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Research
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Comparison of egg quality, yolk cholesterol and fatty acid contents of chicken, quail, partridge and pheasant eggs

Ali AYGÜN[1], Osman OLGUN[1]

[1]Selçuk Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, Konya

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Sorumlu yazar: Ali AYGÜN, e-posta: aaygun@selcuk.edu.tr

Abstract

This experiment was conducted to compare the cholesterol concentrations of yolk and some internal and external quality chicken, quail, partridge and pheasant eggs. Chickens, quails and partridges are housed in cages and pheasants are housed floor pens. Egg quality traits were determined for 20 eggs per poultry species. Egg weight, egg shape index, eggshell strength, albumen ratio, yolk ratio, yolk index, albumen pH, yolk pH, shell ratio, albumen and yolk color characteristics were examined as egg quality analyzes. Ten eggs from each species were used to determine total cholesterol and triglyceride levels of yolks. The highest egg shape index and eggshell strength values were obtained in the pheasant and chicken eggs. The lowest yolk ratio value was obtained in hen eggs. The shell ratio and yolk index of partridge eggs were higher than the other species. Chicken egg had a lower proportion of cholesterol compared with other species. Partridge eggs have a lighter yolk color than other species. There was no statistically significant difference between the other species in terms of egg yolk cholesterol content, while the lowest egg yolk cholesterol value was detected in chicken eggs.

Key words: Chicken, quail, partridge, pheasant, cholesterol, egg quality

Tavuk, sülün, keklik ve bıldırcın yumurtalarının kalitesi, kolesterol ve yağ asidi içeriklerinin karşılaştırılması

Öz

Bu çalışma, tavuk, sülün, keklik ve bıldırcın yumurtalarının kolesterol seviyelerini ve kalite özelliklerinin karşılaştırılması amaçlanmıştır. Tavuklar, bıldırcınlar ve keklikler kafeste, sülünler ise yer sisteminde barındırılmıştır. Her tür için 20 adet yumurtada yumurta kalite özellikleri belirlenmiştir. Yumurta kalitesi analizleri olarak yumurta ağırlığı, yumurta şekil indeksi, yumurta kabuğu mukavemeti, ak oranı, yumurta sarısı oranı, yumurta sarısı indeksi, ak pH, sarı pH, kabuk oranı, ak ve yumurta sarısı renk özellikleri incelenmiştir. Her bir tür için 10 adet yumurtada toplam kolesterol ve trigliserit seviyeleri belirlenmiştir. Tavuk yumurtaları diğer türlerin yumurtalarına göre daha oval bir yapıdadır. Kırılma direnci bakımından en düşük kırılma direnci bıldırcın yumurtalarında tespit edilmiş olup, tavuk ve sülün yumurtaları arasında kırılma direnci bakımından istatistiki olarak farklılık görülmemiştir. En düşük yumurta sarısı oranı tavuk yumurtalarında tespit edilirken, en yüksek yumurta sarısı sülün ve kekliklerde tespit edilmiştir. Yumurta sarı indeksi en düşük tavuk yumurtasında tespit edilmesine rağmen, en yüksek yumurta sarı indeksi keklik yumurtalarında belirlenmiştir. Yumurta sarı rengi en açık keklik yumurtalarında görülürken, diğer türler arasında sarı renginin yoğunluğu bakımından istatistiki olarak bir farklılık görülmemiştir. En düşük yumurta sarı kolesterol değeri tavuk yumurtasında tespit edilirken diğer türler arasında kolesterol miktarı bakımından istatistiki olarak bir farklılık görülmemiştir.

Anahtar kelimeler: Tavuk, sülün, keklik, bıldırcın, kolesterol, yumurta kalitesi

Introduction

Eggs are produced not only for chick production but also as an important source of nutrients for humans.

