COMPARATIVE EXAMINATION OF THE MEAT QUALITY OF THE FEMALE CATTLE OF SIMMENTAL BREED AND CROSSES WITH CHAROLAIS BREED

Maja Petričević, Aleksandar Stanojković, Dušica Ostojić-Andrić, Dragan Nikšić, Veselin Petričević, Marija Gogić, Violeta Mandić

Institute for Animal Husbandry, Autoput 16, P. Box 23, 11080 Belgrade-Zemun, Republic of Serbia
Corresponding author: majanovakovic@live.com
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Abstract: The paper presents the results of a comparative examination of the beef quality obtained from females of two genotype groups: domestic Simmental breed (A) and its crosses with Charolais breed. The sample included a total of 20 heads, 10 in each group. Cattle were slaughtered at the same age with uniform body weights. After slaughtering, warm carcass sides were individually weighed, with and without kidney fat. After cooling, the left carcass sides were cut into the basic parts according to the Rulebook and the three-rib cut was cut off from the back part (9-10-11 rib). The content of tissues in the three-rib cut was statistically different among the groups, the content of muscle tissue was significantly higher ($p < 0.05$) in cattle of the group (A) and the content of fat tissue was statistically ($p < 0.05$) significantly higher in the group (B). The chemical composition of *M. longissimus dorsi* did not differ statistically between groups. The technological quality of the meat was evaluated through the tenderness of the *M. longissimus dorsi* which was statistically significantly better ($p < 0.05$) in the cattle of the group (B) and the content of total pigments statistically ($p < 0.05$) significantly higher in the cattle of group (B). The sensory traits of *M. longissimus dorsi* did not differ statistically significantly between groups.

Key words: Simmental breed, *M. longissimus dorsi*, instrumental colour, instrumental texture, sensory properties

Introduction

Meat is the indispensable component of the highest quality of the right and well-balanced human diet (*Biesalski, 2005*). The definition of meat quality is very complex and can be presented through nutritive, technological and sensory quality of meat.

Nutritional aspect of meat quality can be referred to the content of proteins and fats. Beef is characterized by exceptional nutritional value compared to other types of meat (*Petrović et al., 2002*). Numerous factors (breed, sex, age, diet, production method) affect the variation in the chemical composition of beef. Literary data on meat fat content vary and show great variability associated with production and genetic factors. The fat content in meat ranges from 1-20% (*Žlender and Gašparlin, 2005*). Although fats are considered to be an unfavorable meat component, fat and fatty acids are factors that determine the nutritional quality of the meat and significantly affect the sensory properties of the meat (*Lefaucheur, 2010*). The fat content of the muscle tissue contributes to the succulence, taste, texture and preferable sensory properties (*Šević et al., 2017*).

The technological quality of meat represents its suitability for different processing methods, and comprises technological and physical-chemical properties, pH value, colour intensity, firmness and uniformity of the meat structure (*Mancini and Hunt, 2005* and *Dalmau i sar., 2009*).

Sensory quality of the meat includes a range of properties (colour, marbling, tenderness, succulence, odour, taste) and has great impact on consumer satisfaction (*Dransfield et al., 2003*). In order to assess the quality of meat, a good knowledge of these meat properties is needed. The quality of meat is affected by the characteristics of the animal's muscles and *post mortem* biochemical reactions (*Ouali, 1990; Dransfield et al., 2003*).

The numerous biological, physiological and technological factors influence the yield and quality of beef meat. Consumer demands are changing in the direction towards better meat quality with less fat content. In order to achieve this, adequate nutrition of cattle is necessary, also important is the choice of breed for fattening, the system keeping and housing of fattening cattle and pre-slaughter body weight of animals (*Dokmanović et al., 2014*). The entire process of meat production, from genetics and selection, management of animals to processing and storage of meat, can affect the characteristics of meat. Therefore, the task of each segment of the production chain is to adapt production processes in order to ensure the production of desirable, quality meat (*Karolyi, 2006*).

