

Sensory Properties of Fresh and Thermally Treated Lamb Meat

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Abstract:

In this paper, three groups of 12 lambs (6 male and 6 female) of the “Piroat improved sheep” were examined in order to determine the influence of length of fattening lambs and gender of lambs on sensory properties of fresh and thermally treated lamb meat. The first group of lambs was fattened for 60 days, the second and the third 120 and 180 days. Nutrition of the lamb to rejection (40 days) is the mother's milk. After 40 days, it switched to pelleted concentrate (with 18% protein) and a quality hay, which was ad libitum as the concentrate. At the end of the fattening, the lamb is slaughtered by the usual technique. The examined sensory properties of meat are: colour, odour, texture, marbling with points from 0 to 5. The best sensory features have the fresh meat of the lambs of the third group, and a weaker average score has the meat of the first group. The lamb's sex has an effect on the meat's marbling. Marbling is significantly better for female lambs meat than male lamb meat ($P < 0.05$). The odour, flavour, tenderness and softness for thermally treated lamb meat in all three groups are not significant for male and female lambs. Mean tenderness values are significant ($P < 0.01$) higher in the second in relation to the first group for both genders lambs. The sensory characteristics of roasted meat of female lambs for the three groups were assessed with higher grades compared to male lamb meat. Statistically significant differences between the genders in terms of meat flavour were determined for the second ($P < 0.05$) and the third ($P < 0.01$) group of lambs. It can be concluded that thermally treated meat of female lambs has better sensory qualities than the male lamb's meat.

Keywords:

Sensory Properties, Fattening, Gender, Lambs, Fresh Meat, Thermally Treated Meat

1. Introduction

Goat and sheep both are significant to the world economy, where the demand of sheep is slightly more today [1]. A huge population difference between goat and sheep can easily be maintained under rural conditions because of their ability to adapt to harsh environment, poor management and feeding practices [2]. Consumers

demand lamb that is lean and has good nutritional attributes. Tenderness, juiciness, flavour, odour and overall liking are all important quality determinants of sensory enjoyment of lamb meat. Sensory enjoyment is a key driver strongly influencing the demand of lamb in Australia, and the purchase and willingness to pay decisions of consumers [3].

Lamb meat has a low consumption because of its specific flavour and tenderness, [4]. There are many pre-mortem and post-mortem factors that may alter the organoleptic characteristics of the meat. In particular, the diet of lambs is a factor that influences these organoleptic characteristics [5,6,7 8]. The differences in the sensory characteristics of the meat in ruminants may be affected if they are exclusively fed on forages of cereals, [9].

While the nutritional content of lamb has been shown to be sufficient to claim lamb as a good source of key nutrients [10,11], there is concern regarding the high focus of lean meat yield selection throughout the supply chain on the eating quality attributes, as Australian lambs have become larger, leaner and more muscular [12].

According to [13] from the sensory properties of the quality of raw meat the basic requirements refer to the colour, texture and odour of the meat. Requirements regarding other sensory properties: softness, juiciness and aroma refer to heat-treated meat. The evaluation of the organoleptic properties of fresh meat in this study encompasses the following characteristics: colour, odour, texture and marbling. The colour of fresh meat primarily depends on pigmentary substances (myoglobin and its derivatives), because with bleeding during the slaughter of lambs most of the hemoglobin is removed.

Myoglobin accounts for 95%, and for hemoglobin 5% of iron in the meat [14]. Softness depends largely on the size of muscle fibers, as well as on the amount and properties of connective tissue. The softness of the meat is assessed on the basis of how easily the flesh is broken and chewed which is in direct relation to the juiciness of the meat. The taste of the meat is acidic and salty. The odour of lamb is specific and characteristic of the type of animal from which it is obtained. The basic components of the odour of meat are: amines, indoles, sulfuric hydrogen, ammonia and some acids.

The heat treatment of the food is carried out to ensure product appropriate eating qualities including taste, flavour and texture, extend the product shelf life through heat inactivation of enzymes and microorganisms and finally, to increase the nutrient bioavailability, particularly proteins [15,16].

Thirty male Suffolk lambs (37.2 ± 5.4 kg live weight) were used to evaluate the carcass characteristics and meat sensory. Organoleptic characteristics did not present differences, except juiciness ($P=0.002$) [17].

