The Effect of Live Weight at Slaughter and Sex on Lambs Carcass Traits and Meat Characteristics

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SUMMARY

Twenty-eight (12 male and 16 female) of improved Jezersko-solčava lambs with Romanov (JSR) were used to evaluate the effect of live weight and sex on carcass traits and meat quality. Lambs were weaned at around 60 days of age. They were fed with commercial concentrate and hay ad libitum and slaughtered at 29 kg or 43 kg of average live weight at 105 or 126 days of age. Daily gain from birth to slaughter was higher than 300 g/day and was very similar for both groups. There were no differences between light and heavy lambs in carcass conformation and dressing percentage. Heavy lambs were longer, wider and fatter. The difference in lungs, head and pelt percentage were statistically significant. With increased live weight at slaughter the percentage of neck, back and rib with flank increased and chuck, shoulder and hindleg decreased. Muscle percentage in hindleg increased and bone percentage decreased as live weight increased. Considering meat quality, heavier lambs had lower lightness and higher redness. Lighter lambs had higher pH_{45} value. Differences between sexes were statistically significant for dressing percentage and carcass fatness with higher values for females. Males had higher percentage of liver and head, higher proportion of neck, chuck and shoulder and lower proportion of back and loin. Males tended to have higher values for muscle and bone proportion, and lower proportion of fat in hindleg. Males had lighter meat. Sex had no effect on pH values.

KEY WORDS

lamb, live weight, sex, carcass characteristic, meat quality

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INTRODUCTION

In Slovenia two different types of sheep production prevail; milk and meat production system. Sucklers and light lambs come from dairy sheep breeders located mainly in the West half of Slovenia (Karst, Istria, Bovec). Early weaning is characteristic for dairy breed. The lambs are traditionally sold as sucklers for slaughter (Cividini, 2001).

North and North-East part of Slovenia (Jezersko, Solčava, Savinjska valley) is convenient for meat sheep breeds. Traditionally the lambs of autochthonous Jezersko-solčava breed (JS) and Jezersko-solčava sheep improved with Romanov breed (JSR) stay with their mothers on the pasture until slaughter at about 30 kg live weight. Recently there is also a tendency for additional fattening of lambs after weaning. JSR lambs are then slaughtered at much higher weight (40-45 kg). JSR breed is known as very fertile breed (Cividini et al., 2002), but on the other hand its carcass quality is not well known.

Erjavec et al. (2002) reported that ovine meat consumption per capita increased from 0.6 kg in year 2000 to 0.8 kg per capita in year 2002, which is still very low. This is presumably due to low lamb meat offer on the meat market which is on the other hand the result of inconstancy of lamb production because of small flocks and variable carcass quality.

A great number of factors affect ovine carcass and meat quality (Sanudo et al., 1998, Alfonso et al., 2001) and presumably influence consumer appreciation. Alfonso et al. (2001) report that intrinsic and productive factors exert their influence mainly on carcass quality. Carcass quality is also effected by the breeder and his choice of animal genotype (Hawkins et al., 1985) and breeding technology (Santos-Silva et al., 2002, Diaz et al., 2002). However, pre- and post-slaughter factors and marketing factors principally affect meat quality and can be controlled by the breeder and abattoir (Sanudo et al., 1998).

Therefore the aim of the following research was to compare carcass traits and meat characteristics of improved Jezersko-solčava lambs at different live weight or age and to evaluate the effect of sex on these traits.

MATERIAL AND METHODS

Animals

In the experiment 28 lambs (12 males and 16 females) improved Jezersko-solčava lambs (JSR) were included. All lambs were from a single flock, reared on the farm where they were born, until slaughter. The trial was conducted from September to March. Lambs were reared with their dams on the pasture up to the age around 60 days (about 20 kg live weight), when they were weaned. From 10 days of age, the lambs were fed with commercial concentrate (18% crude proteins, 8% crude fibrins) and hay ad libitum until slaughter. Lambs were weighed once a month, until they reached the planned slaughter weight of around 29 and 43 kg.

