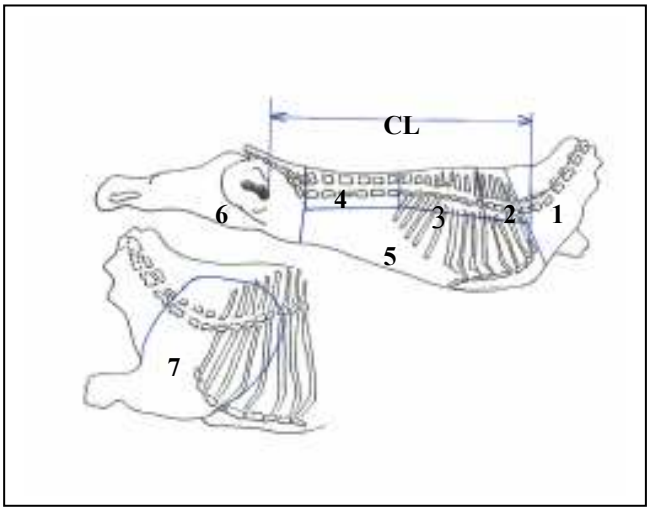
A total of 32 lambs of autochthonous Jezersko-Solčava breed were reared on the mountain farm at 1200 m above sea level. Lambs were born on the farm and stayed there until slaughtered. Sixteen lambs (8 males, 8 females) were reared in the stable (S) and sixteen (8 males, 8 females) on the pasture (P). At the age of 10 days the stable lambs started to be fed with hay and cereals (47% barley, 53 % pressed beet pulp) *ad libitum*. Pasture lambs were only grazing, and received no feed supplementation. Suckling (SU) lambs (8 stable and 8 pasture lambs) were slaughtered at 125 days of age (30 kg of live weight). The group of weaning (W) lambs were weaned at 125 days of age and fed on with hay and cereals (47% barley, 53% pressed beet pulp) *ad libitum* in the stable (8 lambs) or were grazing on the pasture (8 lambs) until slaughter (38 kg of live weight and 164 days of age). At slaughter, lambs were weighed on the farm before transportation to the experimental abattoir at the Zootechnical Department at Biotechnical Faculty (40 km). All lambs were slaughtered at consecutive dates by the same procedures. The bodies were skinned; the head and feet were removed. The carcasses were eviscerated and the internal organs were weighed. All body components such as head, skin, kidneys, liver, heart, lungs and spleen were weighed and classified in terms of their respective percentage with respect to live weight of the animal. Hot carcass weight (HCW) and hot dressing percentage (DP) including kidneys and pelvic fat were determined. Carcass conformation and fatness were subjectively scored according to the Slovenian regulation for grading and classifying carcasses of sheep and lambs (Rules…, 2001), which is in agreement with the European regulations (Council Regulation…, 1994). The temperature and pH of the carcasses 45 min and 24 h after slaughter in the *Longissimus dorsi* muscle behind the last rib were measured using a pH-meter equipped with a penetrating electrode. Carcasses were then chilled at 4°C for 24 h in conventional chiller. The cold carcass weight (CCW) was measured after 24 h. After the chilling, carcass length (CL), leg width (LW) and shoulder width (SW) were measured. Carcass length was recorded from the cranial edge of the symphysis pelvis to the cranial edge of the first rib. Leg and shoulder width were defined as the greatest width of leg or shoulder, measured in a horizontal plane on the hanging carcass. Meat colour was measured as triplicate on the cross section of *Longissimus dorsi* muscle after 30 min of exposure to the air by chromo meter (Minolta CR 300) and expressed as CIE L*a*b* values. After the removal of kidneys and kidney fat, carcasses were further separated into seven joints: neck, chuck, back, loin, shoulder, leg and rib with flank (Figure 1).



1 – Neck
2 – Chuck
3 – Back
4 – Loin
5 – Rib with flank
6 – Leg
7 – Shoulder
CL – Carcass length

Figure 1. Lamb carcass cuts

The weight of each cut was recorded and expressed as the percentage of CCW. The right leg was further dissected in order to separate muscle, fat and bone tissues. The weight of kidney fat and kidney was recorded and expressed as the proportion to CCW.
The data were analyzed using the GLM procedure of SAS (1990). Effects of production system (PS_i) and weaning (W_j) as fixed effects, were included in the model. Interaction between production system and weaning was not statistically significant; therefore it was excluded from the model.