Increasing of the processing temperature significantly affected meat colour by increasing lightness and hue, and reducing redness, yellowness, and saturation. Rising the temperature of treatment from 60 °C to 90 °C significantly increased the cooking loss from 9.1 g/100 g to 36.2 g/100 g [18].

2. Materials and Methods

2.1. Animals, Experimental Design, Feeding And Slaughter Details

The experiment included a total of 36 lambs from the purified “Piroć improved sheep” divided into 3 groups (6 males and 6 females), according to the duration of the fattening period, as follows: I group 60 days fattening; II group 120 days fattening and III group 180 days fattening. The test is performed only in lambs, lambing as unions, at the farm “Djumruk” on Vlasina Lake, Republic of Serbia.

The daily meal of sheep breastfeeding from the beginning of the experiment to the 40th day consisted of: seeds 1.8 kg per lamb; silage 1.5 kg per lamb and concentrate 0.5 kg per lamb. In the first 10 days, the mother's milk was present in the diet of the lambs, and from the 11th day until the end of the fattening, all three groups of lambs had at their disposal a pelleted concentrate and a quality seeds at will. The lambing period of the lambs was completed on the 40th day of their life. In the diet of all three groups of lambs, the pelleted concentrate and the quality seeds were represented until the end of the experiment and that no group was pasture or used any other foods.

After finishing the fattening, the lambs were slaughtered in the slaughterhouse “Jugokop” – Bujanovac, Republic of Serbia. Each group of lambs from farm to slaughterhouse was transported by truck. Twelve hours before slaughter, food was broken at the lambs, while water was available until loading in a truck. Immediately after the landing of the lambs in the livestock depot, a visual inspection was carried out by the veterinary inspection, which concluded that all the lambs were in good condition, with good health and that they could go to slaughter.

The slaughter of the lambs is carried out according to the technological procedure, according to the following phases: preparing lamb for slaughter; raising to the track; bleeding; removing the skin; evisceration and cooling.

2.2. Sensory Testing

Samples for determining the sensory properties of fresh meat were analyzed at the central laboratory of the “Institute for Animal Husbandry” in Zemun Pole, in the Republic of Serbia. The examined sensory properties of meat are: colour, odour, texture, marbling with points from 0 to 5. The examined sensory properties of roasted meat are: odour, flavour, tenderness and softness with points from 0 to 5.

2.3. Statistical Analysis

Variational statistical analysis was performed by analyzing the variance of two-factorial experiment (3 x 2), according to [19]. The differences in the mean values were tested with the Tukey test.

3. Results and Discussion

3.1. Sensory properties of fresh lamb meat

Sensory evaluation of fresh meat in male lambs (points 0 to 5) is presented in Table 1.

Table 1. Sensory evaluation of fresh meat for male lambs (points 0 to 5).

Evaluated properties	Group								
	I			II			III		
	\bar{X}	SD	Cv	\bar{X}	SD	Cv	\bar{X}	SD	Cv
Colour	4.75 ^a	0.23	4.74	4.92 ^b	0.20	4.15	4.92 ^{bc}	0.22	2.63
Odour	4.67 ^a	0.14	3.08	4.88 ^b	0.21	4.29	4.75 ^{ab}	0.22	4.71

Texture	4.63 ^a	0.44	9.49	4.71 ^a	0.19	4.02	4.54 ^a	0.10	2.25
Marble	0.74 ^a	0.33	44.91	3.25 ^b	0.27	8.43	3.92 ^c	0.38	9.60
Average rating	3.57 ^a	0.89	8.24	4.41 ^b	0.10	2.16	4.57 ^b	0.18	3.96

abc– The mean values in a single row marked with different letters are significantly different ($P < 0.01$)

Sensory evaluation of fresh meat in female lambs (points 0 to 5) is presented in Table 2.

Table 2. Sensory evaluation of fresh meat for female lambs (points 0 to 5).

