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EFFECTS OF STORAGE LENGTH AND EXTERNAL EGG QUALITY CHARACTERISTICS ON FERTILITY AND HATCHABILITY OF JAPANESE QUAIL EGGS

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ABSTRACT
This study, aimed at determining the effects of storage length and external egg quality characteristics on fertility and hatchability of Japanese quail eggs was conducted at the poultry unit of the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri. Storage length significantly affected hatchability of fertile eggs and early embryo mortality (P<0.001). Hatchability for days 2, 3, 4, 5 and 6 of 77.26, 73.53, 72, 79.07 and 86.36% were similar but differed significantly from days 1 (56.16%) and 7 (57.63%) which also differed significantly from days 8 (34.29%), 9 (20.0%) and 10(21.67%) that had similar values. Hatchability showed a dramatic drop for eggs set after 7 days of storage. In addition, it was observed that as the period of storage increased, the hatchability of fertile and total eggs set decreased. Egg weight had significant effect on hatchability of total eggs (P<0.01) and fertility and hatchability of fertile eggs (P<0.05). Eggs that weighed more than 10 g had higher fertility (85.23%) and hatchability of total and fertile eggs set (65.91 and 77.33%) than those of less than 9 g (61.15, 38.85 and 63.53%). Shape index did not significantly affect fertility and hatchability of the Japanese quail eggs. Eggs longer than 3 cm had fertility of 78.10% while those between 2.21 and 2.79 cm had 52.78%. Eggs of width between 2.45 and 2.98 cm had the highest fertility (79.18%) and hatchability of total egg (54.65%) while those with width between 2.11 and 2.27 cm had the least (57.41 and 38.89% respectively). In conclusion, normal shaped eggs rather than index is what is important in hatching eggs of Japanese quail.

KEY WORDS: storage length, external egg quality, fertility, hatchability, Japanese quail.

INTRODUCTION

The female Japanese quail rarely go broody and so do not incubate their eggs necessitating the use of artificial incubators. Hatchability value of 72% was obtained by Woodard and Abplanalp (1967), Esen and Ozcelik (2002) and Dere *et al.* (2009). Lower values were reported by Insko *et al.* (1971) and Kirmizibayak and Altinel (2001), and higher by Altan *et al.* (1995). In avian species generally, hatchability has been reported not to decrease over short periods of storage (Kalita, 1995) but extended storage led to correlated decline in hatchability and increase in the proportion of dead embryos (Kalita, 1995 and Petek *et al.,* 2003). A significant negative correlation between the length of pre incubation storage and hatchability in the Japanese quail and other poultry species eggs had earlier been reported (Reynnells *et al.,* 1977; kaygisiz *et al*., 1995). Fasenko *et al.* (1992) observed increased embryonic mortality in domestic fowl eggs with increasing storage length thus reducing hatchability. Aydogan (1998) reported that even under optimal storage conditions, quail eggs lose their hatching quality at a rate of 2% per day, from the fourth day of storage onwards. Similarly, North and Bell (1990) reported hatchability to be reduced by 4% per day following storage for more than four days. A decline in hatchability by as much as 5% per day after seven days of storage have also been reported (Mayes and Takeballi, 1984). The report of Seker *et al*. (2004) suggested eggs should not be stored more than nine days in order to attain high rates of hatchability in Japanese quail. Fertility and hatchability were highest in eggs weighing greater than 12 g and lowest in those less than 10 g (Dere *et al*. 2009). Some studies reported that the best hatchability was obtained in medium weight eggs (Brah *et al*., 1999; Gonzales *et al*., 1999). When compared to chicken, there are few studies about incubation techniques for Japanese quails. These studies are even fewer in tropical and subtropical regions of Africa. This dearth of information is even more acute in the hot dry regions of the tropics of the continent (Mani *et al*., 2008).The aim of this study was to determine the effects of storage length and external egg quality characteristics on fertility and hatchability of Japanese quail eggs in a semi arid area of Nigeria.

