

*Full Length Research Paper*

## **Chemical and sensory characteristics of Bunte Deutsche Edelziege and Balkan goat meat**

**Snezana Ivanovic<sup>1\*</sup>, Jovanka Popov-Raljac<sup>2</sup>, Milan Z. Baltic<sup>3</sup>, Miroslav Zujovic<sup>4</sup>, Zorica Tomic<sup>4</sup>, Slobodan Lilic<sup>5</sup> and Ivan Pavlović<sup>1</sup>**

<sup>1</sup>Scientific Veterinary Institute of Serbia / Autoput 3, 11000 Belgrade, Serbia.

<sup>2</sup>Faculty of Agriculture / Nemanjina 6, 11080 Zemun, Serbia.

<sup>3</sup>Faculty of Veterinary Medicine, Belgrade University / Bulevar oslobođenja 18, 11000 Belgrade, Serbia.

<sup>4</sup>Institute for Animal Husbandry / Autoput 16, 11080 Zemun, Serbia.

<sup>5</sup>Institute of Meat Hygiene and Technology / Kacanskog 13, 11000 Belgrade, Serbia.

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**In this study, chemical composition, colour and sensory characteristics of Bunte Deutsche Edelziege (BDE) and Balkan goat meat were examined. Both species of goats were fed and raised under semi-intensive system of management. Chemical composition (moisture, ash, fat and protein content) and pH value were measured by standard methods and the colour was determined instrumentally. Moisture, protein, fat, ash and colour characteristics were not significantly different in both species of goats. Sensory evaluation revealed that the odour intensity was significantly ( $P < 0.01$ ) higher in the meat of BDE, whereas, tenderness, softness, taste acceptability and overall impression were significant ( $P < 0.001$ ) in the meat of Balkan goat. Therefore, it can be concluded that the meat of Balkan goat has better sensory characteristics in relation to the meat of BDE, although chemical composition and colour characteristics were found to be similar in both meat.**

**Key words:** Goat meat, Bunte Deutsche Edelziege, Balkan goat, chemical composition, colour, sensory characteristics.

### **INTRODUCTION**

Goat and kid meat have great importance in the diet, especially in Asian, African and South American countries, although goat meat production is four times less than the production of lamb and sheep meat in Serbia (Memisi, 2009). Preference for kid meat is higher in many developed countries (Shrestha and Fahmy, 2005). It is estimated that the territory of the Republic of Serbia today raise about 318,000 goats (Zujovic et al., 2011) though there is a ban in raising goats since 1954.

Goat meat has less esteemed than other kinds of meat because of its strong flavor, but on the basis on nutritive and biological value it is not inferior to other kind of meat (Lee et al., 2008). Meat is the main product from goat production particularly in Asia and Africa where it

presents 90% of the total world production. Among the main world producers of goat meat are China, India, Pakistan and Nigeria (Troskot and Pavicic, 2007).

In the countries of European Union, the goat meat production has less importance especially in the countries which have goats for milk production. Greece, Spain and France are the biggest producers of goat meat and they produce two third of total goat meat production in Europe (Memisi and Bauman, 2002).

Due to the fact that goat breeding is forbidden in Serbia for long time, there are no statistical data about the number of goats and goat production. However, in the last two decades, many people and companies are interested in goat breeding (Memisi and Bauman, 2007).

In some parts of Serbia and in the area around our country, there is the production of dried meat products of goat meat, for example pastyrma or bastyrma, that is, word of Turkish origin and the manufacturing of this product probably came from Turkey.

\*Corresponding author. E-mail: [snezaivanovic@gmail.com](mailto:snezaivanovic@gmail.com). Tel: +381-11-2604-020. Fax: +381-11-2651-825.

Chemical composition, colour and sensory characteristics of Bunte Deutsche Edelziege (BDE) and Balkan goat meat were sparsely reported, thus the following study was carried out in our laboratory.

## MATERIALS AND METHODS

### Source of goat meat

Material used was two races of goats' meat, Balkan goat and BDE, both female in the age of three years. The goats were gotten from private farms located in Zajecar district (Eastern part of Serbia) at an altitude of 750-1000 MSL in the rural area of Stara planina (Old Mountain). The goats were raised at the same time. Objects for the goats were built of mixed solid materials and covered with ceramic tiles, with conditions that were satisfactory for goat breeding. The floor was of stuffed soil and covered by thick layer of wheat straw. Watering was *ad libitum*.

