

*Original Contribution***CHEMICAL COMPOSITION AND QUALITY OF TURKEY-BROILER MEAT FROM CROSSES OF LAYER LIGHT (LL) AND MEAT HEAVY (MH) TURKEY****M. Oblakova^{1*}, S. Ribarski², N. Oblakov¹, P. Hristakieva¹**¹Agricultural Institute, Hybrid Centre of Poultry Breeding, Stara Zagora, Bulgaria²Trakia University, Stara Zagora, Bulgaria**ABSTRACT**

The present study was performed in the Turkey Breeding Farm of the Agricultural Institute, Stara Zagora. The experimental birds were crosses of Turkey Layer Light (LL) at 36 weeks of age, used as maternal line, artificially inseminated with semen from Meat Heavy (MH) turkey gobblers. Turkey poults were reared up to 20 weeks of age using a traditional fattening production system. The birds were fed ad libitum with compound feeds according to their category and age. At 20 weeks of age, birds were slaughtered, and samples from breast muscles: m. Pectoralis superficialis, m. Pectoralis profundus and from the thigh muscles (m. Femorotibialis) were obtained. The chemical composition of turkey meat was analyzed – water, proteins, fat, mineral substances and dry matter. Also, meat pH, water holding capacity (WHC %) and the colour of the three studied muscles were investigated. Meat pH was determined by the 24th post mortem hour. Then carcasses were cooled and stored in a refrigerator at 4 °C. WHC of meat and muscle colour were determined by the 24th post mortem hour. There were no statistically significant differences between the contents of main chemical substances of meat between the genders. Breast meat had a relatively higher protein and lower fat content than thigh meat. Statistically significant ($P < 0.05$) is the content of protein in the females breast muscles 23.0% relatively 20.73% of the female thigh muscles. Low degree of reliability ($P < 0.05$) is characterized the contents in males thigh muscles to the males breast muscles males.

Breast meat in both genders had lower meat pH₂₄ values compared to thigh meat. The values of the L* coordinate of breast meat were relatively lower than criteria for PSE turkey meat in both genders ($L^* \geq 50$).

Key words: turkey, broiler, meat color, water-holding capacity chemical composition

INTRODUCTION

During the last decades, the interest to turkey meat is continuously increasing. Its high dietetic value is mainly due to the high protein and low fat content. Together with the high protein level up to 26.7-20.3%, turkey meat is also outlined with high mineral content – 1.17– 1.32%. (1)

Benkova et al. (2) established breast muscle protein content of 24.90% on Ivagal turkeys at 17 weeks of age, and 23.60% at 16 weeks of age. Fat content of breast muscle of male birds was 0.94%, and of females - 1.04%. The respective values of thigh meat were 0.79% in female and 1.34% in male turkeys. The dry matter was higher in breast muscles than in the thighs – 1.15% vs 1.04%.

The colour of meat depends on numerous factors: breed, sex, age. The lightness (L^*) depends on the amount of reflected and absorbed light. The reflection from the surface of myofibrils and through the myofibrils is closely associated with pH values. The lower the pH of meat, the higher the reflection of light from and through myofibrils (3). Meat colour is determined by the content of pigments. The main and most numerous groups of meat pigments is that of haemoproteins – myoglobin, haemoglobin, cytochromes, as well as the enzymes catalase and peroxidase. The myoglobin is a heme protein and the main substance which determines the colour of the meat of a given species. It also determined the values of the colour coordinates a^* that characterized the redness of meat. The array of meat pigments in the yellow spectrum (b^*) depends on the content of intramuscular fat, and the amount of carotenoids, xanthophylls and flavoproteins in

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meat and blood plasma. Carotenoids, depending on the order of the double bonds, are yellow, orange or red pigments. Oxidised flavoproteins are yellow, and when reduced – are colourless. During the autolytic processes accompanying the maturation of meat, porphyrin rings that compose the bilirubinoids open as a result of oxidation. The entity of these events results in accumulation of oxidative breakdown products of various colour – yellow, green etc. (4) Poultry meat with low pH is characterised with a low water holding capacity (5- 7).