MATERIALS & METHODS

The study was carried out at the Poultry Unit of the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno State, Nigeria. Maiduguri, the Borno State capital is situated on latitude 11^0 $5^'$ N, longitude 13^0 $09^'$ E (Encarta, 2007) and at an altitude of 354 m above sea level. The area falls within the Sahelian region of West Africa, which is noted for great climatic and seasonal variations. It has very short period (3 – 4 months) of rainfall of 645.9 mm/annum with a long dry season of about 8 – 9 months. The ambient temperature could be as low as 20^0C during the dry cold season and as high as 44^0C in the dry hot season. Relative humidity is 45% in August which usually lowers to about 5% in December and January. Day length varies from 11 to 12 hours (Alaku, 1982). A total of 850 eggs were collected from 20 weeks old Japanese quail flock brought from the National Veterinary Research Institute (NVRI) Vom, and placed in cages (30 x 30 x 45 cm) fitted with improvised feeders and drinkers. 8 were collected over a period of ten (10) days and each days collection classified according to weight (<9, 9-9.9 and $\geq$10 g), length (2.21-2.79, 2.80-3.0 and >3.0 cm), width (2.11-2.27, 2.28-2.44 and 2.45-2.98 cm) and shape index (≤ 75, 76-80 and >80%). Eggs for incubation were collected twice daily (morning and evening), weighed on a sensitive balance, marked appropriately with a permanent marker, placed in quail crates with broad ends up and incubated artificially at the appropriate time with a forced air incubator (1510 Sportsman cabinet-type incubator, GQF Mfg. Co. USA.). The eggs were turned automatically until the 15^{th} day. Incubation temperature and humidity was 37.5 ^{0}C and 60% respectively. After 18 days of incubation, hatched chicks and unhatched eggs were removed. At the end of hatching, apparently fertile or infertile eggs were determined by breaking them open. Infertile eggs had no blood islet while fertile ones had blood islet or embryo.

Fertility was calculated as:

$$\text{Fertility (\%)} = \frac{\text{Number of fertile eggs}}{\text{Total Number of eggs set}} X100$$

Hatchability was calculated as:

$$\text{Hatchability of fertile eggs set (\%)} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs set}} X100$$

$$\text{Hatchability of total eggs set (\%)} = \frac{\text{Number of chicks hatched}}{\text{Number of eggs set}} X100$$

Eggs that did not hatch were opened, and contents macroscopically examined to determine early, mid and late embryonic mortality as described by Reynnells *et al.* (1977) and Mani *et al*. (2008). Early embryonic mortality occurred when blood islet or very small embryo with very large yolk sac was observed: Mid-term embryonic mortality; when medium sized embryo and yolk sac were observed: late embryonic mortality; when a fully formed embryo with completely, or almost completely absorbed yolk sac was observed.

The data generated was analyzed using the General Linear Model (GLM) procedure of SPSS 13.0 with storage length, shape index, egg weight, length and width as fixed factors. Significant means where applicable were separated by Duncan's Multiple Range Test. The model for the analysis was as mentioned:

$Y_{ijklmn} = A_i + B_j + C_k + D_l + F_m + e_{ijklmn}$

Where Y_{ijklm} = observation on individual measurements based on the $_{ijklm}$ classification

A_i = fixed effect of storage length

B_j = fixed effect of egg weight

C_k = fixed effect of egg length

D_l = fixed effect of egg width

F_m = fixed effect of shape index

e_{ijklmn} = random error

RESULTS & DISCUSSION

Length of storage

The effect of storage length on hatchability and embryo mortalities is presented in Table 1.

TABLE 1. Effect of egg storage length on fertility and hatchability of Japanese quail eggs

	Fertile eggs set	Embryo mortalities		
	Hatched	Early	Mid	Late
Storage days	***	***	*	ns
1	56.16^b	6.85^c	24.66^a	12.33^a
2	77.26^a	5.30^c	4.67^b	12.15^a
3	73.53^a	2.94^c	2.94^b	11.76^a
4	72.00^a	12.00^c	4.00^b	12.00^a
5	79.07^a	9.30^c	6.98^b	4.65^a
6	86.36^a	4.55^c	0.00^b	9.09^a
7	57.63^b	8.47^c	10.17^a	23.73^a
8	34.29^c	48.57^b	11.43^a	5.71^a
9	20.00^c	70.00^a	0.00^b	10.00^a
10	21.67^c	61.67^a	0.00^b	16.67^a
SEM	1.83	1.21	1.05	1.31

Means in a column within a subset with different superscripts ^{a,b} are significantly different.
ns = not significant, * = P<0.05, ** = P<0.01, *** = P<0.001