### Plane of nutrition

Diet of goats during the winter consisted of hay. The hay was collected from natural pastures (3.5 kg per day) and concentrate (0.25 kg per day). In the summer months, the goats were pastured and fed with concentrate in the amount of 0.25 kg per day. The concentrate was made of maize meal, wheat bran with added sodium chloride and premix. The hay was originated from natural meadows of six fitocentric determinate associations: *Arrhenatherum elatioris* Br.-Bl. 1925. *senso lato*, *Festuco-Chrysopogonetum grylli* Randj. 1977., *Danthonietum calycinae* Cinc. et Kojic 1958., *Medicago falcata-Festucetum rubrae*, *Trifolium campestre - Agrostietum vulgaris* i *Festuco vallesiaca*, and *Agrostietum vulgaris* Danon et Blaz. 1978. with predomination of family Poaceae (*Arrhenatherum elatius* L., *Dactylis glomerata* L., *Festuca pratensis* Huds. i *Lolium perenne* L.) and family Fabaceae (*Lotus corniculatus* L., *Trifolium repens* L., *Lathyrus pratensis* L., *Trifolium montanum* L., *Trifolium campestre* L.). The number of species in the analyzed associations is 34 to 77, this directly indicate the high level of biodiversity. The main parameters of the quality of these associations in the samples show that the row of the protein content is 12.29 to 13.00%, and that of the cellulose is 22.30 to 21.60%. These lawns ensure high-quality feed for goat diet in the summer and spring (Tomic et al., 2005, 2009). Goats were slaughtered in an experimental slaughter house in the Institute for animal husbandry.

### Chemical composition and pH value

Moisture content was determined by ISO 1442:1998, fat content by ISO 1443:1992 and ash content by ISO 936:1999. The protein content was calculated from nitrogen content multiplied with 6.25 using ISO 937:1992 and pH value by ISO 2917:2004. Chemical parameters and pH were measured in meat 24 h after slaughter.

### Colour measurements

The colour was measured on the fresh meat cuts (*musculus longissimus dorsi pars lumborum*), from the right side of each carcass (n = 20, for each sample). CIE, CIEL\*a\*b\* and CIEYxy colour coordinates (CIE Colourimetry, 1986) were determined using Minolta Chromameter CR 400 (Minolta Co. Ltd., Osaka, Japan) in D-65 lighting, with standard angle of 2 degrees of shelter and 8 mm aperture of the measuring

head. Also, the colour was measured on the meat pieces (n = 20) baked in Al folia at a temperature of 225°C and achieving up to 75°C in the inner part of meat.

These results were expressed in CIE system, as the average values: y (reflectance or brilliance, %),  $\lambda$  (dominant wavelength, nm) and P (colour purity, %) (CIE Colorimetry Committee, 1986).

In CIEL\*a\*b\*, the results were given as the mean values: L\* (psychometer light), a\* (psychometer tone) and b\* (psychometer chroma).

### Sensory analysis

In each parts of the meat (*musculus longissimus dorsi pars lumborum*), the sensory evaluation were the appearance (colour and surface), texture (structure and firmness) and aroma (smell). The same sensory evaluation was made on meat backed in Al folia at the temperature of 225°C up to achieving of 75°C in the inner part of meat, as well the textural characteristics – softness, chewiness and tenderness, and flavour (smell and taste). The sensory evaluation was made by ten trained assessors, according to relevant ISO 8589:1988 and ISO 8586-1:1993.

### Statistical analysis

Data obtained in the investigations performed in this study were analyzed by descriptive and analytical statistics.

Basic parameters of the descriptive statistics included calculations of the arithmetic mean values, and variability parameters of the investigated properties including the determinations of standard deviations (Sd) and variation coefficients (Cv) were expressed in percents. The differences between the averages were compared by t-test at the level of significance of 99 and 95% (Hadzivukovic, 1991).

## RESULTS

The data of the live weight of goats before they were slaughtered, chemical composition and pH value of goat meat are presented in Table 1. The average live weight of Bunte Deutsche Edelziege was 45.30 kg and this was significantly higher than average live weight of Balkan goats (P < 0.05). Moisture, fat, protein and ash content were similar in the meat of both goats and there were no statistical differences between them (P > 0.05).

