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IN LIVESTOCK PRODUCTION

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INSTITUTE FOR ANIMAL HUSBANDRY
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THE EFFECT OF CROSSING SIMMENTAL CATTLE WITH FRENCH BEEF CATTLE BREEDS ON SLAUGHTER PROPERTIES AND QUALITY OF MEAT

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Abstract: The study presents the review of the results and impact of crossing of Simmental breed with French fattening breeds on slaughter properties of meat and meat quality. The investigation of technological properties and sensory characteristics was conducted on a MLD sample of the region of 10th to 12th vertebra. Statistical and mathematical analysis was performed using the method of Least Squares mixed model with fixed effects (LS - Least Squares). The obtained results showed significant deviations of carcass weight and the amount of bones in carcass sides ($P < 0.05$) from the average. In crosses of F_1 generation obtained by crossing of Simmental cows with Limousine bulls higher meat yield by 11.5 kg was realized compared to the general average, and by 30.7 kg higher meat yield than in Simmental cattle. Highly significant deviation from the general average ($P < 0.01$) was observed in slaughter yield (dressing percentage) and quantity of meat and fat in the carcass sides. Cross-section of MLD was the largest in meat of cattle (Simmental x Charolais). By using the method of sensory evaluation results were established for the important parameters of quality, softness/tenderness ("firmness" or texture) and succulence ("drieness") of cooked or roasted meat ($P < 0.01$).

Keywords: beef, MLD, sensory properties, Simmental, Limousine, Charolais, technological quality

Introduction

Less than 35% of livestock production in total agricultural production (Serbia) indicates an under-developed agriculture of our country. Especially pronounced decline is in cattle population and thus the decline reflects on the production of products of animal origin (meat, milk). Therefore to make use of natural resources and to be able to be competitive in other markets, it is necessary

to look in livestock and cattle production for new models in meat production to bring about positive effects on the domestic market and export (Jukna *et al.*, 2009). Beef production in Serbia is mostly based on Simmental breed. The largest cattle breed in the Republic of Serbia is Simmental (about 85% of the population, or about 360.000 cows and heifers. Beef production for the last two decades in Serbia has decreased by more than 50.000 tons, according to Petrović *et al.*, (2011 and 2013). Crossing of different cattle breeds to obtain progeny that will exhibit improved properties with respect to the fattening and slaughter traits, have been used for decades in the World and Europe, as well as to achieve higher body mass for a shorter duration of fattening, greater daily weight gain and have better carcass characteristics of meat (heterosis effect). By applying the method of crossing in the offspring (F₁ generation) heterosis is manifested in fattening traits and meat quality traits. Factors contributing to the quality and quantity of meat are different and are of genetic and paragenetic nature (housing, rearing, care, food, etc.). The quality of meat is affected by the preparation for slaughter and post-mortem effects (slaughter, cooling of meat, etc..) Most authors have conducted research on the effects of crossing of different breeds of cattle on the yield and quality of beef - Aleksić *et al.*, (2006), Jukna Č. and Jukna V., (1998), Ostojić-Andrić *et al.*, (2011), Maloney (2004), Pavlovski *et al.*, (2004), Petrović *et al.*, (2007) and Sazili *et al.*, (1996). Research results obtained by these groups of authors have indicated positive effects of crossing of several cattle breeds with French and other beef cattle breeds on the yield and quality of meat. Results of our research related to sensory and organoleptic properties of meat were generally consistent with those reported by other researchers indicating minor differences in the effect of the genetic structure on the mentioned properties (Aleksić *et al.*, 2011; Buchter, 1985; Harrington, 1985; Ostojić-Andrić *et al.*, 2008).

