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RESEARCH ARTICLE

Comparison of physical meat quality properties of young and spent female quail of different genetic stock

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Farklı genotip genç ve yaşlı dişi bıldırcınlarda fiziksel et kalitesi özelliklerinin karşılaştırılması

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Öz

Amaç: Bu çalışma, farklı genotipteki genç ve kasaplık yaşta dişi bıldırcınların fiziksel et kalite özelliklerini araştırmak amacıyla yapılmıştır.

Gereç ve Yöntem: Bıldırcınlarda et kalitesi özelliklerini incelemek üzere çalışmada; saf Pharaoh (Coturnix coturnix Pharaoh, yabani tip) ve bunların beyaz varyetesi ile Japon (Coturnix coturnix Japonica) ve Bob White bıldırcınların (Colinus virginianus) melezlenmesiyle elde edilen iki melez hat (sarı ve siyah renkli) olmak üzere 4 farklı genetik materyalden toplamda 80 adet bıldırcına ait taze göğüs ve but eti kullanılmıştır.

Bulgular: Bıldırcın yaşının göğüs ve but eti pH'ı ($p<0,008$, $p<0,001$) ile genotipin but eti pH'ı ($p<0.01$) üzerine etkisi önemli bulunmuştur. Göğüs eti su tutma kapasitesi, genotip ve yaşdan önemli düzeyde etkilenmiştir ($p<0,001$, $p<0,019$). Bıldırcın but ve göğüs etlerinin parlaklık ve kroma değerleri üzerine genotipin etkisi önemli bulunmuştur ($p<0,001$, $p<0,001$).

Öneri: Sonuç olarak, incelenen et kalitesi özelliklerinin birçoğu siyah ve genç bıldırcınlarda diğerlerine göre daha iyi bulunmuştur.

Anahtar kelimeler: Bıldırcın, genotip, yaş, et pH'ı, et rengi,

Abstract

Aim: This study was carried out to investigate the physical meat quality properties of young and spent female quail of different genetic lines.

Materials and Methods: A total of 80 random samples of fresh breast and leg meat of young and spent female quails from four genetic stock as pure line Paharaoh strain (Coturnix coturnix Pharaoh, wild type), recessive white (white) variety of Pharaoh quail, the yellow and black colored cross-line quails obtained by crossing Bob White quail (Colinus virginianus) and Japanese quail (Coturnix coturnix Japonica).

Results: There was significant effect of quail age on breast and leg meat pH ($p<0.008$, $p<0.001$) and a significant genotype effect was determined on leg meat pH ($p<0.01$). The water holding capacity of breast meat was significantly affected by genetic stock and slaughter age ($p<0.001$, $p<0.019$). The genetic stock had significant effects on the lightness and chroma values of leg and breast meat of quail ($p<0.001$, $p<0.001$).

Conclusion: In conclusion, black colored cross-line variety of quail and young birds had greater values of most meat quality characteristics than the other birds.

Keywords: Quail, line, age, meat pH, meat color

Introduction

The popularity of quail meat and egg production, which is an alternative source of animal protein, has been increasing over the World in recent years (Farrapo et al 2017). Quail farms does not need a big capital investments, but particularly for small production capacity they provide a quick capital return with quail's short growth period for egg and meat production (Redoy et al 2017). The quail meat has one of the lowest fat content and good phospholipids level, furthermore it is one of the most desired alternative poultry meats (Santhi and Kalaikannan 2017).

