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Carcass and Meat Quality Characteristics Influenced by Sex in Pekin Duck

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***Abstract*:** *Fattening performance and meat quality are essential for consumers and producers in duck breeding. Therefore, this study aimed to examine the effect of sex on carcass and meat quality characteristics in Pekin Duck. The experiment was conducted on 20 female and 20 male ducks. Ducks were reared with a feeding program to standard commercial practices. Ducks were fed a diet containing 22% crude protein (CP) and 2950 kcal/kg ME for the first four weeks and 16% CP and 3100 kcal/kg ME from the 5th to 10th weeks. At the end of the feeding period, all ducks were transported to an abattoir, and a standard commercial slaughter procedure was carried out. Warm carcass weights were measured after removing all internal organs and abdominal fat. The eviscerated carcasses were chilled for 24 h at four °C and reweighed to determine cold carcass weight. The pH and color values were determined at one h and 24h post-mortem in pectoralis major (PM) and gastrocnemius (GN) muscles. Texture characteristics, drip loss, cooking loss, frozen–thawing loss, and water-holding capacity were determined in PM and GN muscles. Slaughter weight, hot and cold carcass weights of male Pekin ducks were higher than female ducks ($p<0.05$). There were no significant differences between the sexes of ducks in terms of carcass yield. GN muscles of female ducks were more red than male ducks, but female ducks had less yellowness PM muscle than male ducks after 1 hour from slaughter ($p<0.05$). The female ducks had higher cooking loss value in GN muscle compared to male ducks ($p<0.05$). The hardness, springiness, gumminess, and chewiness values of the GN muscle of female ducks were higher ($p<0.05$) than those of male ducks. The study's results showed that sex significantly affects carcass and meat quality characteristics in Peking ducks.*

Keywords: *Fattening, Duck, Carcass, Meat, Organoleptic, Sex*

1. Introduction

Worldwide, ducks are raised primarily for meat and rarely for eggs [1]. They are easy to grow, hardy, and less susceptible to common poultry diseases [2]. Despite all these features, the ongoing decline in the duck industry and duck meat consumption in Türkiye is a significant concern. According to Turkish Statistical Institute (TUIK) data, there are 432,457 heads of ducks in Türkiye as of 2022 [3]. In Türkiye, 0.12% of the approximately 370 million poultry population consists of ducks, and the existence of ducks needs to be addressed. Peking duck is widely raised in duck farming, especially in developed countries [4]. Therefore, there is increasing interest in Peking duck to obtain the maximum yield of gutted and edible meat. Many researchers have reported studies comparing gender and slaughter weights, meat yield, and quality in poultry such as chickens, turkeys, and geese [1,5-7]. However, a comprehensive review of the existing literature revealed that almost no studies have been conducted to examine the effect of sex on carcass and meat quality characteristics in Peking duck, which is widely available in the Turkish duck market. Therefore, this study focuses on the possible effects of sex on carcass and meat quality characteristics in Peking ducks.

2. Material Methods

The study was conducted at the Ondokuz Mayıs University Agricultural Faculty's Farm. The study used Pekin ducks, bought from a commercial hatchery, as animal material. All ducklings were transferred to a production house at daily age. Each animal was sexed from the cloaca, the wing numbers were attached to each individual. Ducks were reared with a feeding program to standard commercial practices. Ducks were fed a diet containing 22% crude protein (CP) and 2950 kcal/kg ME for the first four weeks and 16% CP and 3100 kcal/kg ME from the 5th to 10th weeks. Sawdust + straw were used as bedding material. The lighting schedule was 24 h light (L):0 h dark (D) during the first week, 22L: 2D for 2-4 weeks and 18L: 6D for 5-10 weeks. The temperature was between 28-35 °C during the first week and maintained between 20-32 °C from the 2nd week onwards [8]. Ducks were reared at a stocking density of 5 birds/m^2. The experiment was completed with 20 female and 20 male ducks.

