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Fertility and hatchability of Japanese quail eggs under semi arid conditions in Nigeria

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Abstract. *Some factors affecting the fertility and hatchability of Japanese quail eggs were studied at the Poultry Unit of the University of Maiduguri, Livestock Teaching and Research Farm. The mean values of fertility, hatchability of total and fertile eggs set, early, mid and late embryo mortalities were 74.33, 51.35, 69.09, 10.25, 7.57 and 12.30% respectively. Fertility was highest (84.92%) in the dry cold, least (35.58%) in the dry hot with wet season (80.75%) being intermediate. Similarly, hatchability of total and fertile eggs set were 67.18 and 79.11% in the dry cold, 14.11 and 39.66% in the dry hot and 46.86 and 58.03% in the wet season. Younger quails (≤ 10 and 11 – 22 weeks) had higher fertility and hatchability than older ones (23 – 34 and 35 – 52 weeks). Early embryo mortality also increased with age. Fertility and hatchability of eggs from caged birds was 89.54 and 62.34% as compared to 54.93 and 37.35% from deep litter reared birds and hatchability of fertile eggs was 69.63 and 67.96% respectively. Fertility and hatchability was highest (92.15 and 71.48%) for birds of ratio 1:3 and least for 1:5 (19.60 and 10%). Breeders weighing 181 – 200 g had the highest hatchability (79.22%) and ≤ 140 g the least (60.83%). In contrast, breeder's ≤ 140 g had the highest late embryo mortality (20%) and 141 – 160 g the least (9.67%). Light brown quails had lower hatchability of total and fertile eggs (23.71% and 35.71%) as compared to wild type or normal colored ones (52.04% and 69.84%). Light brown, however, had higher (P<0.05) early and late embryo mortalities (21.43% and 35.71%) than wild type (10.0% and 11.77%). It can be concluded from this study that season, production system, flock age, mating ratio, color and breeder weight affects the fertility and hatchability of Japanese quail eggs. Thus, these factors have to be considered when raising breeders and collecting eggs for hatching.*

Keywords: color, flock age, hatchability, Japanese quail, season

Introduction

Quail rearing for egg production has become an economically viable activity especially in Northern Nigeria and it is increasingly being developed because of increasing interest in the eggs for food and medicine. The objective of any commercial hatchery is to obtain the maximum number of quality chicks out of the eggs set for hatching (Islam et al., 2002). Fertility and hatchability are very important determinants for producing more chicks from a given number of breeding stocks within a stipulated period and are interrelated heritable traits that vary among breeds, varieties and individuals within breeds and varieties (Coony, 1943). They are affected by a number of factors including breeder weight, mating ratio and breeder age (Ipek et al., 2004) and period and condition of egg storage and egg weight (Seker et al., 2004). The latter researchers also reported fertility and hatchability of 62.07 and 57.93% respectively for quails.

Inosco et al. (1971) observed gradual increase in fertility and hatchability up to 12 – 14 weeks age and a decline to 19 weeks with further increase thereafter. Tona et al. (2001) also observed that the decline in hatchability with age was due to embryonic mortality. Narahari et al. (1988) reported fertility rates of 87.7, 90.0 and 93.6% for Japanese quails grouped into light (171 – 200 g), medium (201 – 230 g) and heavy (>230 g) weights respectively. The corresponding hatchability values were 76.5, 82.9 and 85.2%. Ipek et al. (2004) observed that the best fertility rates were obtained in groups that had 1:2 and 1:3 male to female ratios but declined for 1:1 and 1:5 groups. In contrast, Narahari et al. (1988) reported that sex ratios of 1:2 and 1:5 had comparable fertility and hatchability values. There is a dearth of information on the fertility and hatchability of Japanese quail eggs in Nigeria especially the semi arid areas.

The aim of this study was to determine the effects of some factors on fertility and hatchability of Japanese quail eggs.

Material and 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°5´ N, longitude 13°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°C during the dry cold season and as high as 44°C 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). Three hundred Japanese quails hatched from eggs collected from unselected and random mating parents were used for the study. The birds were housed in battery cages (30 x 30 x 45 cm) and deep litter pens (2.0 x 1.5 x 1.5 m). They were fed a commercial broiler starter diet containing 23% crude protein and 3100 kcal/kg of Metabolisable energy from 0 – 6 weeks. Thereafter, a breeder's diet containing 18% crude protein and 2800 kcal/kg of Metabolisable Energy (NRC, 1994) was fed *ad libitum*.

