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EFFECT OF GENOTYPE AND SEX ON CARCASS CHARACTERISTICS OF CHICKENS RAISED IN EXTENSIVE SYSTEM

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Abstract: The aim of this work was to examine the possibility of using different poultry breeds for meat production in extensive systems, concerning their slaughter traits. Total of 200 birds of two genotypes were used in this trial: fast-growing hybrid Ross 308 and pure breed White Rock. Chicks were raised indoors until the age of 4 weeks and subsequently they were enabled to access the range. The trial lasted for 13 weeks. At the end of the trial, 10 male and 10 female chicks per breed were sacrificed for the evaluation of slaughter traits – dressing percentage, yield and share of carcass parts. It was established that both genotype and sex significantly affected carcass traits while genotype affected production traits. Chickens of the Ross 308 hybrid had higher body weights, better feed conversion ratio and higher mortality rate. Chickens of the Ross 308 hybrid had dressing percentage compared to the White Rock breed, while the male chickens had higher dressing percentage compared to the female ones. Chickens of the Ross 308 hybrid had a significantly larger weight and share of breast meat, whereas those of the White Rock breed had a larger share of drumsticks and thighs. A significant influence of the genotype was determined on the amount of abdominal fat in the carcass. Chickens of the White Rock breed had a significantly lower fat content compared to the Ross 308 hybrid, which essentially makes them the genotype which is more suitable for the extensive fattening longer than 10 weeks.

Key words: broilers, White Rock, sex, carcass traits, free-range

Introduction

Intensive production of poultry meat has led to a significant improvements of the production characteristics, but also to the deterioration of poultry welfare

and meat quality. This has further lead to the revitalization of the alternative systems which implies raising chickens on a free range during longer periods of time. Poultry meat from these systems seems to be more acceptable for the consumers, because the food safety and quality have become crucial for them *(Rodić et al., 2006; Bogosavljević-Bošković et al.,2012)*. The modern consumers demand meat which has a low percentage of fats, which is healthier and tastier than broiler meat *(Bogosavljević-Bošković et al., 2008; Castellini et al., 2008; Li et al., 2017).*

The key factor which affects the production and slaughter traits of broilers is the genotype *(Berri et al., 2005).* It is quite questionable whether the fast-growing hybrids are suitable for raising in alternative systems because they are exposed to greater challenges, particularly concerning their health *(Muhammad et al., 2017).* Although the pure breeds are suitable for rearing in extensive systems, the problem is whether their relatively poor production traits could meet the demands of the market-oriented production. There is no precise data on how large the share of meat from the slow-growing genotypes on the European market is, but it is estimated that it ranges between 5 and 10% *(Forte et al., 2018).* The available data for Serbia shows that over 65% of the total meat production originate from highly productive meat type hybrids *(Milošević et al., 2005).*

Present research is conducted to compare the carcass characteristics of pure poultry breeds with those of fast-growing hybrids raised in extensive system.

Materials and methods

The trail was performed on the Experimental farm of Faculty of Agriculture, University of Novi Sad. The farm was adapted for a raising chickens in free range system. The total of 200 chickens of two genotypes were used in this trial: fast-growing hybrid Ross 308 (100 birds) and pure breed White Rock (100 birds). Chicks were raised in the poultry house until the age of 4 weeks (10 birds/m^2) and subsequently they were enabled to access the range covered with grass (1.5 m^2 of range/bird). The trial lasted for 13 weeks.

