

Effects of Age and Sex on Meat Quality of Turkish Native Geese Raised Under A Free-Range System

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Summary

This study was conducted to determine the effects of sex and age on meat quality characteristics of Turkish native geese raised under a free-range system. The range of least squares means for age and sex subgroups in terms of ultimate pH, water holding capacity (WHC), drip loss (DL), cooking loss (CL) and Warner-Bratzler shear force (SF) were 5.74-5.88, 8.99-9.69%, 3.36-3.63%, 27.67-29.97% and 3.15-3.38 kg/cm², respectively. Least squares means for colour characteristics of breast skin were 61.97-62.60 for lightness (L*), 5.11-5.84 for redness (a*) and 11.18-12.26 for yellowness (b*) according to age and sex groups. Colour variables of breast meat were 40.15-40.59 for L*, 12.30-13.61 for a* and 0.83-1.16 for b* parameters. While the effect of age on breast meat quality characteristics were not significant ($P>0.05$), sex affected on ultimate pH and a* parameter significantly ($P<0.05$). Least squares means for age and sex subgroups in terms of ultimate pH, WHC and DL of thigh meat were 5.96-6.04, 5.97-6.90% and 2.51-2.68%, respectively. L*, a* and b* values for thigh skin were 62.57-63.16, 4.25-4.83 and 7.67-9.43, and also were 43.72-44.20, 9.79-10.38 and 0.84-1.23 for thigh meat. The effect of sex on yellowness of thigh skin was significant ($P<0.05$), but both sex and age did not affect on meat quality characteristics of thigh meat ($P>0.05$).

Keywords: Geese, Free-range, Meat quality, Age, Sex

Serbest Çiftlik Koşullarında Yetiştirilen Türk Yerli Kazlarında Cinsiyet ve Yaşın Et Kalitesi Üzerine Etkisi

Özet

Bu çalışma, serbest çiftlik koşullarında yetiştirilen kazların et kalitesi üzerine cinsiyet ve yaşın etkisini belirlemek amacıyla yapılmıştır. Et kalite özelliklerinden final pH, su tutma kapasitesi (WHC), pasif su kaybı (DL), pişirme kaybı (CL) ve kesme gücü (SF) için minimum kareler ortalamaları farklı cinsiyet ve yaş alt gruplarında 5.74-5.88, %8.99-9.69, %3.36-3.63, %27.67-29.97 ve 3.15-3.38 kg/cm² düzeyinde belirlenmiştir. Göğüs derisi için renk özellikleri parlaklık (L*), kırmızılık koordinatı (a*) ve sarı koordinatı (b*) ortalamaları ise sırasıyla 61.97-62.60, 5.11-5.84 ve 11.18-12.26 olarak belirlenmiştir. Göğüs eti için L* parametresi 40.15-40.59, a* parametresi 12.30-13.61 ve b* parametresi 0.83-1.16 olarak belirlenmiştir. Göğüs etinin incelenen kalite özellikleri üzerine yaşın etkisi önemsiz bulunurken, cinsiyetin sadece pH ve a* üzerine etkisi önemli ($P<0.05$) bulunmuştur. But eti için final pH, WHC ve DL ortalamaları farklı yaş ve cinsiyet alt gruplarında sırasıyla 5.96-6.04, %5.97-6.90 ve %2.51-2.68 aralığında belirlenmiştir. But derisi için L*, a* ve b* ortalamaları ise sırasıyla 62.57-63.16, 4.25-4.83 ve 7.67-9.43 düzeyinde ve aynı özellikler but eti için 43.72-44.20, 9.79-10.38 ve 0.84-1.23 düzeyinde belirlenmiştir. But derisi kalite özelliklerinden b* üzerine cinsiyetin etkisi önemli ($P<0.05$) bulunmuş, ancak diğer özellikler üzerine cinsiyet ve yaşın önemli bir etkisi bulunmamıştır.