A total of 1850 eggs used for the study were collected over three seasons (dry cold, dry hot and wet) from birds housed in battery cages and deep litter pens. Birds in the deep litter pens were in a ratio of one male to three females while they were in ratios of 1:1, 1:2, 1:3, 1:4 and 1:5 in the battery cages. Egg collection was from 9 – 52

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weeks of age and birds were weighed weekly using a sensitive digital weighing balance. 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 15th day. Incubation temperature and humidity was 37.5°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 cracking them open and macroscopically examining them for blood islets or dead embryos. Infertile eggs had no blood islet while fertile ones had blood islet or dead embryo.

Fertility was calculated as:

$$\text{Fertility \%} = \frac{\text{Number of fertile eggs}}{\text{Total Number of eggs set}} \times 100$$

Hatchability was calculated as:

$$\text{Hatchability \%} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs set}} \times 100$$

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 by the General Linear Model (GLM) procedure of SPSS 13.0 with season, flock age, production system, mating ratio, color and breeder weight as fixed factors. Significant means where applicable were separated by Duncan's Multiple Range Test. The model for the analysis was

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

where Y_{ijklm} is observation on individual measurements based on the $_{ijklm}$ classification, A_i is fixed effect of season, B_j is fixed effect of flock age, C_k is fixed effect of production system, D_l is fixed effect of mating ratio, F_m is fixed effect of color, G_n is fixed effect of breeder weight and e_{ijklmn} is random error.

Results and discussion

Season

Fertility and hatchability values as affected by season and flock age are presented in Table 1. The mean values of fertility, hatchability of total and fertile eggs set, early, mid and late embryo mortalities were 74.33, 51.35, 69.09, 10.25, 7.57 and 12.30% respectively.

Season had significant effect on Fertility and hatchability of total and fertile eggs set (P<0.001), early and mid embryonic mortality (P<0.01) while egg weight and late embryonic mortality were not. Fertility was highest (84.92%) in the dry cold, least (35.58%) in the dry hot with wet season (80.75%) being intermediate. Similarly, hatchability of total and fertile eggs set were 67.18 and 79.11% in the dry cold, 14.11 and 39.66% in the dry hot and 46.86 and 58.03% in the wet season. Early embryo mortality was highest (17.10%) in the wet season and least (6.55%) in the dry cold while mid embryonic mortality was highest (39.64) in the dry hot and least 2.35 in the dry cold season. Uddin et al. (1994) however, reported non significant effect of season on fertility, hatchability and embryo mortality of quail eggs.

Flock age

Flock age had significant effect on fertility and hatchability of total eggs (P<0.001), hatchability of fertile eggs, early and mid embryo mortality (P<0.05) but non significant effect on late embryo mortality and egg weight. The fertility and hatchability of total eggs, respectively, for the flock age groups ≤ 10, 11 – 22, 23 – 34 and 35 – 52 weeks were 74.29 and 61.43, 85.27 and 60.37; 38.74 and 26.18; and, 88.18 and 49.09%. The corresponding hatchability of fertile eggs were 82.69, 70.80, 67.57 and 55.67%. Thus, fertility and hatchability were higher at younger ≤ 10 and 11 – 22 than older ages 23 – 34 and 35 – 52 weeks. Early embryo mortality also increased with age. The ≤ 10 weeks age group had the least (1.92%) and 35-52

Table 1. Effect of season and flock age on fertility and hatchability traits of Japanese quail eggs

	Total eggs set		Fertile eggs	Embryo mortalities, %		
	Fertile, %	Hatch, %	Hatch, %	Early	Mid	Late
Overall	74.33	51.35	69.09	10.25	7.57	12.30
Season	***	***	***	**	**	ns
Dry cold	84.92[a]	67.18[a]	79.11[a]	6.53[b]	2.35[b]	10.70[a]
Dry hot	35.58[c]	14.11[c]	39.66[c]	12.07[a]	39.66[a]	8.62[a]
Rain	80.75[b]	46.86[b]	58.03[b]	17.10[a]	8.29[b]	16.58[a]
Flock age (weeks)	***	***	*	*	*	ns
≤ 10	74.29[b]	61.43[a]	82.69[a]	1.92[b]	3.85[b]	7.69[a]
11-22	85.27[a]	60.37[a]	70.80[a]	9.73[ab]	5.60[b]	13.87[a]
23-34	38.74[c]	26.18[c]	67.57[b]	14.86[a]	0.00[b]	13.51[a]
35-52	88.18[a]	49.09[b]	55.67[c]	13.40[a]	23.71[a]	7.22[a]
SEM	1.50	1.71	1.84	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

weeks had the highest (13.4%). Similarly, mid embryo mortality was 3.85% for ≤10 and 23.71% for 35 – 52 weeks.