Materials and Methods

The trial was carried out at the experimental farm of the Institute for Animal Husbandry (Belgrade, Serbia). Two groups of female cattle were formed: group A (n = 10) Simmental breed and group B (n = 10) crosses of F1 generation of this breed with the Charolais breed. Both groups of cattle were fed at will with a

combined diet consisting of whole maize plant silage according to the nutrition table depending on the weight group. Final pre-slaughter weights were uniform between groups. One day before slaughter, animals did not receive food, but they had free access to water. Animals were measured just before slaughter and then slaughtered according to standard commercial procedures. Slaughtering and primary processing of carcasses, cutting off the carcass sides and dissection of the three-rib cut were carried out in the experimental slaughterhouse, and the chemical composition, technological and sensory properties determined in the laboratory of the Institute for Animal Husbandry. The three-rib cut (9-10-11 rib) was separated from the left chilled carcass side by a cut along the cranial edge of the 9th and 11th ribs and the cut parallel to the spinal column. The weighing scale of accuracy of 0.001 kg, was used to measure the weight of muscle (especially measured M. *longissimus dorsi*), fat and connective tissue and bones. The chemical composition of the M. *longissimus dorsi* sample was determined (water content - method of sample drying at 103 ± 2 ºC (SRPS ISO 1442, 1998), fat content by the Soxhlet extraction method (SRPS ISO 1444, 1998), the amount of mineral matter (ash) by the method of sample burning at temp. 550 ± 25 ºC (SRPS ISO 936, 1999) and protein content by the Kjeldahl method (SRPS ISO 937, 1992).

Following technological properties of the *M. longissimus dors*i sample were determined: the cooking loss, based on the difference in weight of meat pieces (size: 3 x 4 x 1.5 cm and weight about 70 g) before and after cooking in distilled water (where the meat to water ratio was 1: 2) in a closed glass vessel (at 100 ° C for 10 min) and expressed in percentages relative to the weight of the sample before cooking (Official Gazette of SFRY, No. 2/85, 12/85 and 24/86); the roasting loss, based on the difference in the weight of the pieces of meat before and after roasting. The cut of *M. longissimus dorsi*, which was transversely cut into a muscle fiber parabolic, weighing 150 ± 1 g, was rolled into aluminum foil and roasted for 25 minutes at 250 ° C. The meat was removed from the foil immediately after roasting and measured/weighed. Softness (tenderness) of meat was determined using the consistometer according to Volodkevich (1938) by cutting a piece of meat transversely to the direction of muscle fibers. The pH value of meat, 24 hours post mortem, was measured using pH-meter with combined probing electode Hanna HI 83141 (Hanna Instruments, USA). Before measuring the pH in the meat, the calibration of the pH meter was carried out using a buffer of known pH value (pH = 5).Determination of total pigments was carried out using the Horsney method (*Bunning and Hamm, 1970*) wherein the total pigment content was expressed in mg/kg. The *M. longissimus dorsi* cross-section was determined at the cross-section of the *M. longissimus dorsi* in the area of the 11th rib by marking on the paus paper and then measuring using the planimeter. Instrumental colour measurement was done with the Chroma Meter CR-400 (Minolta, Japan), which was previously calibrated against a standard white surface (illumination D65, viewing angle 2 ° and 8 mm probe) using fresh meat samples (24 hours *post-*

mortem). Meat samples were cut and left for 30 minutes in air to stabilize the colour. The values of the colour are presented in the CIE L*a*b* system (*CIE, 1976*), where the measure L* indicates the lightness of the meat, a * the relative share of the colour red and b * relative share of the colour yellow. For each sample of meat, three readings were made and their mean value was used for statistical data processing. Sensory assessment of odour, taste, tenderness and succulence of meat was carried on a piece of meat after determining the cooking loss. Seven semi-trained assessors were included in sensory evaluation. For each evaluated parameter, a quantitative-descriptive scale of 5 points was used: odour and taste : 1 - very bad, 2 - bad, 3 - nor bad or good, 4 -good, 5 - very good; tenderness: 1 - very firm, 2 –firm, 3 – nor firm or soft, 4 - soft, 5 - very soft; succulence: 1 - very dry, 2 - dry, 3 – nor dry or succulent, 4 - succulent, 5 - very succulent.

The obtained data were processed by analysis of variance in one-way ANOVA program SPSS Statistics 20, and all results are displayed as the mean value ± standard deviation. The statistical significance of the difference between mean values was determined by t-test.

Results and Discussion

Table 1 shows the proportion of individual tissues in the three-rib cut. The share of *M. longissimus dorsi* did not differ between groups. The share of other muscle tissue in the group (A) statistically significantly ($p<0.05$) differed from the group (B). The statistically significant ($p<0.05$) difference was found in the content of fatty tissue that was higher in group (B) and was 23.92% compared to cattle in group (A) - 18.89%.

In the research of *Petričević et al. (2015)* the share of *M. longissimus dorsi* is 29.9%, the remaining muscle tissue is 32.06%, fat tissue 19.93%, connective tissue 0.84% and bone 16.96% determined in the females of Simmental breed.

