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RESEARCH ARTICLE

Determination of some external and internal quality traits of Japanese quail (*Coturnix coturnix japonica*) eggs on the basis of eggshell colour and spot colour

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Öz

Amaç: Bu çalışma bıldırcın yumurtalarında farklı kabuk rengi, benek rengi ve benek yaygınlığına sahip yumurtalarda iç ve dış kalite özelliklerini belirlemek amacıyla yürütüldü.

Gereç ve Yöntem: Araştırmada günlük toplanan 318 adet Japon bıldırcın yumurtası kullanıldı. Uygulama grupları grimsi beyaz kabuk rengi üzerine çok büyük kahve benek (I), grimsi beyaz kabuk rengi üzerine farklı büyüklükte siyah benek (II), kahverengi kabuk rengi üzerine büyük kahve benek (III), kahverengi kabuk rengi üzerine yaygın kahve benek (IV) ve grimsi beyaz kabuk rengi üzerine farklı büyüklükte mavi benek (V) olarak isimlendirildi. Yumurtalar bireysel olarak numaralandırıldı. Yumurta kırılmadan önce dış kalite özellikleri ve kırıldıktan sonra ak uzun ve kısa çapı, ak yüksekliği, sarı çapı ve sarı yüksekliği ölçüldü.

Bulgular: Yumurta kabuk oranı ve kabuk indeksi değerleri bakımından gruplar arasındaki farklılıklar önemli bulundu (P<0.01). İç kalite özelliklerinden ak indeksi, sarı indeksi ve Haung unit değerleri bakımından gruplar arası farklılık istatistiki olarak önemli olduğu belirlendi (P<0.01, P<0.001).

Öneri: Bıldırcın yumurtalarında kabuk ve benek renginin kabuk oranı, kabuk indeksi, ak indeksi, sarı indeksi ve haugh unit gibi kalite özellik değerlerine etkisinin önemli olduğu söylenebilir.

Anahtar kelimeler: Bıldırcın, kabuk ve benek rengi, dış ve iç kalite

Abstract

Aim: In this study was aimed to determining internal and external quality of quail eggs with different eggshell colour, spot colour and spottiness.

Material and Methods: In this study, daily collected 318 eggs were used. The treatment groups were classified as those with very large brown spots on greyish white eggshell colour (I), black spots of varying size on greyish white eggshell colour (II), large brown spots on brown eggshell colour (III), widely distributed brown spots on brown eggshell colour (IV), and blue spots of varying size on greyish white eggshell colour (V). The eggs were individually numbered. External quality characteristics were identified before egg broken out. After eggs were broken out, long and short diameter of albumen, albumen height, yolk diameter and yolk height were evaluated.

Results: The differences for value of eggshell percentage and shell index between groups were statistically significant (P<0.01). The differences for albumen index, yolk index and Haugh unit between groups were significant (P<0.01, P<0.001).

Conclusion: It may be expressed that eggshell colour and spot colour in quail eggs are significantly affected egg quailty characteristics like eggshell percentage, shell eggs index, albumen index, yolk index and haugh unit.

Keywords: Quail, eggshell and spot colour, external and internal quality

Introduction

Several researches have been carried out on the external and internal quality traits of quail eggs (Turkyılmaz 2005, Taha 2011, Alasahan and Gunlu 2012, Dukic Stojcic et al 2012, Genchev 2012, Sari et al 2012, Zita et al 2013, Hrncar et al 2014). Quail eggs differ from the eggs of other avian species in terms of their smaller volume, eggshell colour, spot size, spot colour, and some internal and external quality traits. Quail eggs have an eggshell colour varying from white to blue or green, on which spots of varying size and colour are observed. Mizutani (2003) reported that, in wild quails, the eggshell colour could be white or flesh-tinted with light brown and/or blue and/or brown spotted. As reported by this researcher, the intensity of spottiness as well as the size and colour of the spots can be used as a tool to identify individual female animals. Different colour definitions have been made in previous researches on the eggshell colour of quail eggs. Okumus and Durmus (1998) classified quail eggs as white-coloured, sandy-spotted, lightly spotted, heavily spotted and/or moderately spotted eggs. Sezer and Tekelioglu (2009) indicated that the eggshell colour of quail eggs varied from white to blue or green, while Taha (2011) classified quail eggs as those with black spots of varying size on brown or greyish white eggshell colour, spotless eggs with a white eggshell colour, and eggs with small black or light blue spots on a greyish brown eggshell colour. On the other hand, Hassan et al (2013) classified quail eggs as light eggs (with no spots or rarely very small spots), dotted eggs (with many small spots), spotted eggs (with many large spots), and dark eggs (with a few very large spots).