The significant effect of flock age on fertility and hatchability parameters of Japanese quail eggs observed in this study has also been reported by Narahari et al. (1988) and Seker et al. (2004). Inosco et al. (1971) observed gradual increases in fertility and hatchability of incubated Japanese quail eggs up to 12 – 14 weeks and a decline thereafter to 19 weeks of age. This was followed immediately by another increase. It was observed in this study that hatchability of fertile eggs decreased with increasing age of flock. This is consistent with reports in literature (Lowe and Garwood, 1977; Erensayin, 2002; Sahan and Ipek, 2000; Tona et al., 2001 and Reddish et al., 2003). Narahari et al. (1988) also reported higher rates of fertility and hatchability of Japanese quail eggs from parents 10 – 19 weeks of age with peak at 12 – 14 weeks. Similarly, Seker et al. (2004) reported higher fertility (78.92% vs 62.07%) and hatchability (64.34% vs 57.93%) for younger than older quails respectively. Rizk et al. (2006) however did not observe any significant effect of breeder age on fertility and hatchability in a study involving quails that were 16 – 24 and 24 – 32 weeks. They reported fertility of 86.89% and 87.44% and hatchability of 75.44% and 80.78%. Dere et al. (2009) also did not observe any significant effect of parental age on the fertility and hatchability of Japanese quail eggs. In their study, they reported fertility and hatchability values for two age groups (3 and 6 months) as 82.01% vs 81.75% and 71.11% vs 72.89%. Fertility and hatchability have also been found to vary with hen age in broilers (Fasenko et al., 1992) and Turkey (Sexton, 1977). The decline in hatchability of fertile eggs with increasing age of the breeders may be caused by embryonic mortality. The age of the breeder is thus an important parameter to take into account when collecting eggs for hatching. Contrary to the results of this study, Sari et al. (2010) reported significant effect of flock age on late embryo mortality.

Production system

The effect of production system on fertility and hatchability of Japanese quail eggs is presented on Table 2. Production system had significant (P<0.001) effect on fertility and hatchability of total eggs set but did not significantly affect hatchability of fertile eggs and embryo mortalities. Fertility and hatchability of eggs from caged birds was 89.54 and 62.34% as compared to 54.93 and 37.35% from deep litter reared birds and hatchability of fertile eggs was 69.63 and 67.96% respectively. This agrees with the report of Roshdy et al. (2010) who observed non significant effect of production system on hatchability and embryo mortality of fertile Japanese quail eggs. Similarly, Narahari et al. (1988) reported that hatching performances of quail eggs from cage and deep litter reared breeders were comparable. The significant effect of production system on fertility observed in this study corroborates the study of Sayed (2006) which reported fertility of 89.3 and 84.85% for birds housed in batteries and on floor, respectively. In contrast, Roshdy et al. (2010) did not observe significant production system effect on fertility.

Mating ratio

Mating ratio had significant effect on fertility and hatchability of total eggs set (P<0.001), and hatchability of fertile eggs and early

Table 2. Effects of production system, mating ratio, breeders weight and color on fertility and hatchability of Japanese quail eggs