Chicks were fed for 2 weeks with starter feed, from 2-4 weeks with grower feed and until the end of the trial with finisher feed (Table 1). Feed and water were provided *ad libitum.*

Table 1. Composition of starter, grower and finisher diets

Ingredients, %	Starter	Grower	Finisher
Corn	51.00	53.50	65.50
Soybean meal	30.00	22.50	19.00
Sunflower meal	5.00	8.00	6.00
Yeast	4.00	-	-
Barley	-	5.00	-
Dehydrated alfalfa meal	2.00	3.00	3.00
Soybean oil	4.00	4.00	2.50
Dicalcium phosphate	2.00	2.00	2.00
Limestone	0.80	0.80	0.80
Salt	0.20	0.20	0.20
Premix	1.00	1.00	1.00
Total	100.00	100.00	100.00
Chemical composition			
Dry matter, %	89.78	89.70	89.26
Crude protein, %	22.12	19.11	16.68
Metabolizable energy, MJ/kg	12.384	12.466	12.704
Crude fat, %	6.17	6.33	4.99
Crude fibre, %	4.82	5.14	5.21
Ca, %	0.97	0.96	0.94
P (total), %	0.79	0.74	0.72

At the end of the trial, 10 male and 10 female chicks per breed were sacrificed for the evaluation of carcass traits – dressing percentage, and yield and share of carcass parts. Dressing percentages were evaluated as "standard processing" (whole carcass), "ready to roast" (carcass without head and edible giblets) and "ready to grill" (carcass without head, neck, legs and edible giblets). Thereafter, the dressed cold carcasses were dissected into primal cuts (breast, drumstick, thigh, wing and back).

Data were analyzed by ANOVA and means were separated by Duncan's post hoc test using StatSoft computer package (STATISTICA 13, 2014).

Results

The results showed a significant influence of genotype on production traits of birds. Chickens of hybrid Ross 308 achieved significantly ($P<0.01$) higher body weight compared to the White Rock chickens (4104 g vs. 1791 g). The feed conversion ratio was much higher in the White Rock breed (3.16) compared to the Ross 308 (2.54). On the other hand, mortality rate was only 4% for the White Rock and 7% for the Ross 308.

The influence of the genotype and sex on the processed carcass weight is presented in Table 2. It was determined that the influence of sex and genotype on the live weight of chickens and on processed carcass weight was highly significant (P<0.01). For all the examined parameters, the female chickens had significantly lower weight compared to the male ones, while the White Rock chickens had significantly lower weight compared to the Ross 308 hybrid. There was no significant interaction between the sex and genotype determined.

Table 2. The weight of the processed carcasses, g ($\bar{x}$±SD)

Weight, g	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	S x G
Standard processing	Male	1739 ± 82.35 ^{A}	3492 ± 188.56 ^{B}	0.000	0.000	NS
	Female	1228± 78.73 ^{A}	3085 ± 215.95 ^{B}			
	Average	**1483± 274.55** ^{A}	**3288 ± 427.44** ^{B}			
Ready to roast	Male	1582± 74.93 ^{A}	3234 ± 190.66 ^{B}	0.002	0.000	NS
	Female	1124± 72.02 ^{A}	2876 ± 178.93 ^{B}			
	Average	**1353± 249.01** ^{A}	**3055 ± 498.57** ^{B}			
Ready to grill	Male	1392± 66.08 ^{A}	2882 ± 129.69 ^{B}	0.004	0.000	NS
	Female	978± 62.71 ^{A}	2577 ± 131.43 ^{B}			
	Average	**1185± 225.66** ^{A}	**2730 ± 367.21** ^{B}			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01)
NS – No statistical significance S-sex; G-genotype; S x G- the interaction sex x genotype

The influence of the sex on dressing percentage was statistically significant (P<0.05) (Table 3). Generally, the fast-growing hybrids are highly selected for the uniformity of all production traits, especially for the yield and carcass quality. For this reason, the differences between males and females were smaller when the carcass yield was expressed in relative values. The influence of the genotype was not statistically significant for "standard processing", but it was significant for "ready to roast" and "ready to grill" ones (P<0.05). A significant interaction (P<0.05) between sex x genotype was observed in "standard processing" dressing.