Coturnix family and Coturnix coturnix Japonica are breeding commonly for egg production throughout the world (Furtado et al 2018, Santos et al 2019). In some farms, some mutant birds such as recessive white or the crossbreed lines between coturnix and meat-type family are also raised in small numbers of flocks (Petek et al 2004, Aydin et al 2008). Many researchers have investigated the performance parameters of mutant or colored feather birds including recessive white (Petek et al 2004; Inci et al 2015, Taha et al, 2019), roux (Minvielle et al 1999), brown and golden (Inci et al, 2015, Taha et al 2019), lavender (Bed'hom et al 2012), and their effects on some performance traits (Petek et al 2003, Petek 2005) and bone properties (Suzer et al 2020). However, findings about comparing the meat quality of different quail lines are very limited. There has already been not enough research focused on quail meat quality and theirs affecting factors. Narinc et al (2013) reported that the selection of quail could be used to improve meat quality of quail and the ultimate pH of quail breast meat is an appropriate selection criteria due to its close relationships with water-holding capacity, texture and abdominal fatness. Boni et al (2010) reported that the brightness, redness and yellowness colour parameters of quail meat were 58.93, 12.86, 20.86 for meat from young birds and 61.54, 6.84, 19.81 for meat from spent birds, respectively. In that study, the meat pH of younger quail was lower than spent quail. In another study, Wilkonawska and Kokoszynski (2011) reported that older quails showed greater values of meat pH, redness and yellowness. This study was carried out to investigate the physical meat quality properties of younger and spent female quails of four different genetic lines.

Material and Methods

Ethical approval

This study does not require ethical permission according to Animal Experiments Ethics Committees Regulation on Working Procedures and Principles, Article 8 19-k (Republic of Turkey Ministry of Agriculture and Forestry, 2014; Local Ethics Committee for Animal Experiments, Bursa Uludag University/2021-15/02).

Animals, housing, care and management

A total of 80 female quail of 4 different genetic lines (wild, recessive white, black and yellow feathers) in two different ages (60 and 270 days of ages) were slaughtered (2x4) and their leg and breast meat samples were collected for analysis. The quail lines samples were pure line/wild of Pharaoh strain (Coturnix coturnix Pharaoh), recessive white variety of wild pure line, and two cross-line quail of black and yellow plumage colored lines which were obtained by crossing with pure line stock Japanese quail (Coturnix coturnix Japonica) and Bobwhite. The recessive white quail was appeared spontaneously from a wild-type quail flock (Pharaoh, Coturnix coturnix Pharaoh).

The experimental groups were housed in similar environmental conditions (as floor space, stocking density, drinker or feeder space) in conventional multier cages. Quails in all groups provided ad libitum soybean and maize-based commercial layer ration and received 16 h continuous light and 8 h dark in a day during the laying period.

An equal number of randomly selected birds in all groups were slaughtered according to guidelines of Institute of Turkish Standard (TS 5925, 2014) and both legs and breast were removed from each carcass (TS 5890, 2014). A total of 80 random samples of fresh breast and leg meat of quail (20 samples from each genetic stock from 10 young and 10 spent birds) were collected for this experiment. All samples were kept in a plastic box during transportation to the laboratory with minimum time of delay. The muscle samples were packaged in plastic cups and stored at 4°C for 24 h for the analyses.

Data

The measurements for meat pH, meat color and water holding capacity were performed on breast and leg meat samples of quail. The pH was taken in three points on the medial surface of the left breast muscles (Pectoralis major) and leg muscles (Keskin et al 2017) using a pH meter with 0.01 precision (HANNA HI99163). A meat color meter (Spectrophotometer CM-600d, Konica Minolta Color, Langenhagen, Germany) programmed with standards of International Commission on illumination (D65 illuminant, 10°, CIE L*a*b* system) at an angle of 90° was used to color determination of the meat samples. The lightness (L*, from 0 to 100, from black to white), redness (red-green intensity; a*, from +60 to -60) and yellowness (yellow-blue intensity; b*; from +60 to -60) of meat samples were measured according to Kralik et al (2018). The saturation index (chroma), and hue angle (arctan) were calculated from the values of redness (a*) and yellowness (b*) of the meat samples as following formulas (Ingram et al 2008).

Chroma, $C^*=(a^{*2}+b^{*2})^{0.5}$
Arctan value, $H^*=\tan^{-1}(b^*/a^*).180/\pi)$

Water holding capacity (WHC) of meat samples was taken in three points on each fillet using methodology according to Nakamura and Katoh (1985). For the WHC analysis; 1 g of meat sample was placed in filter paper and centrifuged at 1500 rpm for 4 minutes, and then the sample in the filter paper was dried at 70° C overnight. The WHC of meat samples was calculated by the formula WHC = (post centrifugation weight – post drying weight)/initial weight × 100

Statistical analysis

The statistical analyses for the parameters were performed using SPSS® computer soft ware 13.00 (SPSS Inc. Released 2004) by ANOVA (GLM procedures), in order to evaluate the effect of main factors; bird age (young and spent) and quail line (wild, recessive white, black and yellow) and their interaction on meat quality traits of quail (Snedecor and Cochran, 1989). The following model is carried out.

