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Effects of Pre-Incubation Storage on the Hatchability of Quail (*Coturnix coturnix japonica*) Eggs in the Sahel Region of Nigeria

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Abstract: A study to determine the effect of pre-incubation storage of the eggs of the Japanese quail (*Coturnix coturnix japonica*) was conducted during the cool harmattan season in the north-east arid region (Sahel) of Nigeria. Eggs were collected daily from six-months-old quail and stored at room temperature (25-29°C) for 0 to 20 days before incubation in an electric incubator. Eggs that failed to hatch were opened for determination of fertility and estimation of time of death of embryos. A total of 196 (29.3 %) eggs out of 668 incubated hatched successfully. The length of pre-incubation storage was negatively correlated ($r = -0.91$; $P < 0.0001$) with hatchability. The highest hatchability (72.3%) was obtained from eggs that were not stored (Day 0 of storage). Hatchability dropped sharply after storage for 9 days. No egg hatched following pre-incubation storage of over 11 days. Among the unhatched eggs, there were significantly more apparently infertile than fertile eggs ($P < 0.0002$). There was no relationship between pre-incubation length of storage and the proportion of embryos that died in early, middle or late incubation period. However, the proportion of the apparently infertile eggs increased with increasing length of pre-incubation storage ($r = 0.95$; $P < 0.0001$). No egg stored for 18 days or more was found to be apparently fertile. It was concluded that the length of pre-incubation storage has detrimental effect on hatchability of quail eggs in the Sahel area and that quail eggs for incubation should not be stored at room temperature for more than 9 days, even in the coolest season.

Key words: Japanese quail, egg, hatchability, pre-incubation storage

Introduction

The quail was introduced into Nigeria by the National Veterinary Research Institute (NVRI) Vom as part of an effort to improve the protein intake of the populace. The female domestic quail do not go broody and rarely incubate their eggs, so artificial incubation of the eggs is essential. For the successful hatching of quail eggs knowledge of the factors that affect hatchability of the eggs is essential. None of these factors however, have been studied in Nigeria.

Studies on the effects of pre-incubation storage of eggs on hatchability and other traits of the eggs of Coturnix quail and other poultry species are numerous in the temperate regions of the world but lacking in the 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. In avian species in general, hatchability has been reported not to decrease over short periods of storage (Miller and Wilson, 1974; Reynnells *et al*., 1977; Kalita, 1995; Kaygisiz *et al*., 1995). Storage for longer periods however has led to correlated decline in hatchability and increase in proportion of dead embryos (Mather and Laughlin, 1976; Abdou *et al*., 1990; Kalita, 1995; Kaygisiz *et al*., 1995; Petek *et al*., 2003).

Comparison of hatchability and embryo losses after extended storage of eggs of several avian species revealed hatchability persisting at the highest level and with the rate of decline with age in zygote viability being somewhat more rapid in quail (Sittmann, 1971).

The aim of this study therefore was to determine how pre-incubation storage of quail eggs affects hatchability in the Sahel region of Nigeria noted for high ambient temperatures.

Materials and Methods

The study was conducted during the harmattan (cool and dry) season in the months of January and March. Six month old Quail (*Coturnix coturnix japonica*) kept in cages in a ratio of one male to 4 females and fed on commercial layers mash ration (Pfizer, Nigeria Ltd.) were used for collection of the eggs for the experiment. Eggs were collected daily for a total of 21 days from January 6 (Day 0) to January 26 (Day 20). On each day, eggs of even size and conformation were selected and marked on one side with date of collection and stored with the broad end facing upwards in a room. The room temperature was recorded 3 times daily (morning, afternoon and evening).

On the last day of collection (Day 0 of storage), all the eggs were set on their sides in an electric incubator constructed using incubator kit (Ecostat, UK) and local

materials according to the manufacturers instructions. The incubator had been set 3 days earlier and the temperature had been running steadily at 39°C for 24 hours. The eggs continued to be incubated at 39°C as recommended for quail eggs by the manufacturers of the incubator kits. The eggs were turned manually thrice daily at 8-hourly intervals for 14 days. Eggs were not turned after the 14th day of incubation. All eggs found to be cracked at any stage of the incubation period were removed from the experiment.