The variances, observed in the eggshell colour and spottiness of quail eggs, have attracted the attention of many researchers. In their studies, while some researchers (Sezer and Tekelioglu 2009) have focussed on the identification of the eggshell colour using the quantitative analysis method, some others have focussed on the impact of eggshell colour variations on eggshell structure, egg weight loss, and hatching parameters (Taha 2011, Hassan et al 2013), and have also investigated internal and external egg quality traits (Taha 2011). This study was conducted on quail eggs of different eggshell colour with an aim to determine the impact of eggshell colour, spot colour and spottiness on external and internal egg quality traits.

Materials and Methods

Three hundred and eighteen eggs laid by 16-week-old quails, which were obtained daily from a local table eggs producer from Japanese quails (*Coturnix coturnix japonica*), constituted the material of the study. Each egg was macroscopically examined on the basis of eggshell colour. As a result of the individual examination of all of the quail eggs, five groups were established according to the eggshell colour, spot colour and spottiness, and some external and internal egg quality traits were investigated in these groups. The names of the study groups and the number of eggs included in these groups are presented in Table 1 and Figures 1-5.

In order to determine the external and internal egg quality traits of each group, each egg was individually weighed on a digital scale accurate to 0.01 g (Neck mark), and numbered. Subsequently, the egg length and width values were measured using a digital calliper (Stainless Hardened Mark Digital Caliper). After being broken out, the internal surface of the eggshell of each egg was carefully cleaned with an absorbent tissue, and the eggshell of each egg was weighed to record the eggshell weights. By using the values obtained from these measurements, the external egg quality trait values listed below were calculated (Anderson et al 2004, Rayan et al 2010).

Shape index (%) = (Egg Width / Egg Length) x 100 (Carter 1968)

Elongation = (Egg Length / Egg Width) (Preston 1968)

Eggshell Index (g/100 cm^2) = [Eggshell Weight (g) / Eggshell Surface Area (cm^2)] x 100 (Sauveur 1988)

Eggshell Surface Area (cm^2) = 3.9782 x (Egg Weight (g)).7056 (Carter 1975)

Eggshell Percentage (%) = [Eggshell Weight / Egg Weight] x 100

In order to determine the internal quality traits, each egg was broken out onto a flat glass surface. Eggs with cracks, ripped yolk and uncertain thick albumen were excluded from the study. The diameter and height of the egg yolk and albumen were measured using a digital calliper. Without damaging

Table 1. Data pertaining to the study groups.

Groups	Number of Eggs
Very Large Brown Spots on Greyish White Eggshell Colour (I)	70
Black Spots of Varying Size on Greyish White Eggshell Colour (II)	72
Large Brown Spots on Brown Eggshell Colour (III)	37
Widely Distributed Brown Spots on Brown Eggshell Colour (IV)	40
Blue Spots of Varying Size on Greyish White Eggshell Colour (V)	99

the egg yolk, the yolk and albumen were separated, and the weight of the egg yolk was measured. By using the albumen and egg yolk values obtained from these measurements, the internal egg quality values listed below were calculated (Gonzalez 1995, Genchev 2012).

Albumen Weight (g) = [Egg Weight (g) - (Egg Yolk Weight (g) + Eggshell Weight (g))]

Egg Yolk Percentage (%) = [Egg Yolk Weight (g) / Egg Weight (g)] x 100

Albumen Percentage (%) = [Albumen Weight (g) / Egg Weight (g)] x 100

Albumen Index (%) = [Thick Albumen Height (mm) / (Thick Albumen Long Diameter (mm) + Thick Albumen Short Diameter (mm)) / 2)] x 100 (Heiman and Carver 1936)

Yolk Index (%) = [Egg Yolk Height (mm) / Egg Yolk Diameter (mm)] x 100 (Funk 1948)

Haugh Unit = 100 log [Thick Albumen Height (mm) + 7.57 – 1.7 x (Egg Weight (g)0.37] (Haugh 1937)

Internal Quality Units = 100 log [Thick Albumen Height (mm) + 4.18 – 0.8989 x (Egg Weight (mm)0.6674] (Kondaiah et al 1983)

The statistical analysis of the data obtained in this study was made using the SPSS 12 software package. The normality of data distribution was checked using the Kolmogorow-Smirnov test. The mean values of each group were tested by analysis of variance, and the statistical significance of the differences between the study groups was determined by Duncan's test.

Results

External quality traits

Some external and internal quality trait values of eggs belonging to study groups with different eggshell colours are presented in Tables 2 and 3. The impact of eggshell colour on eggshell percentage and eggshell index was found to be statistically significant ($P<0.01$). Differences between groups for albumen weight, egg yolk weight and shell weight were insignificant ($P>0.05$).

