

THE SENSORY QUALITY OF LAMB MEAT PRODUCED IN DIFFERENT REARING SYSTEMS OF AUTOCHTHONOUS JEZERSKO-SOLCAVA SHEEP BREED

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Original scientific paper

Abstract: The sensory quality of *Longissimus dorsi* (LD) of 32 Jezersko-Solčava lambs was compared between rearing systems (pasture vs. stable) and weaning system (suckling vs. weaned). The sex effect and interaction between rearing system and weaning was also determined. Sixteen lambs (8 males, 8 females) were grazing on mountain pasture (A) and received no food supplementation. The other half (8 males, 8 females) were fattening in stable with hay and cereals *ad libitum* (B). Eight pasture lambs and eight stable lambs stayed with their dams until slaughter and named suckling lambs (1). The other 8 lambs from the pasture and 8 lambs from the stable formed weaned group (2). Pasture and stable lambs were slaughtered at the same live weight (34 kg). Suckling lambs were slaughtered on weaning day at average 30 kg of live weight. Weaned lambs were slaughtered at average 38 kg of live weight. The rearing system affected only meat tenderness with better tenderness in pasture lambs. Meat from weaned lambs was tendered and redder than suckling lambs. The LD of females was redder than male meat. Interaction between rearing system and weaning was statistical significant for meat tenderness, flavour, sheep flavour and odour. Panellists considered meat from weaned lambs on the pasture to have the stronger flavour and odour and the tenderest meat with no sheep meat flavour. Meat from suckling lambs on the pasture had the most pronounced sheep meat flavour. Weaned lambs on pasture had stronger odour but tendered meat than weaned lambs in stable.

Key words: lamb meat, rearing system, weaning, sensory quality

Introduction

In the last few years, the number of sheep is increasing in Slovenia. It is important that consumption of lamb meat in Slovenia has increased from 0,3 kg in

year 2003 to 0,95 kg per capita in year 2005 (*Pintar et al., 2006*). In Slovenia lamb meat is still very rarely as consumption meat in comparison to other European countries. Nevertheless it acquires importance like quality food and culinary speciality. These consumption patterns indicate that Slovenians continue to consume lamb meat but also demand better meat quality. Meat quality is a generic term used to describe properties and perceptions of meat. The consumer is the goal of the production chain of lambs, so the production must give good meat quality, acceptable for the consumer. The most important factors that influence acceptability of lamb meat are aroma, flavour, odour, juiciness and tenderness. One of the main sheep breeds in Slovenia, Jezersko-Solčava breed is raised with different rearing system in the autochthonous region – Jezersko, Solčava, Logarska valley depending on weaning system and mating season or lambing month. When lambing occur in late spring or early summer (April, May, June) lambs are grazing with their dams on the pasture till they reach 25 to 30 kg, when they are slaughtered. 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. Breeders often combine both rearing systems when lambing occurs in early spring. In this case lambing stays first with their dams in the stable and fattening with hay and cereals and than finishing on the pasture. These production systems differ in type of diet and weaning. However, lamb carcasses and meat quality may vary according to the rearing system (*Diaz et al., 2002*). For this purpose evaluation of sensory traits of lamb meat between rearing on the pasture and fattening in the stable was compared. We tested the differences between weaned and suckling lambs. Our study compares also the effect on sensory quality of interaction between rearing system and weaning. Thus, we compared suckling lambs on the pasture, suckling lambs in the stable, weaned lambs on the pasture and weaned lambs in the stable. In previously paper we report the effect of production system on carcass characteristics. However, the effect of type of rearing systems on sensory traits has not been assessed yet in this breed. This research might also be helpful for sheep breeders to find the way of rearing which give the acceptable lamb flavour, odour, juiciness and tenderness for the consumers.

Materials and Methods

A total of 32 Jezersko-solčava lambs were used to evaluate the sensory quality of *Longissimus dorsi* (LD). Half of them (8 males, 8 females) were reared on the mountain pasture (A) at 1200 m above sea level. The other half (8 males, 8 females) were reared in the stable (B). Lambs were born on the farm and stayed there until slaughter. At the age of 10 days hay and cereals (47% barley, 53 % pressed beet pulp) were offered to stable lambs *ad libitum*. Pasture lambs were only grazing, and received no feed supplementation. Pasture and stable lambs were