At the end of the feeding period, all ducks were transported to an abattoir, and a standard commercial slaughter procedure was carried out. During the slaughter process, the ducks were electrically stunned and scalded with hot water (55 - 58 ° C for 2.5 - 4 minutes) after bleeding. The birds' feathers were removed mechanically with a rotary drum for 4 minutes and advanced to an evisceration. Warm carcass weights were measured after removing all internal organs and abdominal fat. The eviscerated carcasses were chilled for 24 h at four °C and reweighed to determine cold carcass weight. The whole pectoralis major (PM) and gastrocnemius (GN) muscles were isolated from the cold carcasses, and subcutaneous fat and fascia were trimmed. Muscles were stored at four °C for physical and chemical analysis.

The pH values were determined using the meat pH meter with a puncture electrode (Testo 205, Lenzkirch, Germany) at one h and 24h post-mortem in PM and GN muscles on the right side of the carcass. Meat color as L* (lightness), a* (redness), and b* (yellowness) value was determined using a chromometer (Konica Minolta CR-300, Minolta Co., Ltd., Osaka, Japan) at one h and 24h post-mortem in PM and GN muscles on the right side of the carcass. Mean pH and color characteristics were measured five times.

Muscle samples (approximately 50 g) from PM and GN muscles were vacuum-packaged in a sealed plastic bag using a vacuum packaging device under atmospheric pressure at room temperature. Then, samples were stored at four °C for 2, 4, and 6 days and weighed, and the drip loss percentage was calculated, as defined by Bond and Warner (2007). Before each final weighing, the surface of the muscle samples was dabbed gently with paper towels. The drip loss was expressed as a percentage relative to the initial weight. The water-holding capacity (WHC) and frozen-thawing loss of meat samples were determined. The filter paper press method assessed the WHC of meat samples (approximately 50 g) from both muscles. The meat samples (about 50 g) from both muscles were vacuum packed and stored at -20 °C for one week to evaluate thawing loss values. The meat sample packages were thawed under tap water, and the thawing loss values were determined. The meat samples' WHC and thawing loss values were expressed as a weight loss percentage. The muscle samples (approximately 50 g) from PM and GN muscles were put in a plastic bag and then cooked for 40 minutes in a water bath at 70 °C constant temperatures. The samples were then exposed to running water for approximately 15 min to cool to room temperature. Before each final weighing, the surface of the muscle samples was dabbed gently with paper towels. The samples were weighed before and after cooking to determine the percentage of cooking loss. Texture characteristics of cooked samples with similar dimensions (cut parallel to the muscle fibers with a cross-section of 3×3×2 cm) include hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience were measured by TA-XT2i Stable Microsystem Texture Analyzer (Stable Micro Systems, UK), using a cylindrical probe with a speed of 1.5 mm/second. Each sample type was measured five times, and the result was expressed in Newton's (N).

The statistical analysis was conducted on a completely randomized design for traits. The statistical analyses were performed using the SPSS 17.0 package program (SPSS, Chicago, IL, USA). Duncan's multiple comparison tests tested significant differences between means. Results were computed as mean ± SE, and statistical significance was determined at $p<0.05$.

3. Results

Slaughter and carcasses characteristics of male and female Pekin ducks are presented in Table 1. Slaughter weight of male Pekin ducks were higher than female duck ($p<0.05$). Similarly, male Pekin ducks had higher hot and cold carcass weight ($p<0.05$). There were no significant differences between sexes of ducks in terms of carcass yield.

TABLE I. Slaughter and carcasses characteristics of male and female Pekin ducks

	Male	Female
Slaughter weight	4302.01±115.02[a]	3569.03±101.01[b]
Hot Carcass weight	2880.01±81.70[a]	2420.30±76.11[b]
Cold Carcass weight	2859.40±82.01[a]	2405.10±75.20[b]
Hot Carcass yield (%)	66.95±0.76	67.78±0.53
Cold Carcass yield (%)	66.46±0.75	67.36±0.51
Chilling loss (%)	0.48±0.04	0.49±0.07

[a, b] Means in rows with different superscripts are significantly different at $p<0.05$.