Fraqueza et al. (8) reported that the reference values of the lightness of pale soft exudative (PSE) turkey meat (L^*) were higher than 50 and pH – lower than or 5.8. Van Laack et al. (9) observed that PSE breast meat in broiler chickens had average L^* of - 60 and pH^{24} – 5.7, whereas Qiao M., et al.. (7) demonstrated that this type of fillets are characterised with L^* 64 and pH^{24} – 5.8. Lower meat lightness values are demonstrated by Petracci M. Et al. (10), accepting as reference L^* values ≥ 56 . Regardless of the prevailing opinions that pH is essential for the colour of meat, Le Bihan-Duval E (11) affirmed that this trait is influenced by factors not associated with pH. The values of a^* are influenced by the content of myoglobin in muscle fibres. While myoglobin content depends on the morphological structure and is directly associated to pH, the post-slaughter temperature has an effect on the rate of biochemical reactions and oxidation of muscles. For b^* values, the muscle lipid content seems to be the most important.

Oblakova, M. et al., (12, 13), investigated the growth performance of turkey broilers produced by the original lines of the National Gene Fund, but the physico-chemical composition and meat quality traits of these crosses are not explored.

The purpose of the present study was to establish the composition and physico-chemical properties of skeletal muscle in 20-week-old turkeys' broilers, crosses of female line (LL) and male (MH) lines.

MATERIAL AND METHODS

The present study was performed at the Turkey Breeding Farm of the Agricultural Institute, Stara Zagora. The experimental birds were crosses of Turkey Layer Light (LL) at 36 weeks of age, used as maternal line, artificially inseminated with semen from Meat Heavy (MH) turkey gobblers. Turkey poults were reared up to 20 weeks of age using a traditional

fattening production system. The birds were fed ad libitum with compound feeds according to their category and age.

At 20 weeks of age, slaughter analysis of 3 male and 3 female birds with live weight close to the group average was performed. The birds were stunned and slaughtered humanely after 12-hour fasting. Samples for analysis of meat were collected from 3 male and 3 female birds. The analysis of meat quality traits was conducted at the Meat and meat products unit, Faculty of Agriculture, Trakia University – Stara Zagora.

The chemical composition of turkey meat was analysed. The samples for physico-chemical analysis of breast and thigh muscles for determination of water, proteins, fat, mineral substances and dry matter, meat pH, water holding capacity (WHC %) were obtained 24 hours post mortem. Meat water, protein, fat and ash contents were determined as per Pojarskaia, L (15). The pH values on hour 24 (pH^{24}) were measured with pH-meter Nesto on samples from m. Pectoralis superficialis, m. Pectoralis profundus and m. Femorotibialis. Water holding capacity of meat was determined by the classical method of Graw, W. R et al. (16), described by Zahariev Z and Pinkas, A (17) with modifications of Petrov, J. (18).

Meat pH was determined by the 24th post mortem hour on cooled and stored carcasses in a refrigerator at 0-4°C. Water Holding Capacity (WHC) of meat and muscle colour was determined by the 24th post mortem hour.

The colour of muscles was analysed in the CIE LAB system (19) using a spectrophotometer Lovibond SP60 (X-Rite Incorporated), calibrated with white and black standards. The values of coordinates L^* (white-black), a^* (red-green) and b^* (yellow-blue) were determined on 24th post mortem hour as followed:

m. Pectoralis superficialis – in the middle third of the medial surface (*facies medialis*) of the muscle;

m. Pectoralis profundus – in the middle third of the lateral surface (*facies lateralis*) of the muscle.

m. Femorotibialis – in the middle third of the medial surface (*facies medialis*) from the part of the cranial edge of the thigh. The colour coordinates were measured by the protocol of (20) consisting in three measurements in a given muscle area: during the first measurement the spectrophotometer was oriented along the length of muscle fibres. The other 2 measurements were done at the same point after rotating the appliance at 45° and 90°

clockwise. The mean arithmetic from the three measurements of L^* , a^* and b^* was then retained.