Eggs contain important nutrients such as protein, essential fatty acids, vitamins and minerals that are necessary for human nutrition. Humans generally consume table eggs, but in small quantities, they consume fertile eggs from other poultry species. In recent years consumer interest has increased for quail, pheasant and partridge eggs (Balcioğlu et al., 2009; Garip et al., 2010; Karabag et al., 2010; Burden, 2013; Kokoszyński, 2017). The structure of the egg is similar in various poultry species, but there are differences in the proportions of these parts (Nys and Guyot, 2011). A few studies have been conducted to compare the cholesterol content and quality of eggs of different poultry species (Song et al., 2000; Choi et al., 2001; Sun et al., 2019). Egg quality is influenced by many factors such as genotype (Basmacioğlu and Ergül, 2005; Şekeroğlu and Sarıca, 2005; Bozkurt and Tekerli, 2009), age (Silversides et al., 2006; Minelli et al., 2007; Akyurek and Okur, 2009), production systems (Van Den Brand et al., 2004; Wang et al., 2009), feed ((Leeson and Caston, 1997; Wu et al., 2005). Basmacioğlu and Ergül (2005) stated that amount of cholesterol in eggs produced in cages were higher than those produced in floor pen. The aim of this study was to compare the eggs of chicken, pheasant, partridge and quail in terms of cholesterol and egg quality. Thus, the physical and nutritional characteristics of quail, pheasant and partridge eggs, which are more interesting in our country in recent years, will be determined.

Material and Method

The eggs of chicken, pheasant, chukar partridge, and quail were obtained from Selçuk University Agriculture farm in Konya, Turkey. Chickens, quails and partridges are housed in cages and pheasants are housed floor pens. Chicken were fed a ration containing 17% HP and 2800 kcal ME/kg, chukar partridge 17% and 2900 kcal ME/kg, pheasant 17% HP and 2900 kcal ME/kg kcal, and quail 20% HP and 2900 kcal ME/kg. Feed and water were provided *ad libitum*. The eggs were collected daily and stored in the laboratory for one day in the room condition (24 ± 2 °C) in order to reduce the variation between the first and last ovulated eggs. Egg quality traits were determined for 20 eggs per poultry species. Egg weight was measured using a balance accurate to 0.01 g. Egg shape index (width/length*100) was measured with a micrometer caliper accurate to 0.01 mm. Eggshell strength (kgf) was measured with an Egg Force Reader (06-UM-001, Ver-sion B, Orka Food Tech. Ltd., Hong Kong, China). After the eggs broken, the albumen and yolk separated using a conventional yolk separator and yolk and albumen were weighed. Albumen and yolk were expressed as percentages relative to total egg weight. Yolk index (height/width) was measured with a measured with a micrometer caliper and a digimatic height gauge accurate to 0.01 mm (Funk, 1948). Then the pH of yolk and albumen was measured using pH meter. Color measurement was performed using a Minolta Chroma Meter CR-400 (Minolta, Osaka, Japan). The lightness (L^*), redness (a^*), and blueness (b^*) color measurements were determined according to the CIELab color space system. The eggshells were washed with water to remove residual albumen and were dried at room condition for 3 days. Then eggshell weight was weighed and expressed as percentages relative to total egg weight.

Ten eggs from each species were used to determine total cholesterol and triglyceride levels of yolks. The contents of total cholesterol and triglyceride of yolks were determined by using the methods of Berrio and Hebert (1990) and Hammad et al. (1996), with modification by GmbH (1989). The eggs were hard-boild for 15 min, then the yolks were separated and 0.1 g samples of yolks were weighed accurately. Yolk lipids were extracted with isopropanol (4 ml/0.1 of yolk), then vortex-mixed and centrifuged at 3000 rpm for 5 min. The yolk lipids determined in the samples filtered by spectrophotometer using a commercial kit (HUMAN Cholesterol liquicolor for cholesterol, HUMAN Triglucerides liquicolormono for triglyceride).

Statistical methods

Data were analyzed via one-way ANOVA, and means were compared by Duncan's multiple range test. All analyses were carried out using Minitab Version 16 (Minitab Inc., State College, PA, USA).