Furthermore, the impact of eggshell colour on egg width was also found to be statistically significant ($P<0.05$). While the egg length and width values were ascertained to be the highest in Group IV, the egg shape index was the highest in Group II, and elongation values were the highest in Group V.

Figure 1. Very large brown spots on greyish white eggshell colour.

Figure 2. Black spots of varying size on greyish white eggshell colour.

Figure 3. Large brown spots on brown eggshell colour.

Internal quality traits

Values pertaining to some internal quality traits of eggs belonging to groups with different eggshell colours are presented in Table 4. The impact of eggshell colour on all of the internal quality traits given in these tables, excluding egg yolk diameter, was found to be statistically significant ($P<0.05$, $P<0.01$, $P<0.001$).

The albumen index, haugh unit and internal quality unit values were the highest in Group I, whilst the egg yolk height and egg yolk index values were the highest in Group V.

Figure 4. Widely distributed brown spots on brown eggshell colour.

Figure 5. Blue spots of varying size on greyish white eggshell colour.

Discussion

In the present study, it was determined that in quail eggs, eggshell colour had significant impact on some external and internal quality traits. The results obtained showed that differences in the eggshell colour and spot colour were associated with variances in eggshell percentage and eggshell index values. The mean eggshell percentage value determined in the present study (8.74%, Table 2) was found to be lower than the values previously reported by Taha (2011), Sari et al (2012) and Zita et al (2013), but was ascertained to be similar to other values reported by Sezer (2007), Nowaczewski et al (2010), and Hrncar et al (2014).

In agreement with Taha (2011), it was ascertained that the impact of eggshell colour and spot colour on egg weight and eggshell weight was statistically insignificant (P>0.05, Table 2). Similar results have been reported for egg weight and shell weight in researches on different animal species. Kozuszek et al (2009), Nowaczewski et al (2013a), and Nowaczewski et al (2013b) reported that, in pheasant eggs with an eggshell colour of blue, light brown, dark brown or olive green, eggshell colour had no significant impact on egg weight or eggshell weight. The results obtained in the present study differ from those reported in previous researches, which suggest eggshell colour to have a statistically significant impact on egg weight and eggshell weight in pheasant eggs (Krystianiak et al 2005) and hens' eggs (Al-Rubaiee 2012) of different eggshell colours (P<0.01).

The present study revealed that eggshell colour and spot colour had a significant effect on the width of quail eggs. The highest egg width value was determined in Group IV (26.14 mm) and the differences between the treatment groups were determined to be statistically significant (P<0.05, Table 3). The egg width values obtained in the present study were in

Table 2. Some external and internal quality traits of groups with different eggshell colours (mean ± SE)

Groups	n	Egg Weight (g)	Albumen Weight (g)	Albumen Percentage (%)	Egg yolk Weight (g)	Yolk Percentage (%)	Eggshell Weight (g)	Eggshell Percentage (%)	Shell Index (g/100 cm^2)
I	65	12.70±0.17	7.51±0.11	59.12±0.28	4.09±0.07	32.15±0.28	1.11±0.02	8.73±0.09^{b}	4.63±0.04^{ab}
II	64	12.35±0.14	7.40±0.09	59.95±0.31	3.88±0.07	31.31±0.31	1.08±0.02	8.74±0.10^{b}	4.60±0.05^{b}
III	37	12.43±0.17	7.41±0.12	59.56±0.38	3.90±0.07	31.37±0.31	1.12±0.02	9.07±0.19^{a}	4.78±0.10^{b}
IV	38	12.76±0.21	7.60±0.12	59.58±0.40	4.10±0.09	32.06±0.37	1.07±0.02	8.36±0.10^{c}	4.44±0.06^{c}
V	93	12.49±0.14	7.42±0.08	59.46±0.23	3.97±0.06	31.77±0.24	1.09±0.01	8.76±0.07^{b}	4.62±0.03^{ab}
Total	297	12.53±0.07	7.76±0.05	59.52±0.14	3.98±0.03	31.74±0.13	1.09±0.01	8.74±0.05	4.62±0.02
	F	1.059	0.575	1.051	1.990	1.529	1.433	3.945	3.501
	P	0.377	0.681	0.381	0.096	0.194	0.223	0.004	0.008

$^{a-c:}$ Differences between mean values with different superscripts in the same column are statistically significant (P<0.01)

Table 3. Some external quality traits of eggs belonging to groups with different eggshell colours (mean ± SE).

