ISPEC Tarım Bilimleri Dergisi, 7(3):548-557, 2023
ISPEC Journal of Agricultural Sciences, 7(3):548-557, 2023
DOI: https://doi.org/10.18016/10.5281/zenodo.8303920

Comparative Investigation of Ross and Cobb Broiler Genotypes with Different Gender in terms of Slaughter, Carcass Characteristics and Some Meat Quality Traits

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Abstract
The aim of this study was to compare the Ross and Cobb genotypes with different gender, which were widely used for poultry production in the world and in Turkey, in terms of slaughter, carcass and some meat quality characteristics. Carcasses used in the study were selected from the rearing houses of the Hastavuk White Meat Integrated Enterprise. A total of 40 carcass samples, 10 male and 10 female from Ross and Cobb genotypes, were used in the study. Management and feeding conditions continued through the procedures were determined by the enterprise. Final live weight, cold carcass weight, pH0 breast, breast L*, thigh a* and skin percentage data were found to be higher in Cobb genotype. Final live weight, cold carcass weight and cold carcass yield were higher in males, while heart percentage and cooking loss values were higher in females. There was no significant relationship between gender and genotype groups in terms of water holding capacity, cooking loss and drip loss. Genotype*gender interaction was determined for final live weight, liver percentage, thigh percentage and breast percentage. There are significant differences between Ross and Cobb genotypes, which have the largest share in the sector. In the face of constantly changing consumer demands, revealing the differences in genotypes that try to appeal to them and the changes will enable the sector to go further.

Research Article

Article History
Received :13.03.2023
Accepted :18.04.2023

Keywords
Broiler
cobb
fast growing
hybrit
meat quality
ross

1. Introduction

As a result of the rapid increase in the world population, it has become one of the most important goals to achieve maximum productivity per unit animal in order to obtain more products. In today's conditions, where the world population is increasing exponentially, the inability to reach food in underdeveloped countries and the resulting malnutrition are important problems that need to be solved. Chicken meat is an important meat product that should be included in the diets of patients with obesity and cardiovascular system due to its cheaper cost compared to other meat sources, containing proteins beneficial for human health, low fat content. It is an important animal protein and the second most consumed meat product in the world because it can be consumed by people of all faiths. (Pereira and Vicente, 2013; Nikolic et al., 2019; Weng et al., 2022).

While the broiler meat sector in Turkey was in the form of small family businesses in the 1970s, with the transition to the contract farming model in the 1980s. Because of the large investments in the 1990s production increased rapidly and the sector reached world standards. While the sector in Turkey grew 10 times between 1990 and 2011. Among 2011 and 2016, it has grown by nearly 20%. This growth of the sector may be due to the fact that broiler meat consumption has the largest share in poultry meat consumption. With the increase in recent years, per capita consumption has increased to approximately 21 kg. (Terin and Yavuz, 2019; Ergün and Bayram, 2021).

Ross and Cobb genotypes are widely used worldwide in the white meat production, which has become an important industry today (Khalid et al., 2021). Ross 308 is a tetralinear that combines the features of 4 different chicken lines developed by Ross Breeders company. Cobb 500 is a different tetralinear hybrid produced by Cobb Breeding Company. The main reasons for the widespread use of both hybrids are high fattening performance, meat yield and high breast meat rate. It takes 42 days for these hybrids to reach the approximate slaughter weight. While the hybrids are genetically designed, the main targets are determined as achieving maximum live weight in the minimum time, as well as improving the feed conversion ratio and disease resistance parameters (Pascalau et al., 2017; Nikolic et al., 2019).

In recent years, as the education and cultural level of consumers increase, they have begun to question the quality, reliability and welfare conditions of animal products more. Meat quality is a complex trait influenced by genotype and environmental nutrition factors. Selection studies to create and develop fast growing broilers have also affected the meat quality and flavor. Studies conducted in recent years revealed that slaughter weight also affects meat quality (Yalçın and Güler, 2012)

The aim of this study was to compare the Ross and Cobb genotypes of different gender, which are widely used for poultry production in the world and in Turkey, in terms of slaughter, carcass and some meat quality characteristics.

2. Material and Methods

This study was carried out with the permission of Balıkesir University Animal Experiments Local Ethics Committee dated 23/02/2023 and numbered 2023/1-2.