Yijk =μ+ai+bj+a×b+eijk,
a; quail line, and b; quail age; a × b, an interaction.
i; 1, 2, 3 or 4 (1; wild, 2;recessive white, 3; yellow cross line, 4; black cross line),
j;1 or 2 (1; young quail, 2; spent quail)
μ; a constant and e; an error term.

Results

The water holding capacity and meat pH values of leg and breast meat obtained from different quail lines were presented in table 1. Age of quails had a significant effect on breast water holding capacity and pH of leg and breast meat ($p<0.019$, $p<0.001$, $p<0.008$). The leg meat pH value and breast meat water holding capacity were significantly affected by genetic stock ($p<0.01$, $p<0.001$). A significant genetic stock x age interaction were found for leg meat pH value ($p<0.014$).

The effects of both genetic stock and age on meat lightness, redness and yellowness of quail meat were presented in table 2. The effects of genetic stocks on both breast and leg meat lightness ($p<0.001$, $p<0.001$) and breast meat yellowness ($p<0.001$) were found to be significantly important. It was determined that the both breast ($p<0.001$, $p<0.001$) and leg meat redness ($p<0.001$) and yellowness ($p<0.001$) values among the groups were significantly different.

The averages of chroma and hue angle values of breast and leg meat of quail were presented in table 3. The quail line had a significant effects on hue angle values of breast and leg meat muscles ($p<0.001$ $p<0.019$) while bird age had a significant effect on breast and leg meat chroma values ($p<0.001$, $p<0.001$). Genetic stock x bird age interaction for leg meat chroma value was found to be significantly important ($p<0.033$).

Table 1. The pH and water holding capacity of different genotype of young and spent quail (mean±SEM)

	pH		Water holding capacity
	Breast	Leg	Breast
Genetic stock			
White	5.780±0.04	6.435±0.03^{ab}	2.59±0.20^{b}
Yellow	5.768±0.03	6.403±0.03^{bc}	2.56±0.19^{b}
Black	5.859±0.04	6.502±0.04^{a}	3.20±0.18^{a}
Wild	5.779±0.03	6.362±0.03^{c}	1.85±0.21^{c}
Age			
Young	5.855±0.03	6.491±0.02	2.68±0.13
Spent	5.738±0.03	6.360±0.02	2.21±0.14
Genetic stock x Age			
WhitexYoung	5.848±0.05	6.525±0.04	2.81±0.23
WhitexSpent	5.711±0.06	6.346±0.03	2.36±0.24
YellowxYoung	5.807±0.04	6.482±0.04	2.40±0.26
YellowxSpent	5.729±0.06	6.324±0.03	1.92±0.25
BlackxYoung	5.937±0.05	6.484±0.04	3.60±0.25
BlackxSpent	5.781±0.06	6.521±0.03	2.79±0.26
WildxYoung	5.827±0.05	6.473±0.04	1.92±0.24
WildxSpent	5.731±0.06	6.250±0.03	1.78±0.25
ANOVA			
Genetic stock	0.417	0.010	0.001
Age	0.008	0.001	0.019
Genotic stockxAge	0.913	0.014	0.681

a-c; within the same columns, values with different superscripts were found significantly different.

Table 2. Effects of genetic stock and age on ligthness, redness and yellowness values of breast and leg meat of quail (mean±SEM)