Evaluated properties	Group								
	I			II			III		
	\bar{X}	SD	Cv	\bar{X}	SD	Cv	\bar{X}	SD	Cv
Colour	4.63 ^a	0.38	3.19	4.92 ^b	0.20	4.15	5.00 ^{bc}	0.23	4.60
Odour	4.75 ^a	0.22	4.71	5.00 ^b	0.31	6.26	4.98 ^{ab}	0.10	1.99
Texture	4.70 ^a	0.38	8.09	4.92 ^a	0.13	2.63	4.83 ^a	0.20	4.23
Marble	0.96 ^a	0.60	62.54	3.63 ^b	0.21	5.77	4.33 ^c	0.26	5.96
Average rating	3.75 ^a	0.05	1.44	4.62 ^b	0.11	2.33	4.78 ^b	0.12	2.46

abc– The mean values in a single row marked with different letters are significantly different ($P < 0.01$)

A characteristic that shows a significant difference ($P < 0.01$) between all three groups both in male and female lambs (Table 1 and Table 2) is marbling, while the texture shows no significant difference between all three groups. In the colour of fresh meat there are significant differences between the first and the second, as well as the first and third groups, for male and female lambs at level $P < 0.01$. The odour shows the significance between the first and the second group, while the average score is significant in the first and second and first and third groups both in male and female lambs at level $P < 0.01$.

Sensory evaluation of fresh meat by sex of lambs (points 0 to 5) is presented in Table 3.

Table 3. Sensory evaluation of fresh meat by gender of lambs (points 0 to 5).

Evaluated properties	Group	Deferences
Colour	I	0.12 ^{ns}
	II	0.00 ^{ns}
	III	0.08 ^{ns}
Odour	I	0.08 ^{ns}
	II	0.12 ^{ns}
	III	0.23 ^{ns}
Texture	I	0.07 ^{ns}
	III	0.29 ^{ns}
Marble	I	0.22 [*]
	II	0.38 [*]
	III	0.41 [*]
Average rating	I	0.18 ^{ns}
	II	0.21 ^{ns}
	III	0.21 ^{ns}

*- $P < 0.05$; ns - not significant

All the tested sensory properties of fresh meat in all groups were assessed with higher grades for female lambs, except for colour of lamb meat from the first group,

which was assessed with slightly higher score (by 0.12 points) female lambs (Table 3).

Statistically significant differences ($P < 0.05$) in the sensory characteristics between male and female lambs were determined only for marbling of lamb meat, which was rated higher in female lambs.

The male Terminal sired lambs had lower sensory scores when compared to the male Maternal and Merino sired lambs. These differences were 5.0, 4.0, 3.7 and 2.9 lower tenderness, overall liking, juiciness and flavour scores when compared to the Maternal sired lambs and 5.2, 3.9, 3.3 and 2.9 lower sensory scores when compared to the Merino sired lambs. The difference in juiciness varied between the two cuts with the effect being greater in the loin (where male Terminal sired lambs had 4.4 and 5.4 less sensory scores compared to the male Maternal and Merino sired lambs) than in the topside (where male Terminal sired lambs had 3.1 and 1.2 less sensory scores compared to the Maternal and Merino sired lambs), [20].

Result of [20], is supported by the effect of age at slaughter as a covariate. The average age at slaughter was 299.0 ± 59.6 (mean \pm SD) however between kill groups this varied from 214 to 434 days. Within the Terminal sired lambs, females had better sensory scores than male lambs. However this effect was small, and only evident within the loin which had 1.8, 1.5, 1.6, 0.9 and 0.9 units higher for tenderness, overall liking, juiciness, flavour and odour, when compared to the wether lambs. Tenderness, flavour intensity and overall acceptability were the only significantly different ($P < 0.05$) palatability meat characteristics between fat classes. No significant differences were found in odour intensity, juiciness and flavour quality, [21]. Colour was least stable when the lamb breed type was Merino, pH at 24 h postmortem was high, and lactic acid concentration was high, [22].

Sex has shown no or a small influence on sensory scores [23,24,25,26].

3.2. Sensory Properties of Thermally Treated Lamb Meat

The odour, flavour and softness in all three groups (Table 4 and Table 5) are not significant for male and female lambs. Mean tenderness values are significant ($P < 0.01$) higher in the second in relation to the first group in both genders of lambs (Tables 4 and 5).

Table 4. Sensory evaluation of roast meat for male lambs (points from 0 to 5).