Table 3. Dressing percentage, % ($\bar{x}$±SD)

Dressing, %	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	S x G
Standard processing	Male	82.35 ± 2.31	82.18± 2.80	0.035	NS	0.028
	Female	78.73± 0.84 ^{A}	80.68 ± 3.21 ^{B}			
	Average	**80.54± 2.36**	**81.43 ± 2.68**			
Ready to roast	Male	74.93± 2.31 ^{A}	76.09± 2.26 ^{B}	0.019	0.000	NS
	Female	72.02 ± 1.13 ^{A}	75.22± 2.79 ^{B}			
	Average	**73.48± 2.17** ^{A}	**75.66 ± 2.35** ^{B}			
Ready to grill	Male	66.08 ± 2.34 ^{A}	67.83± 2.33 ^{B}	0.012	0.007	NS
	Female	62.71± 1.06 ^{A}	67.41± 2.18 ^{B}			
	Average	**64.40± 2.32** ^{A}	**67.62 ± 2.06** ^{B}			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01)
NS – No statistical significance; S-sex; G-genotype; S x G- the interaction sex x genotype

Concerning the weight of the head, neck, legs and edible giblets, we found highly significant differences (P<0.01) between genotypes and sexes for all the examined parameters (Table 4). Chickens of the Ross 308 hybrid and male chickens had a significantly larger weight of the listed carcass parts.

Table 4. The weight of the head, neck, legs, edible giblets and abdominal fat, g ($\bar{x}$±SD)

Parameter	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	S x G
Head weight, g	Male	70.90 ± 6.67 ^{A}	92.65 ± 7.50 ^{B}	0.000	0.000	NS
	Female	49.90 ± 3.28 ^{A}	84.13 ± 7.99 ^{B}			
	Average	**60.40 ± 11.93** ^{A}	**88.39 ± 15.02** ^{B}			
Neck weigh,. g	Male	90.20 ± 8.76 ^{A}	151.30±11.81 ^{B}	0.000	0.000	NS
	Female	62.13 ± 7.37 ^{A}	123.51±9.50 ^{B}			
	Average	**72.92 ± 16.09** ^{A}	**137.41±30.31** ^{B}			
Legs weight, g	Male	88.40 ± 3.27 ^{A}	165.75±14.91 ^{B}	0.000	0.000	NS
	Female	56.00 ± 4.56 ^{A}	124.28±8.08 ^{B}			
	Average	**72.20 ± 17.06** ^{A}	**145.01±24.68** ^{B}			
Edible giblets weight, g	Male	94.70 ± 8.75 ^{A}	199.75 ±18.45 ^{B}	0.000	0.000	NS
	Female	82.50 ± 7.72 ^{A}	175.12 ±15.06 ^{B}			
	Average	**88.60 ± 0.18** ^{A}	**187.44 ±22.49** ^{B}			
Abdominal fat, g	Male	0.0 ^{A}	48.02 ±3.32 ^{B}	0.000	0.000	NS
	Female	0.0 ^{A}	55.83 ±4.84 ^{B}			
	Average	**0.0** ^{A}	**51.92 ±7.34** ^{B}			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01)
NS – No statistical significance; S-sex; G-genotype; S x G- the interaction sex x genotype

What was particularly significant was the yield of abdominal fat which was not even detected in White Rock breed, while in the Ross 308 hybrid it was smaller than expected, considering that the chickens' live weight was over 4 kg. This might have been the result of increased chicken's activity on a range, but also of the feed which contained the lower level of energy compared to the feed which the broiler chickens are regularly fed.

When the weight of the head, neck, legs, edible giblets and abdominal fat of the chickens is expressed in percentages of the live weight, the values are significantly more balanced, both between sexes and between genotypes (Table 5).