Storage days significantly affected hatchability of fertile eggs and early embryo mortality (P<0.001), mid embryo mortality and egg weight (P<0.05) but had non significant effect on late embryo mortality. Hatchability for days 2, 3, 4, 5 and 6 of 77.26, 73.53, 72, 79.07 and 86.36% were similar but differed significantly from days 1 (56.16%)

and 7 (57.63%) which also differed significantly from days 8 (34.29%), 9 (20.0%) and 10(21.67%) that had similar values. Hatchability showed a dramatic drop for eggs set after 7 days of storage. Early embryo mortality was also highest at day 9 (70.0%) and lowest at 3 (2.94%). In contrast, mid embryo mortality was highest at day 1 (24.66%) and lowest at 9 and 10 (0.00%). In this study, the best storage period was determined to be seven days. In addition, it was observed that as the period of storage increased, the hatchability of fertile and total eggs set decreased. Furthermore, prolonged storage led to increased embryonic mortality. The significant effect of storage days on hatchability and embryo mortality has also been reported by Seker *et al*. (2005) and Mani *et al*. (2008). However, low hatchability of stored eggs was observed from day 8 (34.29%) in this study while Mani *et al*. (2008) reported a sharp drop from day 10 (15.2%). The result of this study also agrees with those of Seker *et al*. (2005) as eggs stored from 1-6 days did not differ but differed from those stored from 7 -15 days. The high embryo mortality (19.47%) observed at day 9 of this study, has also been reported by Seker *et al*. (2005). Thus, as the length of storage increased, the hatchability of fertile eggs decreased and embryo mortalities increased. This postulation corroborates Fasenko *et al*. (2001) who observed negative correlation between storage length and hatchability in poultry. Genchev (2009) reported non significant effect of storage (1-11 days) on hatchability but incubation length increased with storage. Woodard and Morzenti (1975) reported that length of storage was critical for eggs of pheasant and quails with significant declines in hatchability. Narahari *et al.* (1988) observed that storing eggs for more than 4 days reduced hatchability while in order to obtain high hatchability, Seker *et al*. (2004) suggested that Japanese quail eggs should not be stored for more than 9 days. However, in order, to prevent rapid embryonic development during storage, ideal storage conditions must be provided since embryo development starts before the egg leaves the uterus.

Egg weight

The effect of egg weight on fertility and hatchability is presented in Table 2. Egg weight had significant effect on hatchability of total eggs (P<0.01) and fertility and hatchability of fertile eggs (P<0.05). Eggs that weighed more than 10 g had higher fertility (85.23%) than those of <9 g (61.15%). However, those between 9-9.9 g (75.72%) did not significantly differ in fertility from those ≥10 g (85.23%). Furthermore, eggs ≥10 g had significantly higher hatchability of total and fertile eggs set (65.91 and 77.33%) than those that were <9 g (38.85 and 63.53%). However, these two egg weight categories did not differ significantly in early, mid and late embryo mortalities. It was also observed that as egg weight increased, fertility and hatchability increased.

TABLE 2. Effect of external egg quality factors on fertility and hatchability of Japanese quail eggs

	Total egg set		Fertile eggs set	Embryo mortalities		
	Fertile	Hatched	Hatched	Early	Mid	Late
Overall	74.33	51.35	69.09	10.25	7.57	12.30
Eggweight (g)	*	**	*	ns	ns	ns
<9	61.15^{b}	38.85^{c}	63.53^{b}	10.59^{a}	9.41^{a}	12.94^{a}
9-9.9	75.72^{a}	52.08^{b}	68.78^{ab}	10.13^{a}	8.02^{a}	12.66^{a}
≥10	85.23^{a}	65.91^{a}	77.33^{a}	10.67^{a}	2.67^{a}	9.33^{a}
Egg length (cm)	*	ns	ns	ns	ns	ns
2.21-2.79	52.78^{b}	38.89^{a}	73.68^{a}	0.00^{a}	10.53^{a}	5.26^{a}
2.80-3.0	70.43^{a}	48.17^{a}	68.40^{a}	9.91^{a}	9.43^{a}	11.32^{a}
>3.0	78.10^{a}	54.07^{a}	69.23^{a}	10.92^{a}	6.45^{a}	13.15^{a}
Egg width (cm)	*	*	ns	*	*	ns
2.11-2.27	57.41^{b}	38.89^{b}	67.74^{a}	0.00^{b}	19.35^{a}	9.68^{a}
2.28-2.44	73.58^{a}	50.94^{a}	69.23^{a}	10.26^{a}	8.46^{b}	11.03^{a}
2.45-2.98	79.18^{a}	54.65^{a}	69.01^{a}	11.74^{a}	4.23^{b}	15.02^{a}
Shape index (%)	ns	ns	ns	ns	ns	ns
≤ 75	71.43^{a}	45.92^{a}	64.29^{a}	12.86^{a}	4.29^{a}	18.57^{a}
76-80	77.22^{a}	54.90^{a}	71.09^{a}	9.14^{a}	7.37^{a}	12.09^{a}
>80	71.20^{a}	48.10^{a}	67.56^{a}	11.11^{a}	8.89^{a}	10.67^{a}
SEM	1.50	1.71	1.83	1.21	1.05	1.31

