

Hatchability and Haematological Characteristics of Crossbred Japanese Quails Reared under Humid Tropical Conditions

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ABSTRACT

Objective: This study evaluated the hatchability and haematological characteristics of crossbred Japanese quail progenies reared under humid tropical conditions to identify the most suitable crossbred strain for improved reproductive and physiological performance.

Materials and Methods: A total of 360 day-old Japanese quail chicks were used in the study, comprising 90 birds from each of four progeny groups. Each progeny group was assigned to three replicates of 30 birds each. Data were collected on fertility, hatchability and haematological characteristics. The experiment was arranged in a randomized complete block design. Data were analyzed using analysis of variance (ANOVA) and significant differences among means were separated using Duncan's New Multiple Range Test

Results: Most hatchability traits showed no significant differences ($p>0.05$) among the progeny groups, except for fertility and hatchability percentages, which differed significantly ($p<0.05$). The PW×CB (Panda White×Cinnamon Brown) progeny recorded the highest fertility (80.22%) and hatchability (75.81%), followed by the PW × PW (Panda White × Panda White) progeny. At three weeks of age, most haematological parameters differed significantly ($p<0.05$) among the progeny groups, whereas Red Blood Cell count (RBC), Mean Corpuscular Volume (MCV) and mean corpuscular haemoglobin (MCH) were not significantly different ($p>0.05$). The PW×CB progeny had the highest haemoglobin concentration (14.33 g/dL), indicating better oxygen transport and tissue respiration. This progeny group also showed high white blood cell counts, suggesting a stronger immune response compared with the other progenies.

Conclusion: The PW×CB (Panda White×Cinnamon Brown) progeny exhibited superior fertility, hatchability and favourable haematological characteristics compared with the other progeny groups. These findings indicate that the PW×CB cross is the most suitable strain for rearing under humid tropical conditions due to its superior reproductive performance and physiological status.

INTRODUCTION

The Japanese quail is a small avian species native to the Far East. It was first domesticated and reared in cages in Japan and China during the 15th century because of its attractive singing ability. The species was introduced into Nigeria in 1992¹. Hatchability is a complex biological trait influenced by several reproductive factors, including semen quality, breeding season, fertility rate and embryonic survival². Proper egg handling and effective incubation management are essential for improving hatchability and maximizing chick production³. Haematological analysis is widely used to evaluate the health status of birds and serves as an important tool for disease diagnosis and clinical monitoring⁴. It also helps detect physiological changes that may not be evident during physical examination but can adversely affect the health and productivity of birds. Despite the increasing importance of Japanese quail production in Nigeria, information on the hatchability and haematological characteristics of crossbred Japanese quails remains limited.

Therefore, this study was conducted to evaluate the hatchability and haematological characteristics of crossbred Japanese quails under humid tropical conditions.

MATERIALS AND METHODS

A crossbreeding study involving Japanese quails was conducted to evaluate the growth and reproductive performance of four progeny groups under humid tropical conditions in Nigeria. The breeding stock used in the study was obtained from the Teaching and Research Farm, Michael Okpara University of Agriculture, Abia State, Nigeria. The base population consisted of 48 adult Japanese quails, including 18 Cinnamon Brown females, 6 Cinnamon Brown males, 18 Panda White females and 6 Panda White males.

The mating schemes were:

- CB×CB: Pure line
- PW×PW: Pure line
- CB×PW: Main cross
- PW×CB: Reciprocal cross

The mating ratio was 1:3

Following mating and hatching, a total of 360 pedigree day-old Japanese quail chicks obtained from the four crossbred groups were used in the study. Each crossbred group comprised 90 chicks and was allocated to three replicates, with 30 chicks per replicate.

Data collection:

Parameters measured include:

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

$$\text{Fertility (\%)} = \frac{\text{Number of chicks hatched}}{\text{Number of eggs set}} \times 100$$

$$\text{Dead in germ (\%)} = \frac{\text{Number of dead embryo}}{\text{Number of chicks hatched}} \times 100$$

$$\text{Dead in shell (\%)} = \frac{\text{Number with dead in shell}}{\text{Number of chicks hatched}} \times 100$$

Number of chicks emerge = This was defined as the total number of chicks that successfully emerged from the eggs

Number of chicks Piped = This was determined by counting the eggs in which the chicks had pipped (cracked the eggshell) but failed to hatch completely

$$\text{Mortality} = \frac{\text{Number of dead birds}}{\text{Number of birds at housing}} \times 100$$

Haematological parameters: At the eighth week of age, 2 mL of blood was collected from each strain via the wing vein into individually sterilized tubes containing fluoride and oxalate as anticoagulants for haematological analysis. The haematological parameters evaluated included red Blood Cell Count (RBC), white Blood Cell Count (WBC), haemoglobin concentration (Hb), Mean Corpuscular Volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). All parameters were analysed immediately using an automated haematology analyser (BC-2300, Mindray Medical Co., Ltd., China) according to the manufacturer's standard operating procedures.

