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Note

Influence of age on physical traits of Japanese quail *(Coturnix coturnix japonica)* eggs

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Summary — External and internal traits of Japanese quail eggs during 6 months of lay were analyzed. Variables such as egg weight, specific gravity, egg shape index, albumen and yolk heights and their indices, internal quality unit (IQU) and shell and membrane thickness were recorded at 8, 12, 17, 21, 25, 30, 34 and 39 weeks of age. Egg weight, egg length, yolk height and yolk index increased as quail aged. Specific gravity, shell plus membrane thickness, egg shape index, albumen height and IQU decreased at the end of the experiment. Highest values of shell thickness (0.201 mm) and IQU (69.68) obtained at 17 and 8 weeks of age, respectively, indicated that a better quality of egg was attained at the beginning of lay.

egg quality / age / quail

Résumé — Influence de l'âge sur les caractéristiques physiques de l'œuf de la caille. *La production de la caille* (Coturnix coturnix japonica) *prend de l'importance par suite des qualités de l'espèce pour la production d'œufs. Il existe peu de publications sur les caractéristiques physiques qui permettent d'évaluer l'évolution de la qualité des œufs, au cours du cycle de ponte. Nous avons déterminé, sur 1 044 œufs de caille choisis en fonction de l'âge de la pondeuse (8, 12, 17, 21, 25, 30, 34 et 39 sem) : le poids de l'œuf, sa densité, ses longueur et largeur pour calculer son index de forme, la longueur et la hauteur de l'albumen et du jaune, l'épaisseur de la coquille, l'épaisseur de la membrane et finalement les unités de qualité interne (IQU) comme index le plus précis de la variabilité de qualité de l'œuf. Les résultats obtenus sont indiqués aux tableaux II, III, IV. Le poids moyen de l'œuf est de 10,69 g et augmente avec l'âge. La longueur de l'œuf augmente de 30,54 à 32,12 mm entre 8 et 30 sem d'âge pour diminuer ensuite. La hauteur du jaune et l'index de forme sont maximum à 39 sem d'âge. La densité est de 1,072 à 1,069 respectivement à 8 et 39 sem d'âge. L'épaisseur de la coquille s'accroît de 8 à 17 sem d'âge (0,194 à 0,201) pour diminuer ensuite. La hauteur de l'albumen et l'IQU sont plus élevés à 8 sem d'âge et diminuent ensuite. Deux variables, l'épaisseur de la coquille et l'IQU, caractérisent le mieux la qualité de l'œuf et sont les plus élevés à 17 et 8 sem d'âge respectivement. C'est en début de ponte que la qualité de l'œuf de caille est la meilleure.*

qualité de l'œuf / âge / caille

INTRODUCTION

Several desirable characteristics such as early sexual maturity, rapid growth, short generation interval, early onset (about 6 weeks) and high rate of lay and less feed and space requirements per bird have contributed to the commercial exploitation of Japanese quail *(Coturnix coturnix japonica)* for both meat and egg production and also as a laboratory animal (Wilson *et al*, 1961).

At present, the consumption of quail eggs is limited in Spain. In future, quail products could become more popular as conventional food, as in other countries such as France, Italy, Greece, Japan and China, or as dietetic food rich in vitamins and minerals (Panda and Singh, 1990), particulary as nutrition for children and the elderly (Bissoni, 1987).

Several factors influencing the production and quality characteristics of quail eggs have been reported. However, information about the relationship between external and internal traits of eggs and age of layer is rather limited (Yannakopoulos and Tserveni-Gousi, 1985, 1986; Narayanankutty *et al*, 1989).

The aim of the present experiment was to determine the influence of Japanese quail age on the external and internal traits of eggs during 6 months of lay.

MATERIALS AND METHODS

One hundred twenty female Japanese quails, 7 weeks old, were divided at random into 12 groups of 10 birds. The quails in each group were housed in wire cages (400 x 335 mm) with a 17 h photoperiod. Layer diet containing 2 950 Kcal ME/kg, 17% protein, 2.3% calcium, 0.84% phosphorus, 0.78% lysine and 0.32% methionine was given *ad libitum* to the birds.

Maximum and minimum temperatures were recorded for egg collection periods. Room average temperatures ranged from 19.5°C to 31.5°C (table I).

A total of 1 044 eggs were used throughout the experiment. Eggs were collected during 2 consecutive d during 4–5 week periods when the birds were 8, 12, 17, 21, 25, 30, 34 and 39 weeks of age. Eggs laid were removed from the laying cages in late afternoon and broken out the following morning for quality evaluation. Egg weights were recorded to the nearest 0.01 g and specific gravity was obtained using hydrostatic balance. Length and width of egg were measured by a caliper to the nearest 0.05 mm and egg shape index (width/length*100) was then calculated.