Means in a column within a subset with different superscripts ^{a,b} are significantly different.
ns = not significant, * = P<0.05, ** = P<0.01, *** = P<0.001

The significant effect of egg weight on fertility and hatchability of Japanese quail eggs had also been reported previously (Narahari *et al*., 1988, Altan *et al*., 1995, Petek *et al*., 2003; El-Sheikh, 2007; Sari *et al*., 2010). The results of this study are consistent with those of Seker *et al*. (2005) who reported that fertility and hatchability rates increased with egg weight in Japanese quail. They reported fertility rates of 69.72, 75.83 and 79.81% for light, medium and heavy egg weight groups respectively while the corresponding hatchability values were 67.51, 76.72 and 77.68%. These values are close to those reported in this study but higher than those reported by Esen (1988). The author recorded fertility rates of 54.54, 64.22 and 66.43% for light, medium and heavy egg weight groups respectively while the corresponding hatchability values were 55.55%, 57.14 and 64.06%. Similarly, Sachdev *et al*. (1985) reported higher fertility and hatchability for heavy (10.1-11 g) than light (7.01 – 8.90 g) eggs. Altan *et al*. (1995) observed that egg weight is critical to hatchability and Narahari *et al*. (1988) corroborated it by postulating that fertility and hatchability are directly proportional to egg weight. In contrast, Proudfoot and Hulan (1981) reported that weight of egg had no effect on fertility and hatchability of fertile eggs, while Copur *et al*. (2010) reported that hatchability was higher in light (≤13 g) than the heavy (≥14 g) eggs. This contrasting report may be because light eggs in their study correspond to heavy eggs in this study. The non-significant effect of egg weight on embryo mortality observed in this study had also been reported by Seker *et al*. (2005). However, Sari *et al*. (2010) reported significant egg weight effect on embryo mortality.

Egg Shape index

Shape index did not significantly affect fertility and hatchability of the Japanese quail eggs. This is in agreement with the findings of Copur *et al*. (2010) and Lofti *et al*. (2011) who reported non significant effect of shape index on hatchability of fertile and total egg set and embryo mortalities. Sari *et al.* (2010) also did not observe any significant effect of shape index on fertility, hatchability and embryo mortalities of Japanese quail eggs. However, Lofti *et al* (2011) observed that normal shaped eggs hatched better than abnormal (too long or rounded) ones and concluded that egg shape index was not an efficient parameter for predicting economic hatching results in the Japanese quail. Thus, shape of egg rather than the index is what is important in hatching eggs. Narushin and Romanov (2002) had also earlier reported that normal shaped eggs had higher hatchability because there was sufficient internal space in bilateral position for embryo, especially at late embryonic stage.

Egg length and width

Egg length did not have significant effect on hatchability of total and fertile eggs set, early, mid and late embryo mortalities but significantly ($P<0.05$) affected fertility. Eggs longer than 3 cm had fertility of 78.10% while those between 2.21 and 2.79 cm had 52.78%. Egg width significantly ($P<0.05$) affected fertility and hatchability of total eggs set, early and mid embryo mortalities but did not affect hatchability of fertile eggs and late embryo mortality. Eggs of width between 2.45 and 2.98 cm had the highest fertility (79.18%) and hatchability of total egg (54.65%) while those with width between 2.11 and 2.27 cm had the least (57.41 and 38.89%) respectively. Early embryo mortality was highest (11.74%) for eggs with width 2.45 -2.98 and least (0%) for those with 2.11- 2.27 cm. The reverse was however the case with mid embryo mortality, widest eggs had least value (4.23%) while narrowest had highest (19.35%).

CONCLUSION

It can be concluded from this study that, to achieve optimum fertility and hatchability, Japanese quail eggs should not be stored for more than seven days before setting in an incubator. In addition, the eggs should weigh more than 10 g, be more than three centimeters in length and between 2.45 and 2.98 cm wide. This is because; shape rather than index is what is important in hatching eggs.

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