At the end of hatching, eggs that failed to hatch were opened out and the contents macroscopically observed and classified as per Reynnells *et al.* (1977) as either apparently infertile- when no formation of blood islet was observed (because these include both embryos that were actually not fertilized in the first instance and those that were fertilized but have died during storage before commencing development), or apparently fertile - when blood islet or embryo was observed (these do not include those embryos that were actually fertilized but have died during storage before commencing development). The approximate time of death of the embryo was estimated as early: When blood islet or very small embryo with very large yolk sac was observed, mid-term: When medium sized embryo with medium sized yolk sac was observed, or late: When a fully formed embryo with a completely, or almost completely absorbed yolk sac was observed.

Hatchabilities were calculated as percentages and the data evaluated using correlation analysis. Apparent fertility and infertility and embryo mortality were all calculated both as percent of total and of unhatched eggs and evaluated using linear regression analysis and paired t-test. All results were regarded as significant when $P < 0.05$. All means were presented as ± SEM.

Results

The room temperature during the whole period of incubation ranged from 25.0 to 29.0°C. There was no serious variation in temperature over the duration of the study at any of the 3 periods of recording (morning 25.9 ± 0.08°C; afternoon 28.1 ± 0.01°C; Evening 27.0 ± 0.00°C). A total of 709 eggs were set at the beginning of incubation. Forty one (5.8%) was however, found with cracked shell during the incubation period and was removed. A total of 196 (29.3 %) eggs out of the remaining 668 eggs hatched successfully. The break down of hatchability for the different pre-incubation storage periods is shown in Table 1. The length of pre-incubation storage was negatively correlated ($r = -0.91$; $P < 0.0001$) with hatchability. The highest hatchability (72.3%) was obtained from eggs that were not stored (Day 0 of storage). Hatchability was generally good in eggs stored for 0 to 4 days, fair for those stored for 5 to 9 days, but dropped sharply after storage for 9 days. No egg hatched following pre-incubation storage of over 11 days. Four hundred and seventy two eggs (70.7%) failed to hatch.

Table 1: Hatchability of Coturnix quail eggs following pre-incubation storage for 0 to 20 days at room temperature

Pre-incubation storage time (days)	Number of eggs incubated to term	Number of eggs that hatched	Percent Hatchability
0	33	24	72.3
1	32	19	59.4
2	35	18	51.4
3	35	24	68.6
4	34	21	61.8
5	33	15	45.5
6	35	18	51.4
7	35	20	57.1
8	33	15	45.5
9	34	16	47.1
10	33	5	15.2
11	34	1	2.9
12	33	0	0.0
13	31	0	0.0
14	35	0	0.0
15	32	0	0.0
16	28	0	0.0
17	31	0	0.0
18	30	0	0.0
19	22	0	0.0
20	20	0	0.0
Total	668	196	29.3

The proportion of unhatched eggs that were apparently fertile or apparently infertile are given in Table 2. There were significantly more apparently infertile eggs than apparently fertile eggs ($P < 0.0002$). The proportion of unhatched eggs that were apparently infertile among the total eggs incubated increased with increasing length of pre-incubation storage ($r = 0.95$; $P < 0.0001$ and $r = 0.91$; $P < 0.0001$, respectively). No egg stored for 18 days or more was found to be apparently fertile.

Table 3 shows the approximate time of death of embryos among unhatched eggs following pre-incubation storage of eggs for 0 to 20 days. There was no difference in the proportion of embryos that died in early, middle or late incubation period ($P < 0.48$; $P < 0.59$ and $P < 0.18$, respectively). There was also no relationship between pre-incubation length of storage and the proportion of embryos that died in any of the 3 periods.

Discussion

The large number of eggs whose shell became cracked during incubation in this study further emphasizes the reported (Ruskin, 1991) fragility of the shell of quail eggs. The length of the incubation period and the duration of hatching observed in this study are similar to what was reported elsewhere (Ruskin, 1991). However, since the time each individual egg hatched was not recorded, it is not known whether pre-incubation storage had any effect on the length of incubation. Studies involving Japanese quail elsewhere (Mirosh and Becker, 1974; Singh and Johnson, 1974; Petek *et al.*, 2003) have

Table 2: Proportions of unhatched eggs after full term of incubation that was apparently fertile or apparently infertile following pre-incubation storage for 0 to 20 days