These results of instrumentally measured colour of fresh meat expressed in CIE and CIEL\*a\*b\* system are presented in Table 2. Average value for reflectance (y) was 76.5 in meat of BDE and 74.5 in meat of Balkan goats.

Average values for dominant wavelengths ( $\lambda$ ) was 654.0 nm in the meat of BDE and 644.9 nm in the meat of Balkan goats, colour purity was 21.3 and 20.5%, lightness (L\*) 34.5 and 33.7, redness (a\*) was 20.2 and 20.7, and yellowness (b\*) was 5.0 in fresh meat of BDE and 4.8 in meat of Balkan goats, respectively. Between the measured values for colour of fresh meat, there were no statistical differences (P > 0.05).

Instrumentally measured colour characteristics of baked goat meat are presented in Table 3. Values of reflectance (y) were 26.5 in meat of BDE and 27.2 in

**Table 1.** Live weight, chemical composition and pH value of goat meat.

<i>Bunte Deutsche Edelziege</i>	n	Mean ± Sd	Sx	Minimum- maximum	Cv
Live weight, kg	20	45.30 ± 5.59 <sup>a</sup>	4.85	38.00 - 55.00	12.33
Moisture, %	20	74.71 ± 0.89	8.79	72.33 - 75.48	1.19
Fat, %	20	3.60 ± 0.94	0.40	2.40 - 5.17	26.27
Protein, %	20	20.35 ± 0.97	2.40	18.67 - 21.81	4.79
Ash, %	20	1.03 ± 0.05	0.11	0.96 - 1.12	4.86
pH	20	5.67 ± 0.06	0.67	5.57 - 5.77	1.07
<i>Balkan goats</i>					
Live weight, kg	20	41.00 ± 3.44 <sup>b</sup>	6.87	32.00 - 46.00	8.38
Moisture, %	20	75.00 ± 0.62	8.60	74.22 - 76.26	0.83
Fat, %	20	3.68 ± 0.47	0.62	2.87 - 4.21	12.75
Protein, %	20	20.56 ± 0.55	2.36	19.79 - 21.66	2.67
Ash, %	20	1.03 ± 0.02	0.17	0.99 - 1.06	2.13
pH	20	5.65 ± 0.12	0.65	5.47 - 5.82	2.07

<sup>a,b</sup>(P < 0.05)**Table 2.** Colour of fresh meat expressed in CIE and CIEL\*a\*b\* system – BDE.

<i>Bunte Deutsche Edelziege</i>	n	Mean ± Sd	Sx	Minimum-maximum	Cv
Reflectance - y	20	76.5 ± 2.6	0.9	71.0 - 80.0	3.4
Dominant wavelength – λ (nm)	20	654.0 ± 19.3	6.8	612.0 - 680.0	2.9
Colour purity – P (%)	20	21.3 ± 2.2	0.8	18.7 - 25.4	10.1
Lightness - L*	20	34.5 ± 2.4	0.8	31.9 - 38.5	6.9
Redness - a*	20	20.2 ± 1.9	0.7	17.3 - 22.2	9.3
Yellowness - b*	20	5.0 ± 1.3	0.5	3.4 - 7.3	26.0
<i>Balkan goat</i>					
Reflectance - y	20	74.5 ± 4.9	1.7	67.0 - 79.0	6.5
Dominant wavelength – λ (nm)	20	644.9 ± 24.8	8.8	609.0 - 680.0	3.8
Colour purity – P (%)	20	20.5 ± 2.9	1.0	16.7 - 23.9	14.2
Lightness - L*	20	33.7 ± 4.9	1.7	28.3 - 42.7	14.5
Redness - a*	20	20.7 ± 2.1	0.8	18.1 - 23.8	10.3
Yellowness - b*	20	4.8 ± 1.2	0.4	3.1 - 7.1	24.5