Anahtar sözcükler: Kaz, Serbest çiftlik koşulları, Et kalitesi, Yaş, Cinsiyet



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INTRODUCTION

Geese are mainly kept for their meat, down and feathers, and fatty liver in various regions of the world. Geese are slow growing animals among the other poultry species. However, over the centuries geese have become accustomed to the special climatic conditions of their breeding areas ¹. Geese are the most common poultry species for certain world regions.

Geese production is widely free-range production system in Turkey. Intensity of geese production in Turkey has regional differences. Kars and Ardahan provinces which lie in northeastern part of Turkey and have a rate of 48.5% of Turkey's geese population ². Geese meat production in this region is consumed by the regional people, but it has recently started a trading value ³⁻⁶.

The rapid growth of human population in developing countries causes an increase in the need for foods of animal origin. The improvements in the educational level of society results with the changes in the consumption habits. The beliefs that animal fats (particularly saturated fats) might increase the risk of coroner disorders, and the production costs being lower than cattle and sheep breeding, caused the fast growth of poultry meat consumption in developed countries ⁷. Moreover, parallel to the socio-economic improvements, consumer concerns have tended towards meat quality and safety control ⁸. Quality concept of consumers may have wide variety, since consumers define meat quality according to their own perceptions and preferences. But, consumers usually give particular importance to appearance and colour of meat and amount of fluid leakage to the pack at the point of sale. Skin colour also have a critical role, when poultry is marketed as a fresh whole bird. The meat texture is also taken into account by the consumers, but it can only be appreciated when the product is consumed ⁸.

The quality of poultry meat may be affected by numerous factors associated with either the animal or its environment, such as age, sex, breed, species, rearing and feeding system, handling and slaughtering condition ^{9,10}. Although meat quality characteristics of several poultry species have been investigated extensively, reports on meat quality characteristics of geese and on environmental factors affecting meat quality characteristics of geese are limited. Furthermore, there is no available scientific report on meat quality characteristics of Turkish native geese. The aim of the current study was to determine the effects of age and sex of geese on meat quality characteristics of Turkish native geese raised under a free-range system.

MATERIAL and METHODS

Animals and Slaughtering

The study was carried out with Turkish native geese in

Kars province. The geese were grouped by sex (male=21 geese and female=21 geese) and age (6-8 months old=22 geese and 18-20 months old=20 geese). They were raised in free-range conditions and were grazed in the pasture.

Birds were killed by exsanguination with a neck cut that severed the carotid artery and jugular vein. The whole carcasses were split along the vertebral column into left and right halves. Right side of each carcass was put into a special package in order to supply chilled condition of 4°C during transport. Right sides of carcasses were transported to Istanbul by plane, and then delivered to Istanbul University Veterinary Faculty, Carcass and Meat Quality Measurement Laboratory of Department of Animal Breeding and Husbandry within the special package at the day of slaughter.

Meat Quality Analyses

In order to determine meat quality characteristics of Turkish native geese, *M. pectoralis major* (breast meat) and *M. peroneus longus* (thigh meat) were removed from the right side of each carcass, and these samples were kept at 4°C for 24 h. Meat quality characteristics investigated in the current study were ultimate meat pH, water holding capacity (%), drip loss (%), cooking loss (%), Warner-Bratzler shear force (kg/cm²) and meat colour variables (L*, a*, b*). Furthermore, colour variables of skin, which affect the preference of consumers, were also determined.

Ultimate meat pH measurements were performed at 24 h post slaughter using a digital pH meter (Testo 205), equipped with a penetrating electrode and thermometer. The pH measurements were performed directly on *Pectoralis major* and *Peroneus longus* muscles.

Drip loss measurement was applied at 72 h post mortem using the method described by Honikel ¹¹. Briefly, initial weights of meat samples were recorded, and then meat samples were suspended in an inflated polyethylene bag without any contact with the bag. After a 48 h storage period at 4°C in the refrigerator, the meat samples were gently dried with paper towels, and final weights of meat samples were measured. Drip loss (%) was estimated by the ratio of weight loss (initial weight - final weight) to initial sample weight ¹¹.