The color characteristics of the pectoralis major (PM) and the gastrocnemius (GN) muscles of male and female Pekin ducks are presented in Table 2. GN muscles of female ducks were more red than male ducks, but female ducks had less yellowness PM muscle than male ducks after 1 hour from slaughter ($p<0.05$). There were no significant differences between the sexes of ducks in terms of other color characteristics of PM and GN muscles. The differences among measurement time (1 hour and 24 hours after slaughter) in terms of L*, a*, and b* values were significant in both muscles of male and female ducks ($p<0.05$). Also, L*, a*, and b* values of PM and GN muscle at 1 hour and 24 hours after slaughter were significantly different in both sexes ($p<0.05$).

TABLE II: The Color characteristics of pectoralis major (PM) and gastrocnemius (GN) muscles of male and female Pekin ducks

Traits	Muscles	Male	Female
Lightness (L*)			
1 h	PM	30.22±0.69	31.18±0.90
	GN	44.11±1.24	43.50±0.61
24 h	PM	41.63±0.86	43.88±1.15
	GN	50.62±1.66	52.937±0.94
Redness (a*)			
1 h	PM	18.24±0.66	17.77±0.62
	GN	13.05±0.43[b]	14.98±0.79[a]
24 h	PM	19.74±0.49	18.91±0.29
	GN	17.59±0.89	15.45±0.98
Yellowness (b*)			
1 h	PM	5.62±0.27[a]	5.36±0.38[b]
	GN	2.84±0.55	3.13±0.31
24 h	PM	6.71±0.77	5.09±0.29
	GN	6.23±1.13	5.59±0.99

[a, b] Means in rows with different superscripts are significantly different at $p<0.05$.

The pH, drip loss, cooking loss, frozen–thawing loss, and water-holding capacity values in pectoralis major (PM) and gastrocnemius (GN) muscles of male and female Pekin ducks are presented in Table 3. There were no significant differences between the sexes regarding pH, drip loss, frozen–thawing loss, and water-holding capacity values of PM and GN muscles. Similarly, cooking loss values were the same between sexes in PM muscle, but female ducks had higher cooking loss value in GN muscle compared to male ducks ($p<0.05$). The differences among measurement time (1 hour and 24 hours after slaughter) in terms of pH values were significant in both muscles of male and female ducks ($p<0.05$). Also, pH values of PM and GN muscle at 1 hour

and 24 hours after slaughter were significantly different in both sexes ($p<0.05$). The differences among measurement time (2, 4, 6 days after slaughter) in terms of drip loss values were significant in both muscles of male and female ducks ($p<0.05$). Also, drip loss values of PM and GN muscle at 2, 4, 6 days after slaughter were significantly different in both sexes ($p<0.05$).

Texture characteristics in pectoralis major (PM) and gastrocnemius (GN) muscles of male and female Pekin ducks are presented in Table 4. There were no significant differences between the sexes regarding hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience texture characteristics of PM muscle. Hardness, springiness, gumminess and chewiness values of GN muscle of female ducks were higher ($p<0.05$) than those of male ducks. There were no significant differences between the sexes of ducks in terms of other texture characteristics of GN muscle.

TABLE III. The pH, drip loss, cooking loss, frozen–thawing loss and water holding capacity values in pectoralis major (PM) and gastrocnemius (GN) muscles of male and female Pekin ducks