**Table 3.** Colour of baked meat expressed in CIE and CIEL\*a\*b\* system – BDE.

<i>Bunte Deutsche Edelziege</i>	n	Mean ± Sd	Sx	Minimum - maximum	Cv
Reflectance - y	20	26.5 ± 1.9	3.1	24.2 - 29.4	7.1
Dominant wavelength – λ (nm)	20	583.1 ± 1.5	68.6	581.0 - 585.0	0.3
Colour purity – P (%)	20	35.6 ± 3.7 <sup>a</sup>	4.2	30.2 - 40.0	10.3
Lightness - L*	20	54.7 ± 1.7 <sup>a</sup>	6.4	51.3 - 57.3	3.1
Redness - a*	20	7.6 ± 1.7	0.9	4.6 - 9.4	22.2
Yellowness - b*	20	12.8 ± 1.1	1.5	11.2 - 14.3	8.8
<i>Balkan goat</i>					
Reflectance - y	20	27.2 ± 1.3	3.2	24.9 - 29.5	4.9
Dominant wavelength – λ (nm)	20	583.6 ± 1.3	68.7	581.0 - 585.0	0.2
Colour purity – P (%)	20	37.9 ± 5.2 <sup>b</sup>	4.6	31.6 - 52.0	13.7
Lightness - L*	20	56.7 ± 1.6 <sup>b</sup>	6.7	54.2 - 59.2	2.8
Redness - a*	20	7.8 ± 1.4	0.9	4.9 - 9.4	17.5
Yellowness - b*	20	13.3 ± 0.9	1.6	11.6 - 14.6	6.8

<sup>a,b</sup>(P < 0.05)

**Table 4.** Sensory evaluation of fresh meat.

		Attributes				Percentage of maximal possible quality	Weighted average
		Appearance	Texture		Flavour		
		Colour Surface	Visual evaluated structure	Palpatory evaluated firmness	Olfactory evaluated odour		
		Coefficient of importance					
		<b>4</b>	<b>3</b>	<b>3</b>	<b>10</b>	100	100/20
<b>Balkan goat</b>	<b>M</b>	20.00	14.85	14.10	48.20	97.15	4.86
	<b>Sd</b>	0	0.15	0.33	0.35		
	<b>Cv</b>	0	3.03	7.06	7.69		
<b>BDE</b>	<b>M</b>	19.80	14.55	13.95	48.30	96.60	4.83
	<b>Sd</b>	0.15	0.32	0.39	0.47		
	<b>Cv</b>	3.03	6.60	8.40	9.92		

**Table 5.** Sensory evaluation of baked meat.

		Attributes					Percentage of maximal possible quality	Weighted average
		Appearance	Texture		Flavour			
		Colour Surface	Visual evaluated structure	Palpatory evaluated firmness	Olfactory evaluated odour	Taste		
		Coefficient of importance						
		<b>4</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>6</b>	100	100/20
<b>Balkan goat</b>	<b>M</b>	19.60	14.55	14.10	19.00	29.40	96.65	4.83
	<b>Sd</b>	0.20	0.23	0.24	0.25	0.20		
	<b>Cv</b>	4.08	4.72	5.21	5.26	4.08		
<b>BDE</b>	<b>M</b>	19.40	14.55	14.40	19.80	29.10	97.05	4.85
	<b>Sd</b>	0.23	0.23	0.24	0.20	0.23		
	<b>Cv</b>	4.72	4.72	5.10	4.08	4.72		

meat of Balkan goats, average dominant wavelength ( $\lambda$ ) was 583.1 and 583.6 nm, redness ( $a^*$ ) was 7.6 and 7.8 and yellowness ( $b^*$ ) was 12.8 in meat of BDE and 13.3 in meat of Balkan goats, respectively.

Between these values there were no statistical differences ( $P > 0.05$ ). Average value of colour purity ( $P$ ) of 35.6% was significantly less ( $P < 0.05$ ) in meat of BDE than in meat of Balkan goats (37.9%). Also, lightness ( $a^*$ ) of 54.7 was significantly less in meat of BDE than in meat of Balkan goats (56.7) ( $P < 0.05$ ).

Data of sensory evaluation of fresh meat are presented in Table 4 and data about sensory evaluation of baked goat meat are presented in Table 5. Percentage of maximal possible quality of BDE fresh meat was 96.60 and of Balkan goats meat 97.15. Weighted average evaluation was 4.86 for Balkan goats meat and 4.83 for meat of BDE. Between evaluations of sensory characteristics there was not statistical differences ( $P > 0.05$ ).

Percentage of maximal possible quality for baked meat of Bunte Deutsche Edelziege was 97.05 and for Balkan goat meat 96.65. Value for weighted average evaluations was 4.83 for Balkan goat meat and 4.85 for BDE meat. Between these evaluations there was not statistical differences ( $P > 0.05$ ).