In order to measure water holding capacity (WHC), modified Grau and Hamm method described by Beriain et al. ¹² was applied using 5 g meat samples at 72 h post mortem. WHC was expressed as percentage of weight loss of 5 g meat samples, immediately after being kept under a pressure of 2250 g weight for 5 min ¹³.

Cooking loss was measured at 72 h post mortem using the method described by Woelfel and Sams ¹⁴. In this method, meat samples taken from *Pectoralis major* muscle were firstly weighed, and then placed in aluminum trays and cooked in an electrical oven at 180°C until the internal

temperature reached 80°C. Internal temperatures of samples were monitored with a Testo 177-T4 data logger equipped with thermocouples placed in the geometric centre of each sample. Cooked samples were cooled in room temperature for 2 h, and then samples were dried with paper towels, and reweighed. Cooking loss (%) was estimated by means of percentage of weight loss of the cooked sample to initial sample weight.

Cooked meat samples of *Pectoralis major* muscle used for measurement of cooking loss were then used to determine shear force value. Four sub-samples (cut parallel to the muscle fibres with a cross section of 1 x 1 cm) were removed from each cooked sample. Shear force values of sub-samples were determined using an Instron Universal Testing Machine (Model 3343) equipped with a Warner Bratzler (WB) shear force apparatus. An average of four sub-samples was accepted to be WB shear force value of that sample.

Skin and meat colour measurements were applied at 24 h post mortem. Nine colour measurements were performed from median surface of each sample, and colour coordinate value was determined by calculating average of these nine measurements. Colour was evaluated using the CIELAB colour space. L* (lightness), a* (redness) and b* (yellowness) values were obtained using Minolta CR 400 colorimeter (Minolta Camera Co., Osaka, Japan) with illuminant D65 as the light source.

Statistical Analysis

In order to determine the effects of age and sex on

meat quality characteristics, least-squares procedures were performed using SPSS 10.0 statistical package¹⁵. The mathematical model used in the analyses of these characteristics included fixed effects of age (6-8 months or 18-20 months), sex (male or female) and age x sex interaction.

RESULTS

The effects of age and sex on breast skin colour and meat quality characteristics are presented in Table 1. Least squares means for breast meat quality characteristics were 5.74-5.88 for ultimate pH, 8.99-9.69% for WHC, 3.36-3.63% for drip loss, 27.67-29.37% for cooking loss and 3.02-3.38 kg/cm² for WB shear force depending on the age and sex subgroups. The range of least squares means for colour variables of breast meat were determined 40.15-40.59 for lightness (L*), 12.30-13.61 for redness coordinate (a*), and 0.83-1.16 for yellowness coordinate (b*). Colour variables of breast skin were 61.97-62.60 for L*, 5.11-5.84 for a* and 11.18-11.98 for b* parameter.

The effect of age of geese on skin colour and meat quality characteristics of breast were not significant ($P>0.05$). Sex of geese significantly influenced ultimate meat pH ($P<0.05$) and redness coordinate value ($P<0.01$) for *Pectoralis major* muscle. Ultimate meat pH for breast muscle was lower in male geese compared with female ones. Breast meat samples obtained from male geese had higher redness means than those of female geese. On the other hand, the effect of sex on WHC, drip loss, cooking

Table 1. Least square means and significance levels for meat quality characteristics of *Pectoralis major* muscle and breast skin colour variables in Turkish native geese

Tablo 1. Türk yerli kazlarında *Pectoralis major* kasının et kalitesi özellikleri ile göğüs derisinin renk değişkenlerine ilişkin minimum kareler ortalamaları ve önem kontrolleri