RESULTS AND DISCUSSION

The average live weight of stable and pasture lambs was 34 kg. The basic statistical data showed that at 34 kg live weight at slaughter stable lambs were younger (137 days) than pasture lambs (152 days), but daily gain from birth to slaughter was not statistically different between production systems. Suckling lambs were slaughtered at 30 kg average live weight (125 days of age) and weaned lambs at 38 kg average live weight (165 days of age).

Least-squares means for growth, dressing percentage, conformation and fatness grading and measurements of carcass length, leg and shoulder width are presented in Table 1. No significant differences in daily gain and dressing percentage from birth to slaughter comparing the production system or weaning were observed. Stable lambs displayed significantly greater fatness than lambs raised on pasture, as indicated by the percentage of kidney fat (1.99 vs. 1.16). Moron-Fuenmayor and Clavero (1999) reported higher dressing percentage in lambs fed concentrates in comparison with the non-supplemented group of lambs reared on pasture and slaughtered at 20 kg of live weight. They also reported higher percentage of internal and external fat deposits in lambs fed concentrates confirming our results. Diaz et al. (2002) compared pasture and sheepfold lambs, both fattened with concentrate after weaning and slaughtered at 26 kg of live weight. In their study they found out significantly greater fatness in sheepfold lambs than in pasture lambs and also more dorsal fat thickness, higher quantity of kidney knob and channel fat. The experiment where the effect of feeding system, genotype and slaughter weight was investigated (Santos-Silva et. al, 2002) approved our results. Lambs of two genotypes raised on pasture and slaughtered at 24 kg showed a higher proportion of carcasses graded in fatness class 1, pasture lambs slaughtered at 30 kg had higher fatness score, with most of carcasses included in class 2. Carcass length and leg width were greater in pasture lambs than in stable lambs. Weaning had a significant effect on carcass fatness, carcass conformation and CL, LW and SW. Weaning lambs had greater values of carcass fatness and carcass conformation. They had longer carcasses and wider leg and shoulder than suckling lambs as expected because of greater age and slaughter weight.

Table 1. Carcass traits of experimental lambs (least square means ± SEE)

Variables	Production system (PS)		Weaning (W)		Significance	
	Stable (S)	Pasture (P)	Suckling lambs (SU)	Weaning lambs (W)	PS	W
N	16	16	16	16		
Slaughter weight (kg)	34	34	30	38		
Hot carcass weight (kg)	14.71 ± 0.25	15.11 ± 0.25	13.15 ± 0.28	16.67 ± 0.28	ns	***
Cold carcass weight (kg)	14.81 ± 0.28	15.24 ± 0.28	13.22 ± 0.28	16.82 ± 0.28	ns	***
Daily gain (g/day)	219.26 ± 11.80	206.41 ± 11.80	221.01 ± 11.80	204.66 ± 11.80	ns	ns
Dressing percentage (%)	43.06 ± 0.45	44.32 ± 0.45	44.02 ± 0.45	43.36 ± 0.45	ns	ns
Carcass fatness score	6.87 ± 0.22	4.31 ± 0.22	4.94 ± 0.22	6.25 ± 0.22	***	**
Pelvic fatness score	6.31 ± 0.30	3.68 ± 0.30	4.06 ± 0.30	5.94 ± 0.30	***	***
EUROP conformation	7.75 ± 0.20	8.00 ± 0.20	7.56 ± 0.20	8.19 ± 0.20	ns	*
Carcass length-CL (cm)	59.77 ± 0.38	62.11 ± 0.38	58.72 ± 0.38	63.15 ± 0.38	**	***
Leg width-LW (cm)	20.51 ± 0.20	21.21 ± 0.20	20.05 ± 0.19	21.66 ± 0.19	*	***
Shoulder width-SW (cm)	18.71 ± 0.22	19.00 ± 0.22	17.95 ± 0.22	19.76 ± 0.22	ns	***

Carcass fatness score: 5+=15, 5_0=14, 5-=13, …1+=3, 1_0=2, 1-=1; EUROP-conformation: E+=15, E_0=14, E-=13, …P+=3, P_0=2, P-=1; *P≤0.05. **P<0.01. ***P<0.001. ns P>0.05

Vergara and Gallego (1999) examined the effect of the type of suckling and length of lactation period in three groups of lambs slaughtered at 24 kg of live weight (from 12 kg live weight all the lambs had commercial concentrate offered *ad libitum* until slaughter). Carcasses of unweaned lambs had greater fatness score and greater weight of pelvic fat than weaned lambs at 35 days. The authors concluded that greater fatness in unweaned lambs had been associated with a higher dressing proportion and possibly related to the fact that the rumens of milk fed lambs are relatively underdeveloped.