	Total eggs set		Fertile eggs	Embryo mortalities (%)			
	Fertile, %	Hatch, %	Hatch, %	Early	Mid	Late	Egg weight, g
Overall	74.33	51.35	69.09	10.25	7.57	12.30	9.33
Production system	***	***	ns	ns	ns	ns	ns
Cage	89.54^{a}	62.34^{a}	69.63^{a}	9.58^{a}	9.35^{a}	10.98^{a}	9.49^{a}
Litter	54.93^{a}	37.33^{a}	67.96^{a}	11.65^{a}	3.88^{a}	15.05^{a}	9.00^{b}
Mating ratio	***	***	*	*	ns	ns	ns
1:1	82.50^{a}	53.75^{a}	65.15^{a}	18.18^{bc}	3.03^{a}	13.64^{a}	9.30^{a}
1:2	79.17^{a}	20.83^{c}	26.32^{b}	42.11^{b}	21.05^{a}	10.53^{a}	9.47^{a}
1:3	92.15^{a}	65.87^{a}	71.48^{a}	7.59^{c}	7.59^{a}	12.41^{a}	9.33^{a}
1:4	60.00^{b}	40.00^{b}	66.67^{a}	16.67^{bc}	16.67^{a}	0.00^{a}	9.50^{a}
1:5	19.60^{c}	6.00^{d}	10.00^{b}	90.00^{a}	0.00^{a}	0.00^{a}	8.67^{a}
Breeder's weight, g	ns	ns	*	*	ns	*	***
≤ 140	79.47^{a}	48.34^{a}	60.83^{b}	7.50^{ab}	11.67^{a}	20.00^{a}	9.23^{c}
141-160	73.70^{a}	50.87^{a}	69.02^{ab}	13.33^{a}	6.67^{a}	9.80^{b}	9.10^{c}
161-180	69.76^{a}	49.76^{a}	71.33^{ab}	11.19^{a}	5.59^{a}	10.49^{b}	9.31^{c}
181-200	77.78^{a}	61.62^{a}	79.22^{a}	2.60^{b}	6.49^{a}	11.69^{b}	9.64^{b}
>200	75.00^{a}	50.00^{a}	66.67^{ab}	10.26^{a}	10.26^{a}	12.82^{b}	10.62^{a}
Color	***	***	**	*	ns	*	ns
Wild type	74.52^{a}	52.04^{a}	69.84^{a}	10.00^{b}	7.58^{a}	11.77^{b}	9.33^{a}
Light brown	66.67^{b}	23.81^{b}	35.71^{b}	21.43^{a}	7.14^{a}	35.71^{a}	9.21^{a}
SEM	1.50	1.71	1.84	1.21	1.05	1.31	0.03

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

embryo mortality (P<0.05) (Table 2). On the other hand, the effect on mid and late embryo mortality and egg weight was not significant. Fertility was highest (92.15%) for birds of ratio 1:3 and least for 1:5 (19.60%). Mating ratios 1:1 (82.50%) and 1:2 (79.17%) did not differ significantly from mating ratio 1:3 (92.15%). However, they all differed significantly from ratios 1:4 (60%) and 1:5 (19.60%) which also differed significantly. The ratio of 1:3 had the highest, 65.87 and 71.48%, hatchability of total and fertile eggs set respectively while the ratio of 1:5 had the lowest (6 and 10%). In contrast, 1:5 had the highest early embryo mortality value (90%) while 1:3 had the least (7.59%).

Mating ratio is an important determinant of good fertility (Jadhav and Siddiqui, 2007). The significant effect of mating ratio on fertility and hatchability of Japanese quail eggs observed in this study had also been previously reported (Woodard et al., 1973; Narahari et al., 1988; Altan and Oguz, 1993; Ipek et al., 2004 and Jadhav and Siddiqui, 2007). In this present study, fertility rates for ratios 1:1 – 1:3 were higher than those of 1:4 and 1:5. This agrees with Gebreil (2002) who reported that flock fertility increased significantly with increasing females to males up to the mating ratio 1:3 and declined thereafter. Peak fertility in this study was at ratio 1:3 (92.15%) which agrees with the findings of Narahari et al. (1988) that peak fertility was 1:3 (95.4%) and declined significantly to (86.4%) at 1:6. They also reported that mating ratios of 1:1, 1:2, 1:3 , 1:4 , 1:5 and 1:6 male to females resulted in fertility percentages of 87.2 , 95.0 , 95.4 , 93.4 , 80.0 and 86.4 %, respectively. Ipek et al. (2004) reported significant (P<0.05) effect of mating ratio on hatchability which corroborates the findings of this study. They obtained hatchability values of 78.1%, 84.6%, 85.2%, 81.5% and 78.22% at mating ratios of 1:1, 1:2, 1:3, 1:4 and 1:5 respectively. Similar findings were reported by Mandour and Sharaf (1993) and Gebreil (2002). Gebreil (2002) in his study observed that hatchability percentage of fertile eggs were 82.16, 87.30, 87.25, 87.43, 84.61 and 82.53% at mating ratios of 1:1, 1:2, 1:3, 1:4, 1:5 and 1:6 respectively. In contrast, Narahari et al. (1988) reported that mating ratios 1:1, 1:2, 1:3, 1:4, 1:5 and 1:6 gave comparable hatchability of 76.6, 75.7, 74.6, 74.3, 72.6 and 75.6% respectively.