slaughtered at 34 kg of live weight. The contents of pasture grass were 29.07 g/kg crude proteins, 3.05 g/kg crude lipids and 47.81 g/kg crude fibrins. The estimation of botanical composition of pasture was 50 % of grass, 30 % of herbs and 20% of leguminous. Suckling (1) lambs (8 stable and 8 pasture lambs) were slaughtered at 125 days of age (30 kg of slaughter weight). The group of weaned (2) 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 (164 days of age, 38 kg of slaughter weight). All lambs were slaughtered at consecutive dates by the same procedures. At slaughter, lambs were weighing on the farm before transportation to the experimental abattoir at the Zootechnical Department at Biotechnical Faculty (40 km). The LD of all lambs was taken 24 h post mortem from loin (cut between 3rd and 6th lumbar vertebra) of each carcass. The LDs were vacuum packaged in PVC bags and frozen after 3 days ageing at 4°C. Before analysis samples were thawed overnight at 4°C. Meat colour was sensorial evaluated on the freshly cut surface of the chilled raw samples on a 7-point scale. The sensorial traits were evaluated on heated samples in an oven at 175°C to 75°C internal temperature. Four panellists were asked to assess tenderness, juiciness, flavour and odour and sheep meat flavour and odour on a 7-point scale, with intensity increasing from 1 to 7. Shear force was measured on 1 cm thick LD muscle with Instron instrument, type 1111. We used 10 mm long cutter, diameter of cutter was 1 mm and angle of cutter 60°. The speed of vertical movement of the cutter was 5 cm/min; the deep of cutting was 9.4 mm. The measuring values were in Newton (N). The data were analyzed using the mixed procedure of SAS (1990). The model included fixed effects ascribed to rearing system (R_i), weaning (W_j), sex (S_k) and rearing system x weaning interaction. Interaction between weaning and sex and production system and sex were not statistical significant and so excluded from the model.

Results and Discussion

In Table 1 the effect of rearing system, weaning and sex on sensorial traits and shear force are presented. In comparison of rearing systems there were no significant differences in any sensory traits except in tenderness. The meat of pasture lambs was tendered (5.54) than meat of stable lambs (5.33). The differences were low and both ratings, meat tenderness for pasture and meat tenderness for stable lambs, represented good quality for tenderness. The instrumental measurements of shear force show no statistical differences in meat tenderness between pasture and stable lambs. Study of *Lowe et al. (2002)* indicate that if nutrition is adequate and stress levels are low, there are no differences in meat tenderness of pasture lambs compared with those having feed supplements. *Priolo et al. (2002)* found more tender lamb meat in stall fattening lambs due to

higher intramuscular fat values when compared with pasture lambs. *Vestergaard et al. (2000)* compared bull calves grazing on a roughage-based pasture with intensively-fed housed young bulls slaughtered at 360 kg and 460 kg. Meat of intensively-fed bulls was tenderer than meat of pasture bulls which is contrary to our results. They ascribed their results with positive correlation ($r=0.79$) between myofibril fragmentation index (MFI) at 24 h post mortem and meat tenderness. Lower muscle protein degradation in LD of pasture bulls may have lowered the rate of post mortem tenderization, and have as a result less tender meat of pasture lambs. Contrary to results of *Vestergaard et al. (2000)* and *Aalhus et al. (1991)* found higher muscle protein degradation in meat of exercised compared to control lambs. Meat from exercised lambs was significantly tenderer than meat from control lambs which is in agreement with our results. In present study, tendered meat of pasture lambs can be consequence of greater physical activity of pasture lambs compared with stable lambs as established in study of *Aalhus et al. (1991)*. The meat tenderness is often connecting with antioxidants (*Harris et al., 2001; Rowe et al., 2004*). *Harris et al. (2001)* evaluated increased levels of α -tocopherol in beef through supplemental vitamin E in the diet in combination with injecting steaks with CaCl_2 . They found that beef with increased levels of α -tocopherol exhibited a faster rate of decline of Warner-Bratzler shear force values and faster rate of troponin-T degradation. Tendered meat of pasture lambs in present study may be connected with higher concentration of antioxidants in meat of pasture lambs (grass) than in meat of stable (hay) lambs, but unfortunately not analyzed.