Variable	Age (A)		Sex (S)		Pooled SEM	Significance		
	6-8 months (n= 22)	18-20 months (n= 20)	Male (n= 21)	Female (n= 21)		A	S	A×S
Ultimate pH	5.82	5.79	5.74	5.88	0.027	NS	*	NS
WHC, %	9.00	9.68	9.69	8.99	0.375	NS	NS	NS
Drip loss, %	3.63	3.36	3.56	3.43	0.131	NS	NS	NS
Cooking loss, %	29.13	27.97	27.67	29.37	0.443	NS	NS	NS
WB shear force, kg/cm ²	3.38	3.02	3.15	3.25	0.129	NS	NS	NS
Meat colour								
Lightness (L*)	40.24	40.50	40.15	40.59	0.606	NS	NS	NS
Redness (a*)	13.06	12.85	13.61	12.30	0.214	NS	**	*
Yellowness (b*)	0.95	1.04	1.16	0.83	0.228	NS	NS	NS
Skin colour								
Lightness (L*)	61.97	62.60	62.15	62.42	0.358	NS	NS	NS
Redness (a*)	5.54	5.41	5.84	5.11	0.264	NS	NS	NS
Yellowness (b*)	11.45	11.98	11.18	12.26	0.271	NS	NS	NS

* $P<0.05$, ** $P<0.01$; NS: not significant ($P>0.05$)

loss, WB shear force, skin colour variables and lightness and yellowness of breast were not significant.

Mean ultimate pH of thigh meat found for age and sex subgroups varied from 5.96 to 6.04 (Table 2). The ranges of mean WHC and drip loss were 5.97-6.90% and 2.51-2.68%, respectively. The ranges of mean values for colour variables of thigh meat were 43.72-43.86 for lightness, 9.79-10.38 for redness and 0.84-1.23 for yellowness.

of non significant gender effect on ultimate pH for leg muscle was also reported by numerous authors¹⁷.

Ultimate pH results for breast muscle, which varied from 5.74 to 5.88, found in the current study were in accordance with previous findings of 5.61-5.96 for broiler chicken^{24,26-28}, 5.77 for chicken raised in free-range conditions²⁹, 5.70 for turkeys³⁰, 5.95 for ducks³¹, 5.77-5.88 for native chicken species³² and 5.65-5.96 for Polish geese³³.

Table 2. Least squares means and significance levels for meat quality characteristics of *Peroneus longus* muscle and thigh skin colour variables in Turkish native geese

Tablo 2. Türk yerli kazlarında *Peroneus longus* kasının et kalitesi özellikleri ile but derisinin renk değişkenlerine ilişkin minimum kareler ortalamaları ve önem kontrolleri

Variable	Age (A)		Sex (S)		Pooled SEM	Significance		
	6-8 months (n= 22)	18-20 months (n= 20)	Male (n= 21)	Female (n= 21)		A	S	A×S
Ultimate pH	6.04	5.96	6.02	5.99	0.031	NS	NS	NS
WHC, %	6.19	6.68	6.90	5.97	0.357	NS	NS	NS
Drip loss, %	2.51	2.68	2.59	2.59	0.100	NS	NS	NS
Meat colour								
Lightness (L*)	43.72	43.86	44.20	43.86	0.787	NS	NS	NS
Redness (a*)	10.19	9.99	10.38	9.79	0.218	NS	NS	NS
Yellowness (b*)	1.23	0.84	1.15	0.91	0.288	NS	NS	NS
Skin colour								
Lightness (L*)	62.57	63.16	63.07	62.66	0.440	NS	NS	NS
Redness (a*)	4.83	4.25	4.72	4.36	0.227	NS	NS	NS
Yellowness (b*)	8.10	9.01	7.67	9.43	0.396	NS	*	NS

* $P < 0.05$, NS: not significant ($P > 0.05$)

DISCUSSION

The ultimate meat pH has great importance in evaluation of meat quality, since it may directly affect quality characteristics, such as water holding capacity, cooking loss, texture and colour⁹. In the current study, the effect of geese age on ultimate meat pH was not significant for both breast and thigh meat. Similar to the current result, non-significant age effect on ultimate meat pH was also reported for chicken¹⁶ and duck¹⁷. However, Abdullah et al.¹⁸ found higher ultimate pH in younger broilers than older ones, and they noted that ultimate meat pH in poultry tended to decrease with an increasing age at slaughter. In the current study, male geese had lower ultimate pH than those of female geese for breast muscle ($P < 0.05$), but such a difference was not observed for thigh muscle. In the previous studies, significant differences between poultry groups in terms of breast meat ultimate pH were explained by differences in glycogen reserves at slaughter^{19,20}, responses to preslaughter stress²¹, and slaughter weight^{22,23}. In contrast to the current result, Musa et al.²⁴ and Kaynak et al.²⁵ found non significant difference between male and female chickens in terms of ultimate pH of breast muscle. On the other hand, the result