Results and Discussion

The internal and external characteristics of the eggs of some different bird species are shown in Table 1. Differences between species were significant in terms of all internal and external egg quality parameters examined ($P<0.01$). The egg weight from the examined species of bird differed significantly ($P<0.01$), and increased in the following order: chicken (62.24 g), pheasant (31.47 g), partridge (20.75 g), and quail (13.18 g). Chicken had the highest egg weight, followed by pheasant, partridge, and quail. The higher the live weight in poultry, the higher the egg weight. There is a positive

relationship between egg weight and body weight (Rahn et al., 1975; Lacin et al., 2008). Egg weight ranges from 60.05 to 67.41 g in chickens (Curtis et al., 1986; Lacin et al., 2008; Svobodova et al., 2014), 20.55 to 22.44 g in partridge (Garip et al., 2010; Caglayan et al., 2014), 10.40 to 13.70 g in quails (Camci et al., 2002; Kumari et al., 2008; Alkan et al., 2010) and 31.00 to 31.80 g in pheasants (Kirikçi et al., 2005; Garip et al., 2010).

Table 1. The internal and external quality of eggs of different poultry species

Traits	Chicken	Pheasant	Partridge	Quail	SEM	P values
Egg weight, g	62.24^{a}	31.47^{b}	20.75^{c}	13.18^{d}	0.312	0.001
Egg shape index, %	77.22^{b}	81.96^{a}	75.97^{b}	76.89^{b}	0.536	0.001
Eggshell strength (kgf)	3.81^{a}	3.94^{a}	3.12^{b}	1.62^{c}	0.098	0.001
Albumen ratio, %	64.70^{a}	56.93^{c}	55.67^{c}	59.85^{b}	0.444	0.001
Yolk ratio, %	25.21^{c}	32.63^{a}	32.88^{a}	30.59^{b}	0.395	0.001
Yolk index	0.39^{c}	0.45^{b}	0.49^{a}	0.45^{b}	0.006	0.001
Albumen pH	8.29^{b}	8.41^{b}	8.57^{a}	8.68^{a}	0.03	0.001
Yolk pH	5.71^{c}	5.95^{a}	5.95^{a}	5.85^{b}	0.04	0.001
Shell ratio, %	10.00^{bc}	10.44^{b}	11.45^{a}	9.56^{c}	0.157	0.001

$^{a-d}$ Values bearing different superscript in rows are statistically different; P<0.01.

A greater shape index (P < 0.01) was noticeable in the pheasant egg compared to the other species eggs. This means that the pheasant eggs are more rounded that the eggs of other species. The shape index mostly detected are sharp pointed, normal (standard), and round eggs which are enumerated on the SI as <72, 72–76, and >76, respectively (Altuntaş and Şekeroğlu, 2008). According to the shape indexes obtained from our study, only partridge eggs show normal shape index value (75.97%). The eggs of other species appear to have a more rounded shape. The more rounded and sharp pointed eggs are of low commercial value and the problem is that they are placed in viols. Furthermore, the probability of breakage during transportation is higher than for normal shaped eggs (Jacob et al., 2000).

Chicken and pheasant had the highest eggshell breaking strength, followed partridge and quail eggs. Eggshell breakage is important for poultry industry during egg collection, transport, packaging and storage processes. The variety and density of eggshell proteins and layers regulate the breaking strength of the egg (Hincke et al., 2008; Fathi et al., 2010). The different species of eggshell strength may be due to the fact that the amount of shell matrix proteins and layers is different.