2.1. Material

Meat samples used in the study were selected from the fast growing Ross and Cobb genotypes, which were grown under standard conditions in the rearing houses of the Hastavuk White Meat Integrated Enterprise. Management and feeding conditions continued through the procedures were determined by the enterprise.

The carcasses used in the research were selected from among the animals routinely slaughtered in accordance with the slaughtering procedures of the enterprise. A total of 40 carcass samples, 10 male and 10 female from each genotype, were used in the study.

2.2. Methods

The animals, which were selected for the study, were weighed before being taken to the slaughter band and the live weight was determined before slaughtering. The slaughtering was done in the slaughterhouse inside the enterprise, within the framework of the slaughtering procedures of the enterprise. The first pH analysis was performed on the breast of carcasses immediately after slaughtering and pH 0 data of breast meat was recorded. After the end of these processes, the carcasses were brought to the laboratory by paying attention to the cold chain rules and rested for 24 hours at +4°C. At the end of the 24th hour, the carcasses were weighed again and the cold carcass weight was determined and the cold carcass yield was calculated by dividing it to the final live weight. pH 24 and L*, a*, b* data from breast and thigh meat were taken at this stage. Carcasses were divided into parts as thigh, breast, wing and neck, and the percentage values of the parts were determined by proportioning them with the cold carcass weights. After this process, samples were taken from breast part for other meat quality analyses. All analyses were studied in fresh samples without waiting. In addition to pH and color analyses, water holding capacity, cooking loss and drip loss analyzes were performed.

2.2.1. pH

The pH analysis of the samples was measured by a Mettler Toledo brand portable pH meter with a glass electrode on the carcass immediately after the slaughtering and 24 hours after the slaughtering from 2 different points determined on the breast and thigh.

2.2.2. Color

Color analysis of the samples were carried out 24 hours after slaughtering on the carcass from 2 different points determined on the breast and thigh. For the analysis, Konica Minolta CR-400 brand colorimeter was used and the brightness (L*), redness (a*) and yellowness (b*) values of the breast and thigh meat were measured.

2.2.3. Water holding capacity

Meat samples rested for 24 hours at +4°C ,as described Beriain et al. (2013) according to the method of Grau and Hamm (1957), weighed as 5 g and divided into 5 separate pieces, placed between filter papers whose weight was determined before, and 2250 g weight was applied on it for 5 minutes. At the end of 5 minutes, the weights on the samples were removed and the filter papers were weighed again. The water holding capacity (%) was determined by proportioning the difference between the initial weight and the final weight to the initial weight of filter paper.

2.2.4. Cooking loss

Meat samples, rested at +4°C for 24 hours, were weighed as 50 g and cooked at 80°C for 45 minutes according to the Honikel (1988) method, allowing the internal temperature to reach 70°C. Afterwards, the samples were weighed again and the cooking loss was determined as % by dividing the difference between the initial weight and the final weight to the initial weight of the samples.

2.2.5. Drip loss

Meat samples, rested at +4°C for 24 hours were weighed and their initial weights were determined and rested for 24 hours at +4°C. Meat samples were weighted again after 48 hours from slaughtering. The drip loss (%) was determined by dividing the

difference between calculated two weights to the initial weight of the samples (Honikel, 1988).

2.3. Statistical analyses

SPSS 25 (SPSS Inc., Chicago, IL, USA) program was to evaluate the data. The differences between the groups were determined by two-way analysis of variance. In the model, gender and genotype were independent variables. Each of the slaughter, carcass and meat quality characteristics were dependent variables.

3. Results and Discussion

Slaughter and carcass characteristics of Ross and Cobb broilers with different genders were presented in Table 1. Ross genotype had lower values than Cobb genotype in terms of final live weight ($P<0.01$). It was determined that males reached higher final live weight values than females ($P<0.01$). Males had higher values than females in terms of cold carcass weight ($P<0.01$).

Final live weight and carcass weight of broiler chickens used in the study differed significantly in terms of genotype and gender groups ($P<0.05$; $P<0.01$). It was an expected result that cold carcass weight was different, since there was no similarity between the groups in terms of final live weights. The animals used in the study were selected by the enterprise, and before the selection, it was not possible to weight the animals one by one in terms of the final live weights on the basis of groups. The reason for the difference between fattening and cold carcass weights was due to the differences in genotype and gender groups, as well as the fact that the animals in the groups did not have similar live weights.