Table 5. The share of the head, neck, legs, edible giblets and abdominal fat in the live weight of chickens, % ($\bar{x}$±SD)

Parameter	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	S x G
Head,%	Male	3.16±0.16^{A}	2.17±0.13^{B}	NS	0.003	NS
	Female	3.18±0.32 ^{A}	2.20±0.18 ^{B}			
	Average	**3.17±0.26 ^{A}**	**2.18±0.19 ^{B}**			
Neck, %	Male	4.27±0.31 ^{a}	3.56±0.28 ^{b}	NS	0.015	NS
	Female	3.98±0.34	3.53±0.26			
	Average	**4.09±0.39 ^{a}**	**3.39±0.26 ^{b}**			
Legs, %	Male	4.26±0.32	3.99±0.32	NS	NS	NS
	Female	3.53±0.18	3.25±0.29			
	Average	**3.81±0.44**	**3.57±0.34**			
Edible giblets, %	Male	4.58±0.17	4.71±0.22	0.036	0.028	NS
	Female	5.33±0.44^{a}	4.58±0.34^{b}			
	Average	**5.04±0.52**	**4.64±0.36**			
Abdominal fat, %	Male	0.00 ^{A}	1.05±0.09 ^{B}	NS	0.007	NS
	Female	0.00 ^{A}	1.25±0.11 ^{B}			
	Average	**0.00 ^{A}**	**1.15±0.12 ^{B}**			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01); $^{a-b}$ (P<0.05); NS – No statistical significance S-sex; G-genotype; S x G- the interaction sex x genotype

The Ross 308 chickens had a significantly lower share of the head and neck in live weight compared to the White Rock chickens. Significant difference (P<0.05) between genotypes was determined in the share of edible giblets, but only in female chickens. Differences in the share of abdominal fat were the most prominent, because in the carcasses of the White Rock breed there was no abdominal fat, whereas the share of it in the carcasses of the Ross 308 hybrid was 1.05% for male and 1.25% for female chickens.

Table 6. The yield of the basic carcass parts, g ($\bar{x}$±SD)

Parameter	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	S x G
Drumsticks weight, g	Male	235.12±8.15 ^{A}	441.67 ± 60.34 ^{B}	0.000	0.000	NS
	Female	156.88±9.48 ^{A}	376.89 ± 35.30 ^{B}			
	Average	**186.92±41.56** ^{A}	**409.28 ± 75.22** ^{B}			
Thighs weight, g	Male	272.80±18.59 ^{A}	497.31 ± 50.18 ^{B}	0.000	0.000	NS
	Female	187.50±18.29 ^{A}	428.97 ± 35.34 ^{B}			
	Average	**220.3±46.65** ^{A}	**463.14 ± 60.93** ^{B}			
Breast weight, g	Male	327.80±19.98 ^{A}	940.42 ± 60.72 ^{B}	0.000	0.000	NS
	Female	253.38±30.34 ^{A}	879.59 ± 85.44 ^{B}			
	Average	**282.04±44.62** ^{A}	**910.01 ± 95.33** ^{B}			
Wings weight, g	Male	173.60±6.54 ^{A}	356.91 ± 19.12 ^{B}	0.000	0.000	NS
	Female	126.38±8.79 ^{A}	317.60 ± 18.77 ^{B}			
	Average	**144.54±25.12** ^{A}	**337.26 ± 22.41** ^{B}			
Back weight, g	Male	386.40±55.38 ^{A}	643.47 ± 68.49 ^{B}	0.000	0.000	NS
	Female	254.63±26.21 ^{A}	577.72 ± 55.28 ^{B}			
	Average	**305.31±76.65** ^{A}	**610.60 ± 75.63** ^{B}			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01)
NS – No statistical significance S-sex; G-genotype; S x G- the interaction sex x genotype

Concerning the yield of the most quality parts of the carcass, the obtained results showed that this trait was under the significant influence of the sex (P<0.01) and genotype (P<0.01) (Table 5). Male chickens had a significantly larger weight of the basic parts of the carcass compared to the female ones, as well as the chickens of the Ross 308 hybrid compared to the White Rock breed.

When the weight of the basic parts of the carcass is expressed in relative values, we obtain different results (Table 7). Namely, the sex had a significant influence only on the share of the breast (P<0.05), and the genotype did so on all parts of the carcass except wings. The greatest difference was determined in the share of the breast, which was almost 10% larger in the Ross 308 hybrid. This is a consequence of an intensive selection on the yield of breast meat.