However, Genchev et al.³⁴ reported higher ultimate pH (6.17) for Japanese quails compared with current study, which might be attributed to the difference in species of poultry. The ultimate pH results of geese thigh meat found in the current study (between 5.96 to 6.04 depending on age and sex) were similar to the reports of 6.02-6.10 by Castellini et al.³⁵ for organic broilers and 6.14 by Debut et al.²³ for broiler chicken, but lower than the reported value of 6.20 for broilers³⁶.

At the point of purchase of meat at market, a number of factors including price, sensory quality, product safety and nutritional quality are taken into consideration by consumer. Although appearance and colour are the most important quality characteristics at selection of product, consumer judgements may also be influenced by any negative quality attributes such as excessive leakage of fluid into the pack⁸. In the current study, the effects of age and sex on WHC and drip loss were not significant for both breast and thigh muscles. Non significant age effects on WHC or drip loss were also reported for chicken meat^{18,37}. However, Anadón³⁸ reported linear decrease in breast WHC with increasing age. Supporting the current study, the differences in WHC between male and female birds were reported to be not significant for duck meat^{39,40}.

and for chicken meat^{18,24}. Mean WHC of breast meat, which varied from 5.97 to 6.68 depending on age and sex of geese, found in the current study were higher than those reported for duck^{17,39} and for chicken²⁴, but lower than reports for broiler meat¹⁸. The differences between current study and reports mentioned above in terms of WHC might be attributed to the differences in the methods used to determine WHC or differences in poultry species.

In the current study, cooking loss value of breast meat was not influenced by age and sex of geese. Similar findings were also reported in previous studies for influence of age on cooking loss value of broiler breast¹⁸, and effect of sex on cooking loss in broiler chicken^{27,41}. On the other hand, mean cooking loss values obtained in the current study (between 27.67-29.37%) were similar with previous reports for duck⁴⁰ and for chicken⁴¹. However, current results for cooking loss value were higher than reports of Owens and Sams⁴² for turkey breast meat and reports of De Marchi et al.²⁷ and Karlsson et al.³⁷ for chicken breast meat; and lower than reports of 33.45-33.98% by Castellini et al.³⁵ for chicken. According to Kadim et al.⁴³, the differences in cooking loss results between several researches might be attributed to differences in cooking temperature and duration, ultimate pH and muscle used.

Tenderness level of meat samples influence the appreciation of consumer during the eating phase¹⁰. In the current study, age and sex had no significant influence on Warner Bratzler shear force values. Various authors also reported non significant differences in instrumental meat tenderness due to sex in broiler chicken^{25,27,44} and in duck^{17,40} or due to age in chicken²⁷ and in duck¹⁷. WB shear force values found for breast muscle (between 3.02 and 3.25) in the current study were in accordance with reports of Jassim et al.¹⁷ and Omojola⁴⁰ for duck breast, reports of Castellini et al.³⁵ for broilers raised in organic system. However, most of WB shear force values reported for broiler chickens^{25,27,41,44,45} were lower than current results.

According to the reports of Shackelford et al.⁴⁶ meat samples having Warner Bratzler shear force values exceeding 5.5 kg would be evaluated as tough by a trained sensory panel and by consumers. Moreover, Bickerstaffe et al.⁴⁷ noted that shear force values of cooked meat samples accurately reflects the consumer perception of tenderness, and meat samples classified as "very tender" by consumers had mean shear force value of 5.1 kg. In the current study, WB shear force values found for geese breast muscles were quite lower than levels specified in above references. Hence, meat of Turkish native geese might be considered to be very tender meat.

