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RESEARCH ARTICLE

Effect of hen age on egg quality, hatching performance and chick quality in Chukar Partridges *(Alectoris chukar)*

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Kınalı Kekliklerde *(Alectoris chukar)* damızlık yaşının yumurta kalitesi, kuluçka performansı ve civciv kalitesine etkisi

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Öz

Amaç: Bu çalışma, kınalı kekliklerde farklı ebeveyn yaşların yumurta kalite özellikleri, kuluçka performansı ve civciv kalitesi üzerindeki etkisini araştırmayı amaçlamıştır.

Gereç ve Yöntem: Farklı yaştaki kınalı keklik sürülerinden elde edilen toplam 510 yumurta, keklik yaşının kuluçka performansı, yumurta kalite özellikleri ve civciv kalitesi üzerindeki etkilerini belirlemek için kullanılmıştır. Her yaş grubundan (1, 2 ve 3 yaş) günlük olarak toplanan 20 yumurta iç kalite özellikleri açısından değerlendirilmiştir. Her yaş grubu için toplam 150 yumurta kuluçka makinesine yerleştirilmiştir. Kuluçkadan sonra, kuluçka performansını ve embriyonik ölüm oranlarını belirlemek için yumurtalar kırılmıştır. Kuluçkadan çıkan günlük civcivler civciv kalite özelliklerini belirlemek için puanlanmıştır.

Bulgular: Yumurtaların iç kalite özellikleri farklı yetiştirme yaşlarından istatistiksel olarak etkilenmemiştir. Farklı ebeveyn yaşı kuluçka randımanı, erken ve orta embriyonik ölümleri etkilememiş, geç embriyonik ölüm ve döllülük oranı ise keklik yaşından etkilenmiştir. Değerlendirilen civciv kalite özellikleri farklı ebeveyn yaşından etkilenmiştir.

Öneri: Yaşla birlikte azalan döllülük oranına rağmen, bu çalışmanın sonuçları optimum civciv kalitesi için 3 yaşlı kınalı keklik yumurtalarının kuluçkalanmasını ve damızlık kınalı kekliklerin 3 yaşına kadar yetiştirilebileceği önermektedir.

Anahtar kelimeler: Tona skoru, ebeveyn yaşı, kuluçka randımanı, haugh birimi.

Abstract

Aim: This study was aimed to investigate the effect of different hen ages on egg quality characteristics, hatching performance and chick quality in chukar partridges.

Materials and Methods: A total of 510 eggs obtained from chukar partridge flocks were used to determine the effects of different hen age on hatching performance, egg quality traits and chick quality. Daily collected 20 eggs from each age group (1, 2 and 3 years of age) were assessed for internal quality characteristics. A total of 150 eggs per each age group were set into incubator and hatcher set. After hatching, unhatched eggs were broken to determine hatching performance and embryonic mortality. Hatched day-old chicks were scored to determine chick quality characteristics.

Results: Internal egg quality traits were not statistically affected by different breeding ages. Different breeding ages did not affect hatchability, early and middle embryonic mortality while late embryonic mortality and fertility of eggs were statistically affected. The evaluated chick quality traits were affected by the different hen age.

Conclusion: Despite decreasing fertility rate with age, the results of this study suggest incubating eggs of chukar hens with 3 years age for optimum chick quality and being raised chukar hens up to 3 years of age.

Keywords: Tona score, breeding age, haugh, hatchability.

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Introduction

Chukar partridges, mostly bred for hunting and meat purposes, were distributed among mountainous regions of Middle East, Western Europe and some parts of Asia (Robinson 2007).

Producing high-quality chicks is crucial for successful production. Chick quality is evaluated with binomial distribution with the purpose of determining early culling rate (Decuypere and Bruggeman 2007). There is lack of data regarding the percentage of culling chicks after hatching without any standardized methodology for culling chicks. Successful raising of hatched chicks is economically crucial for hatching industry economical aspect.

Embryos should develop under optimal incubation conditions to obtain sufficient amount of high-quality hatched chicks (Molenaar et al 2010). Tona and Pasgar scores are common methods to determine chick quality including visual evaluation, chick weight and length and mass loss rate during incubation (Kamanlı and Durmuş 2014). The most popular method was known as Tona Score which was primarily determined using a score of 100 point (Tona et al 2004). Assessing the chick quality with Tona Score is based on various physical conditions of the day-old chicks such as activity, eyes, feathers, legs, novel area, yolk and membrane remaining (Tona et al 2003). Although several studies were reported that chick quality was affected by preincubation (Tona et al 2004, Reijrink et al 2009, Reijrink et al 2010) and incubation (Lourens et al 2005) conditions, there is lack of study investigating chick quality parameters in partridges.