Considering the cold carcass yield data, males had higher values than females ($P<0.05$). No significant difference was found between genotypes in terms of this feature ($P>0.05$). The fact that the carcass yield of males was higher than that of females were suggested that males have better fattening performance and carcass development than females (Akçapınar and Özbeyaz, 2021).

The gizzard rate of females was found to be higher than the rate determined for males ($P<0.001$), but no difference was found between genotypes in this regard ($P>0.05$). When liver and heart rates were examined, no significant difference was found between genotype and gender groups ($P>0.05$). There was an interaction between gender and genotype groups in terms of final live weight and liver ratio ($P<0.05$).

Table 1. Slaughter and carcass characteristics of broilers with different genotype and gender

	Genotype (G_1)		Gender (G_2)		SEM	P		
	Ross	**Cobb**	**Female**	**Male**		**G_1**	**G_2**	**G_1*G_2**
Final live weight (kg)	2845.80	3155.15	2818.80	3182.15	63.90	**	**	*
Cold carcass weight (kg)	2041.90	2276.20	2016.65	2301.45	49.40	**	**	-
Cold carcass yield (%)	71.66	72.06	71.46	72.25	0.16	-	*	-
Liver (%)	1.87	1.78	1.78	1.86	0.02	-	-	*
Heart (%)	0.42	0.43	0.43	0.43	0.009	-	-	-
Gizzard (%)	0.89	0.86	0.93	0.83	0.01	-	***	-

SEM: Standart error of mean. -: P>0.05; *: P<0.05; **: P<0.01; ***: P<0.001

In several studies on Ross and Cobb hybrids, the final live weights ranged from 4403 kg to 1854 kg for the Ross genotype (Banaszak et al., 2021; Özbek, 2021; Sam

and Okon, 2022; Moses et al., 2022) and, it was reported to range from 3520 kg to 1874 kg for the Cobb genotype (Hristakieva et al., 2014; Banaszak et al., 2021; Hassan et al., 2021; Sam and Okon, 2022). While cold carcass weight was reported in the range of 3589 kg-1307 kg for Ross genotype (Hussein et al., 2019; Banaszak et al., 2021; Özbek, 2021; Sam and Okon, 2022; Moses et al., 2022) and it was in the range of 2086 kg-1341 kg for the Cobb genotype (Hristakieva et al., 2014; Banaszak et al., 2021; Hassan et al., 2021; Sam and Okon, 2022).

Carcass yield was calculated by proportioning the final live weight to the carcass weight. In this respect, the evaluation of breeds or genotypes in terms of carcass yield was very important as it eliminated the direct effects of final live weight and carcass weight of the animals. The values found in the study were similar to the values found by Banaszak et al. (2021); lower than the values found by Hristakieva et al. (2014) and Sam and Okon (2022) higher than the values reported by Hussein et al. (2019), Hassan et al. (2021), Özbek, (2021) and Moses et al. (2022).

The liver values found in the study were lower and the gizzard ratio were similar and lower than the values found in other studies on this subject (Banaszak et al., 2021; Hassan et al., 2021; Singh et al., 2021; Sam and Okon, 2022). This situation could be explained by many reasons such as ration composition, genetics and individual differences. It has been reported that the gastrointestinal organs of animals fed with higher fiber rations were more developed than other groups (Deniz et al., 2007). Moses et al. (2022) found in their study that the liver and gizzard ratios of chickens fed with higher fiber diets were higher than the ratios in the study.

The values related to the heart rate determined in the study were found in parallel with similar studies (Banaszak et al., 2021; Özbek, 2021; Singh et al., 2021; Sam and Okon, 2022). Since broilers were routinely started to fattening at 1 day of age and slaughtered between 35-56 days of age, they had similar growth rates. In this respect, the similarity in heart rate between groups or genotypes were inconsistent with the normal stage of fattening (Akçapınar and Özbeyaz, 2021).

Some meat quality parameters of Ross and Cobb broilers with different gender were given in Table 2. It was determined that Cobb genotype had higher values than Ross genotype in terms of pH 0 measured from breast meat ($P<0.05$). There was no difference between genders in terms of pH 0 measured from breast meat ($P>0.05$). It was determined that the Cobb genotype was higher than the Ross genotype in terms of b* value taken from the breast meat ($P<0.001$). There was no significant difference between the gender s in terms of breast meat b* value ($P>0.05$).