After breaking open the eggs, albumen and yolk width were measured by a caliper to the nearest 0.05 mm. Two measures on great and small diameter of thick white were realized and the average was calculated. Albumen and yolk heights were measured with a tripod micrometer to the nearest 0.01 mm. Shell and shell membrane thickness were measured to the nearest 0.01 mm using Ames shell thickness gauge at the equatorial region and the 2 poles and the average values were calculated. Internal quality unit (IQU) was calculated according to the equation derived by Kondaiah *et al* (1983) as follows:

$$IQU = 100 \log (H+4,18-0,8989*W^{0,6674})$$

where H = albumen height in mm and W = egg weight in g.

The data collected were subjected to statistical analysis. The analysis of variance model was:

$$Y_{ij} = \mu + E_i + \epsilon_{ij}$$

Table I. Minimum, average and maximum temperatures.

Age (wk)	*Temperatures (°C)*		
	Minimum	*Average*	*Maximum*
8	23	25	27
12	23	25	27
17	23	24	25
21	26	28.5	31
25	29	31.5	34
30	25	27.5	30
34	21.5	23	25
39	16	19.5	23

where Y = variables; μ = mean value; E = age (8–39 weeks); ϵ = residual error. The significance of differences was assessed by the multiple range test. Non linear regression analysis was conducted using the quail age as independent variable and egg weight as dependent variable, respectively. Moreover, a linear stepwise regression analysis was made using specific gravity, egg shape, albumen and yolk index, IQU and shell plus membrane thickness as dependent variables and quail age, average and maximum temperature as independent variables. Independent variables were introduced in the regression model when prediction was improved at a 5% level.

RESULTS

Mean values (± SD) for measured and calculated variables are presented in tables II, III and IV according to the age of laying quail. Age had a considerable influence on all traits of the eggs studied. The average weight of egg increased from 9.67 g at 8 weeks to 10.61 g at 12 weeks of age and thereafter remained relatively constant (table II).

Specific gravity tended to decline significantly ($P < 0.001$) from 1 072 at 8 weeks to 1 069 at 39 weeks of age (table II). This decrease indicated lower shell quality of eggs from aged quails.

Egg shape index showed a tendency to decrease as the quail aged (from 79.63 to 77.44 at 8 and 39 weeks, respectively); this decrease might be attributable to an increase in egg length without proportionate increase in the width of the egg (table II).

Albumen height presented the greatest value (4.92 mm) at 8 weeks of age and then decreased to 4.04 mm by the end of the experimental period (table III). The albumen index showed a similar trend.

Internal quality unit (IQU) was also reduced as the quail aged in a similar manner to the albumen height. The highest IQU value (69.68) was observed at 8 weeks of age (table III).

Yolk height and yolk index were the greatest when quail hens were 39 weeks old (11.79 mm and 53.79, respectively) (table III). Both traits showed the lowest values at 25 weeks of age, probably due to the high ambient temperature during this period that resulted in reduction of yolk quality.

Shell thickness increased progressively from 0.194 mm at 8 weeks to 0.201 mm at 17 weeks of age. Then, shell thickness decreased until the end of the experiment

Table II. External characteristics of quail eggs at different ages.

Age (wk)	*Egg weight (g)*	*Specific gravity*	*Egg length (mm)*	*Egg width (mm)*	*Egg shape index*
8	9.67 ± 0.08 ^{a}	1.072 ± 0.0004 ^{a}	30.54 ± 0.12 ^{a}	24.28 ± 0.07 ^{a}	79.63 ± 0.26 ^{a}
12	10.61 ± 0.08 ^{b}	1.069 ± 0.0005 ^{b}	31.67 ± 0.12 ^{b}	24.94 ± 0.07 ^{bc}	78.85 ± 0.26 ^{b}
17	10.75 ± 0.09 ^{b}	1.069 ± 0.0005 ^{b}	31.99 ± 0.12 ^{bc}	24.93 ± 0.07 ^{bc}	78.06 ± 0.27 ^{c}
21	10.79 ± 0.09 ^{b}	1.069 ± 0.0005 ^{b}	32.07 ± 0.13 ^{c}	24.95 ± 0.08 ^{bc}	77.90 ± 0.29 ^{c}
25	10.74 ± 0.09 ^{b}	1.066 ± 0.0005 ^{c}	32.11 ± 0.13 ^{c}	24.85 ± 0.08 ^{bc}	77.48 ± 0.30 ^{c}
30	10.71 ± 0.10 ^{b}	1.066 ± 0.0005 ^{c}	32.12 ± 0.14 ^{c}	24.83 ± 0.09 ^{bc}	77.39 ± 0.31 ^{c}
34	10.83 ± 0.10 ^{b}	1.069 ± 0.0006 ^{b}	32.00 ± 0.15 ^{bc}	25.01 ± 0.09 ^{c}	78.18 ± 0.33 ^{bc}
39	10.68 ± 0.12 ^{b}	1.069 ± 0.0007 ^{b}	31.95 ± 0.17 ^{bc}	24.71 ± 0.11 ^{bc}	74.44 ± 0.38 ^{c}
Means	10.60 ± 0.035	1.068 ± 0.0004	31.8 ± 0.07	24.81 ± 0.03	78.12 ± 0.10