## DISCUSSION

### Live weight, chemical composition and pH value

Live weight before slaughter of BDE was higher than weight of Balkan goats ( $P < 0.05$ ). Average moisture content was similar in meat of both goats: 74.71% in meat of BDE and 75.00% in meat of Balkan goats. Fat, protein and ash content of BDE and Balkan goats were 3.60 and 20.35, 1.03 and 3.68, 20.56 and 1.03,

respectively. The pH value measured 24 h after slaughter was similar, 5.67 in meat of BDE and 5.65 in meat of Balkan goats (Table 1).

It is difficult to compare these results with the findings of other authors because they investigated mostly kid meat and impact of age and diet on the chemical composition of meat. For example, Lee et al. (2008) noticed less moisture content and higher content of protein, fat and ash in meat of Boar × Spanish crossbred male goats in the age of 8 to 12 months. In another investigation, Lee et al. (2008a) found that meat of weaned crossbred Boer × Spanish 4-month-old kids fed by hay and concentrate have chemical composition similar to our results. Moisture content was 75.79; protein content 20.10; fat content 2.02 and ash content was less (1.62%).

The values of pH measured 24 h after slaughter in meat of Criollo Cordobes (5.72 to 5.75) and in meat of Anglonubian kids (5.71 to 5.74) (Peña et al., 2009) were higher when compared with the values of this study's results. Wattanachant et al. (2008) examined the pH of goat meat, breed mongrel Anglonubia × Tai native aged one, three, and race Saanan × Tai native age of seven years, 24 h after slaughter. The ultimate pH of meat in all tested samples varied in the range of 6.5 to 6.6.

Less moisture content of 66.3 and 66.9% and higher values for protein of 21.1 and 22.0%, and fat content of 11.4 and 10.0% was noticed by Mushi et al. (2008) in meat of castrated male Norwegian goats and castrated male Cashmere goats, respectively.

### Colour measurements of meat samples

On the basis of the measured and calculated values (Table 2), mean reflectance of the fresh meat of BDE was  $y = 76.5\%$ , and the value of standard deviation  $SD = 2.6$ , and the coefficient of variation 3.4%, while for the fresh meat of Balkan goats was  $y = 74.5\%$  with  $SD 1.7$  and  $CV 6.5\%$ , respectively. Similar values were found for the psychometric light in the CIE  $L^*a^*b^*$  system. The value of psychometric light for BDE meat was  $L^* = 34.5 \pm 2.4$ , while the Balkan goat meat was slightly higher  $33.7 \pm 4.9$ . Between the calculated values of psychometric light  $L^*$  of goat meat in both examined groups were not found statistically significant differences ( $P > 0.05$ ).

Similar values found Ryan et al. (2007),  $L^* = 38.4$  to 38.9 for fresh meat of Boer goats fed with different amounts of concentrate (50 to 90%) *ad libitum*. Lee et al. (2008) found  $L = 36.18$  m in the samples of *M. longissimus dorsi* of Boar × Spanish kids, ages 8 to 12 months, fed on the pasture. Similar values were found by Mushi et al. (2008) in castrated males of Norwegian goats ( $L^* = 36.61$ ) and this was slightly higher in castrated males of Cashmere goats ( $L^* = 40.8$ ). Slightly higher  $L^* = 46.76$  and  $L^* = 47.91$  was found by Argüello et al. (2005) for weaning male kids Majorera and fed by

milk replacer, respectively.

Lee et al. (2008a) found the dependence of psychometric light of diet. In *M. longissimus dorsi* of Boer × Spanish kids, aged 4 months, fed only with hay. They found  $L^* = 43.57$ , the kids fed with concentrate,  $L^* = 39.81$  and the kids fed mixed  $L^* = 42.17$ , respectively.

Peña et al. (2009) determined that the *M. longissimus dorsi* of kids in age of 62 days average,  $L^* = 42.54$ , and for kids 93 days old  $L^* = 42.85$  (Criollo Cordobes), and the kids Anglonubian,  $L^* = 48.82$  and  $L^* = 47.14$ , respectively. Higher values were found in the *M. semimembranosus* at Moxitó kids 4 months old,  $L^* = 47.2$  and Canindé kids  $L^* = 46.1$  (Madruga, 2008).

Todaro et al. (2002) examined the impact of age on the colour of *M. longissimus dorsi* of Girgentana kids slaughtered at the age of 25 and 35 days and found  $L^* = 47.76$  and  $L^* = 46.21$ , respectively.

