

UTJECAJ GENOTIPA I SPOLA NA INTENZITET RASTA, ODLIKE TRUPA I MESA JUNADI KRIŽANACA HOLŠTAJNA S MESNIM PASMINAMA GOVEDA

SAŽETAK

Proizvodnja goveđeg mesa usmjerena je na optimizaciju intenziteta rasta, klaoničkih odlika trupa i stabilnosti kvalitativnih svojstava mesa, koji imaju ključnu ulogu u učinkovitosti i konkurentnosti proizvodnje. Na navedene pokazatelje utječu genotip, hranidba, dob, spol i uvjeti tova. Cilj istraživanja bio je utvrditi utjecaj genotipa i spola na intenzitet rasta, odlike trupa i mesa križanaca holštajna s mesnim pasminama, pri čemu su geni *CAPN1*, *DGAT1* i *TG* korišteni kao genetski markeri. Istraživanje je provedeno na 134 jedinke (63 junadi i 71 junica) križanaca holštajna (HOL) s pasminama simentalac (SIM), belgijsko plavo govedo (BPG), piemontese (PIE) i limuzin (LIM), praćenih od teljenja do završetka tova u dobi od 15 do 16 mjeseci. Analizom frekvencija genotipova potvrđen je polimorfizam sva tri gena (*CAPN1*, *DGAT1* i *TG*), pri čemu su najzastupljeniji genotipovi bili *CAPN1*-GG (0,555), *DGAT1*-KA (0,925) te *TG*-CC (0,747).

Analizirani geni nisu pokazivali izravan učinak na intenzitet rasta (porodna i završna masa, bruto i neto prirast), klaoničke odlike trupa (klasa trupa, stupanj zamašćenja, masa toplih i hladnih polovica te topli i hladni randman) i pokazatelje kvalitete mesa poput intramuskularne masti i mramoriranosti. Međutim, utvrđen je značajan utjecaj *DGAT1* gena na boju mesa u *m. gracilis* ($p < 0,05$).

Križanci HOL × SIM i HOL × BPG ostvarili su najbolje pokazatelje rasta. Također, HOL × SIM imali su povoljnije klaoničke odlike u odnosu na HOL × LIM te višu ocjenu mramoriranosti i veći udio IMF u odnosu na HOL × BPG i HOL × PIE.

Spol se pokazao kao ključni čimbenik koji utječe na intenzitet rasta (porodna i završna masa, bruto i neto prirast; $p < 0,001$), klaoničke odlike trupa (klasa trupa, stupanj zamašćenja, masa toplih i hladnih polovica, topli i hladni randman te sastav tkiva; $p < 0,001$) i pokazatelje kvalitete mesa poput pH24 u *m. gracilis* ($p < 0,05$) i boje mesa u *m. gracilis* ($L^{*}24$, $p = 0,005$; a^{*} i b^{*} , $p < 0,001$) i MLD ($L^{*}24$, $p = 0,006$; $b^{*}24$, $p = 0,05$), mramoriranosti ($p < 0,001$) te nutritivnog sastava mesa MLD-a (udio vode, proteina, IMF-a te pepela; $p < 0,001$). Za pouzdaniju procjenu učinka polimorfizama potrebna su daljnja istraživanja na većem broju jedinki i u različitim uzgojnim uvjetima. Integracija proizvodnih i molekularno-genetskih pokazatelja važna je za unapređenje selekcije i učinkovitosti proizvodnje i kvalitete goveđeg mesa.

Ključne riječi: *CAPN1*, *DGAT1*, *TG*, spol, intenzitet rasta, odlike trupa i mesa junadi

THE INFLUENCE OF GENOTYPE AND SEX ON GROWTH INTENSITY, CARCASS AND MEAT CHARACTERISTICS IN CROSSBREDS OF HOLSTEIN WITH BEEF CATTLE BREEDS

EXTENDED (STRUCTURED) ABSTRACT

Beef production is based on optimizing growth intensity, carcass traits, and the stability of meat quality characteristics, which directly affect economic efficiency and production competitiveness. These traits are influenced by both genetic and non-genetic factors, among which genotype, nutrition, age, sex, and fattening conditions are particularly important. Special attention in both science and practice has been directed toward the application of molecular genetics in selection through the analysis of gene polymorphisms associated with growth performance, carcass traits, and meat quality.