^{a,b,c} Means with a column with different superscripts are significantly different ($P < 0.001$).

although a sudden drop between 25 and 30 weeks was observed (table IV).

Membrane thickness also decreased gradually with the advancement of the laying period. The values ranged from 0.031 mm at 8–12 weeks to 0.017 mm at 39 weeks of age (table IV). The shell plus membrane thickness varied from 0.207–0.229 mm during the experimental period.

A negative exponential curve was the function which best fitted egg weight and quail age. Function was the following: Y = 10.95*(1–exp(–0.29*x)) where Y = egg weight in g and X = quail age in weeks.

The *r* square value obtained for this curve was 98%. Results of stepwise regression analysis from remaining variables are shown in table V. Specific gravity and shell plus

Table III. Albumen and yolk quality of quail eggs at different ages.

Age (wk)	*Albumen quality*			*Yolk quality*	
	Albumen height (mm)	*Albumen index*	*IQU*	*Yolk height (mm)*	*Yolk index*
8	4.92 ± 0.04 [a]	13.82 ± 0.15 [a]	69.68 ± 0.53 [a]	11.50 ± 0.04 [cd]	51.85 ± 0.29 [d]
12	4.64 ± 0.04 [b]	12.72 ± 0.16 [b]	64.71 ± 0.54 [b]	11.64 ± 0.04 [ab]	51.18 ± 0.30 [cd]
17	4.62 ± 0.04 [b]	12.88 ± 0.16 [b]	64.15 ± 0.55 [b]	11.67 ± 0.04 [ab]	51.39 ± 0.31 [cd]
21	4.28 ± 0.05 [c]	11.71 ± 0.18 [c]	60.38 ± 0.60 [c]	11.39 ± 0.05 [d]	50.92 ± 0.33 [bc]
25	3.28 ± 0.05 [e]	9.93 ± 0.18 [e]	55.37 ± 0.60 [e]	10.98 ± 0.05 [f]	45.01 ± 0.34 [a]
30	4.13 ± 0.05 [d]	11.15 ± 0.19 [d]	59.13 ± 0.63 [cd]	11.20 ± 0.05 [e]	50.23 ± 0.35 [b]
34	4.18 ± 0.05 [cd]	11.63 ± 0.20 [cd]	59.21 ± 0.67 [cd]	11.59 ± 0.05 [bc]	53.26 ± 0.37 [e]
39	4.04 ± 0.06 [d]	11.39 ± 0.23 [cd]	57.93 ± 0.77 [d]	11.79 ± 0.06 [a]	53.79 ± 0.43 [e]
Means	4.33 ± 0.01	11.90 ± 0.06	61.32 ± 0.21	14.33 ± 0.01	50.96 ± 0.12

[a,b,c,d,e,f] Means within a column with different superscripts are significantly different ($P < 0.001$).

Table IV. Shell and membrane thickness of quail eggs at different ages.

Age (wk)	*Shell thickness (mm)*	*Shell membrane thickness (mm)*	*Shell plus membrane thickness (mm)*
8	0.194 ± 0.001 [b]	0.031 ± 0.0005 [a]	0.226 ± 0.0001 [c]
12	0.197 ± 0.001 [b]	0.031 ± 0.0005 [a]	0.229 ± 0.0005 [d]
17	0.201 ± 0.001 [d]	0.022 ± 0.0005 [c]	0.224 ± 0.0001 [c]
21	0.198 ± 0.001 [cd]	0.020 ± 0.0005 [d]	0.219 ± 0.0001 [b]
25	0.191 ± 0.001 [a]	0.024 ± 0.0006 [b]	0.216 ± 0.0001 [b]
30	0.193 ± 0.001 [a]	0.013 ± 0.0006 [f]	0.207 ± 0.0001 [a]
34	0.198 ± 0.001 [cd]	0.020 ± 0.0006 [d]	0.219 ± 0.0001 [b]
39	0.198 ± 0.001 [cd]	0.017 ± 0.0007 [e]	0.215 ± 0.0001 [b]
Means	0.197 ± 0.0004	0.022 ± 0.0002	0.219 ± 0.0005

[a,b,c,d,e,f] Means within a column with different superscripts are significantly different ($P < 0.001$).