Hatching performance and egg quality is affected by hen age. Several studies reported that egg quality deteriorated and embryonic mortality was increased with flock age (Lapao et al 1999, Tona et al 2004). While there is lack of study investigating chick quality of the partridges, there are some studies investigating the effect of hen age on several production parameters in different partridge breeds. Mourão et al (2010) reported that the red-legged partridge hens could reach maximum reproductive capacity at 2 years of age. Kırıkçı et al (2006) suggested that young rock partridge hens with 32-week age should be used as breeding material due to their higher hatching performance compared with old ones with 84-week age.

Egg quality is one of the factors affecting chick quality (Tona et al 2005). Both oversized and small-sized eggs have negative impact on hatching performance and chick quality (Decuypere et al 2001). Average egg weight of the partridges was varied between 19-23 g in several studies (Song et al 2000, Kırıkçı et al 2004, Tilki and Saatcı 2004, Çağlayan et al 2009, Kırıkçı et al 2018).

The aim of this study was to investigate the effect of hen ages on egg quality, hatching performance and chick quality in chukar partridges.

Material and Methods

This study was approved by the Ethics Committee for Experimental Animal Production and Research Center at the Faculty of Veterinary Medicine, Selçuk University (Authorization no: 2022/47).

The study was carried out at Bahri Dagdas International Agricultural Research Institute located in Konya province of Turkiye. The partridges were housed in semi-open outdoor battery cages with the dimension of 6.0 × 1.2 × 1.5 m. Each battery cage was consisted of 30 female and 10 male partridges with the same age. The partridges stayed in natural light conditions until ovulation. After the first egg was collected at 36-weeks of age, artificial lighting program was implemented at a rate of 1 h artificial light per week. The artificial lighting program was terminated after making a total of 16 h light during the whole period of egg production. Ad libitum commercial diet with 18% CP (DM) and 2850 kcal ME/kg was offered to the partridges. Water was provided via automatic nipples.

The eggs for this study were obtained from 6 breeding cages from each of 2 cages of the partridges with different ages (1, 2 and 3 years of age). The uncracked and clean eggs were collected twice a day with the equal number of the eggs per each group. Daily collected 20 eggs from each age group were assessed for internal quality characteristics. The eggs were weighed and then broken on the round glass table to measure thick layer of albumen width, length and height, yolk height and diameter (Kanon EMS-150). The components of the eggs were weighed with 0.01 sensitivity.

The internal quality characteristics were examined according to these formulas:

Albumen index (%): [(Albumen height / (albumen length + albumen width)/2)] × 100

Yolk index (%): (Yolk height / yolk diameter) × 100

Haugh Unit: $100 \log (H + 7.57 - 1.7 W^{0.37})$

Equal number of the eggs from each treatment group were collected daily, numbered and then put into storage chambers (HD-960L-3in1, Turkiye). The conditions of storage chambers were at 15 °C and 75% RH; with the position of pointed-end-up and turned once a day at 45° (Çam et al 2022a). After 10 days of storage period, when stored eggs were reached the number of 150 eggs per each age group, the eggs were weighed (0.01 sensitivity) and kept at room

temperature for 18 hours for preincubation heating. Then, the eggs were set into incubator (Çimuka T1600 C, Turkiye) with the position of blunted end up at 37.7 °C and 59% RH. After 21 days of incubation, the eggs were weighed, put into linen bags for exact identification and set into hatcher set at 37.2 °C and 72% RH. The eggs were turned 6 times a day at incubator and weren't turned at hatcher set.

The hatched chicks were counted once a day during the period of 23 and 25 days to determine incubation length. On the 27th day, the unhatched eggs were broken for rough macroscopic examination to determine the stages at embryonic death, hatchability and fertility rate (Çam et al 2022a). As for chick quality, all hatched chicks were examined on the day of hatch according to the Tona criteria (Tona et al 2003).

Hatchability = (Number of hatched eggs)/(Number of total incubated eggs) x 100

Fertility rate = (Number of fertile eggs)/(Number of total incubated eggs) x 100

Hatchability of fertile eggs = (Number of hatched eggs)/(Number of fertile eggs) x 100

Embryonic mortality of fertile eggs = (Number of embryo death)/(Number of fertile eggs) x 100

Embryonic mortality was classified according to periods of embryonic deaths as; early (0-8 d), mid (9 d to transfer) and late (transfer to hatch) stages.