Comparisons between suckling and weaned lambs show that weaning can alter lamb tenderness for more tender. Tendered meat of weaned lambs confirmed lower values for shear force of weaned lambs in comparison with suckling lambs. *Vergara and Gallego (1999)* found opposite results, with more tender and juiciness meat in suckling lambs than in weaned. Meat tenderness is often connected with fat content. First, it accumulates in subcutaneous and intramuscular sites which could provide insulation for muscles against the effect of cold shortening (*Wood et al., 1999*). At high levels of intramuscular fat it is possible that the muscle has a lower resistance to shearing because of the dilution of fibrous protein by soft fat. In present study, weaned lambs have more intramuscular fat and could influence on meat tenderness. Carcasses of weaned lambs were also heavier which could slow the cooling of carcasses. *Veiseth et al. (2004)* found that heavier (35 kg) carcasses had less shortening of sarcomeres and tendered meat than lighter (27 kg) lambs. Thus, higher values of intramuscular fat and heavier carcasses of weaned lambs in present study could lead to slower temperature decline and is a possible explanation for better tenderness.

Weaning influenced meat colour. Lamb meat colour was rated more intense in weaned lambs. Weaned lambs were heavier and older at slaughter than suckling lambs. Hem pigment content is increasing with age at slaughter and

intensifies red colour pigment. Nevertheless, the changes in food intake, like milk to forage and concentrates can affect the meat colour (Tejeda *et al.*, 2008). Milk feeding until slaughter produces paler meat with less pigment in very young animals, but after 4 month of age, milk feeding does not result in significantly paler meat than roughage feeding (Okeudo *et al.*, 1994). Vipond *et al.* (1995) pointed out that grazing suckling animals would be highly beneficial. In general, an improved sensorial quality of the meat has been described in milk-fed animals but the differences are small.

The differences between sexes were statistical significant only for meat colour and shear force. Female lambs have intensively red coloured meat than male lambs. Sañudo *et al.* (1998) found similar results with redder meat of female lambs in comparison with male lambs. In generally, sex has no effect on meat colour (Tejeda *et al.*, 2008; Teixeira *et al.*, 2005). Sex influenced on shear force with lower values for meat of females. Lower values of shear force in present study could be because of higher intramuscular fat content in females. Vergara and Gallego (1999) did not find any differences in shear force between sexes.

Table 1. Means (\pm SE) of sensorial traits, shear force and intramuscular fat content of suckling (1) and weaned (2) lambs both sexes (M, F) subjected to two production system (A, B)

Sensory traits (1 to 7 point scale)	Rearing system (R)			Weaning (W)			Sex (S)			SE
	Pasture (A) sw=34	Stable (B) sw=34	Sig.	Suckling (1) sw=30	Weaned (2) sw=38	Sig.	Male (M) sw=34	Female (F) sw=34	Sig.	
Meat colour	5.23	5.15	ns	4.98	5.40	***	5.05	5.33	***	0.06
Tenderness	5.54	5.33	*	5.33	5.54	*	5.44	5.43	ns	0.06
Juiciness	5.16	5.11	ns	5.07	5.19	ns	5.08	5.19	ns	0.05
Flavour	5.44	5.45	ns	5.41	5.48	ns	5.44	5.44	ns	0.05
Sheep meat flavour	1.91	1.83	ns	1.91	1.82	ns	1.82	1.91	ns	0.06
Odour	5.62	5.51	ns	5.57	5.56	ns	5.58	5.55	ns	0.04
Sheep meat odour	1.90	1.86	ns	1.88	1.87	ns	1.92	1.83	ns	0.06
Instrumental measurement										
Shear force (N)	43.49	41.49	ns	47.94	37.03	***	45.16	39.81	*	1.71
Intramuscular fat content (g/100 g of meat)	2.25	3.45	***	2.49	3.22	**	2.39	3.32	***	0.15

ns: not significant; *, ** and *** indicate significance levels at 0.05, 0.01 and 0.001, respectively; sw (slaughter weight); Meat colour: 1=light, 7=dark; Tenderness: 1=tough, 7=tender; Juiciness, 1=dry, 7=juicy; Flavour: 1=no, 7=intense; Sheep meat flavour: 1=no, 7=abundant; Sheep meat odour: 1=no, 7=abundant

Results of effect of interaction between rearing system and weaning for meat quality variables are presented in Table 2. Differences between groups of

lambs (A1, A2, B1, B2) were statistically significant for meat flavour, sheep meat flavour, meat odour and meat tenderness as sensorial traits and shear force as instrumental measurement of tenderness. Meat of weaned lambs on pasture was the most tender (5.78), followed by meat from suckling lambs in the stable (5.37). Suckling lambs on the pasture and weaned lambs in the stable had the smallest values for meat tenderness (5.30). Thus, weaning and prolongation of grazing lambs on the pasture can improve meat tenderness but not prolongation of fattening in the stable. Instrumental measurement of shear force confirmed the sensorial values of tenderness with the lowest values in weaned lambs on the pasture. Suckling lambs fattening in the stable have lower shear values than suckling lambs grazing on the pasture.