Slaughter

On slaughter day, lambs were weighed on the farm before transportation to the experimental abattoir at the Zootechnical Department at Biotechnical Faculty in Domžale (50 km). All lambs were slaughtered at two consecutive dates by the same procedures. After slaughter, hot carcass weight (HCW) and weight of head, pelt, liver, lungs, hearth and spleen were determined. HCW was defined as weight of the whole carcass of each animal after bleeding, removing entrails, head, pelt, forefeet, hindfeet, tail, udder, genitalia, liver, heart and lungs. Kidney with knob channel fat belongs to the carcass. Carcass conformation and fatness classes were subjectively scored according to the Slovenian regulation for grading and classifying carcasses of sheep and lambs (Pravilnik …, 2001), which is in agreement with the European regulations (Council Regulation…, 1994). pH was measured at 45 min and 24 h after slaughter in the Longissimus dorsi muscle behind last rib using a pH-meter equipped with a penetrating electrode. Carcasses were kept at room temperature for 2 h, and where then chilled at 4°C for 24 h in conventional chiller. After chilling cold carcass weight (CCW), carcass length (CL), leg width (LW) and shoulder width (SW) were measured. 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. Carcass length was recorded from the cranial edge of the symphysis pelvis to the cranial edge of the first rib. Leg width and shoulder width were defined as the greatest width of leg or shoulder, measured in a horizontal plane on the hanging carcass. After removal of kidney

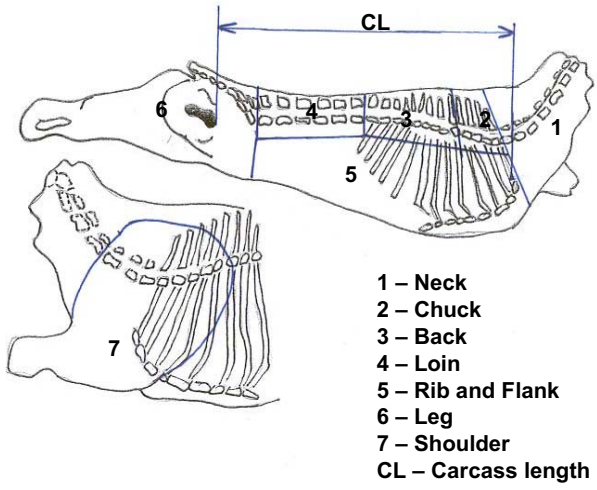

Figure 1. Lamb carcass cuts.

fat, carcass was further separated into seven joints: neck, chuck, back, loin, shoulder, leg and rib with flank (Figure 1).

The weight of each joint was recorded and expressed as percentage of CCW. Right leg was further dissected into muscle, subcutaneous fat and bone.

Statistical analysis

Data were analyzed using the GLM procedure of SAS (1990). Effects of live weight (W_i), sex (S_j) and interaction between live weight and sex as fixed effects were included in the model. Interaction between live weight and sex was not statistically significant, so it was excluded from the model.

RESULTS AND DISCUSSION

Some basic statistical data are presented in Table 1. The mean slaughter weight of light lambs was 29.5 kg and of heavy lambs 43.4 kg. Heavy lambs were slaughtered 3 weeks than light lambs. Daily gain from birth to slaughter was higher than 300 g/day and was very similar for both groups. Male and female lambs had similar weight at slaughter, but male lambs grew faster and were younger at slaughter than female lambs.

Non-carcass components

With increased live weight percentage of liver, lungs, heart and spleen decreased, but only the difference in lungs percentage was statistically significant ($p<0.05$). The percentage of head also decreased and of pelt increased ($p<0.05$).

Sex effected only liver and head percentage, with male lambs having higher percentage. Zygoyiannis et al. (1990) and Carson et al. (1999) also found that sex of lamb had no effect on the weights of any recorded non-carcass components.

Carcass characteristics

With increased live weight carcass weight, length, shoulder and leg width and carcass fatness increased, while carcass conformation and dressing percentage did not change. No difference in dressing percentage from lambs at 24 and 30 kg live weight was found by Santos-Silva et al. (2002).

Differences between sexes were statistically significant just for dressing percentage and carcass fatness ($p<0.05$), with female animals having higher dressing percentage and fatness score. Higher carcass fatness in females was also found by Vergara & Gallego (1999).

Carcass cuts

Mean values for the proportion of different carcass cuts and tissue composition of hindleg are presented in Table 4. With increased live weight at slaughter the percentage of neck ($p=0.095$), back and rib with flank ($p<0.05$) increased and chuck ($p=0.082$), shoulder and hindleg ($p<0.05$) decreased. Lean ($p=0.068$) percentage in hindleg increased and bone percentage ($p<0.05$) decreased as live weight increased. Fahmy

Table 1. Average values and standard deviations for birth weight, slaughter weight, age at slaughter and daily gain from birth to slaughter in improved Jezersko-solčava lambs.