Material and Method

The present research included three groups of cattle of different genetic structure. The first group of slaughter cattle comprised the crosses of Simmental cows of lower production performance in regard to milk production with Charolais bulls (27 animals). The second group consisted of cattle, F₁ generation obtained by crossing of Simmental cows and bulls of French Limousine breed (23 animals). The third group of slaughter cattle were Simmental cattle (20 head). Young cattle obtained in our research were reared on experimental cattle farm of the Institute for Animal Husbandry, Belgrade-Zemun. Slaughter of animals and primary processing were carried out in the experimental slaughterhouse of the Institute and physical-chemical, thermal and other sensory testing in the laboratory of the Institute of Animal Husbandry. Upon completion of cooling, for 24 hours at 4⁰C, dissection of

the three rib cut was performed. Three rib cut (region of the 9th-10th-11th rib) was always cut from the left chilled carcass side along the cranial line from 9 to 11 rib and cut parallel to the spinal column and vertical to the ribs. Investigation of physical-chemical properties and organoleptic properties was carried out on a sample of MLD, region of 10th to 12th vertebra. The evaluation was performed by three member score panel, using the score from 1 to 5, after reaching the harmonization of assessments and opinions.

Statistical and mathematical analysis was performed using the Least Squares Mixed Model with fixed effects (LS - Least Squares) using the Least-Squares Program (LSMLMW), Harvey, in 1990. When analyzing the impact of genetic groups of cattle on meat quality traits, the following model was used:

$$Y_{ij} = \mu + GG_i + b_1(x_1 - x_2) + e_{ij}$$

Where:

- μ = general average,
- GG_i = fixed effect of genetic group (1-3),
- b_1 = linear regression effect of pre-slaughter body weight,
- e_{ij} = random error

Results and Discussion

Statistical analyzes showed significant deviations of carcass weight and the amount of bone in the carcass ($P < 0.05$), from the general average. In F_1 generation crosses obtained by crossing of Simmental cows with Limousine bulls, the higher meat yield was realized by 11.5 kg than the general average, and by 30.7 kg than in Simmental cattle (Table 1).

Table 1. Slaughter properties of cattle, the mean values (LSM), the error of mean values (SE) and the deviation from the general average (\hat{c}_i)

Traits	LSM	S.E.	Sim x Cha (\hat{c}_i)	Sim x Lim (\hat{c}_i)	Simm (\hat{c}_i)	F _{exp.}
Carcass weight with fat, kg	399.9	2.1	7.7	11.5	-19.2	*
Killing out, %	60.0	0.5	1.7	2.1	-3.8	**
Kidney fat, kg	5.1	0.3	-0.8	0.7	0.1	NS
Carcass side meat, kg	141.0	1.8	9.1	5.3	-14.4	**
Carcass side bones, kg	27.5	0.9	-1.0	-0.7	1.7	*
Carcass side fat, kg	6.1	0.3	-0.9	-0.6	1.5	**

NS NOT significant ($P > 0.05$), * Significant ($P < 0.05$), ** Highly Significant ($P < 0.01$)

Sim x Cha - F_1 generation between Simmental and Charolais beef cattle

Sim x Lim - F_1 generation between Simmental and Limousine beef cattle

Simm - F_1 generation between Simmental and Limousine beef cattle

Highly significant deviations from the general average ($P < 0.01$) were observed in regard to slaughter yield trait and quantity of meat and fat in the carcass side. Thus, the carcass yield of Simmental cattle was lower by 3.8% than the general average and by 5.9% lower than in crossbred cattle (Limousin x Simmental). Animals, crosses of Simmental x Charolais had more meat in the carcass sides by 9.1 kg and 23.5 kg more than the Simmental breed (Table 1).

The influence of the genetic structure on traits of MLD as LSM deviations (\hat{c}_i) is shown in Table 2. Results obtained for MLD properties revealed statistically significant deviations from the general average in terms of colour and pH_{24} value of MLD ($P < 0.05$). Colour of meat of cattle - crosses with the French beef cattle breeds was brighter compared to red meat of MLD from Simmental breed. For properties of marbling and muscle structure of MLD no significant differences ($P > 0.05$) were established.