Although the albumin ratio of partridge and pheasant eggs was lower than that of the other two species, yolk or shell ratios were found to be higher than these species.. The lowest and highest yolk indexes were detected in chicken and partridge eggs, respectively. Albumen pH was significantly higher (P<0.01) in quail and partridge eggs, and lower in the chicken and pheasant eggs, while yolk pH was significantly higher (P < 0.01) in partridge and pheasant eggs, and lower in the chickens. Similar results was obtained by Vlčková et al. (2019) who stated that chicken eggs yolk ratio (%) was lower than quails eggs yolk ratio (%). Egg quality was affected by strains, age, nutrition and environment (Hocking et al., 2003; Roberts, 2004; Aygun and Yetişir, 2014; Sekeroglu et al., 2014). Partridge, quail and pheasants, unlike chickens, are mainly used for hatching eggs. Ar and Yom-Tov (1978) reported that precocial birds produce eggs with significantly more yolk than altricial ones to supply more nutrients for chicks to survive independently.

The albumen and yolks colors of different avian specious eggs are shown Table 2. The difference between a* and b* albumen of the different species is insignificant (P>0.05). The albumen L* value of chicken and pheasant eggs was higher than the other species (P<0.01). The yolk L* and b* values of quail egg were significantly higher than chicken and pheasant (P<0.01). The yolk a * value of the partridge egg was markedly lower than other species (P<0.01). Egg yolk color is considered by consumers as an important quality criterion. Egg yolk color changes depending on the ration of the birds. The more carotenoids in the ration, the darker the egg yolk color (Schwägele, 2011).

The egg yolk cholesterol, triglyceride and fatty acids levels of the different species are shown in Table 3. Egg yolk triglyceride levels of different species were found to be similar (P>0.05).

Table 2. Color values of albumen and yolk of chicken, pheasant, partridge and quail egg

Parameters	Chicken	Pheasant	Partridge	Quail	SEM	P values
Albumen						
L*	36.006[b]	39.388[b]	49.500[a]	58.857[a]	2.413	0.001
a*	-1.105	-2.232	-2.686	-2.349	0.472	0.193
b*	11.502	14.752	16.023	12.342	5.917	0.169
Yolk						
L*	52.849[b]	52.456[b]	54.379[ab]	55.892[a]	0.536	0.001
a*	5.159[a]	4.289[a]	2.388[b]	4.307[a]	0.395	0.001
b*	42.610[b]	42.509[b]	46.167[ab]	53.700[a]	2.113	0.004

[ab] Values bearing different superscript in rows are statistically different; P<0.01.

Table 3. Triglyceride and cholesterol contents of chicken, pheasant, partridge and quail egg yolks

Parameters	Chicken	Pheasant	Partridge	Quail	SEM	P values
Triglyceride, mg/dl	173.24	172.46	177.42	175.36	1.51	0.112
Cholesterol mg/dl	136.87[b]	159.72[a]	166.16[a]	154.12[a]	2.89	0.001

[ab] Values bearing different superscript in rows are statistically different; P<0.01.

The level of yolk cholesterol in chicken egg was found to be significantly lower than in quail, partridge or pheasant eggs (P<0.01). But no significant differences were found for cholesterol among quail, partridge and pheasant. These results may be related to the result of more intensive selection in chickens compared to other birds. On the other hand, it may also be due to the nutrient content in the feed of these animals, genotype, production systems and age (Chand, 1987; Oloyo, 2003; Basmacioğlu and Ergül, 2005; Zemkova et al., 2007; Canogullari et al., 2009; Anderson, 2011). Cholesterol concentration in egg may be influenced by diet content (Li-Chan and Kim, 2008). Many studies have shown that nutrient cholesterol does not significantly affect on cholesterolaemia (Kritchevsky, 2000; Kritchevsky and Kritchevsky, 2000; Herron and Fernandez, 2004). It was stated that consumption of one or two eggs per day did not increase cholesterolaemia or the risk of cardiovascular disease (Dawber et al., 1982; Hu et al., 1999).

Conclusion

The results indicated that egg quality and cholesterol content varied within poultry species. Because of the higher cholesterol levels of pheasant, partridge and quail eggs, it is useful to pay attention to the consumption of these eggs as an alternative to chicken eggs.

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