Lambs		Birth weight (kg)	Slaughter weight (kg)	Age at slaughter (days)	Daily gain from birth to slaughter (g/day)
Light	$\bar{X}$	4.6	29.5	105	321
	SD	0.6	1.7	28	58
Heavy	$\bar{X}$	4.2	43.4	126	316
	SD	0.6	5.0	18	57
Male	$\bar{X}$	4.4	37.0	97	340
	SD	0.6	9.0	26	67
Female	$\bar{X}$	4.4	37.8	111	307
	SD	0.6	7.4	30	48

Table 2. Effect of live weight and sex on non-carcass components in improved Jezersko-solčava lambs (LSMeans ±SEE).

Non-carcass components (%)	Live weight (W) Light (N= 12)	Heavy (N = 16)	Sex (S) Male (N=12)	Female (N=16)	P values for W	S
Liver	2.16 ± 0.05	2.09 ± 0.04	2.20 ± 0.05	2.06 ± 0.04	0.303	0.043
Lungs	2.18 ± 0.09	1.93 ± 0.08	2.06 ± 0.09	2.04 ± 0.08	0.047	0.852
Heart	0.50 ± 0.02	0.43 ± 0.01	0.46 ± 0.02	0.44 ± 0.01	0.089	0.179
Spleen	0.17 ± 0.005	0.18 ± 0.006	0.16 ± 0.01	0.16 ± 0.01	0.307	0.619
Head	4.94 ± 0.09	4.39 ± 0.08	4.97 ± 0.09	4.36 ± 0.08	<0.000	<0.000
Pelt	8.38 ± 0.25	9.40 ± 0.22	8.85 ± 0.25	8.93 ± 0.22	0.005	0.819

Table 3. Effect of live weight and sex on carcass characteristics in improved Jezersko-solčava lambs (LSMeans ±SEE).

	Live weight (W)		Sex (S)		P values for	
Carcass traits	Light	Heavy	Male	Female	W	S
DP (%)	45.7 ± 0.4	46.1 ± 0.5	44.8 ± 0.5	47.0 ± 0.4	0.542	0.004
HCW (kg)	13.5 ± 0.6	20.1 ± 0.5	16.6± 0.6	16.9 ± 0.5	<0.001	0.708
EUROP-conformation	3 ± 0	3 ± 0	3.0 ± 0	3.0 ± 0	-	-
EUROP-fatness	3.0 ± 0.1	3.4 ± 0.1	3.0 ± 0.1	3.4 ± 0.1	0.013	0.013
CL (cm)	58.6 ± 0.8	66.2 ± 0.7	62.8 ± 0.8	62.1 ± 0.7	<0.001	0.549
LW (cm)	17.9 ± 0.5	22.2 ± 0.4	20.0 ± 0.5	20.2 ± 0.4	<0.001	0.818
SW (cm)	15.1 ± 0.3	18.2 ± 0.3	17.0 ± 0.3	16.3 ± 0.3	<0.001	0.060

HCW: hot carcass weight; DP: Dressing percentage; EUROP-conformation: E=5, U=4, R=3, O=2, P=1; CL: Carcass length; LW: Leg width; SW: Shoulder width

Table 4. Effect of live weight and sex on percentage of carcass cuts in improved Jezersko-solčava lambs (LSMeans ±SEE).