Pasture lambs had carcasses with higher percentage of liver, heart and spleen in comparison to stable lambs (Table 2). Visceral organ size turned out to be affected by the level of feed intake (Fluharty et al., 1999, Moron Fuenmayor and Clavero, 1999, Drouillard, 1991, Fluharty and McClure, 1997). To determine the effect of diet source (pasture alfalfa vs. concentrate) Fluharty et al. (1999) found out that lambs grazed on alfalfa had greater liver, omasum, abomasums, small and large intestine weights than lambs fed the concentrate diet. Contrary to the present experient Moron Fuenmayor and Clavero (1999) found greater percentage of liver in supplemented lambs than in those grazing on pasture. It was reported that liver weights can be decreased with nutrient restrictions. The result of Drouillard et al. (1991) suggests that mechanisms involved in reducing total energy expenditure of liver tissue may differ under conditions of dietary protein and energy restriction. The maintenance of energy requirements can be attributed to the visceral organs, especially the liver and were associated with the high rates of protein synthesis in these tissues. High (125 %) protein diets of lambs slaughtered at 36 kg of live weight, resulted in greater weights and faster accretion rates of liver and kidney compared with normal (100 %) protein intake (Fluharty and McClure, 1997). Greater proportion of liver weights in pasture lambs of the present study can be attributed to the greater protein and energy intake on pasture. Weaning had significant effect on all non-carcass components. Greater proportion of liver, lungs, heart, spleen and head was found in suckling lambs. The proportion of pelt was greater at weaned lambs as expected because of higher slaughter weight.

Table 2. Percentages of non-carcass components of experimental lambs (least square means ± SEE)

Non-carcass components	Production system (PS)		Weaning (W)		Significance	
	Stable (S)	Pasture (P)	Suckling lambs (SU)	Weaning lambs (W)	PS	W
N	16	16	16	16		
Slaughter weight (kg)	34	34	30	38		
Liver (%)	1.38 ± 0.03	1.77 ± 0.03	1.68 ± 0.03	1.48 ± 0.03	***	***
Lungs (%)	1.78 ± 0.04	1.72 ± 0.04	1.91 ± 0.04	1.60 ± 0.04	ns	***
Heart (%)	0.45 ± 0.01	0.54 ± 0.01	0.52 ± 0.01	0.48 ± 0.01	***	*
Spleen (%)	0.17 ± 0.01	0.21 ± 0.01	0.21 ± 0.01	0.17 ± 0.01	**	*
Head (%)	5.36 ± 0.08	5.43 ± 0.08	5.52 ± 0.08	5.27 ± 0.08	ns	*
Pelt (%)	9.38 ± 0.24	9.55 ± 0.24	9.40 ± 0.24	9.53 ± 0.24	ns	**

*P<0.05. **P<0.01. ***P<0.001. ns P>0.05

Means for the proportion of the shoulder, back, loin, rib and flank, leg and leg composition shown in Table 3 indicate that significant differences between production systems were found. Pasture lambs had greater shoulder and leg values than stable lambs. Stable lambs had greater back, loin and rib and flank values. The results of the dissection of the leg had shown higher muscle and lower fat values in the pasture lambs. There were no significant differences between production systems in leg-bone tissue proportion. In similar experiment (Diaz, 2002) production system did not affect the proportion of muscle or bone in leg, but influenced fat which was greater in sheepfold lambs than in lambs raised on pasture. Weaning had no affect on major cuts, except on rib and flank and leg. Suckling lambs had lower values for rib and flank and higher values for leg. Weaned lambs showed higher fat proportion in leg than suckling lambs. Summers et al. (1978) investigated the effects of weaning and feeding systems in lambs slaughtered at 45 kg of live weight. They found similar proportions for leg, loin, rack, neck and shoulder between weaned-pasture-concentrate and unweaned-pasture-concentrate lambs. They also found higher values for breast and flank and kidney fat in unweaned-pasture-concentrate lambs.