Much larger values of  $L^* = 45.58$  to 47.94 were found by Ding et al. (2010) in meat of Boer Guanzhong dairy goats and 90 days of age. Dhandaa et al. (2003) recorded  $L^* = 37.7$  to  $L = 43.6$  in meat of mongrels of Angora goats, Saanen and feral goats with Boer, Saanen and Feral goats.

On the basis of values from the chromacy diagram, the CIE system with display of colours that includes the spectral curve, samples of meat goats were in the red spectrum. Dominant wavelength of *M. longissimus dorsi* of BDE were in the range of 612 to 680 nm (average 654.0 nm), and of Balkan meat goats 609 and 680 nm (average 644.9 nm) and between these values were not found statistically significant differences ( $P > 0.05$ ).

Slightly higher values for the purity of  $P = 3.21$  has fresh meat of BDE (18.7 to 25.4) compared to the Balkan goats meat in which average  $P = 20.5$  (16.7 to 23.9), without statistically significant difference ( $P > 0.05$ ). Approximately equal value ( $P > 0.05$ ) were found for  $a^*$  in meat of BDE, average at 20.2 (17.3 to 22.2), and in meat of Balkan goats 20.7 (18.1 to 23.8), respectively. There were no significant differences in the colour of the tested samples ( $P > 0.05$ ), which shows the value of psychometric chroma  $b^*$ , which was slightly higher in meat of BDE  $b^* = 5.0$  (3.4 to 7.3) compared to 4.8 (3.1 to 7.1) that was determined in meat of Balkan goats.

Significantly lower values for the redness of the meat of Boar × Spanish male goats fed on the pasture, in age of 8 to 12 months, Lee et al. (2008) found average  $a^* = 14.24$ , while the value  $b^* = 11.25$  was significantly higher. Ryan et al. (2007) found similar values for the redness of Boer goats fed in quantities of 50 to 90% *ad libitum* and  $a^* = 19.4$  to 20.6, and for lame that was 22.8 to 24.1, while the values for psychometric chrome were significantly more chrome  $b^* = 11.9$  to 12.6 and Hue angle was 31.4 to 31.9.

Lee et al. (2008a) researched on the impact of diet, found less value of  $a^*$  in fresh meat of kids fed only by hay  $a^* = 9.34$ , fed only with concentrate  $a^* = 9.91$  and in meat of kid with mixed diet  $a^* = 9.89$ , while yellowness

values were significantly higher by 12.45, 11.09 and 11.88, respectively. Accordingly, the values of chrome were 15.41, 14.63 and 15.22, and the hue angle 51.78, 47.30 and 49.37, respectively.

Less value for redness were determined by Peña et al. (2009). In fresh meat of Cordobes Criollo kids at age 62 days, they found  $a^* = 10.78$ , and in age of 93 days  $a^* = 10.48$ . The values for yellowness were higher, and that  $b^* = 15.23$  and  $15.67$ , respectively. Less values for  $a^*$  was found in meat Anglonubian kids  $a^* = 8.19$  and  $9.33$  (in age of 62 and 93 days). Similar results were noted in the research of Madruga et al. (2008), who found  $a^* = 9.7$  and  $b^* = 11.6$  in meat of Moxitó kids at 4 months old, and  $a^* = 10.8$  and  $b^* = 10.6$  in meat of Canindé kids of the same age.

Examining the impact of age of Girgentana kids on the fresh meat colour, Todaro et al. (2004) reported that the value of redness increases with age and it was  $a^* = 1.57$  in meat of kids slaughtered at the age of 25 days and  $a^* = 2.30$  in meat of kids slaughtered at 35 days of life. Yellowness values remain approximately equal,  $b^* = 13.15$  and  $b^* = 13.00$ , respectively. The values for chrome in meat of younger kids were 13.31 and Hue angle 83.07, while in meat of older kids these values were 13.29 and 79.93, respectively.

The value of redness were less in the investigations of Dhanda et al. (2003) who found in meat of mongrels of Angora, Saanen and feral goats with Boer, Saanen and Feral goats  $a^* = 10.3$  to  $12.4$ ,  $b^* = 6.7$  to  $8.0$ , values for hue angle were higher related to the obtained results, 31.2 to 35.4, while chrome had less value of 12.4 to 14.8. Similar results were obtained by Madruga et al. (2008), who found  $a^* = 9.7$  and  $a^* = 10.8$  in *m. semimembranosus* of Moxitó i Canindé kids in age of 4 month and  $b^* = 11.6$  and  $b^* = 10.6$ , respectively.