Examined characteristics	Group								
	I			II			III		
	\bar{X}	SD	Cv	\bar{X}	SD	Cv	\bar{X}	SD	Cv
Odour	4.09 ^a	0.19	4.63	4.29 ^a	0.43	10.04	3.98 ^a	0.20	5.13
Flavour	4.03 ^a	0.22	5.53	4.11 ^a	0.12	3.02	3.94 ^a	0.22	5.69
Tenderness	4.04 ^a	0.55	13.61	4.33 ^a	0.41	9.43	4.03 ^a	0.17	4.25
Softness	4.01 ^a	0.22	5.37	4.29 ^b	0.33	7.74	4.13 ^{ab}	0.26	6.35
Average rating	4.04 ^a	0.17	4.32	4.26 ^b	0.14	3.23	4.02 ^{ac}	0.13	3.15

abc – The mean values in a single row marked with different letters are significantly different ($P < 0.01$).

Table 5. Sensory evaluation of roast meat for female lambs (points from 0 to 5).

Examined characteristics	Group		
	I	II	III

	\bar{X}	SD	Cv	\bar{X}	SD	Cv	\bar{X}	SD	Cv
Odour	4.23 ^a	0.32	7.54	4.42 ^a	0.26	5.84	4.13 ^a	0.25	6.06
Flavour	4.11 ^a	0.26	6.22	4.42 ^a	0.13	2.93	4.44 ^a	0.31	6.96
Tenderness	4.08 ^a	0.30	7.42	4.42 ^a	0.34	7.73	4.15 ^a	0.20	4.88
Softness	3.98 ^a	0.20	5.13	4.33 ^b	0.20	4.72	4.32 ^{ab}	0.31	7.20
Average rating	4.11 ^a	0.19	4.62	4.40 ^b	0.11	2.49	4.26 ^{ac}	0.12	2.89

abc –The mean values in a single row marked with different letters are significantly different ($P < 0.01$).

The sensory characteristics of roasted flesh of female lambs in the three groups were assessed with higher grades compared to male lamb meat (Table 6). Statistically significant differences between the sexes in terms of meat taste were determined in the second ($P < 0.05$) and the third ($P < 0.01$) group of lambs. It can be concluded that the meat of female lambs has better sensory qualities than the male lamb's meat.

Table 6. Comparison of the sensory evaluation of roast meat according to gender of the lambs (points 0 to 5).

Examined characteristics	Group	Differences
Odour	I	0.14 ^{ns}
	II	0.13 ^{ns}
	III	0.15 ^{ns}
Flavour	I	0.08 ^{ns}
	II	0.31 [*]
	III	0.50 ^{**}
Tenderness	I	0.04 ^{ns}
	II	0.09 ^{ns}
	III	0.12 ^{ns}
Softness	I	0.03 ^{ns}
	II	0.04 ^{ns}
	III	0.19 ^{ns}
Average rating	II	0.14 ^{ns}
	III	0.24 [*]

*- $P < 0,05$; **- $P < 0,01$; ns – not significant

Based on the results in Table 6, it can be concluded that the thermally treated meat of the female lamb has better sensory properties than the meat of the male lamb.

The increased amount of intramuscular fat and the deposition of larger layers of fat intramuscularly, for heavier lambs, is favorably reflected on the meseness of the carcass (muscle and fat tissue together), on the commercial and organoleptic properties of fresh (marbles) and roasted meat (culinary properties). This conclusion reinforces the more favorable organoleptic qualities of roasted meat in heavier lambs (lambs of the second group), especially in terms of flavour.

The results of [27] show that the weight of the carcasses significantly affects the instrumental measures, with the exception of the capability of binding water. The increase in body weight increases the pH and redness of the meat, and reduces paleness. Sensory properties do not depend on the weight of the carcasses, with the exception of the softness of the meat.

4. Conclusions

The sensory properties of raw lamb meat quality are related to colour, odour, texture and marble of meat. Sensory properties of lamb meat depend from the length of fattening and gender. Lambs of the second and the third groups have better sensory properties than lambs of the first group. With the prolongation of the fattening from 60 to 120 and 180 days, the sensory properties of lamb meat are improved. The sensory properties between male and female lambs were determined only for marble of lamb meat, which was rated higher for female lambs.

For heavier lambs, are achieved more favorable results in terms of quality thermally treated lamb meat. No qualitative indicator of the value of meat gives preference to the meat of light lambs. The thermally treated meat of female lambs has better sensory properties than thermally treated meat for male lamb.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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