Table 3. Carcass cuts of experimental lambs (least square means ± SEE)

Variables	Production system (PS)		Weaning (W)		Significance	
	Stable (S)	Pasture (P)	Suckling lambs (SU)	Weaning lambs (W)	PS	W
n	16	16	16	16		
Slaughter weight (kg)	34	34	30	38		
Cold carcass weight	14.81 ± 0.28	15.24 ± 0.28	13.22 ± 0.28	16.82 ± 0.28	ns	***
Kidney (%)	0.72 ± 0.03	0.74 ± 0.03	0.80 ± 0.03	0.66 ± 0.03	ns	**
Kidney fat (%)	1.99 ± 0.14	1.16 ± 0.14	1.23 ± 0.14	1.92 ± 0.14	**	**
Neck (%)	7.76 ± 0.09	7.73 ± 0.09	7.73 ± 0.09	7.75 ± 0.09	ns	ns
Chuck (%)	3.61 ± 0.09	3.79 ± 0.09	3.83 ± 0.09	3.58 ± 0.09	ns	ns
Shoulder (%)	17.95 ± 0.17	19.02 ± 0.17	18.70 ± 0.17	18.27 ± 0.17	***	ns
Back (%)	8.2 ± 0.10	7.75 ± 0.10	7.95 ± 0.10	8.00 ± 0.10	**	ns
Loin (%)	9.38 ± 0.14	8.90 ± 0.14	9.06 ± 0.14	9.21 ± 0.14	*	ns
Rib and flank (%)	20.74 ± 0.17	19.16 ± 0.17	19.61 ± 0.17	20.29 ± 0.17	***	*
Leg (%)	29.39 ± 0.24	31.24 ± 0.24	30.75 ± 0.24	29.88 ± 0.24	***	*
Leg composition:						
-muscle (%)	69.38 ± 0.43	71.30 ± 0.43	70.46 ± 0.43	70.22 ± 0.43	**	ns
-fat (%)	10.73 ± 0.40	8.24 ± 0.40	8.66 ± 0.40	10.31 ± 0.40	***	*
-bone (%)	19.89 ± 0.30	20.46 ± 0.30	20.88 ± 0.30	19.47 ± 0.30	ns	*

*P<0.05. **P<0.01; ***P<0.001; ns P>0.05

Variables of meat colour are presented in Table 4. Production system affected meat color so that lambs from pasture had higher CIE L*, a* and b* values of *Longissimus dorsi* muscle. Moron-Fuenmayor and Clavero (1999) found slightly darker red muscle colour of lambs fed concentrates (6.0) while the colour of pasture lambs (7.2) was cherry red (scale from 1=dark purple to 8 very light cherry red).

Table 4. L*, a*,b* values of *Longisimus dorsi* of experimental lambs (least square means ± SEE)

Variables	Production system (PS)		Weaning (W)		Significance	
	Stable (S)	Pasture (P)	Suckling lambs (SU)	Weaning lambs (W)	BT	W
N	16	16	16	16		
CIE L*	38.52 ± 0.48	39.88 ± 0.48	39.87 ± 0.48	38.53 ± 0.48	*	*
a*	17.55 ± 0.33	19.55 ± 0.33	18.14 ± 0.33	18.96 ± 0.33	**	ns
b*	5.99 ± 0.19	7.66 ± 0.19	6.86 ± 0.19	6.79 ± 0.19	***	ns
pH45	6.44 ± 0.05	6.40 ± 0.04	6.47 ± 0.05	6.38 ± 0.05	ns	ns
pH24	5.63 ± 0.02	5.64 ± 0.02	5.68 ± 0.02	5.60 ± 0.02	ns	*

*P<0.05; **P<0.01; ***P<0.001; ns P>0.05

Suckling lambs had lighter meat colour (39.87) compared to weaned lambs (38.53). Vergara and Gallego (1999) concluded that values from L* increased when lambs stayed longer with their mothers. However, red index (a*), yellow index (b*) and pH45 did not vary with weaning.

CONCLUSION

The following differences between production systems were established. Pasture lambs displayed significantly lower carcass and internal fatness, and lower leg-fat content than stable lambs, when slaughtered at 34 kg. Pasture lamb carcasses were longer and wider and had greater percentage of shoulder and leg. Meat colour of pasture lambs tended to be more red, yellow and lighter in colour. No significant differences in daily gain and dressing percentage from birth to slaughter comparing the production systems or weaning were observed.

Weaned lambs had greater values of carcass fatness and carcass conformation. They had longer carcasses and wider leg and shoulder than suckling lambs as expected because of greater age and slaughter weight. They showed higher fat proportion in leg, higher rib and flank and lower leg values. Meat from suckling lambs tended to be lighter in colour.

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