Table 1. The share of tissues in three-rib cut

Item	A	B	t-test
Three-rib cut (%)			
M. longissimus dorsi	34.26 ± 5.63	34.53 ± 4.00	ns
Other muscle tissue	30.43 ± 2.89	23.30 ± 3.80	*
Fat tissue	18.89 ± 5.40	23.92 ± 4.14	*
Connective tissue	0.71 ± 0.42	0.93 ± 0.08	ns
Bones	15.54 ± 6.61	16.67 ± 3.78	ns

ns – not significant
* significant at the level of ($p<0.05$)

The chemical composition of *M. longissimus dorsi* is shown in Table 2. There was no statistically significant difference in the chemical composition of *M.*

longissimus dorsi. Petričević et al. (2015) report the following values: the water content 73.54%, fat content 3.33%, ash 1.07% and protein 22.04% for females of domestic Simmental breed. In the paper by *Filipčík et al. (2009)*, the protein content is 21.13% for the female crosses of the Simmental and Charolais breed. *Śmiecińska et al. (2006)* state that the fat content ranges from 2.73 to 2.94%, protein 21.47 to 21.64%, ash 1.11 to 1.13% and water 74.00 to 74.90%, in female crosses of the Simmental and Charolais breed. In their research, *Bures and Bartoň (2012)* confirm the value of the protein content of 21.20% for the female crosses of the Simmental breed and Charolais, while the value of the dry matter is 26.60%.

Table 2. The chemical composition of M. *longissimus dorsi*

Item	A	B	t-test
Water, (%)	73.08 ± 1.58	73.11 ± 1.29	ns
Fat, (%)	2.80 ± 1.84	2.95 ± 1.42	ns
Ash, (%)	1.03 ± 0.09	1.08 ± 0.03	ns
Protein, (%)	23.07 ± 0.49	22.86 ± 0.32	ns

ns – not significant

Table 3 shows the technological properties of *M. longissimus dorsi* significant difference (p p<0.05) was found in meat softness that was more favourable in group (B). The content of total pigments was statistically significantly (p <0.05) higher in group (B) and amounted to 198.57 mg/kg compared to the group (A) - 161.02 mg/kg.

The colour of meat plays an important role in the purchase of meat and can be influenced by numerous factors before and after slaughter (*Mancini and Hunt, 2005*). The colour of the meat surface is inversely related to the iron content that increases with the age of the animal (*Chambaz et al., 2003*). Changes in the meat brightness can be explained by changes of the final pH and intramuscular fat content (*Priolo et al., 2001*). An increase in the pH value 48 hours *post mortem* leads to a change in the colour of beef (*Węglarz, 2010*). In the paper by *Filipčík et al. (2009)* pH value of 5.50, value L * 38.67, a * 12.52 and b * 11.05 are reported. The cooking loss is 28.50% for the female crosses of the Simmental breed and Charolais. In the research of *Petričević et al. (2015),* the value of cooking loss is 26.64%, roasting loss 38.81%, meat colour (L *) 38.44%, softness 9.77% and pH24 5.52 for female cattle of domestic Simmental breed. *Śmiecińska et al. (2006)* state the pH value from 5.40 to 5.41 for female crosses of the Simmental breed and Charolais. *Bureš and Bartoň (2012)* cite the value of 58.6 cm^2 for the surface of the *M. longissimus dorsi* cross section, while the pH24 is 5.46 for the female crosses of Simmental and Charolais breed. The value of L* is 42.20, a* 13.70 and b* 13.00 for female crosses of the Simmental breed and Charolais (*Bures and Bartoň, 2012*).

Table 3. The technological properties of *M. longissimus dorsi*

Item	A	B	t-test
Cooking loss, %	40.60 ± 1,72	40.36 ± 0.21	ns
Roasting loss, %	40.07 ± 2.66	38.56 ± 0.23	ns
Softness/tenderness	10.93 ± 2.34	8.51 ± 0.72	*
pH $_{24}$	5.50 ± 0.07	5.56 ± 0.01	ns
Total pigments (mg/kg)	161.02 ± 52.19	198.57 ± 18.32	*
Cross-section surface *M. longissimus dorsi* (cm^2)	77.49 ± 9.78	76.07 ± 6.37	ns
Colour			
L*	36.42 ± 0.51	37.08 ± 0.19	ns
a*	19.54 ± 0.52	20.23 ± 0.35	ns
b*	5.86 ± 1.36	6.08 ± 0.07	ns

ns – not significant

* significant at the level of (p<0.05)

The sensory properties of cooked and roasted meat are shown in Table 4. Based on the results of the sensory evaluation of *M. longissimus dorsi*, the statistical significance of the parameters tested was not observed. The sensory evaluation (odour, taste, softness, succulence) of cooked and roasted meat was practically the same in both groups of cattle (average aggregate estimate), group (A): cooked meat - 4.61 and roasted meat - 4.92; group (B): cooked meat - 4.72 and roasted meat - 4.92. Better sensory estimates were determined in animals of the group (B) in all parameters.