Statistical analysis: The experiment was conducted using a Randomized Complete Block Design (RCBD). Data were Analysed by Analysis of Variance (ANOVA) using the SAS statistical software package . When significant differences were detected, treatment means were separated using Duncan's New Multiple Range Test .

$$Y_{ijk} = \mu + S_i + B_j + e_{ijk}$$

Y_{ijk} : Individual Observation

μ : Population mean

S_i : Effect of genotype ($i = 1 \dots 4$)

B_j : Block effect (hatch)

e_{ijk} : Experimental error (identically, independently, normally distributed with zero mean and constant variance (iind, 0, σ^2))

RESULTS AND DISCUSSION

The mean fertility and hatchability parameters of the four Japanese quail progeny groups are presented in Table 1. Most of the parameters evaluated did not differ significantly ($p > 0.05$) among the progeny groups. However, fertility (%) and hatchability (%) differed significantly ($p < 0.05$). The absence of significant differences in the number of pipped eggs, brooding mortality, rearing mortality and laying mortality is consistent with the findings of Obi et al.⁷.

The PW×CB progeny recorded the highest fertility (80.22%) and hatchability (75.81%), with fertility and hatchability values ranging from 73.66 to 80.22% and 60.74 to 75.81%, respectively. These findings are comparable to those reported by Oke and Chinadum⁸, who observed fertility values ranging from 70.58 to 73.19% in guinea fowl. Furthermore, the hatchability values obtained in the present study were higher than the range of 50.41 to 57.17% reported by Oke and Chinadum⁸.

Variations in hatchability may be influenced by factors such as the laying rate, pre-incubation egg storage conditions and embryonic mortality. Reduced hatchability may also result from prolonged egg storage, inadequate

Table 1: Fertility and hatchability traits of four strains of Japanese quails

Parameters	PW×PW	PW×CB	CB×PW	CB×CB	SEM
Fertility (%)	73.79 ^b	80.22 ^a	73.86 ^b	73.66 ^b	2.32
Hatchability (%)	73.84 ^b	75.81 ^a	60.74 ^d	63.66 ^c	2.60
Dead-in-germ (%)	23.89	26.90	37.21	32.96	5.28
Dead-in-shell (%)	15.74	8.14	15.03	16.20	1.65
Pipped (%)	15.37	12.67	13.18	13.06	1.35
Brooding mortality (%)	2.33	1.67	2.33	2.61	0.18
Rearing mortality (%)	2.00	1.33	1.67	1.67	0.14
Laying mortality (%)	0.00	0.00	0.00	0.67	0.17

^{abcd}Mean within the rows with different superscripts are significantly different ($p < 0.05$), SEM: Standard error of the mean, PW×PW: Panda white×Panda white, PW×CB: Panda white×Cinnamon Brown, CB×PW: Cinnamon Brown×Panda white and CB×CB: Cinnamon Brown×Cinnamon Brown

Table 2: Hematological values of four strains of Japanese quail at week 3

Parameters	PW×PW	PW×CB	CB×PW	CB×CB	SEM
Hb (g/dL)	11.14 ^b	14.33 ^a	13.58 ^a	13.23 ^a	0.48
PCV (%)	43.94 ^b	49.98 ^a	49.57 ^a	50.43 ^a	2.21
RBC ($\times 10^{12}/L$)	2.89	3.38	3.11	3.22	0.11
WBC ($\times 10^9/L$)	227.83 ^b	247.63 ^a	243.97 ^a	246.97 ^a	2.61
MCV (f)	165.52	167.58	167.41	163.46	6.79
MCH (P _g)	41.58	44.30	40.77	42.47	0.75
MCHC (g/L)	218.92 ^b	234.75 ^a	208.42 ^b	206.83 ^b	2.67
PLT ($\times 10^9/L$)	55.08 ^a	51.88 ^a	47.92 ^{ab}	40.25 ^b	1.60

^{ab}Mean within the rows with different superscripts are significantly different ($p < 0.05$), SEM: Standard Error of the mean, Hb: Hemoglobin, PCV: Packed cell volume, RBC: Red blood cell, WBC: White blood cell, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, MCHC: Mean corpuscular Hemoglobin concentrations, PLT: Platelet count, PW×PW: Panda white × panda white, PW×CB: Panda white×Cinnamon Brown, CB×PW: Cinnamon brown×Panda white and Cb×CB: Cinnamon Brown×Cinnamon Brown

Table 3: Hematological Values of four strains of Japanese quails at week 6 of age