The colour of meat is used to judge the freshness and quality of meat by consumers at the point of purchase at market⁸. In the current study, there were no significant differences in lightness (L^*) values of breast and thigh meat due to sex and age at slaughter. Similar to the

current study, non significant age effect on meat lightness values were also reported for broiler meat^{27,35,37}. However, Abdullah et al.¹⁸ observed lower L^* value in broiler chickens slaughtered at 32 days than those of chickens slaughtered at 42 days, and they explained this difference by lower ultimate pH of birds slaughtered at 42 days. Similar meat lightness levels in younger and older geese in the current study might be the consequence of similar ultimate pH in these groups. Supporting the current result, similar L^* value in male and female birds were reported by numerous authors for chicken^{27,41} and for quail⁴⁸. On the other hand, meat lightness values of the current study (40.15-40.59 for breast meat, 43.72-44.20 for thigh meat) were comparable with previous reports for geese meat^{33,49}.

The effect of age had no significant influence on meat redness for both breast and thigh muscle. On the other hand, the effects of sex on meat redness were significant in breast muscle ($P < 0.01$), but not in thigh muscle ($P > 0.05$). In the current study, a lower meat redness in breast meat of female geese may be attributed to their higher ultimate pH. Supporting this result, Saláková et al.⁵⁰ also reported significant influence of meat ultimate pH on meat redness. The redness values found in the current study (12.30-13.61 for breast meat, 9.79-10.38 for thigh meat) were lower than those reported by Okruszek et al.³³ for Polish geese and by Fernandez et al.⁴⁹ for French Landes grey breed. This difference indicate darker meat colour in Polish geese and French Landes grey breeds, and might be explained by difference in breed of geese, slaughter age and feeding system between studies. In the current study, yellowness coordinate values (b^*) was not influenced by age and sex of geese. Similar findings were also found for broiler chicken^{18,25,27}. Current results for b^* coordinate values were similar with previous reports for Polish geese³³.

Colour of skin has a great importance in the acceptance of meat by consumers at the point of purchase at market when poultry is sold with skin⁵¹. In the current study, effects of age and sex of geese on colour variables (L^* , a^* and b^*) of breast and thigh skin were not significant ($P > 0.05$), except effect of sex on yellowness of thigh skin ($P < 0.05$). Thigh skin of female geese had more yellow colour than that of male geese. Supporting the current result, Sirri et al.⁵² found significant difference between male and female chickens in thigh skin colour, which was higher in females than males.

Totosaus et al.⁵¹ noted that chicken breast meat could be divided into three colour category according to their instrumental L^* values: dark meat ($L^* < 47$), normal meat ($L^* = 47$ to 50) and pale ($L^* > 50$). In the previous studies conducted with broiler chickens, instrumental colour variables of normal coloured (not pale and not dark) meats were reported about 48-50 for lightness, 2-3 for redness and 3-7 for yellowness^{26,27,41,44}. Colour characteristics of normal coloured turkey breast meats in the literature were about 48-54 for lightness, 4-5 for redness and 2-3

for yellowness^{42,53,54}. Results of the current study indicate that colour characteristics of geese meat are apparently different from those of turkey and chicken meat, having more red colour compared with turkey and chicken. This could be attributed to higher red myofibre composition of geese meat (80% red and 20% white myofibres by Rémignon⁵⁵).

On the other hand, meat colour characteristics (particularly redness value) of Turkish native geese were very similar to the results of suckling goat kids⁵⁶, goat kids fattened for 56 days after weaning^{57,58} and Kivırcık lambs slaughtered at 30 kg live weight⁵⁹. The Warner Bratzler shear force results of Turkish native geese (between 3.02-3.38 kg/cm²) shows that geese breast meat can be classified as very tender. The Warner Bratzler shear force results in the current study were lower than the results reported by several researchers for lamb meat^{13,59,60} as 3.45-7.11 kg/cm² and for goat kid meat^{56,58} as 4.04-7.37 kg/cm² in Turkey. These results indicate that geese meat, having similar meat colour to, and being more tender than lamb and goat kid meat, can be an alternative meat source for consumers avoiding consumption of red meat of ruminants.

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