	Live weight (W)		Sex (S)		P values for	
Carcass cuts	Light	Heavy	Male	Female	W	S
CCW[1] (kg)	13.00± 0.6	19.55 ± 0.5	16.1 ± 0.6	16.4 ± 0.5	<0.001	0.672
Kidney (%)	0.88 ± 0.03	0.81 ± 0.03	0.87 ± 0.03	0.82 ± 0.03	0.146	0.334
Kidney fat (%)	2.15 ± 0.27	2.50 ± 0.24	1.45 ± 0.27	3.19 ± 0.24	0.3386	<0.001
Neck (%)	6.05 ± 0.20	6.52± 0.20	7.00 ± 0.20	5.57 ± 0.20	0.095	<0.001
Chuck (%)	7.78 ± 0.15	7.41 ± 0.13	7.98 ± 0.15	7.21 ± 0.13	0.082	0.001
Shoulder (%)	18.10 ± 0.20	16.40 ± 0.17	17.59 ± 0.20	16.91 ± 0.17	<0.001	0.015
Back (%)	6.72 ± 0.11	7.57 ± 0.10	6.76 ± 0.11	7.52 ± 0.10	<0.001	<0.001
Loin (%)	7.33 ± 0.21	7.74 ± 0.20	7.20 ± 0.21	7.88 ± 0.19	0.170	0.024
Rib and flank (%)	19.09 ± 0.32	20.19 ± 0.28	19.56 ± 0.32	19.71 ± 0.28	0.016	0.722
Hindleg (%)	31.90 ± 0.30	30.90 ± 0.27	31.58 ± 0.30	31.18 ± 0.27	0.018	0.340
			Hindleg composition, %			
-muscle	70.38 ± 0.80	72.43 ± 0.71	72.28 ± 0.80	70.53 ± 0.71	0.068	0.115
-fat	5.66 ± 0.72	6.44 ± 0.64	4.24 ± 0.72	7.86 ± 0.64	0.424	0.001
-bone	23.96 ± 0.33	21.13± 0.29	23.48 ± 0.33	21.61 ± 0.29	0.001	<0.001

[1]CCW: cold carcass weight

(1997) reported that the proportion of loin cut tended to increase, the proportion of hindleg decrease, whereas the proportion of shoulder varied within a narrow range.

Female lambs were fatter than male lambs as indicated by external fat estimation and kidney fat. Sex affected also the proportion of neck, chuck, shoulder, back and loin ($p<0.05$). Males had higher proportion of neck, chuck and shoulder and lower proportion of back and loin. The composition of hindleg showed that males tended to have higher values for muscle ($p=0.115$) and bone proportion ($p=0.001$), and lower proportion of fat ($p<0.01$). Similar results were found by Hawkins et al. (1985).

Meat quality

Considering meat quality traits, live weight at slaughter had a significant effect on pH24, L* and b* value of meat colour (Table 5). Lighter lambs had higher pH45 values. This could be a consequence of higher stress. Since the weight groups of lambs were slaughtered at different dates, this could be also important effect on post mortem course of the glycolysis. Heavier lambs had lower lightness and higher redness. Similar results were published by Sanudo et al. (1996) and Santos Silva et al. (2002).

Sex had no effect on pH values but effected L* value. Male lambs had lighter meat than female lambs. The differences in meat color between sexes in L* values could be due to the fact that male lambs grew faster and were younger at similar live weight. No sex effect on meat color was also found by Horcada et al. (1998), Vergara & Gallego (1999), Vergara et al. (1999) and Sanudo et al. (1998). The average pH_{45} was 6.15 and pH_{24} 5.5, which is characteristic for normal course of post mortem glycolisis. Similarly Horcada et al. (1998) and Sanudo (1998[a]) found no differences in pH values.

CONCLUSIONS

An increase of live weight at slaughter from around 30 to 43 kg affected carcass and meat quality in Jezersko-solčava lambs. Heavier lambs had lower proportion of more valuable cuts, but at the same time the tissue composition of hindleg was favourable with higher lean meat percentage and lower percentage of bone.

Table 5. Effect of live weight and sex on meat colour estimates and pH values in improved Jezersko-solčava lambs (LSMeans ±SEE).

	Live weight (W)		Sex (S)		P values for	
Meat quality traits	Light	Heavy	Male	Female	W	S
pH_{45}	6.33 ± 0.04	6.23 ± 0.04	6.26 ± 0.04	6.30 ± 0.04	0.135	0.497
pH_{24}	5.71 ± 0.02	5.50 ± 0.02	5.62 ± 0.02	5.59 ± 0.02	<0.001	0.262
CIE L*	40.82 ± 0.40	39.68 ± 0.35	41.48 ± 0.40	39.02 ± 0.35	0.043	<0.001
a*	17.24 ± 0.28	18.41 ± 0.25	18.04 ± 0.28	17.61 ± 0.25	0.005	0.272
b*	7.01 ± 0.22	7.31 ± 0.19	7.37 ± 0.22	6.94 ± 0.19	0.314	0.157

Meat colour from lighter lambs was more desirable with higher lightness and lower redness.

Sex mainly influenced fat deposition, with female animals having higher carcass fatness score, and higher proportion of kidney fat. They also had higher percentage of fat and lower percentage of muscle and bone in hindleg.

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