Table 2. Effect of interaction between production system and weaning on sensorial traits and shear force of lamb meat (LS means \pm SE)

Sensory traits (1 to 7 point scale)	Pasture		Stable		S.E.
	Suckling lambs (A1)	Weaned lambs (A2)	Suckling lambs (B1)	Weaned lambs (B2)	
Tenderness	5.30a	5.78b	5.37a	5.30a	0.09
Flavour	5.31a	5.56b	5.50ab	5.41ab	0.07
Sheep meat flavour	2.08a	1.73b	1.75b	1.91ab	0.08
Odour	5.55ab	5.70a	5.59ab	5.42bc	0.06
Instrumental measurement					
Shear force (N)	52.25a	34.73b	43.63c	39.34bc	2.42

a,b,c; means followed by different letters are significantly different at $P < 0.05$

The differences in meat flavour were statistically significant only between suckling and weaned lambs on the pasture. Meat from weaned lambs had intensive meat flavour. Previously the differences of flavour between grazing and concentrate-based fattening lambs have been reported (*Priolo et al., 2002; Fisher et al., 2002; Sañudo et al., 2000*). *Priolo et al. (2002)* found higher values for flavour and sheep meat flavour in meat from lambs grazing on the pasture in comparison with concentrate fed lambs. *Fisher et al. (2002)* and *Sañudo et al. (2000)* compared sensorial traits of lamb meat between various breeds and production systems. They found more intensive lamb meat flavour for every breed when grazing on the pasture in comparison with concentrate fattening lambs. In generally, pasture fed lamb meat is connected with concentration of poly unsaturated fatty acids, especially n-3 poly unsaturated fatty acids, like α -linolenic fatty acid, which is abundant in green leaves of grass (*Webb and O'Neill, 2008*).

Values for sheep meat flavour varied from 1.73 to 2.08 which indicate that there was no explicit sheep meat flavour in meat of any group. The highest value

for sheep meat flavour had suckling lambs and the lowest weaned lambs on the pasture. Statistical significant difference for sheep meat flavour was also between suckling lambs on the pasture and suckling lambs in the stable with higher values for suckling lambs on the pasture. The differences in meat odour were statistical significant only between weaned lambs on the pasture (5.70) and weaned lambs in the stable (5.42).

Conclusion

The results demonstrates that both rearing systems, grazing on the pasture and fattening lambs in the stable with hay, barley and beet pulp produce good quality meat which is acceptable for consumers. The effects of rearing system, weaning and sex in general did not influenced on sensory traits, except meat tenderness and meat colour. However, meat from lambs grazing on the pasture was tendered then meat produced from stable lambs. Weaned lambs had more intensive meat flavour and odour and the tendered meat in comparison with suckling lambs. Sex influenced only meat colour with redder meat in females. Interaction between rearing system and weaning displayed an important effect on sensory traits, especially on flavour, sheep meat flavour, odour and tenderness. The intensity of flavour and odour was increasing with weaning lambs on the pasture and continuing grazing on the pasture until slaughtering. Weaned lambs on the pasture also had the tenderest meat. Nevertheless, weaned lambs had the lowest rating for unpleasant sheep meat flavour. Thus weaning lambs on the pasture can produce meat with some more intensively flavour and odour but the tenderest meat with no sheep meat flavour.

Acknowledgment

This work was supported by the Ministry of Agriculture, Forestry and Food and Ministry of Science and Technology of the Republic of Slovenia.