Groups	n	Egg Length (mm)	Egg Width (mm)	Shape Index (%)	Elongation
I	70	33.63±0.20	26.08±0.13^{a}	77.62±0.37	1.29±0.01
II	72	33.18±0.20	25.77±0.12^{ab}	77.75±0.31	1.29±0.01
III	37	33.60±0.30	25.94±0.16^{ab}	77.32±0.54	1.30±0.01
IV	40	33.82±0.26	26.14±0.14^{a}	77.43±0.52	1.29±0.01
V	99	33.55±0.18	25.61±0.10^{b}	76.46±0.33	1.31±0.01
Mean	318	33.53±0.10	25.85±0.06	77.23±0.18	1.30±0.00
	F	1.075	3.295	2.344	2.339
	P	0.369	0.012	0.055	0.055

$^{a-c}$:Differences between mean values with different superscripts in the same column are statistically significant (P<0.01)

agreement with those previously reported by Taha (2011) in a study suggesting that eggs with an eggshell colour of brown had a larger egg width. On the other hand, the present study suggested that the impact of eggshell colour and spot colour on egg shape index and elongation was statistically insignificant. This finding was in compliance with the report of Taha (2011) for quail eggs, but differed from previous reports available for hens' eggs Al-Rubaiee (2012) and pheasant eggs (Nowaczewski et al 2013a, Nowaczewski et al 2013b), which revealed eggshell colour to significantly affect egg shape index. Of the internal quality traits investigated in the present study, the albumen index, egg yolk index and HU values were ascertained to significantly differ for eggshell colour and spot colour (P<0.01, P<0.001, Table 4). While the impact of eggshell colour on the albumen index and egg yolk index was found to be statistically insignificant in quail eggs, as reported

Table 4. Internal quality traits of eggs belonging to groups with different eggshell colours (Mean±SE).

Groups	n	Albumen Length (mm)	Albumen Width (mm)	Albumen Height (mm)	Yolk Diameter (mm)	Yolk Height (mm)
I	59	46.68±0.70^{a}	35.82±0.58^{a}	5.38±0.10^{a}	26.79±0.22	11.84±0.16^{a}
II	61	45.98±0.60^{ab}	35.40±0.50^{a}	5.11±0.10^{b}	26.49±0.18	11.64±0.18^{a}
III	34	43.53±0.75^{b}	33.64±0.73^{b}	4.45±0.10^{c}	26.41±0.24	11.03±0.16^{b}
IV	33	46.01±0.84^{a}	35.51±0.69^{a}	4.56±0.12^{c}	26.76±0.38	11.72±0.24^{a}
V	85	44.77±0.48^{ab}	34.37±0.36^{ab}	4.37±0.06^{c}	26.53±0.19	12.01±0.12^{a}
Mean	272	45.45±0.29	34.96±0.24	4.79±0.05	26.59±0.10	11.73±0.08
	F	3.119	2.494	28.034	0.485	4.196
	P	0.016	0.043	0.000	0.747	0.003

Groups	n	Albumen Index (%)	Yolk Index (%)	Haugh Unit	Internal Quality Unit
I	59	13.18±0.29^{a}	44.25±0.54^{a}	93.26±0.48^{a}	66.13±0.94^{a}
II	61	12.65±0.28^{a}	43.96±0.63^{a}	92.07±0.51^{a}	64.29±1.02^{a}
III	34	11.64±0.29^{b}	41.83±0.62^{b}	88.61±0.47^{b}	57.71±0.98^{b}
IV	33	11.32±0.36^{b}	43.88±0.76^{a}	88.87±0.65^{b}	57.34±1.45^{b}
V	85	11.11±0.18^{b}	45.32±0.40^{a}	88.07±0.35^{b}	56.32±0.83^{b}
Mean	272	12.00±0.13	44.17±0.26	90.26±0.25	60.54±0.52
	F	12.557	4.331	26.152	21.449
	P	0.000	0.002	0.000	0.000

$^{a-c}$: Differences between mean values with different superscripts in the same column are statistically significant (P<0.05, P<0.01, P<0.001).

by Taha (2011), and in pheasant eggs, as reported by Kirikci et al (2005), the impact of eggshell colour on the HU values was found to be statistically significant in pheasant eggs, as reported by Kozuszek et al (2009). Furthermore, Al-Rubaiee (2012) suggested that eggshell colour significantly affected the egg yolk index of hens' eggs.

The highest and lowest Haugh unit values were determined in Group I (93.26) and in Group V (88.07) respectively and the differences between the treatment groups were determined to be statistically significant (P<0.01, Table 4). The results obtained in the present study differ from those reported in previous researches (Caglayan et al, 2014), which suggest spotted and unspotted eggs to have a statistically insignificant impact on Haugh unit in partridge eggs.

Conclusion

It could be expressed that eggshell colour and spot colour in quail eggs are significantly affected egg quailty characteristics like eggshell percentage, shell eggs index, albumen index, yolk index and haugh unit.

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