The analysis of data was performed with ANOVA (EXCEL 2010). The obtained results were statistically processed and the reliability criteria for the arithmetic mean as obtained by Nikolov G. and Ts. Yablanski (21).

RESULTS AND DISCUSSION

Table 1 presents the results from the chemical analysis of breast and thigh meat samples of

male and female turkey broilers. It could be seen that there were no statistically significant gender-related differences in the content of main chemical substances. Statistically significant ($P<0.05$) is the content of protein in the females breast muscles 23.0% relatively 20.73% of the female thigh muscles. Low degree of reliability ($P<0.05$) is characterized the contents in males thigh muscles to the males breast muscles males.

Table 1. Chemical composition of breast and thigh muscles of 20-week-old turkey broilers (%)

	breast muscles males (n=3)	breast muscles females (n=3)	thigh muscles males (n=3)	thigh muscles females (n=3)
Water content%	73.18±0.15	72.72±0.27	73.03±0.37	73.77±0.25
Protein%	23.04±0.34	23.03±0.35 ^a	21.74±0.91	20.73±0.58
lipids%	2.49±0.32	3.08±0.29	4.47±0.44 ^b	4.35±0.62
Ash%	1.19±0.04	1.16±0.04	1.25±0.05	1.13±0.05
Dry matter%	26.73±0.12	27.26±0.26	27.01±0.37	26.24±0.25

a- breast muscles females- thigh muscles females Significantly ($P<0.05$)

b- thigh muscles males- breast muscles males Significantly ($P<0.05$)

With regard to the water, mineral and dry matter contents, there were no considerable differences between breast and thigh meats.

Our data are comparable to values reported by Ngoka, D. A et al. (22) in a study on the effects of sex, age and preslaughter factors on meat quality and chemical composition of breast turkey meat. The author found out that breast meat of male birds was with statistically significantly higher mineral content than that of females. Breast meat had relatively higher content of proteins in both genders (23.04% and 23.03% in males and females vs thigh meat – 21.74% and 20.73% respectively at $p<0.05$). The results were also in accordance with those of Werner C (23) for higher breast meat protein content in different turkey genotypes – from 24.9% in BUT6 to 25.9% in Kelly BBB. We did not observe any differences in meat protein content of both muscles between the genders unlike Misikova E. and A. Hlasny (24) who reported higher breast meat protein content in female carcasses in three lines of turkeys.

Breast muscles were characterized with lower lipid content than thigh meat. For thigh meat,

fat content was 4.47% in males which was almost twice higher than fat content of breast meat (2.49%; $p<0.05$). There were insignificant differences between male and female turkeys with respect to breast and thigh meat fat contents.

Water holding capacity (WHC%) and pH of m. Pectoralis superficialis, Pectoralis profundus and m. Femorotibialis, determined by the 24th post mortem hour are shown in **Table 2**. The WHC of meat is an important meat quality trait for detection of the occurrence of PSE meat in poultry (25- 27). The WHC percentages of the two breast muscles showed no statistically significant differences: m. Pectoralis profundus had slightly higher WHC than m. Pectoralis superficialis. The breast muscles WHC were within the reference range for this type of meat and relatively lower than data reported by other researchers which investigated the effect of some preslaughter and slaughter factors in breast meat WHC in turkeys (22, 28, 27). The higher drip loss was attributed to the lower pH values. It is generally acknowledged that lower meat pH were associated with lower meat WHC.