Statistical Analysis

All procedures during the analysis were performed by using the SPSS program (ver. 29.0). Egg quality and incubation traits, as a function of hen age effect, were analysed by using one-way ANOVA. The comparisons between multiple groups were determined by Bonferroni post-hoc test. Hatching performance and chick quality parameters were analysed by using Pearson Chi Square Test with Monte-Carlo method to obtain more accurate results. The analyses were performed at 95% confidence level.

Results

Egg quality traits of chukar partridges in different age groups were shown in Table 1. No significant difference was observed for all investigated egg quality traits such as haugh unit, albumen and yolk index.

The egg weights and weight loss rate during incubation were shown in Table 2. There were no significant difference of egg weights and weight loss rate during incubation among age groups.

The number of hatched eggs at different days of hatching among treatment groups were shown in Table 3. Although there were no significant differences among age groups on day 23 and 25; the hatching period of the eggs from 1-year-old partridges were significantly prolonged compared with other groups according to the results on day 22 and 24 ($P<0.05$).

Hatching results and embryonic mortality rates were presented in Table 4. The results showed that fertility and late embryonic mortality rate were significantly affected by different age groups ($P<0.05$). The eggs from 1-year old partridges showed higher fertility rate compared with those from 3-year-old partridges. Hatchability, embryonic deaths at early and late period had no significant differences among age groups. Fertility rate was decreased by increasing age. Late embryonic mortality rate increased significantly by age.

Chick quality results among different age groups were shown in Table 5. There were significant effects in different age groups ($P<0.05$). The lower rate of chicks with 100 point was obtained from the partridges with 2 years of age. As for the average chick quality point and the rate of low-quality chicks, the chicks from 3-year-old partridges were showed higher quality. Figure 1 showed that the chick quality was increased with age.

Discussion

Although several studies investigated effect of hen weight (Kırıkçı et al 2007), preincubation storage (Çağlayan et al 2009, Günhan and Kırıkçı 2017, Çam et al 2022b) and

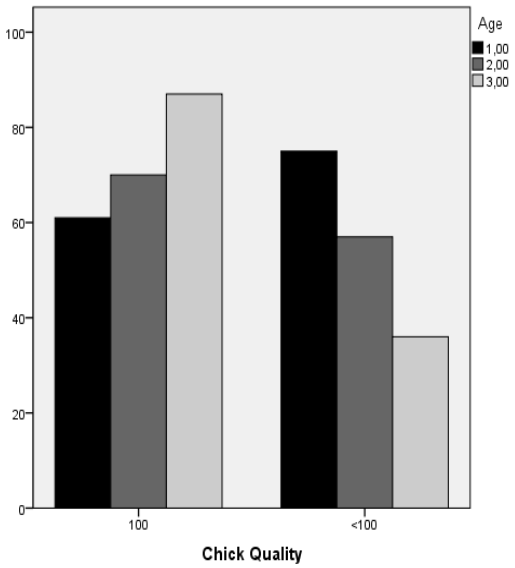

Figure 1. Chick quality scores of different age groups in Chukar partridge

Table 1. Internal egg quality traits of chukar partridges with different age groups (Mean ± SE)

Age (year)	Albumen Index	Yolk Index	Haugh Unit
1	2,24±0,09	47,49±1,68	82,45±0,85
2	2,10±0,09	45,30±0,92	81,09±0,78
3	2,33±0,08	45,34±0,79	78,93±4,25
P Values	-	-	-

-: P>0.05 which means that significant differences were observed among age groups in terms of the related variable.

Table 2. Initial and transfer egg weight (g) during incubation, chick weight (g) and weight loss rate (%) values in chukar partridge eggs among different age groups (Mean ± SE)

Age (year)	Initial Weight	Transfer Weight	Chick Weight	Weight loss rate
1	21,36±0,11	18,73±0,11	14,68±0,10	12,29±0,27
2	21,23±0,11	18,65±0,11	14,56±0,10	12,14±0,19
3	21,20±0,11	18,53±0,11	14,55±0,10	12,62±0,21
P Values	-	-	-	-

-: P>0.05 which means that no significant differences were observed among age groups in terms of the related variable.

breeding system (Çetin et al 1997, Özbey and Esen 2007) on egg quality traits in partridges, the effect of hen age on egg quality traits is still lacking. Contrary to the results of pheasant eggs (Günlü et al 2018), the present results showed that chukar egg quality traits were not significantly affected by different hen age.