Table V. Coefficients of stepwise regression analysis.

	a	b	c	d	e	f	R^2
Specific gravity	1.077 ***	–0.0001***			–0.0009**		0.06
Egg shape index	81.9 ***	–0.394***	0.011**				0.03
Albumen index	222.95 ***	–0.493**	0.019**	–0.0002*		–0.241***	23.26
IQU	101.75 ***	–2.585***	0.101***	–0.001**	–0.186***		29.02
Yolk index	67.06 ***				–0.325***	–0.305*	20.18
Shell plus membrane thickness	0.262 ***	–0.0005***				–0.001***	0.08

Equations in the form: $a + bx + cx^2 + dx^3 + ey + fz$ where x = quail age; y = average temperature; z = maximum temperature. Coefficients with a superscript (***) $P < 0.0001$; (**) $P < 0.01$; (*) $P < 0.05$.

membrane thickness was negatively correlated with age ($P < 0.001$ and $P < 0.001$, respectively). Average temperature negatively influenced specific gravity ($P < 0.01$). Shell plus membrane thickness was also negatively affected by the maximal temperature ($P < 0.001$).

Egg shape index was quadratically influenced by age but not by ambient temperature. However, yolk index was negatively affected by ambient temperature ($P < 0.001$). Cubic functions fitted albumen index and IQU. Maximal temperature had a negative influence on albumen index ($P < 0.001$). IQU was affected by average temperature ($P < 0.001$).

DISCUSSION

The mean egg weight (10.60 g) observed in this study was higher than those reported by Wilson *et al* (1961) (9.81 g); Mohanty *et al* (1987) (6.4 g at 15 months of age); Sachdev *et al* (1989) (9.28 g) and Narayanankutty *et al* (1989) (8.56–9.93 g at 12 and 24 weeks of age), but lower than the values (11.3 to 12.9 g at 7 and 22 weeks of lay) reported by Yannakopoulos and Tserveni-Gousi (1985) and 12.09 g found by Tserveni-Gousi (1987). Such a wide variation in egg weight could be due to different lines of quails, their age, feeding and managemental practices, and so on.

A gradual increase in egg weight with age was also reported by Tiwari and Panda (1978), Yannakopoulos and Tserveni-Gousi (1986) and Nagarajan *et al* (1991).

The mean value (31.8 mm) for egg length in this experiment is similar to the findings of Ricklefs (1983) in control birds and Mohanty *et al* (1987).

A decrease in albumen index with age also was reported by Sachdev *et al* (1989), but differed from the finding of Narayanankutty *et al* (1989). Kondaiah *et al* (1983), Singh and Panda (1986) and Mohanty *et al* (1987) obtained albumen indexes higher than 0.12, whereas the findings of Mahapatra *et al* (1988) and Narayanankutty *et al* (1989) did not reach 0.10. High temperature had a marked influence on albumen index and IQU as evident from their lowest values recorded at 25 weeks of age.

Upward trend of yolk index with age was also observed by Narayanankutty *et al* (1989) and Nagarajan *et al* (1991), but it differed from those found by Sachdev *et al* (1989). The overall mean yolk index observed in this study was higher than the values of Mahapatra *et al* (1988) (0.38 in 17-week-old quails), Sachdev *et al* (1989) (0.49) and Singh and Panda (1990) (0.44), and lower than those reported by Kondaiah *et al* (1983) and Imai *et al* (1986).

Singh and Panda (1986) and Mahapatra *et al* (1988) reported shell thickness lower than that observed by us. The lower values of shell thickness found between 25 and 30 weeks of age could be attributable to the effect of the exposures of quail hens to high temperature leading to the decreased calcification of the shell. A possible important factor could be the lowered blood flow through ovarian follicles and shell gland due to peripheral vasodilation during a period of high temperature (Wolfenson, 1981). The effects of hyperthermia in birds on progressive respiratory alkalosis (Richard, 1970) with reduced intake of dietary calcium and lowered carbonic anhydrase activity in the shell gland have also been observed.

The regression equations of specific gravity, egg shape index and shell plus membrane thickness were similar to those reported by Yannakopoulos and Tserveni-Gousi (1986), although fit goodness has been lower.

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