Table 7. The share of the basic parts of "ready to grill" carcass, % ($\bar{x}$±SD)

Parameter	Sex	Genotype		P values		
		White Rock	Ross 308	S	G	P x G
Drumsticks,%	Male	16.84 ± 0.72^{a}	15.32 ±0.62^{b}	NS	0.041	NS
	Female	16.06 ± 0.76^{a}	14.62 ±0.75^{b}			
	Average	**16.36 ± 0.81**^{a}	**14.97 ±0.84**^{b}			
Thighs, %	Male	19.54 ± 0.39^{A}	17.25 ±0.43^{B}	NS	0.000	NS
	Female	19.16 ± 0.10^{A}	16.64 ± 0.31^{B}			
	Average	**19.31 ± 0.82**^{A}	**16.94 ± 0.78**^{B}			
Breast, %	Male	23.58 ± 1.97^{A}	32.62 ± 2.30^{B}	0.023	0.000	NS
	Female	25.84 ± 1.35^{A}	34.12 ± 1.87^{B}			
	Average	**24.97 ± 1.91**^{A}	**33.37 ± 2.78**^{B}			
Wings, %	Male	12.46 ± 0.61	12.38 ± 0.54	NS	NS	NS
	Female	12.95 ± 0.86	12.32 ± 0.61			
	Average	**12.76 ± 0.78**	**12.35 ± 0.75**			
Back, %	Male	27.57 ± 2.47^{A}	22.32 ± 1.14^{B}	NS	0.000	NS
	Female	25.99 ± 1.34^{A}	22.41 ± 1.22^{B}			
	Average	**26.60 ± 1.89**^{A}	**22.36 ± 1.45**^{B}			

$^{A-B}$ Values which have a different letter in superscript are statistically significant (P<0.01) $^{a-b}$ (P<0.05); NS – No statistical significance; P-sex; G-genotype; P x G- the interaction sex x genotype

Discussion

In presented research we found significant differences in production results between fast-growing hybrid Ross 308 and White Rock breed, which were expected. Other authors also reported that fast-growing hybrids achieved much higher body weights compared to the slow-growing hybrids (*Nielsen et al. ,2003; Wang et al. 2009)* or pure breed (*Tang et al. 2009).* However, they all concluded that fast-growing hybrids are less suitable for rearing in extensive systems.

Carcass weight and dressing percentage were under the significant influence of the genotype and sex, which was also confirmed in the research of *Shahin and Elazeem (2005)* and *Pathak et al. (2009). Batkowska et al. (2015)* examined how suitable were the cross breeds for the extensive fattening and they compared them to the commercial Cobb hybrid. The highest dressing percentage was determined in the Cobb 500 chickens (around 75%), while cross breeds had lower dressing percentage for 5.6% (Cobb x Green-legged Partridgenous), or 7.2% (Cobb x Sussex). *Rajkumar et al. (2016)* stated that the chickens of the pure Aseel breed had smaller dressing percentage compared to the commercial broiler lines under the conditions of the extended fattening. As opposed to these authors,

Fanatico et al. (2008) did not found a significant influence of the genotype on dressing percentage when comparing slow-growing and fast-growing hybrids under the conditions of extensive rearing.

Mikulski et al. (2011) concluded that the yield of carcass parts was largely affected by the genotype and raising system, which was also confirmed by *Pavlovski et al. (2007)* and *Đukić Stojčić et al. (2016). Almasi et al. (2015)* determined a significant influence of the genotype on the yield of the parts of the carcass in slow-growing and medium-growing hybrids. In our research, the weight of all parts of the carcass was larger in the Ross 308 hybrid, but the share of almost all parts of the carcass was larger in the White Rock breed, with the exception of the share of breast meat. This implies the significant differences in the composition of the carcass which are the consequence of the selection of hybrids on the increased yield of breast meat *(Milošević et al., 1999; Castellini et al., 2002). Bogosavljević-Bošković et al. (2009; 2011)* determined that the broilers which had access to the free ranges had a lower share of breast meat compared to the broilers reared indoor.