Breeder's weight

The effect of breeders' weight on fertility and hatchability is presented in Table 2. Weight of breeder did not significantly affect fertility and hatchability of total eggs set but significantly (P<0.05) affected hatchability of fertile eggs. Breeders weighing 181 – 200 g had the highest hatchability (79.22%) and ≤140g the least (60.83%). In contrast, breeders ≤ 140 g had the highest late embryo mortality (20%) which differed significantly (P<0.05) from breeders in the weight group 141 – 160 g that had the least (9.67%). However, this group did not differ significantly from breeders in the weight group; 161 – 180 (10.49%), 181 – 200 g (11.69%) and >200 g (12.82%).

Ipek et al. (2004) reported significant (P<0.05) effect of live weight of breeder on hatchability of fertile eggs set which is in line with the result of this study. The quails in their study were grouped into light (171 – 200 g), medium (201 – 230) and heavy (>230 g). Fertility for the groups were 87.7%, 90.0% and 93.6% respectively and corresponding values for hatchability were 76.5%, 82.9% and 85.2% respectively. Marks (1991) also made a similar observation which was corroborated by Narahari et al. (1988) who postulated that fertile eggs from moderately heavier dams hatched better than those from lighter dams. The non significant effect of breeder hen weight on fertility of Japanese quail eggs observed in this study had also been reported by Coban et al. (2008). They however observed that male breeder weight also affected egg fertility.

Color

The color of quail had significant effect on fertility and hatchability of total eggs (P<0.001), hatchability of fertile eggs (P<0.01) and early and late embryo mortality (P<0.05) but did not significantly affect mid mortality and egg weight (Table 2). Light brown quails had lower hatchability of total and fertile eggs (23.71% and 35.71%) as compared to wild type or normal colored ones (52.04% and 69.84%). Light brown, however, had higher (P<0.05) early and late embryo mortalities (21.43% and 35.71%) than wild type (10.0% and 11.77%). Color however, did not significantly affect mid embryo mortalities. El-Fiky et al. (2000) estimated the fertility percentages for two color types of quail (Brown and White) to be 84.3% and 80.9%. They also reported hatchabilities of 62.7% and 57%. Similarly, estimates for embryo mortality were reported by the authors as 5.07% and 5.18% for early and 16.50% and 18.25% for late for the two color types respectively.

Conclusion

Fertility and hatchability of total and fertile eggs set was higher in the dry cold than other seasons. They were also higher at younger than older ages. Eggs from cage reared birds had higher fertility and hatchability than those reared on litter. The optimum male to female mating ratio for good fertility and hatchability in Japanese quail is 1:3. Breeders that weighed 181–200g had significantly higher hatchability than their ≤ 140g counterpart. Light brown quails had significantly lower hatchability of total and fertile eggs than normal colored or wild type quails. Thus, for good fertility and hatchability, quail eggs should be collected in the dry cold season from young cage reared birds in a mating ratio of 1:1, 1:2 and 1:3 male to females.

Season, production system, flock age, mating ratio, color and breeder weight affects the fertility and hatchability of Japanese quail eggs. Thus, these factors have to be considered when raising breeder stock and collecting eggs for hatching.

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The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods,Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows,IXth International Conference on Production Diseases in Farm Animals, September 11–14, Berlin, Germany.

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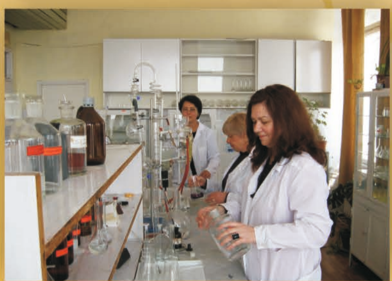

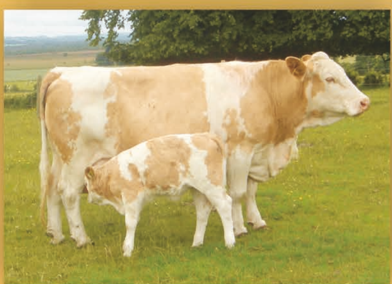

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