Higher values was found by Mushi et al. (2008),  $a^* = 15.1$  in fresh meat of castrated males of Norwegian goats and  $a^* = 15.0$  in meat of castrated males of Cashmere goats. These results for  $b^*$  were similar to results in our investigations and they found  $b^* = 6.0$  and  $b^* = 7.0$  for Norwegian and Cashmere goats.

Ding et al. (2010) and Mushi et al. (2008) found similar of  $a^*$  values for meat of various mongrels of Boer and Guanzhogn dairy kids in the age of 90 days,  $a^* = 14.29$  to  $15.12$ . These values did not change in the age of 6 and 10 months (15.00 to 15.53).

These results of instrumental analysis of colour of baked meat are presented in table 3. Mean reflectance in baked meat of BDE and Balkan goat, were 26.5 and 27.2, respectively. Dominant wavelength was very similar in meat, 583.1 in BDE meat and 583.6 in meat of Balkan goat. Significant differences were established in the purity of meat ( $P < 0.05$ ), that is, 35.6 in meat of BDE and 37.9 in meat of Balkan goat as well in lightness which was in meat of BDE  $L^* = 54.7$  and in meat of Balkan goat  $L^* = 56.7$ . Redness and yellowness were similar ( $P > 0.05$ ) in meat of both goats,  $a^* = 7.6$  and  $b^* = 12.8$  for meat of

BDE and  $a^* = 7.8$  and  $b^* = 13.3$  for meat of Balkan goat, respectively.

### Sensory evaluation of meat samples

Results of sensory evaluation are presented in Tables 4 and 5. Among the colour of fresh meat, statistical differences ( $P > 0.05$ ) was not found (Table 4). The colour of meat of Balkan goat obtained in the evaluation was 20.00 and of BDE meat was 19.80. Visual structure and firmness of fresh meat were also similar ( $P > 0.05$ ). Structure was evaluated for meat of Balkan goat with 14.85 and for BDE meat 14.55 and firmness was evaluated with 14.10 for meat of Balkan goat and 13.95 for BDE meat. Olfactory odour was evaluated for meat of Balkan goat with 48.20 and for BDE meat with 48.30.

The colour of baked meat (Table 5) was similar, 19.60 for meat of Balkan goat and 19.40 for BDE meat ( $P > 0.05$ ).

Same evaluation of 14.55 for structure was obtained in both BDE and Balkan goat meat.

Firmness of Balkan goat meat was evaluated with 14.10 and for BDE meat with 14.40. Among flavor characteristics, no significant differences ( $P > 0.05$ ) were noticed. Odour was evaluated with 19.00 for meat of Balkan goat and with 19.80 for BDE goat. Taste was evaluated with 19.40 for meat of Balkan goat and 29.10 for meat of BDE goat.

### Conclusion

Average live weight before slaughter was 45.30 kg (BDE) and significantly less 41.00 kg of Balkan goats, raised under the same conditions. Chemical composition and pH value were similar in meat of both goats. Mean reflectance of the fresh meat of BDE goats was  $y = 76.5$  and  $y = 74.5\%$  for Balkan goat meat. The value of psychometric light for fresh meat of BDE goat was  $L^* = 34.5$ , while the Balkan goat meat was slightly higher  $L^* = 33.7$ .

Other instrumentally measured colour parameters were similar in fresh meat of goats as well as sensory evaluated colour and odour acceptability of fresh meat. Colour purity and lightness were lower (35.6 and 54.7) in meat of BDE goat in the relation to 37.9 and 56.7, that was established in meat of Balkan goat ( $P < 0.05$ ). Sensory characteristics were similar in meat of BDE and Balkan goat and among them there were no statistical differences ( $P > 0.05$ ).

### REFERENCES

- Argüello A, Castro N, Carote J, Solomon M (2005). Effects of diet and live weight at slaughter on kid meat quality. *Meat Sci.* 70: 173-179.
- CIE Colorimetry Committee (1986). Technical notes: working program on colour differences. *J. Opt. Soc. Am.* 64: 896-897.
- CIE Colorimetry (2nd ed.) (1986). Publication CIE No. 15.2, Vienna: Central Bureau of the Commission Internationale de L'Ectarge.