Senzorni kvalitet mesa jagnjadi proizvedenih u različitim sistemima odgajivanja autohtone jezersko-solčava rase ovaca

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Rezime

U ovom istraživanju ispitivan je uticaj sistema odgajivanja, odbijanja i pola na kvalitet mesa jagnjadi slovenačke autohtone jezersko-solčava rase. Jezersko-

solčava rasa ovaca je točna rasa sa dobrim osobinama plodnosti koja je rasprostranjena u centralnom severnom i severno-zapadnom delu Slovenije. Gaji se tradicionalno u dva odgajivačka sistema zavisno od meseca jagnjenja. Jedan sistem je ispaša na brdskim i planinskim pašnjacima sa majkama do klanja. Neki odgajivači često odbijaju jagnjad i nastavljaju sa njihovom ispašom na pašnjacima. Jagnjad koja su rođena u zimskom periodu tradicionalno ostaju sa majkama u štali do klanja. Od 10 do 14 dana uzrasta jagnjad dobijaju seno i žitarice ili komercijalne koncentrate *ad libitum*. Neki odgajivači odbijenu jagnjad nastavljaju da hrane senom i žitaricama do klanja. Tradicionalna težina pred klanje jagnjadi rase jezersko-solčava je od 30 do 35 kg. Ovi proizvodni sistemi se razlikuju u tipu obroka i da li su jagnjad odbijena ili ne. Poznato je da se klanične karakteristike trupa jagnjadi razlikuju zavisno od sistema odgajivanja (Diaz i sar., 2002). Jagnjad koja su pasla na pašnjaku imaju manje masti na trupu u poređenju sa onima koji su hranjeni koncentratima. Uprkos povećanju populacije ovaca u Sloveniji, u poslednje dve decenije, potrošnja mesa je još uvek veoma mala u odnosu na ostale evropske zemlje. Potrošač je poslednja karika u lancu proizvodnje jagnjadi, prema tome kvalitet mesa mora biti prihvatljiv za potrošača. Najvažniji faktori koji utiču na prihvatljivost jagnječeg mesa od strane potrošača su aroma, ukus, miris, sočnost i mekoća mesa. U ovu svrhu upoređen je senzorni kvalitet *Longissimus dorsi* (LD) 32 jagnjeta jezersko-solčava rase gajenih u različitim sistemima (ispaša vs. štalsko držanje) i sistemima odbijanja (sisančad vs. odbijena jagnjad). Uticaj pola i interakcija između sistema gajenja i odbijanja je takođe određivana. 16 jagnjadi je bilo na ispaši na planinskim pašnjacima (A) i nisu imali nikakvu dopunsku ishranu. Ostala jagnjad je tovljena u štali i hranjena senom i žitaricama *ad libitum* (B). Osam jagnjadi iz pašnjačkog sistema i osam iz štalskog su ostala sa svojim majkama do klanja i nazvana su sisančad (1). Od preostalih 8 iz pašnjačkog sistema i 8 iz štalskog oformljena je grupa odbijene jagnjadi (2). Jagnjad iz pašnjačkog i štalskog sistema su zaklana pri istim težinama (34 kg). Jagnjad - sisančad su zaklana na dan odbijanja sa prosečnom težinom od 30 kg. Odbijena jagnjad su zaklana pri prosečnoj težini od 38 kg. Sistem odgajivanja je uticao samo na mekoću mesa jer je utvrđena bolja mekoća mesa jagnjadi iz pašnjačkog sistema. Meko meso jagnjadi iz pašnjačkog sistema može biti posledica veće fizičke aktivnosti ove jagnjadi u poređenju sa jagnjadi iz štalskog sistema kako je utvrđeno u ispitivanju Aalhus i sar. (1991) ili čak kao posledica više koncentracije antioksidanata u mesu kod jagnjadi iz pašnjačkog sistema (trava) u poređenju sa mesom jagnjadi iz štalskog sistema (seno), ali nije analizirano. Odbijanje utiče na povećanje mekoće mesa. Trupovi odbijene jagnjadi su bili teži i imali više intramuskularne masti koja je mogla da dovede do sporijeg pada temperature i moguće je objašnjenje bolje mekoće mesa (Wood i sar., 1999; Veiseth i sar., 2004). Odbijena jagnjad imaju meso intenzivnije crvene boje u proeđenju sa sisančadima verovatno zbog povećanja pigmenta sa uzrastom. Odbijena jagnjad na pašnjaku imaju jači ukus i miris mesa i mekše meso bez specifičnog ukusa ovčetine. Fisher i sar. (2002) i Sañudo i sar. (2000) su utvrdili intenzivniji ukus jagnječeg mesa kod različitih rasa na ispaši nego kod jagnjadi hranjenih koncentratom. Webb i O'Neill

(2008) su ovaj specifični ukus mesa jagnjadi iz pašnjačkog sistema doveli u vezu sa koncentracijom α -linolenske masne kiseline koje ima u izobilju u zelenim listovima trave.

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Received 31 May 2009; accepted for publication 15 August 2009