Table 4. The sensory properties of *M. longissimus dorsi*

Item	A	B	t-test
Cooked			
Odour	4.88 ± 0.25	5.00 ± 0.00	ns
Taste	4.93 ± 0.19	5.00 ± 0.00	ns
Tenderness	4.37 ± 0.75	5.00 ± 0.00	ns
Succulence	4.25 ± 0.87	4.67 ± 0.58	ns
Roasted meat			
Odour	4.88 ± 0.25	5.00 ± 0.00	ns
Taste	4.75 ± 0.50	5.00 ± 0.00	ns
Tenderness	4.62 ± 0.75	5.00 ± 0.00	ns
Succulence	4.62 ± 0.75	4.67 ± 0.58	ns

ns – not significant

The tenderness (texture) and succulence of cooked or roasted meat, and to a certain extent aroma and taste, as reported by *Petričević et al. (2015),* are important parameters of meat quality. *Glitsch, (2000)* also states that the tenderness and taste are the most important attributes that determine the quality of food in Europe. Differences in the sensory properties of the meat can occur as a result of the different content of intramuscular fat in the meat (*Christensen et al., 2011).*

Based on the results of the sensory evaluation of the cooked meat, *Petričević et al. (2015)* state that the tenderness of the meat in female cattle is statistically significantly better compared to the males of the Simmental breed.

Conclusion

Based on the results of the study, it can be concluded:

- Simmental cattle of group (A) achieved statistically significant (p<0.05) greater share of remaining muscle tissue and significantly (p<0.05) lower share of fat tissue in the three-rib cut;
- Crosses of Simmental breed and Charolais - group (B) had statistically significant (p<0.05) better meat tenderness and significantly (p<0.05) greater content of total pigments;

Based on presented results, it can be concluded that the female beef of the domestic Simmental breed and crosses of Charolais with Simmental breed have approximately the same quality of meat except in regard to the tissue of the three-rib cut, which was better in the Simmental breed, and in regard to the meat tenderness which was better in crosses of Charolais with Simmental breed.

Uporedno ispitivanje kvaliteta mesa ženske junadi simentalske rase i meleza šarolea sa simentalskom rasom

M. Petričević, A. Stanojković, D. Ostojić-Andrić, D. Nikšić, V. Petričević, M. Gogić, V. Mandić

Rezime

U radu su prikazani rezultati uporednog ispitivanja kvaliteta mesa junadi ženskog pola dve genotipske grupe: domaće simentalske rase (A) i njenih meleza sa šarole rasom. Uzorkom je obuhvaćeno ukupno 20 grla, po 10 u svakoj grupi. Junad su zaklana u istom uzrastu sa ujednačenim telesnim težinama. Nakon klanja izvršeno je pojedinačno merenje toplih polutki sa i bez bubrežnog loja. Posle hlađenja leva polutka je rasecana u osnovne delove prema pravilniku i iz leđnog dela izdvojen je trorebarni isečak (9-10-11 rebro). Udeo tkiva u trorebarnom isečku se statistički razlikovao među grupama i to u udelu mišićnog tkiva koji je bio

statistički (p<0.05) značajno veći kod junadi grupe (A) i udelu masnog tkiva koji je bio statistički (p<0.05) značajno veći u grupi (B). Hemijski sastav *M. longissimus dorsi* se nije statistički razlikovao između grupa. Što se tiče tehnološkog kvaliteta, mekoća *M. longissimus dorsi* je statistički (p<0.05) značajno bila bolja kod junadi grupe (B) i sadržaj ukupnih pigmenata je statistički (p<0.01) značajno bio veći kod junadi grupe (B). Senzorne karakteristike *M. longissimus dorsi* nisu se statistički značajno između grupa.

Ključne reči: simentalska rasa, M. *longissimus dorsi*, instrumentalna boja, instrumentalna tekstura, senzorne osobine

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