There was an important link between the b* parameter of meat color and the fat between the muscles. As the intermuscular fat ratio increased, it caused more yellowness and less blueness in fresh meat. Therefore, the b* data had a greater value in animals with higher intermuscular fat (Jacob and Pethick, 2014). In this respect, it can be said that the fat ratio in the carcass content of the Cobb genotype was higher than the Ross genotype. At the same time, the fact that the higher final live weight of the Cobb genotype than the Ross genotype strengthened the possibility that the carcass fat ratio might be higher.

Table 2. Some meat quality characteristics of broilers with different genotype and gender

	Genotype (G_1)		Gender (G_2)		SEM	P		
	Ross	**Cobb**	**Female**	**Male**		**G_1**	**G_2**	**G_1*G_2**
pH 0 breast	6.55	6.64	6.58	6.62	0.02	*	-	-
pH 24 breast	5.87	5.89	5.89	5.87	0.01	-	-	-
pH 24 thigh	6.38	6.30	6.33	6.35	0.02	-	-	-
Breast L*	48.83	51.86	50.48	50.21	0.77	-	-	-
Breast a*	1.70	2.25	1.82	2.13	0.30	-	-	-
Breast b*	4.06	6.00	5.22	4.85	0.25	***	-	-
Thigh L*	54.30	53.34	53.98	53.66	0.51	-	-	-
Thigh a*	4.74	6.01	5.57	5.18	0.30	*	-	-
Thigh b*	6.00	7.08	6.53	6.55	0.30	-	-	-
Cooking loss (%)	29.32	29.69	30.50	28.51	0.52	-	*	-
Water holding capacity (%)	14.30	15.00	14.40	14.90	0.79	-	-	-
Dripp loss (%)	0.99	0.74	1.03	0.70	0.16	-	-	-

SEM: Standart error of mean. -: P>0.05; *: P<0.05; ***: P<0.001

In terms of a* value measured from the thigh, the data of the Cobb genotype was found to be higher than the the Ross genotype (P<0.05), but there was no statistical difference between the gender s in terms of the thigh a* value (P>0.05). The amount of myoglobin, which had a direct effect on the a* value of meat, varied according to breed, age, genotype and gender, as well as the physical activity of the animal and the muscles in different parts of the body (Üstüner, 2014).

It was seen that the color parameters found in the study were generally in harmony with the color values found in the other studies (Janisch et al., 2011; Siekmann et al., 2018; Hussein et al., 2019; Kokoszyński et al., 2022). Color characteristics were affected by many factors such as genotype, feeding, season, ration content, slaughter weight, stress before and during slaughter.

The fact that the Cobb genotype had higher values than the Ross genotype in terms of pH 0 measured from the breast meat, suggested that this genotype was less resistant to the stress that occured during slaughtering. As a matter of fact, stress caused a large part of the glycogen in the muscles to be consumed in the preslaughtering period. When there was not enough glycogen in the muscles, lactic acid formation decreased, rigor mortis occured in a short time and this resulted in higher pH (Jacob and Pethick, 2014; De Lima Jùnior et al., 2016).

Similar to the values found in the study, the pH value measured from the breast after slaughtering for the Ross genotype was determined 6.20 by Hussein et al. (2019) and Banaszak et al. (2021) found it to be 6.68. The same value was reported as 6.54 for the Cobb genotype (Banaszak et al., 2021).

In the study, the pH values determined from the breast and thigh meat were among the desired optimal values, and no difference was detected between the genotype and gender groups (Table 2). In the several studies carried out, the pH values measured from the breast and thigh meat 24 hours after slaughtering were consistent with the research findings (Banaszak et al., 2021; Hassan et al., 2021; Özbek, 2021; Kokoszyński et al., 2022).

As shown in Table 2 cooking loss values calculated for females were found to be higher than males (P<0.05). There was no significant difference between genotypes in terms of cooking loss (P>0.05). The high

ratio of connective tissue and fat in the meat of females explained this situation. The high levels of connective tissue in meat caused less water binding of the meat and increased the cooking loss value. At the same time, as meat with high fat content would lose more weight while cooking so the cooking loss value would also increase because of this reason (Şireli, 2018).

The cooking loss values found in the study were similar to the values reported by Özbek, (2021) and Janisch et al., (2011). Hussein et al. (2019), Hassan et al. (2021) and Siekmann et al. (2018) found lower values than reported in the study.

The water holding capacity of meat was primarily dependent on the immobilization of water in the tissues of the myofibrillar system. As a result of pressure, the water in the cell was released and wetness occured on the surface of the meat. The low water holding capacity means that a large amount of water can be lost during processing of the meat, which would cause economic damage (Kadim et al., 2004).