- Dhanda S J, Taylor GDB, Murray JPC (2003). Growth, carcass and meat quality parameters of male goats: effects of genotype and live weight at slaughter. *Small Rumin. Res.* 50: 57-66.
- Ding WL, Kou B, Cao Y Wei (2010). Meat quality parameters of descendants by grading hybridization of Boer goat and Guanzhong Dairy goat. *Meat Sci.* 84: 323-328.
- Hadzivukovic S (1991). *Statisticki metodi*, University of Belgrade, Faculty of Agriculture, Belgrade, Serbia (in Serbian).
- Lee HJ, Kannan G, Eega R K, Kouakou B, Getz RW (2008). Nutritional and quality characteristics of meat from goats and lambs finished under identical dietary regime. *Small Rumin. Res.* 74: 255-259.
- Lee HJ, Kouakou B, Kannan G. (2008a). Chemical composition and quality characteristics of chevon from goats fed three different post-weaning diets. *Small Rumin. Res.* 75: 177-184.
- Madrugá SM, Torres ST, Carvalho FF, Queiroga CR, Narain N, Garrutti D, Souza Neto AMN, Mattos WC, Costa GR (2008). Meat quality of Moxotó and Canidé goats as affected by two levels of feeding. *Meat Sci.* 80(4): 1019-1023.
- Memisi N, Bauman F (2002). *Goat*, Agriculture library, Belgrade, p. 75.
- Memisi N, Bauman F (2007). *Goat Nutrition*. Admiralbooks, Belgrade, p. 230.
- Memisi N (2009). Proizvodne i klanicne karakteristike jarica domace balkanske koze. *Tehnologija mesa*, 3-4, 50: 205-210.
- Mushi ED, Eik OL, Thomassen SM, Sørheim O, Ådnøy T (2008). Suitability of Norwegian short-tail lambs, Norwegian dairy goats and Cashmere goats for meat production-Carcass, meat, chemical and sensory characteristics. *Meat Sci.* 80: 842-850.
- Peña F, Bonvillani A, Freire B, Juárez M, Perea J, Gómez G. (2009). Effects of genotype and slaughter weight on the meat quality of Criollo Cordobes and Anglonubian kids produced under extensive feeding conditions. *Meat Sci.* 83: 417-422.
- Ryan MS, Unruh AJ, Corrigan EM, Drouillard SJ, Seyfert M. (2007). Effects of concentrate level on carcass traits of Boer crossbred goats. *Small Rumin. Res.* 73: 67-76.
- Shrestha JNB, Fahmy MH (2005). Breeding goats for meat production: a review. 1. Genetic resources, management and breed evaluation. *Small Rumin. Res.* 58: 93-106.
- Stamenkovic T, Devic B (2006). Senzorska svojstva ovcije stelje. *Tehnologija mesa*, 3-4, 47: 115-122.
- Todaro M, Corrao A, Alicata ML, Shinelli R, Giaccone P, Priolo A (2004). Effects of litter size and sex on meat quality traits of kid meat. *Small Rumin. Res.* 54: 191-196.
- Tomic Z, Nestic Z, Mrfat-Vukelic S, Zujovic M. (2005). Quality and plant association structure of grasslands on Stara Planina Mountain, 8<sup>th</sup> International Symposium Modern Trends in Livestock Production. *Biotechnol. Anim. Husbandry*, 21: 253-258.
- Tomic Z, Nestic Z, Zujovic M, Maksimovic N, Stanisic N (2009). Floristic Composition of Permanent Grassland On The Stara Planina Mountain, IV International Symposium of Livestock Production Ohrid, Macedonia, Proceedings.
- Troskot A, Pavicic Z (2007). Proizvodnja i kakvoća kozjeg mesa. *Meso*, 1, 11: 43-46
- Wattanachant S, Sornprasitt T, Polpara Y. (2008). Quality characteristics of raw and canned goat meat in water, brine, oil and Thai curry during storage. *Songklanakarin, J. Sci. Technol.* 30 (Suppl. 1): 41-50.
- Zujovic M, Memisi N, Ivanovic S (2011). Present status, possibilities and perspective of development of goat production in Republic of Serbia. 3<sup>rd</sup> International congress on animal husbandry "New Perspectives and Challenges of Sustainable Livestock Production", *Biotechnol. Anim. Husbandry*, 27(3): 431-443.