Traits	Muscle	Male	Female
pH			
1 h	PM	6.04±0.05	6.12±0.08
	GN	6.38±0.04	6.29±0.062
24 h	PM	5.82±0.11	5.76±0.032
	GN	6.19±0.08	6.13±0.083
Drip loss (%)			
2 d	PM	9.16±0.91	9.97±0.76
	GN	4.01±0.40	5.10±0.47
4 d	PM	11.85±0.74	11.88±0.80
	GN	5.81±0.47	6.13±0.40
6 d	PM	13.49±0.84	13.77±0.79
	GN	7.42±0.52	7.68±0.47
Cooking loss (%)	PM	25.74±0.57	24.73±0.87
	GN	18.30±0.63[b]	20.91±1.27[a]
Frozen–thawing loss (%)	PM	3.43±0.32	3.06±0.38
	GN	1.64±0.16	1.75±0.19
Water holding capacity (%)	PM	3.55±0.28	3.86±0.36
	GN	2.36±0.10	2.34±0.15

[a, b] Means in rows with different superscripts are significantly different at $p<0.05$.

4. Discussion

In the present study, some fattening performance and meat quality traits of Pekin ducks were determined, which are essential to evaluate some production characteristics of male and female Pekin ducks. When the slaughter and carcass characteristics of male and female Peking ducks were evaluated, it was determined that male ducks had higher slaughter and carcass weight than females. As in all livestock, males had higher carcass and slaughter weights than females in Pekin ducks. The results of our study are consistent with the results of Omojola [1]. As a result of higher slaughter weight of male ducks, absolute weights of non-carcass components and some organs of male ducks were also higher ($p<0.05$) than that of female lambs (data are not shown). However, relative carcass weight were similar for male and female ducks. Observations in the present study for carcass weight and carcass yield of male Pekin ducks were higher than the values for the same breed reported by Omojola [1] and Ahaotu and Agbasu [9]. Although chilling is one of the environmental factors which result in a considerable increase in the toughness of the meat, which is not reduced by maturing [10], in the present study chilling loss of meat from male and female ducks was similar.

Although carcass weight differed between sexes in the present study, this effect was reflected in some of the meat quality traits studied. This situation may result in the low correlation coefficients between many of the meat quality characteristics, performance and carcass characteristics [10]. Meat quality traits, such as pH, dripping loss and CIELab color characteristics were affected by storage time. The interactions of sex and storage time on any of the studied parameters were not significant, and thus, these were not shown in the tables. There is a slight tendency for females because they are more excitable, to have slightly higher pH values than females. No differences in final pH were reported by Wawro et al. [11], Michalczuk et al. [12], Onbaşilar and Yalçin [2] between males and female Pekin ducks, confirming the results with respect to the pH value of meat from male and female Pekin ducks. The main factor determining the quality of meat is its pH, which is related to biochemical processes during the transformation of muscle to meat. Consequently, changes in the pH during the postmortem period influence the organoleptic characteristics of the meat [13]. Final pH results in a difference in water-holding capacity, assessed by drip loss or cooking loss. Indeed, a low pH is associated with poor water-holding capacity and a high pH is associated with poor shelf-life. Our result with respect to pH supports the idea that meat with a pH higher than 5.8 does not present a significant difference in water-holding capacity, irrespective of its color (Fogarty et al. 2000). The ultimate pH ranges for both PM and GN muscles from male and female Pekin ducks are acceptable and within the normal pH ranges, assuming that an ultimate pH greater than 5.8 is undesirable (Tejeda et al. 2008). The pH values obtained from the current study were very similar to those of ducks from Pekin ducks and some duck breeds [2,11,12,14]. The pH values measured at 1 h were higher than that at 24 h of LD and ST muscles. The slaughter of an animal initiates biochemical changes in the muscle tissue. Anaerobic glycolysis produces a lactic acid build up, and therefore, this accumulation of lactic acid in postmortem muscle reduces the localized pH [15]. These authors have showed that the large variation in the pH fall in LD and ST muscles may be because of variations in glycolysis and accumulation of lactic acid within the carcass, resulting in a decline in muscle pH as observed in the present study.