Pre-incubation storage time (days)	Apparently infertile			Apparently fertile		
	Number of eggs	% of total	% of unhatched	Number of eggs	% of total	% of unhatched
0	5	15.2	55.5	4	12.1	44.4
1	5	15.6	38.5	8	25.0	51.6
2	8	22.9	47.1	9	25.7	52.9
3	5	14.3	45.5	6	17.1	54.6
4	7	20.6	53.8	6	17.6	46.2
5	12	36.4	66.7	6	18.2	33.3
6	10	28.6	58.8	7	20.0	41.1
7	10	28.6	66.7	5	14.3	33.3
8	9	27.3	50.0	9	27.3	50.0
9	8	23.5	44.4	10	29.4	55.6
10	16	48.5	57.1	12	36.4	42.9
11	26	76.5	78.8	7	20.6	21.3
12	26	78.8	78.8	7	21.2	21.2
13	24	77.4	77.4	7	22.6	22.6
14	28	80.0	80.0	7	20.0	20.0
15	28	84.4	84.4	4	12.5	12.5
16	26	92.9	92.9	2	7.1	7.1
17	29	93.5	93.5	2	6.5	6.5
18	30	100.0	100	0	0.0	0.0
19	22	100.0	100	0	0.0	0.0
20	20	100.0	100	0	0.0	0.0
Total	354			118		

reported the length of incubation to be highly dependent on the length of pre-incubation storage.

The hatchability figures in quail eggs not stored at all, or stored for a short duration in this study were generally lower than figures reported for the same species elsewhere (Woodard and Abplanalp, 1967, 1971; Begin and Maclaury, 1974). The lower Figures in our study could be due to the age of the birds from which eggs were obtained (6 months). Hatchability has been known to decline with increasing age of the dam in poultry (Moseley and Landaeur, 1949; Hay and Talmage, 1949; Tomhave, 1956, 1958). A decline in hatchability of 10.2% has been reported between the age of 10 and 25 weeks and of 20.2% between 9 and 70 weeks in coturnix quail (Woodard and Abplanalp, 1967 and 1971). The quail in our study were also fed commercial poultry layers mash, which contains a lower crude protein and metabolizable energy (16% protein, 2500 kCal ME/kg min - Pfizer Livestock Feeds Plc.) than the recommended level for quail (22% crude protein, 2900 kCal ME/kg ration - Ruskin, 1991). Since quail husbandry has just been introduced to this climatic zone and figures of production, fertility and hatchability are unavailable for comparison, the influence of the climate can also not be ruled out.

This study demonstrated a significant negative correlation between the length of pre-incubation storage and hatchability in coturnix quail eggs. This is in agreement with previous observations in the species (Sittmann, 1971; Mirosh and Becker, 1974; Singh and Johnson 1974; Reynnells *et al.*, 1977) and in other poultry species (Miller and Wilson, 1974; Mather and Laughlin, 1976; Reynnells *et al.*, 1977; Abdou *et al.*, 1990; Kaygisiz *et al.*, 1995). It has been reported however (Reynnells *et al.*, 1977), that the effect of egg storage on fertility and hatchability appeared first and is most severe in coturnix quail than in Bobwhite quail. The sharpest drop in hatchability in this study appeared from eggs stored for 9 days, later than the 7 days reported for the Bobwhite quail. The length of storage period beyond which no egg hatched is earlier (11 days) in this study compared with 14 days observed in the same species in previous studies elsewhere (Reynnells *et al.*, 1977).

The observation in this study that mortality in the 3 stages of development (early, middle and late) occurred in similar proportions is similar to previous observations (Sittmann *et al.*, 1971; Reynells, *et al.*, 1977) in chickens, turkeys and Coturnix quails. The study by Sittmann, (1971) however, reported a high proportion of pips still alive at the end of incubation, which was not observed in the present study and an overall lower total embryo loss in quail than in the other 2 species.