What is particularly significant when we observe the quality of the carcass is the fat percentage. An increased amount of fat in broiler chicken carcasses is a problem which had been indicated by *Milošević and Supić (1995)*, as well. They stated that the percentage of total fat in broiler chicken carcasses could range even up to 10%, depending on the diet, and the percentage of abdominal fat can range up to 3%.

The differences in the weight of abdominal fat were precisely the most prominent part of this experiment, because there was no abdominal fat in the carcasses of the White Rock breed. It is certain that the amount of abdominal fat was influenced by the effect of chickens' activity on the ranges, as well as the feed which contained the lower level of energy. The results of the other authors, when the percentage of abdominal fat is concerned, vary considerably. *Milošević et al. (2005)* stated that, in the free range rearing system, the percentage of abdominal fat in the chickens of the Hybro genotype which were 56 days old was 1.95%. Within the same rearing system, but up to 70 days, *Perić et al. (2003)* stated that the percentage of abdominal fat in the Ross 308 genotype was 0.65%. *Rajkumar et al. (2016)* also marked the low percentage of abdominal fat in the pure Aseel breed (0.73-0.78%). *Wang et al. (2009)* determined that the breeding of slow-growing hybrids on a free range significantly decreased the amount of abdominal fat, while having no effect on the yield and the weight of the basic parts of the carcass. *Milošević et al. (2005)* stated that it is possible to lower the amount of fat in the carcasses of fast-growing hybrids used in the extensive production, as well, by applying a suitable feeding regime, which would significantly contribute to the quality of the poultry meat.

Conclusion

Based on the results of this research, it can be concluded that both genotype and sex significantly affected carcass traits while genotype affected production traits. Chickens of the Ross 308 hybrid had higher body weights, better feed conversion ratio and higher mortality rate. Chickens of the Ross 308 hybrid had higher "ready to roast" and "ready to grill" dressing percentage compared to the White Rock breed, while the male chickens had higher dressing percentage compared to the female ones. Chickens of the Ross 308 hybrid had a significantly larger weight and share of breast meat, whereas those of the White Rock breed had a larger share of drumsticks and thighs. A significant influence of the genotype was determined on the amount of abdominal fat in the carcass. Chickens of the White Rock breed had a significantly lower fat compared to the Ross 308 hybrid, which essentially makes them the genotype which is more suitable for the extensive fattening longer than 10 weeks.

Uticaj genotipa i pola na klanične karakteristike pilića u ekstenzivnom sistemu gajenja

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Rezime

Cilj ovog rada bio je da utvrdi mogućnost uzgoja brzorastućeg hibrida Ross 308 i čiste rase vajtrok u uslovima ekstenzivnog tova, posebno kada su u pitanju klanične osobine. Po 100 pilića od svakog genotipa odgojeno je unutar objekta do 4 nedelje starosti, a posle toga su pilići puštani na zatravljeni ispust do 13. nedelja starosti, koliko je trajo tov. Na kraju tova, 10 muških i 10 ženskih pilića po genotipu je žrtvovano i određene su klanične osobine – klanični randmani, masa i udeo pojedinih delova trupa u konfekciji.

Rezultati su pokazali da postoji visoko značajan uticaj genotipa i pola pilića na klanične osobine, kao i značajan uticaj genotipa na proizvodne osobine. Pilići hibrida Ross 308 imali su značajno veću masu, bolju konverziju hrane i veći mortalitet. Imali su i veći randman "spremno za pečenje" i "spremno za roštilj" u odnosu na piliće rase vajtrok, dok su muški pilići imali veće randmane u odnosu na ženske. Hibrid Ross 308 imao je značajno veći prinos i udeo belog mesa u trupu, dok je rasa vajtrok imala veći udeo bataka i karabataka. Posebno je značajan uticaj

genotipa na sadržaj abdominalne masti, koje kod pilića rase vajtrok bio značajno niži, što ovu rasu čini pogodnijom za uzgoj u uslovima produženog tova.