TABLE IV: Texture characteristics in pectoralis major (PM) and gastrocnemius (GN) muscles of male and female Pekin ducks

Traits	Muscle	Male	Female
Hardness	PM	77.15±9.85	80.49±7.20
	GN	35.93±5.32[b]	63.30±11.30[a]
Adhesiveness	PM	-2.33±0.62	-2.44±0.49
	GN	-1.17±0.24	-1.23±0.25
Springiness	PM	0.58±0.03	0.55±0.03
	GN	0.45±0.04[b]	0.54±0.04[a]
Cohesiveness	PM	0.66±0.02	0.66±0.02
	GN	0.74±0.01	0.72±0.02
Gumminess	PM	49.02±5.90	45.92±4.20
	GN	25.72±3.62[b]	43.91±7.42[a]
Chewiness	PM	30.24±4.09	30.02±3.17
	GN	13.10±2.73[b]	27.07±5.64[a]
Resilience	PM	0.34±0.03	0.35±0.02
	GN	0.44±0.02	0.42±0.02

[a, b] Means in rows with different superscripts are significantly different at $p<0.05$.

The structural orientation of protein and fat content within muscle foods directly influences the moisture content, while the amount of free water maintained within meat depends on the space between myofilaments. The water-holding capacity, defined as the ability of meat to retain its water upon application of external forces [16], such as cutting, heating, grinding, or pressing, is a primary indicator of the degree of juiciness of meat. Muscles that lose water easily are drier and lose more weight during refrigeration, storage, transport and marketing. The percentage of the water-holding capacity (WHC) obtained in this study was not sex-dependent. However the highest WHC was obtained in PM muscle compared to GN muscle from the male and female of

Pekin duck. The values of obtained for WHC in this study compared with the range values reported for broiler chicken fed graded levels of supplemental enzyme [17].

The female Pekin gave higher hardness, springiness, gumminess and chewiness values than the male. Cooking yield of meat is dependent on the cooking loss percent. Meat with less cooking loss will invariably give higher yield per unit cut. The female ducks had higher cooking loss values in GN muscle. The higher cooking loss in the female could therefore be due to the low ability of meat from the female duck to hold on the water on application of external force. Consumers first use this criterion to judge meat quality and acceptability [18]. Color is mainly influenced by the myoglobin content and nature, muscle composition and physical state [19,20], and the meat structure. GN muscles of female ducks were redder than male ducks, but female ducks had less yellowness PM muscle than male ducks after 1 hour from slaughter, the color ratings for other ducks were statistically similar. Tenderness is regarded as the most essential sensory attribute affecting meat acceptability [21]. Tenderness has also been identified as the most critical eating quality, which determines whether consumers are repeat buyers. Koohmarate et al. [22] and Dransfield [23] reported that consumers prefer to pay a premium for high-quality products. The female duck produced the most tender meat as adjusted by the texture analyses. The juiciness of meat is directly related to the intramuscular lipid and moisture content of the meat. In combination with water, the melted lipid constitutes a broth which when retained in meat is released upon chewing. Juiciness is made up of two effects, the impression of moisture released during chewing and the salivation produced by flavor factors [5]. The highest chewiness rating was given by the texture analysis of the GN muscle from female Pekin ducks.

The current study compared Pekin male and female ducks' carcass and meat quality characteristics. The Pekin duck breed's performance and meat quality parameters determined in this study are comparable to the other duck breeds. This study showed that the fattening performance of male and female Pekin ducks is quite acceptable in Türkiye if the optimum fattening conditions are provided. Although some meat quality characteristics of Peking duck vary depending on sex, changes in quality parameters with storage period were within the preferable range of consumers. This is particularly important because Pekin duck meats are locally in demand yearly. In the case of carrying out an improvement program for the performance and meat quality of Pekin duck in Türkiye, the performance and meat quality of Pekin duck reported in this study indicate that it may have implications in such breeding programs. These results presented here also provide valuable input into characterizing Peking ducks' performance and meat quality, which may improve duck production in Türkiye. The results of the present study may indicate that future studies with Pekin duck should include selection studies in improvement programs and responses to the improving fattening performance and meat quality.

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