Increase in storage time has been associated with increase in the incidence of mal-position and malformation in guinea fowls (Brah and Sandhu, 1990). Body weight to one week of age was also found to be lower for chicks from eggs stored for longer period than those from eggs stored for shorter period at room temperature in Tanzania (Abdou *et al.*, 1990). Other performance traits reported to be affected by length of storage prior to incubation of greater than 2 weeks in meat strain of chicken include adult weight, egg weight

Table 3: Approximate time of death of embryos following Pre-incubation storage of eggs for 0 to 20 days

Preincu-bation storage time (days)	Embryos that died early in the incubation period			Embryos that died in mid-incubation			Embryos that died in late incubation		
	No. of embryos	% of total	% of unhatched	No. of embryos	% of total	% of unhatched	No. of embryos	% of total	% of unhatched
0	3	9.1	33.3	0	0.0	0.0	1	3.0	0.0
1	1	3.1	7.7	6	18.8	46.2	1	3.1	7.7
2	0	0.0	0.0	2	5.7	11.7	7	20.0	41.2
3	0	0.0	0.0	2	5.7	18.7	4	11.4	36.4
4	0	0.0	0.0	4	11.7	30.8	2	5.9	15.4
5	0	0.0	0.0	2	6.1	11.1	4	12.1	22.2
6	0	0.0	0.0	2	5.7	11.7	5	14.3	29.4
7	1	2.9	6.7	2	5.7	13.3	2	5.7	13.3
8	0	0.0	0.0	7	21.2	38.9	2	6.1	11.1
9	5	14.7	27.8	5	14.7	27.8	0	0.0	0.0
10	5	15.2	17.9	7	21.2	25.0	0	0.0	0.0
11	2	5.9	6.1	3	8.8	9.1	2	5.9	6.1
12	4	12.1	12.1	3	9.1	9.1	0	0.0	0.0
13	3	9.7	9.7	4	12.9	12.9	0	0.0	0.0
14	7	20.0	20.0	0	0.0	0.0	0	0.0	0.0
15	4	12.5	12.5	0	0.0	0.0	0	0.0	0.0
16	2	7.1	7.1	0	0.0	0.0	0	0.0	0.0
17	2	6.5	6.5	0	0.0	0.0	0	0.0	0.0
18	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
19	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
20	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Total	39		49			30			

and juvenile and adult viability (Becker, 1960; Merritt, 1964). Proudfoot (1968) however, observed no such effects of pre-incubation storage in WL fowls, suggesting a possibility of strain differences in these effects.

The condition under which eggs are stored may also influence hatchability. Reynnells *et al*. (1977) observed a significant difference in hatchability of coturnix quail and Bobwhite quail eggs stored for 29 days at room temperature (25.5-27.8°C) and those stored in a cooler (15-16°C). Some of the eggs stored in the cooler hatched through day 27 for Coturnix quail and day 29 for Bobwhite quail. None of the quail eggs stored for more than 14 days and Bobwhite eggs stored for more than 25 days at room temperature respectively, hatched. Overall hatchability was also found to be lower in guinea fowl eggs held in a cooling cabinet (10°C) for up to 20 days compared with those stored at room temperature (17.9 to 32.3°C) (Brah and Sandhu, 1990). The lower hatchability of eggs held in the cooling cabinet was mainly due to early chick mortality, while incidence of mal-position and malformations increased with increasing storage time for eggs stored at room temperature. Periodic heating of eggs during storage was also reported to lead to better hatchability and better quality of chicks in both hens (Asijamal and Bogenfurst, 1994) and coturnix quail (Kraszewka-Damanska and Pawluczuk, 1977). Best results with the hen's eggs were found when the total treatment period was greater than 12 hours during a storage period of less than 14 days. Petek *et al*. (2003) recommends that storage period for quail eggs should be no longer than 3 days. In another study, the hatchability of Coturnix quail eggs was maintained for 10 days when warmed in an incubator at 37.7°C for 30 minutes as compared with 5 days in control eggs stored at 20°C throughout (Kraszewka-Damanka and Pawluczuk, 1977). The improvement in hatchability declined if the warming was carried out less than every 3 days.

Conclusion: This study demonstrated a detrimental effect of prolonged pre-incubation storage on hatchability of quail eggs which falls off sharply from around 9 days of storage. The poor hatchability manifested itself as higher proportion of unhatched eggs whose embryos apparently failed to develop at all. Prolonged pre-incubation storage therefore most likely makes the environment of the embryo in the egg increasingly unsuitable for survival and development in a way not yet fully understood. In conclusion therefore it is advised that quail eggs for incubation should not be stored at room temperature for more than 9 days, even in the coolest season. Further studies are imperative to study the effect of pre-incubation storage of quail eggs on hatchability, particularly in the hot season; the effect of pre-incubation storage condition such as cooling and the effects of other factors such as the age of the dam, nutrition and power failures during different periods of incubation on hatchability of quail eggs.

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