Factors	Lightness, *L**		Redness, *a**		Yellowness, *b**	
	Breast	Leg	Breast	Leg	Breast	Leg
Genetic stock						
White	47.66±1.08^{ab}	52.34±0.81^{ab}	12.20±0.99	5.60±0.48	14.89±0.43^{a}	12.98±0.47
Yellow	44.06±1.09^{b}	49.28±0.82^{bc}	13.07±0.98	6.24±0.49	12.56±0.42^{b}	12.09±0.46
Black	51.35±1.07^{a}	54.83±0.80^{a}	12.72±0.97	5.78±0.47	15.30±0.41^{a}	13.69±0.45
Wild	40.93±1.08^{b}	46.48±0.81^{c}	12.60±0.98	7.12±0.48	11.78±0.43^{b}	12.19±0.46
Age						
Young	45.85±0.75	50.46±0.02	14.52±0.69	8.41±0.34	15.05±0.30	13.82±0.32
Spent	46.14±0.76	51.00±0.02	10.78±0.70	3.95±0.33	12.21±0.30	11.65±0.33
Genetic stockxAge						
WhitexYoung	47.86±1.52	51.82±1.15	13.68±1.33	7.00±0.68	16.73±0.62	13.24±0.66
WhitexSpent	47.45±1.53	52.85±1.16	10.73±1.34	4.19±0.65	13.06±0.61	12.71±0.65
YellowxYoung	44.70±1.50	49.71±1.17	14.40±1.32	8.78±0.67	13.36±0.62	13.85±0.64
YellowxSpent	43.40±1.51	48.86±1.18	11.74±1.34	3.70±0.68	11.75±0.61	10.35±0.63
BlackxYoung	49.24±1.49	54.01±1.19	16.01±1.33	7.72±0.65	16.56±0.60	14.54±0.65
BlackxSpent	53.46±1.50	55.65±1.20	9.40±1.32	3.83±0.66	14.04±0.59	12.83±0.64
WildxYoung	41.60±1.49	46.31±1.19	13.97±1.33	10.15±0.65	13.56±0.60	13.66±0.62
WildxSpent	40.26±1.50	46.65±1.18	11.23±1.32	4.08±0.66	10.00±0.61	10.72±0.63
ANOVA						
Genetic stock	0.001	0.001	0.941	0.116	0.001	0.058
Age	0.786	0.511	0.001	0.001	0.001	0.001
Genetic stockxAge	0.215	0.733	0.430	0.095	0.289	0.112

a-c; within the same columns, values with different superscripts were found significantly different

Table 2. The chroma and hue angle color values of young and spent quail meat obtained from different genetic stocks (mean±SEM)

Factors	Chroma		Hue Angle	
	Breast	Leg	Breast	Leg
Genetic stock				
White	19.34±0.87	14.24±0.56	0.884±0.029^{a}	1.166±0.024^{a}
Yellow	18.24±0.86	13.77±0.55	0.774±0.030^{b}	1.115±0.023^{b}
Black	20.40±0.85	14.98±0.54	0.926±0.031^{a}	1.178±0.022^{a}
Wild	17.35±0.84	14.34±0.55	0.747±0.029^{b}	1.082±0.021^{b}
Age				
Young	21.17±0.62	16.31±0.40	0.816±0.021	1.031±0.017
Spent	16.49±0.60	12.36±0.41	0.849±0.022	1.239±0.018
Genetic stockxAge				
WhitexYoung	21.69±1.23	15.03±0.80	0.885±0.042	1.080±0.034
WhitexSpent	16.99±1.24	13.46±0.81	0.884±0.041	1.252±0.033
YellowxYoung	19.71±1.22	16.51±0.80	0.752±0.040	1.005±0.032
YellowxSpent	16.76±1.24	11.04±0.82	0.795±0.042	1.225±0.032
BlackxYoung	23.76±1.23	16.51±0.80	0.859±0.041	1.083±0.034
BlackxSpent	17.03±1.22	13.45±0.81	0.993±0.042	1.274±0.033
WildxYoung	19.52±1.24	17.17±0.82	0.770±0.043	0.958±0.034
WildxSpent	15.18±1.23	11.51±0.80	0.724±0.042	1.257±0.033
ANOVA				
Genetic stock	0.083	0.507	0.001	0.019
Age	0.001	0.001	0.268	0.001
Genetic stockxAge	0.496	0.033	0.173	0.678

a-b; within the same columns, values with different superscripts were found significantly different