Ključne reči: brojleri, vajtrok, genotip, pol, klanične osobine, ispust

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References

ALMASI A., ANDRASSYNE B.G., MILISITS G., KUSTOSNE P.O., SUTO Z. (2015): Effects of different rearing systems on muscle and meat quality traits of slow-and medium-growing male chickens, British Poultry Science, 56:3, 320-324.

BATKOWSKA J., BRODACKI A., ZIĘBA G., HORBANCZUK J.O., ŁUKASZEWICZ M. (2015): Growth performance, carcass traits and physical properties of chicken meat as affected by genotype and production system. Archives Animal Breeding, 58, 325–333.

BERRI C., LEBIHAN-DUVAL E., BAÉZA E., CHATRIN P. PICGIRAAD L., JEHL N., PICKARD M., QUENTIN M., DUCLOS M.J. (2005): Further processing characteristics of breast and leg meat from fast, medium and slow growing commercial chickens. Animal Research, 54, 123-134.

BOGOSAVLJEVIĆ-BOŠKOVIĆ S., MITROVIĆ S., PETROVIĆ M., ĐOKOVIĆ R., DOSKOVIĆ V. (2008): Uticaj uzrasta i sistema držanja na odabrane parametre kvaliteta mesa pilića u tovu. Savremena poljoprivreda, 57, 3-4, 137-143.

BOGOSAVLJEVIĆ-BOŠKOVIĆ S., PETROVIĆ D., DOSKOVIĆ V., ŠARANČIĆ D.(2009): Prinos osnovnih delova trupa pilića u zavisnosti od dužine tova i sistema gajenja. Biotechnology in Animal Husbandry, 25, 5-6, 1039-1044.

BOGOSAVLJEVIĆ-BOŠKOVIĆ S., DOSKOVIĆ V., MITROVIĆ S., RAKONJAC S., PETROVIĆ M.D. (2011): Broiler meat quality: The effect of rearing system and length of fattening period, Biotechnology in Animal Husbandry, 27, 4, 1635-1642.

BOGOSAVLJEVIĆ-BOŠKOVIĆ S., RAKONJAC S., DOSKOVIĆ V., PETROVIĆ M. D. (2012): Broiler rearing system: a review of major fattening results and meat quality traits. World Poultry Science Journal, 68: 217-228.

CASTELLINI C., MUGNAI C., DAL BOSCO A. (2002): Meat quality of three chicken genotypes reared according to the organic system. Italian Journal of Food Science, 14:411–412.