Table 2. MLD[#] and pH_{24} value and physical characteristics of meat

Traits	LSM	S.E.	Sim x Cha (\hat{c}_i)	Sim x Lim (\hat{c}_i)	Simm (\hat{c}_i)	F _{exp.}
Colour (1-5)	4.6	0.09	0.31	0.42	-0.73	*
Marbling (1-5)	4.5	0.07	-0.27	0.18	0.09	NS
Structure estimate.(1-5)	4.5	0.07	0.29	0.49	-0.78	NS
pH₂₄ value	5.9	0.05	-0.09	-0.10	0.19	*
Physical characteristics of meat						
Firmness (Voloktiewitsch)	5.8	.08	-0.9	-1.0	1.8	**
Muscle fibre diameter, μm	45.9	.09	-1.4	-1.8	3.2	**
Total pigment, ppm	85.9	1.1	0.5	3.3	-3.8	*
Muscle eye MLD, cm^2	104.9	.71	2.7	-1.0	-1.7	**

^{NS} NOT significant ($P > 0.05$), * Significant ($P < 0.05$), ** Highly Significant ($P < 0.01$)

MLD# - musculus longissimus dorsi

Statistically significant deviations ($P < 0.01$) of physical characteristics of meat (meat firmness, thickness of muscle fiber and cross-sectional area of MLD) were established. The total meat pigment showed significant variation ($P < 0.05$). Cross-section of MLD was the largest in meat of cattle Simmental x Charolais.

Table 3. Organoleptic traits

Traits	LSM	S.E.	Sim x Cha (\hat{c}_i)	Sim x Lim (\hat{c}_i)	Sim (\hat{c}_i)	F _{exp.}
Organoleptic traits						
Cooking test - firmness (1-5)	4.5	0.09	0.39	0.41	-0.91	**
Cooking test – dryness (1-5)	3.7	0.09	0.33	0.39	-0.72	**
Cooking test – taste (1-5)	4.1	0.07	0.09	0.06	-0.15	**
Cooking test – aroma (1-5)	4.2	0.08	-0.10	0.19	-0.09	NS
Roasting test – firmness	4.5	0.06	0.12	0.29	-0.41	*
Roasting test – dryness	3.6	0.07	0.08	0.09	-0.17	*
Roasting test – taste	4.0	0.09	-0.11	0.20	-0.09	*
Roasting test – aroma	4.1	0.07	-0.10	0.05	0.05	NS

^{NS} NOT significant (P>0.05), * Significant (P<0.05), ** Highly significant (P<0.01)

The results of the impact of genetic structure of cattle on organoleptic properties are shown in Table 3. By using the method of sensory evaluation results were obtained for the important parameters of meat quality, softness/tenderness ("firmness" or texture) and succulence ("dryness") of cooked or roasted meat (P<0.01).

Conclusion

The results of the present study showed that in the statistical analyzes, significant deviations of carcass weight and the amount of bones in carcass sides (P<0.05) from the average were established. In F₁ generation crosses obtained by crossing of Simmental cows with Limousine bulls, the higher meat yield was realized by 11.5 kg than the general average, and by 30.7 kg than in Simmental cattle.

Highly significant deviations from the general average (P<0.01), were observed for slaughter yield trait and quantity of meat and fat in the carcass sides. Results obtained for MLD properties revealed statistically significant deviations from the general average in terms of colour and pH₂₄ value of MLD (P<0.05). Colour of meat of cattle - cross with the French beef cattle breeds was brighter than red meat of MLD from Simmental cattle. For properties of marbling and muscle structure of MLD no significant differences (P>0.05) were established.

Statistically significant deviations (P <0.01) of physical characteristics of meat (meat firmness, thickness of muscle fiber and cross-sectional area of MLD) were established. Cross-section of MLD was the largest in meat of cattle Simmental x Charolais. By using the method of sensory evaluation results were obtained for the important parameters of meat quality, softness/tenderness

("firmness" or texture) and succulence ("dryness") of cooked or roasted meat ($P < 0.01$).