Discussion

In this study, physical quality characteristics of both leg and breast muscle of different quail strain were investigated. Compared to spent quail, leg and breast meat pH values of young birds were found greater and significantly different. In a previous study, Sengul et al (2018) reported that the pH values of quail breast meat were not significantly affected by age. Black variety of quail had a significantly greater leg meat pH value compare to wild type or pure line stocks of Paharoh quail. Poultry meat pH is affected by several factors such as pre-slaughter management, sex, nutrition, slaughter age, heat stress and air velocity (Guler et al 2019, Dos Santos et al 2020, Badar et al 2021). Samson et al (2019) reported that up to 20% fermented mango seed kernel can be included in the quail diets without deleterious effect on their meat colour and pH values. A direct correlation between meat pH value and texture, water-holding capacity, color, and shelf life has been reported previously in broiler and quail (Fletcher 1999, Kaye 2014, Mir et al 2017). There is a close relationship between meat pH and meat color. The dark meat color indicates a high pH while the light meat color indicates low pH (Anadon 2002). The pH values of quail muscles determined in this study was similar to some previous results that ranged between 5.711 and 6.525 (Narinc et al 2013; Nasr et al 2017). Wilkonawska and Kokoszynski (2011) reported that older Pharaoh quails (33 and 42 day old birds) showed higher values of meat pH. The significant genetic line x age interaction for leg meat pH revealed that meat from black spent bird had significantly greater pH values while the meat from young white, yellow and wild type had greater leg meat pH values.

In this study the redness, yellowness and chroma value of quail meat significantly affected by the age of the bird while genetic stock had a significant effect on lightness and hue angle values of the meat. The meat samples collected from young birds had significantly greater values of redness, yellowness and chroma values compared to spent quail. Wilkonawska and Kokoszynski (2011) reported that older Pharaoh quails, between 33 and 42 day old birds, showed higher values of redness and yellowness values. In this study, the black variety of the birds had significantly greater lightness and hue angle values of the breast and leg meat and yellowness of breast meat. Nasr et al (2017) investigated the performance, carcass traits, meat quality and amino acid profiles of quail of four different plumage colors (white, golden, gray and brown) and reported that white quails had the highest lightness and yellowness with the lowest level of redness. In another study, age x live weight interaction for redness and yellowness values of quail meat were found significant (Şengül et al 2018). Gontijo et al (2017) reported that no difference in hue angle of quail meat was observed. A significant genetic line x age interecation for chroma values indicated that there was a significant differences for meat taken between young and spent birds of yellow and wild variety while differences for meat taken between young and spent birds of white and black variety was not significant.

In general, the water holding capacity of the meat is an important technological feature and it is desirable to keep the water of meat in the carcass for easy processing of meat and minimizing yield loss. The water content of fresh meat varies depending on many factors, such as the bird species, sex, age and muscle structure of the animal. There is a strong relationship between meat pH value and water holding capacity which means the low level of pH reduces the water holding capacity. In the present study, water holding capacity of meat from black variety which is a cross line of Pharaoh quail and BobWhite was found significantly greater than the other genetic stocks, especially pure line genetic stock (wild type). Similar to our findings Gontijo et al (2017) reported that meat obtained from meat-type strains had a greater water-holding capacity. In contrast, Nasr et al (2017) showed that the water holding capacity of meat from white quail was the highest compare to the other quail lines.
The muscle tissue of quail meat is consist of poultry white meat or pectoral muscles, red meat as drumsticks or thighs and intermediate muscles of the dorso-scapular part and wings (Glinkina et al 2020). If we compare leg and breast meat properties of quail, in general, leg meat had significantly greater pH and Hue angle values with significantly less redness and chroma values compare to breast meat.

Conclusion

The results of this study may allow us to determine the best quail line for producing quail meat with a higher physical value, and higher composition of quail meat depending on the slaughter age. It can be concluded that black variety of quail and young birds had greater values of most meat quality characteristics compare to other genetic stocks and spent birds. Further research on nutritional and sensory characteristics of quail meat, especially in a more dense population would be very useful in the future studies.

Conflict of Interest

The authors did not report any conflict of interest or financial support.

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During this study, any pharmaceutical company which has a direct connection with the research subject, a company that provides and / or manufactures medical instruments, equipment and materials or any commercial company may have a

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Ethical Approval

This study was carried out with the permission of the Bursa Uludag University Animal Experiments Local Ethics Committee (Decision No: 2021-15/02) report.

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