Egg weight loss during incubation is an important parameter for decreasing hatching results due to excessive weight loss (Rocha et al 2013). Chukar egg weight loss in the study was in the normal range which would result any detrimental effect for hatching results (Mayes and Takeballi 1984). In this study, egg weight loss rate did not significantly increase with partridge hen age contrary to those in red-legged partridges (Cabezas-Diaz et al 2005). This difference may be due to differences in initial egg weight and egg laying week both of which would affect egg weight loss during incubation (Tona et al 2001, Abudabos et al 2017). In this study, average initial egg weights were found to be similar between treatment groups and the eggs were collected within the same week. In addition, a possible explanation for the similar chick weights among age groups could be due to the high correlation between initial egg weight and chick weight which may mask other temporary environmental conditions (Suarez et al 1997).

Table 3. The rate of hatched chicks in different days of hatching

Age (year)	The rate of hatched chicks			
	22nd day	23rd day	24th day	25th day
1	0^{b}	89,7	$10,3^{a}$	0
2	$8,7^{a}$	88,2	$2,4^{b}$	0,8
3	$11,4^{a}$	86,2	$2,4^{b}$	0

a, b: Significant differences among age groups were observed in different superscripts with the same columns (P<0.001).

Table 4. Hatching results (%) of Chukar partridges among age groups

Age (year)	H	F	HOFE	Embryonic Mortality Rates				
				E	M	L	P	T
1	88,3	$97,4^{a}$	90,7	4,0	2,7	0^{b}	2,7	9,4
2	82,5	$94,8^{ab}$	87,0	5,5	1,4	$3,4^{a}$	2,7	13,0
3	79,9	$90,3^{b}$	88,5	4,3	3,6	$1,4^{ab}$	2,2	11,5

H: Hatchability, F: Fertility, HOFE: Hatchability of fertile eggs; E: Early, M: Middle, L: Late, P: Pipped, T: Total; a, b: Significant differences among age groups were observed in different superscripts with the same columns (P<0.05).

Table 5. Chick Quality Parameters of Chukar partridge among age groups

Age (year)	Chick Quality Parameters		
	Chicks with score 100 (%)	Average score of all chicks	Chicks with score <100 (%)
1	44,9[b]	95,97±0,41[ab]	55,1[a]
2	44,9[b]	93,87±1,09[b]	44,9[a]
3	70,7[a]	98,00±0,38[a]	29,3[b]

a, b: Significant differences were observed in different superscripts with the same columns (P<0.001).

Hen age may affect the incubation lengths (Suarez et al 1997). Several studies reported that incubation duration was affected by pre-storage conditions (Çam et al 2022b), incubation and hatching conditions (Gomez-de-Travecedo et al 2014, González-Redondo and Quesada-Pérez 2022) in partridge eggs; but the effect of hen age on incubation duration is lacking. Hatching period was lengthened in the eggs from 1-year-old partridges.

In present study, fertility was decreased and embryonic death in late period was increased with age in chukar partridges which was similar to the studies with other partridge breeds (Kırıkçı et al 2006, Mourão et al 2010). This could be attributed to a decrease the efficiency of sperm storage tubules in hens with increasing age (Gumułka and Kapkowska 2005) or a decrease in male semen quality (Kotlowska et al 2005). Hen age-related differences in hatching results might have been affected by other environmental factors such as laying week, climate and management system considering similar results compared with the literatures. In our study, the factors mentioned above was eliminated therefore the obtained results could be mainly attributed to age-related effects.

Chick quality is an important indicator of good chick performance with high early life survival and potentiality of later production yields (Tona et al 2003). However, there is a lack of studies investigating chick quality in partridge chicks. The present results showed that chukar chick quality was improved in older partridge hens. Similarly, the chick quality was positively affected by increasing age in broilers (Sinclair et al 1990, Ipek and Sozcu 2015, Iqbal et al 2016).

Conclusion

The present study showed that neither internal egg quality characteristics nor egg weight loss during incubation were not affected by chukar hen age. Although fertility decreased with age, this study recommends incubating eggs laid by 3-year-old chukar hens to obtain high-quality day-old chicks, and raising the chukar partridges until they reach 3 years of age in breeding farms. This approach would be profitable and sustainable according to relevant findings.

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Conflict of Interest

Authors declare that there are no conflicts of interest related to the publication of this article.

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Author Contributions

Motivation / Concept: KK; Design: MC, MSS, KK; Control/ Supervision: MC, KK; Data Collection and / or Processing: MSS, ZKK, MC, HH, AB; Analysis and / or Interpretation: MSS, MC; Literature Review: MSS, MC; Writing the Article: MSS, MC; Critical Review: MC, MSS, ZKK, KK, AB, HH

Ethical Approval

SUVDAMEK Research and Application Center, Animal Experiments Ethics Committee 6.5.2022, 2022/47 Number Ethics Committee Decision.