The aim of this study was to determine the effects of genotype (polymorphisms of the *CAPN1*, *DGAT1*, and *TG* genes) and sex on the aforementioned traits in Holstein crossbreds with beef breeds. The study was conducted on 134 animals (63 males and 71 females), Holstein (HOL) crossbreds with Simmental (SIM), Belgian Blue (BPG), Piedmontese (PIE), and Limousin (LIM) breeds. Calves were monitored from birth until the end of the fattening period at 15 to 16 months of age. Growth performance (birth and final body weight, gross and net daily gain), carcass characteristics (hot and cold carcass side weights, dressing percentage, carcass conformation, and fat cover), proportions of muscle, fat, and bone tissue, chemical composition of meat, pH values, colorimetric parameters (L^* , a^* , b^*) of the *Musculus longissimus dorsi* (MLD) and *Musculus gracilis*, and the degree of marbling of the *Musculus longissimus dorsi* were analyzed.

Analysis of genotype frequencies confirmed polymorphism in all three analyzed genes as follows: *CAPN1* genotypes GG (0.555), GC (0.437), and CC (0.008); *DGAT1* genotypes KA (0.925) and KK (0.075); and *TG* genotypes CC (0.747), CT (0.246), and TT (0.007). Although rare genotypes such as CAPN1-CC and TG-TT showed a trend toward higher growth intensity and more favorable carcass and meat traits, these effects were not included in further analysis because they were recorded in only one individual.

No statistically significant differences were found between the compared genotypes of the *CAPN1*, *DGAT1*, and *TG* genes in terms of growth performance (birth and final body weight, gross and net daily gain), carcass traits (hot and cold carcass side weights, dressing percentage, and tissue composition), or basic meat quality parameters (meat color, pH value 24 hours post mortem, marbling, and nutritional composition of the MLD). An exception was observed for the *DGAT1* polymorphism, where the *DGAT1*-KA genotype showed significantly higher values of redness ($a^* - 24.44$) and yellowness ($b^* - 8.53$) in the *m. gracilis* 24 hours post mortem ($p \leq 0.05$), indicating a potentially favorable effect on sensory properties. These values indicate an intensely red color and a desirable warm hue of the meat, which is considered highly favorable from the perspective of consumer visual acceptance.

The best growth performance under identical rearing conditions was achieved by HOL × SIM and HOL × BPG crossbreds. HOL × SIM also showed more favorable carcass traits compared to HOL × LIM and HOL × PIE, including a higher carcass class, a greater

degree of fatness, and higher hot and cold carcass side weights, while the lowest proportion of fat tissue in the rib cut was recorded in HOL × PIE. Although no association was found between crossbreeds and meat color in the *m. gracilis*, higher marbling and intramuscular fat content in HOL × SIM, compared with other crossbreeds, did not result in greater meat lightness (MLD), i.e., they did not lead to higher L* values.

The analysis of sex effects showed a highly significant influence on all growth performance indicators (birth and final body weight, gross and net daily gain; $p < 0.001$). Male animals had an 8 % higher proportion of muscle tissue and a 13 % higher proportion of bone tissue, as well as superior carcass traits (all $p < 0.001$), whereas females had approximately 60 % more fat tissue in the rib cut ($p < 0.001$), a higher degree of marbling ($p < 0.001$), and more favorable sensory properties of the meat.

In terms of chemical composition, females had a twofold higher fat content (3.31 % vs. 1.56 %), a 4 % higher protein content, and a 12 % higher ash content, while meat from males contained approximately 4.0 % more water (all $p < 0.001$). Collagen content did not differ significantly between sexes, indicating that textural properties were not influenced by sex.

In conclusion, the results confirm that sex is the main factor determining growth performance, carcass traits, and meat quality. Polymorphisms of the *CAPN1*, *DGAT1* and *TG* genes did not show a statistically significant effect on growth performance or carcass traits, nor on most meat quality parameters, indicating the need for further research on larger populations and under different production conditions to ensure their reliable application in selection programs. However, the *DGAT1* gene polymorphism showed a statistically significant effect on meat color parameters (a^* and b^*) in the *m. gracilis*. The findings indicate the need for further research on larger populations and under different production conditions to ensure the reliable application of *CAPN1*, *DGAT1*, and *TG* polymorphisms in selection programs.

Keywords: *CAPN1*, *DGAT1*, *TG*, sex, growth intensity, beef carcass and meat traits