The low water holding capacity meant that a high amount of water could be lost during the processing of the meat and therefore economic damage will occur along with the weight loss in the final product (Honikel, 2004). In the study there was no significant differences between genotype and gender groups in terms of water holding capacity (Table 2). Haasan et al. (2021) and Banaszak et al. (2021) reported higher WHC values for Ross ad Cobb genotypes.

The state of removal water from meat was described as drip loss. In the study there was no significant differences between genotype and gender groups (Table 2). The results were in accordance (Janisch et al., 2011; Siekmann et al., 2018) or lower (Banaszak et al., 2021; Singh et al., 2021) than the reported values of drip loss values for Ross and Cobb genotypes.

Table 3. Different carcass part ratios of broilers with different genotype and gender

	Genotype (G_1)		**Gender (G_2)**		**SEM**	**P**		
	Ross	**Cobb**	**Female**	**Male**		**G_1**	**G_2**	**G_1 x G_2**
Thigh (%)	27.92	27.73	27.61	28.05	0.27	-	-	*
Breast (%)	32.77	30.46	31.58	31.66	0.40	-	-	**
Wing (%)	9.49	9.52	9.43	9.57	0.11	-	-	-
Skin (%)	5.41	7.41	6.37	6.46	0.20	***	-	-
Rest (%)	23.95	23.09	24.88	24.17	0.39	-	-	-

SEM: Standart error of mean. -: P>0.05; *: P<0.05; **: P<0.01; ***: P<0.001

The ratio of carcass parts to whole carcass of Ross and Cobb broilers with different genders were given in Table 3. In terms of skin percentage, Cobb genotype was found to have higher values than Ross genotype (P<0.001), but there was no significant difference between genders (P>0.05). When the whole carcass ratios of the carcass parts were examined, there was no significant difference between the genotype and gender groups when the thigh, breast, wing and rest ratios were examined (P>0.05). There was an interaction between gender and genotype groups in terms of thigh and breast percentage data (P<0.05; P<0.01). Within the scope of the study, broiler chickens were started to fattening at the age of 1 day old and sent to slaughtering at live weights close to each other. In this respect, there was no significant difference

between the genotypes or the gender, since the developmental rates were similar. This was an expected situation in terms of the normal stage of fattening (Akçapınar and Özbeyaz, 2021). The values found in the study were similar to the breast rates reported for the Ross and Cobb genotype (Hristakieva et al., 2014; Gholami et al., 2020; Singh et al., 2021), higher (Janisch et al., 2011; Sam and Okon, 2022) or lower (Hassan et al., 2021; Özbek, 2021). For wing ratio, the values found for both genotypes were similar (Hristakieva et al., 2014; Özbek, 2021; Singh et al., 2021; Sam and Okon, 2022) or higher (Hussein et al., 2019; Gholami et al., 2020). The differences between the results of the study and several study results might also be due to the differences in the carcass fragmentation methods.

4. Conclusion

As a result, it was determined that Ross and Cobb genotypes had significant differences in terms of final live weight, cold carcass weight, pH 0 breast, breast L*, thigh a* and skin ratio. Final live weight, cold carcass weight, pH 0 breast, breast L*, thigh a*, skin percentage data were found to be higher in Cobb genotype. In the study, when the results between the gender were examined, it was determined that gender had an effect on the final live weight, cold carcass weight, cold carcass yield, heart percentage and cooking loss. Final live weight, cold carcass weight and cold carcass yield were higher in males, while heart percentage and cooking loss values were higher in females. Genotype*gender interaction was determined in terms of final live weight, liver percentage, thigh percentage and breast percentage.

The broiler breeding sector in Turkey and in the world is growing rapidly and appeal to many people from all walks of life. There are significant differences between Ross and Cobb genotypes, which have the largest share in the sector. In the face of constantly changing consumer demands, revealing the differences in genotypes that try to appeal to them and the changes will enable the sector to go further.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

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To Cite Yaranoğlu, B., Eyi, R., Yaranoğlu, M.H., 2023. Comparative Investigation of Ross and Cobb Broiler Genotypes with Different Gender in terms of Slaughter, Carcass Characteristics and Some Meat Quality Traits. *ISPEC Journal of Agricultural Sciences*, 7(3): 548-557.
DOI: https://doi.org/10.18016/10.5281/zenodo.8303920.