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Efekat ukrštanja simentalске sa francuskim tovnim rasama goveda na klanične karakteristike i kvalitet mesa

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Rezime

Manje od 35% stočarstva u ukupnoj poljoprivrednoj proizvodnji (Srbija) ukazuje na nedovoljno razvijenu poljoprivredu naše zemlje. Posebno je izražen pad broja grla goveda a samim tim i proizvodnje produkata animalnog porekla (meso, mleko). Proizvodnja junećeg mesa u Srbiji se uglavnom zasniva na simentalскоj rasi. Proizvodnja junećeg mesa je za dve zadnje decenije u Srbiji smanjena za više od 50.000t. Primenom metoda ukrštanja kod potomaka (F_1 generacija) se ispoljava efekat heterozisa kako osobina tovnosti tako i svojstava kvaliteta mesa. Faktori koji doprinose količini i kvalitetu mesa su različiti i odnose se na genetske i paragenetske (odgoj, nega, ishrana i dr). Na kvalitet mesa utiče priprema za klanje, i postmortalni uticaji (klanje, postupak hlađenja mesa i dr.).

Naša istraživanja su obuhvatila tri grupe junadi različite genetske strukture. Prva grupa junadi za klanje je dobijena iz ukrštanja simentalске rase goveda nižih proizvodnih sposobnosti u pogledu proizvodnje mleka i bikova šarole rase. Druga grupa je obuhvatila junad, meleze F_1 generacije dobijene ukrštanjem krava simentalске rase i bikova francuske limuzin rase. Treća grupa junadi za klanje su bila grla simentalске rase. Junad obuhvaćena našim istraživanjem su dobijena i gajena na ekperimentalnoj farmi goveda, Instituta za stočarstvo, Beograd-Zemun. Klanje grla i primarna prerada su obavljani u kapacitetu ekperimentalne klanice Instituta a fizičko-hemijska, senzorna termička i druga ispitivanja u laboratoriji Instituta za stočarstvo. Po završenom hlađenju, tokom 24 na 4°C , obavljena je disekcija trorebarnog kotleta. Trorebarni kotlet (regija 9-10-11 rebro) je uvek odsecan od leve ohlađene polutke duž kranijalne linije od 9 do 11. rebra i paralernim rezom u odnosu na kičmeni stub i vertikalnim rezom u odnosu na rebra.

Ispitivanje fiziko-hemijskih osobina i organoleptičkih osobina obavljeno je na uzorku MLD-a regija 10. do 12. kičmenog prsljena. Ocenjivanja su obavili trojica ocenjivača ocenom od 1-5 nakon usaglašavanja ocena i mišljenja. Statističko-matematička analiza obavljena je primenom mešovitog modela najmanjih kvadrata sa fiksnim uticajima (LS - Least Squares).

Statistički analizirano, ustanovljena su značajna odstupanja mase trupa i količine kosti u u polutkama ($P < 0.05$) od opšteg proseka. Kod meleza F_1 generacije dobijenih ukrštanjem simentalских krava sa limozin bikovima je ostvaren prinos mesa za 11.5 kg više u odnosu na opšti prosek, odnosno 30.7 kg više u odnosu na junad simentalске rase.

Visoko značajna odstupanja od opšteg proseka ($P < 0.01$) su ustanovljena kod osobina randmana klanja i količine mesa i loja u polutkama. Tako je randman klanja kod junadi simentalске rase za 3.8% manji u odnosu na opšti prosek i 5.9% manji u odnosu na grla meleze (simmental x limousin). Grla, melezi (simmental x sharolais) su imali više mesa u polutkama za 9.1 kg odnosno 23.5 kg više u odnosu na količinu mesa junadi simentalске rase.

Uticaj genetske strukture na osobine MLD kao LSM odstupanja (či) prikazan je u tabeli 2. Rezultati osobina MLD ukazuju na statistički analizirano značajna odstupanja od opšteg proseka u pogledu boje i vrednosti pH24 value MLD ($P < 0.05$). Boja mesa grla junadi dobijenih iz ukrštanja sa francuskim tovnim rasama je svetlija u odnosu na crveno meso MLD junadi simentalске rase. Za osobine mramoritosti i strukturu mišića MLD nisu ustanovljene značajne razlike ($P > 0.05$). Ustanovljena su statistički visoko značajna odstupanja ($P < 0.01$) fizičkih karakteristika mesa (tvrdoće mesa, debljine mišićnog vlakna i površine poprečnog preseka MLD). Ukupni pigment mesa je pokazao značajna variranja ($P < 0.05$).

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