Table 2. Physycal properties of breast and thigh muscles of 20-week-old turkey broilers (%)

	n	Water holding capacity %		pH	
		<i>m. pectoralis superficialis</i>	<i>m. pectoralis profundus</i>	breast muscles	thigh
Males	3	21.77±0.52	22.10±0.48	5.96±0.08	6.07±0.11
Females	3	21.94±0.31	22.32±0.36	5.82±0.12	6.42±0.11

The obtained pH₂₄ values were within the specific range for this type of meat. Breast muscle of both genders had lower pH₂₄ than thigh meat. The lower pH₂₄ in breast muscles - 5.96 in male and 5.82 in female birds was consequent to the higher proportion of anaerobic muscle metabolism and the higher share of the anaerobic type (white) muscle fibres compared to red leg muscles. Insignificantly higher were pH₂₄ values of thigh meats - 6.42 in females and 6.07 in males. These values were similar to white muscles of White Emperor turkeys (1),

namely: 5.99 in breast meat of male and 5.71 - in female turkey poults. The study on meat pH in the present study allowed assuming the presence of PSE meat. The established pH values were obtained by the 24th post mortem hour, when most of the post mortem events already resumed.

Tables 3 and 4 summarises the data for the colour traits of m. Pectoralis superficialis, m. Pectoralis profundus and m. Femorotibialis in the CIElab system (L*, a* and b*).

Table 3. Colour of breast muscles of turkey broilers

	breast muscles males (n=3)		breast muscles females (n=3)	
	<i>m. pectoralis superficialis</i>	<i>m. pectoralis profundus</i>	<i>m. pectoralis superficialis</i>	<i>m. pectoralis profundus</i>
L* value	45.78±0.90	46.82±0.74	49.84±0.88 a	47.94±0.82
Redness a*	2.85±0.37	4.15±0.32	3.40±0.35	4.16±0.36
Yellowness b*	9.39±0.49	10.64±0.53	11.24±0.59 b	11.22±0.42

a-females *m. pectoralis superficialis* - males *m. Pectoralis superficialis* Significantly (P<0.05)

b- females *m. pectoralis superficialis* - males *m. Pectoralis superficialis* (P<0.05)

Table 4. Colour of thigh muscles of turkey broiler

	<i>m. femorotibialis</i>	
	Males (n=3)	Females (n=3)
L* value	42.02±0.70	42.18±1.11
Redness a*	8.32±0.31	8.37±0.38
Yellowness b*	9.92±0.66	10.13±0.56

The analysis of meat lightness values L* indicated that they were within the reference range for this type of meat. There was a tendency towards higher L* values in both breast muscles (m. Pectoralis profundus and m. Pectoralis superficialis) in female turkeys. The differences for L* values of m. Pectoralis profundus (47.94 in females and 46.82 in males) were not significant. The lightness of m. Pectoralis superficialis in females was statistically significantly higher than that of males (49.84 vs 45.78; p<0.05). As redness (a*) was concerned, the differences between the genders were negligible for both breast muscles. For m. Pectoralis superficialis they ranged between 2.85 in males and 3.40 in females. The yellowness of meat was most pronounced in female birds (p< 0.05).

The lightness of m. Femorotibialis (**Table 4**) did not exhibit such a difference between male (L* 42.02) and females (L* 42.18). The L* values obtained in both genders were considerably lower than criteria for turkey PSE meat (L* ≥ 50), (29, 6, 25).

The a* values characterising the redness of m. Femorotibialis (8.32 and 8.37) were almost twice as high as those of breast muscles.

The yellowness as seen from the colour coordinate b* values demonstrated insignificantly lower values for m. Pectoralis profundus and m. Femorotibialis compared to results reported by other investigators (8). Among the three studies muscles, m. Pectoralis profundus had the lowest b* values in both genders, but difference vs the other muscles were not significant.

CONCLUSION

There were no statistically significant differences between the contents of main chemical substances of meat between the genders. Breast meat had a relatively higher protein and lower fat content than thigh meat. Statistically significant (P<0.05) is the the content of protein in the females breast muscles 23.0% relatively 20.73% of the female thigh muscles. Low degree of reliability (P<0.05) is characterized the contents in males thigh muscles to the males breast muscles males.

Breast meat in both genders had lower meat pH₂₄ values compared to thigh meat. The water holding capacity of breast muscles were within the reference range for this type of meat. The values of the L* coordinate of breast meat were relatively lower than criteria for Pale, Soft Exudative Meat turkey meat in both genders ($L^* \geq 50$).

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