CASTELLINI C., BERRI C., LE BIHAN-DUVAL E., MARTINO G. (2008): Qualitative attributes and consumer perception of organic and freerange poultry meat, World's Poultry Science, 64, 500-513.
ĐUKIĆ STOJČIĆ M., PERIĆ L., LEVART A., SALOBIR J. (2016): Influence of rearing system and nettle supplementation (Urtica dioica) on the carcass traits and fatty acid composition of Redbro broilers. European Poultry Science, 80. DOI: 10.1399/eps.2016.145.
FANATICO A.C., PILLAI P.B., HESTER P.Y., FALCONE C., MENCH J.A., OWENS C.M., EMMERT J.L. (2008): Performance, livability, and carcass yield of slow- and fast-growing chicken genotypes fed low-nutrient or standard diets and raised indoors or with outdoor access. Poultry Science, 87, 1012–1021.
FORTE C., MANUALI E., ABBATE Y., PAPA P., VIECELI L., TENTELLINI M., TRABALZA-MARINUCCI M., MOSCATI L. (2018): Dietary Lactobacillus acidophilus positively influences growth performance, gut morphology, and gut microbiology in rurally reared chickens. Poultry Science, 97, 3, 930–936.
LI Y., LUO CH., WANG J., GUO F (2017): Effects of different raising systems on growth performance, carcass, and meat quality of medium-growing chickens. Journal of Applied Animal Research, 45, 1, 326-330.
MIKULSKI D., CELEJ J., JANKOWSKI J., MAJEWSKA T., MIKULSKA M. (2011): Grow performance, carcass traits and meat quality of slower-growing and fast-growing chickens raised with and without outdoor access. Asian-Australian Journal Animal Science, 24: 1407–1416.
MILOŠEVIĆ N., SUPIĆ B. (1995): Genetski aspekti proizvodnje brojlerskog mesa. Savetovanje živinara Jugoslavije, Živinarstvo, 7-8, 125-136.
MILOŠEVIĆ N., SUPIĆ B., PERIĆ L., PAVLOVSKI Z., MITROVIĆ S. (1999): Pravci genetskog napretka u proizvodnji živinskog mesa i jaja. Savremena poljoprivreda, 1-2, 57-64.
MILOŠEVIĆ N., PERIĆ L., STRUGAR V. (2005): Gajenje tovnih pilića na ispustu. Biotechnology in Animal Husbandry, 21, 1-2, 65-72.
MUHAMMAD I.K., FAISAL F.K., MAJID M., MOHAMMAD U.K., ALI S.M., NIKOLAI P., PIGOREV I., GLINUSKIN A., LAISHEVTCEV A. (2017): Free range poultry husbandry and physiochemical quality of meat: A review. International Journal of Research Ayurveda Pharm, 8 (Suppl 1):74-79.
NIELSEN B.L., THOMSEN M.G., SORENSEN P., YOUNG J.F. (2003): Fed and strain effects on the use of outdoor areas by broilers. British Poultry Science, 44, 2, 161-169.
PATHAK V., BHAT Z.F., BUKHARI S.A.A., AHMAD S.R. (2009): Carcass quality parameters of Vanaraja chicken. Indian Journal Poultry Science, 44, 1, 97-99.
PAVLOVSKI Z., ŠKRBIĆ Z., CMILJANIĆ R., LUKIĆ M., TOMAŠEVIĆ D. (2007): Uticaj sistema gajenja i bioloških faktora na konformaciju trupa i klanične osobine pilića u tovu. Biotechnology in Animal Husbandry, 23, 3-4,59-66.

PERIĆ L., MILOŠEVIĆ N., ORLIĆ D., SUPIĆ B. (2003): Raising chickens on a free range, 1. Production parameters and health status, ZFB Lucrari Stiintifice, Timisoara, XXXVI, 360-363.
RAJKUMAR U., MUTHUKUMAR M., HAUNSHI S., NIRANJAN M., RAJU M.V.L.N., RAMA RAO S.V., CHATTERJEE R.N. (2016): Comparative evaluation of carcass traits and meat quality in native Aseel chickens and commercial broilers. British Poultry Science, 57:3, 339-347.
RODIĆ V., PERIĆ L., VUKELIĆ N., MILOŠEVIĆ N. (2006): Consumer's attitudes towards chicken meat produced in extensive systems. World's Poultry Science Journal, XII European Poultry Conference, Book of Abstracts, 62, 186-187.
SHAHIN A.K., ELAZEEM A.F. (2005): Effect of breed, sex and diet and their interactions on carcass composition and tissue weight distribution of broiler chickens. Archiev fur Tierzucht, 48, 612-26.
TANG H., GONG Y. Z., WU C. X., JIANG J., WANG Y., LI K. (2009): Variation of meat quality traits among five genotypes of chicken. Poultry Science, 88:2212-2218.
WANG K.H., SHI S.R., DOU T.C., SUN H.J. (2009): Effect of a free-range raising system on growth performance, carcass yield, and meat quality of slow-growing chicken. Poultry Science, 88(10):2219-2223.

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