Parameters	PW×PW	PW×CB	CB×PW	CB×CB	SEM
Hb (g/dL)	16.23 ^{ab}	16.54 ^a	16.21 ^b	15.92 ^b	0.57
PCV (%)	44.78	52.11	51.79	54.89	2.25
RBC ($\times 10^{12}/L$)	3.19 ^b	4.49 ^a	3.20 ^b	3.32 ^{ab}	0.13
WBC ($\times 10^9/L$)	256.54 ^b	267.43 ^a	265.12 ^{ab}	265.46 ^a	2.86
MCV (f)	197.10	199.23	195.23	191.76	6.24
MCH (P _g)	39.35	40.02	39.14	39.87	0.67
MCHC (g/L)	217.12	228.65	206.76	206.45	1.97
PLT ($\times 10^9/L$)	57.10 ^a	53.47 ^{ab}	50.45 ^b	45.35 ^b	1.89

^{ab}Mean within the rows with different superscripts are significantly different ($p < 0.05$), SEM: Standard Error of the mean, Hb: Hemoglobin, PCV: Packed cell volume, RBC: Red blood cell; WBC: White blood cell, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, MCHC: Mean corpuscular Hemoglobin concentrations, PLT: Platelet count. PW×PW: Panda white×panda white, PW×CB: Panda white×Cinnamon Brown, CB×PW: Cinnamon brown×Panda white and Cb×CB: Cinnamon Brown×Cinnamon Brown

parental nutrition, environmental stress experienced by the breeding stock, eggshell damage, or suboptimal incubation and hatching conditions, as reported by Obi et al.⁷

Among the progeny groups, the PW×CB cross exhibited the highest fertility and hatchability, together with the lowest mortality from the brooding to laying stages. These findings suggest that the PW×CB progeny possesses superior reproductive performance and may be the most suitable cross for breeding under humid tropical conditions. Improved reproductive efficiency in this progeny could contribute to reduced production costs and increased economic returns in Japanese quail production.

The mean haematological values of the four Japanese quail progeny groups at 3 weeks of age are presented in Table 2, whereas the corresponding values at 6 weeks of age are presented in Table 3.

Most of the haematological parameters differed significantly ($p < 0.05$) among the four Japanese quail progeny groups at both sampling periods. However, red

Blood Cell Count (RBC), Mean Corpuscular Volume (MCV) and Mean Corpuscular Haemoglobin (MCH) at 3 weeks of age did not differ significantly ($p > 0.05$).

Haemoglobin (Hb) concentration differed significantly ($p < 0.05$) among the progeny groups at 3 weeks of age, with values ranging from 11.14 to 14.33 g/dL. The PW×CB progeny recorded the highest Hb concentration (14.33 g/dL), followed by the CB×CB progeny (13.58 g/dL). The Hb values obtained in the present study were lower than the value of 16.21 g/dL reported by Agina et al.⁹ but higher than the value of 11.23 g/dL reported by Sujata et al.¹⁰. At 6 weeks of age, Hb concentration also differed significantly ($p < 0.05$), with values ranging from 15.92 to 16.54 g/dL. The PW×CB progeny again recorded the highest Hb concentration (16.54 g/dL), which is consistent with the value reported by Agina et al.⁹. The relatively high Hb concentration observed in the PW×CB progeny suggests a greater capacity for oxygen transport, efficient cellular metabolism and enhanced tissue respiration. Haemoglobin plays a vital physiological role in transporting oxygen to

body tissues for the oxidation of nutrients and energy production, while also facilitating the transport of carbon dioxide from the tissues to the lungs. Conversely, reduced Hb concentration may indicate environmental stress or other physiological challenges affecting the birds.

Packed cell volume (PCV) did not differ significantly ($p>0.05$) among the progeny groups at either 3 or 6 weeks of age. The PCV values ranged from 43.94 to 50.43% at 3 weeks and from 44.78 to 54.89% at 6 weeks. These values fall within the normal physiological range of 35 to 55% reported for birds. However, the observed values differed from the wider range of 25.00 to 66.00% reported by Agina et al.⁹. Packed cell volume is influenced by the physiological and nutritional status of birds and is therefore a useful indicator of protein status and the need for protein supplementation under different physiological conditions⁴. Elevated PCV values generally indicate an increase in red blood cell mass or a reduction in circulating plasma volume, whereas persistently high PCV values may be associated with primary or secondary polycythaemia. The CB×CB and PW×CB progeny groups recorded the highest numerical Packed Cell Volume (PCV) values at both sampling periods, with values of 65.43 and 59.98%, respectively, at 3 weeks of age and 65.89 and 62.11%, respectively, at 6 weeks of age.

Red Blood Cell (RBC) count did not differ significantly ($p>0.05$) among the progeny groups at 3 weeks of age, with values ranging from $2.89\text{--}3.22\times 10^{12}/\text{L}$. However, significant differences ($p<0.05$) were observed at 6 weeks of age. At 3 weeks, the PW×CB progeny recorded the highest RBC count ($3.22\times 10^{12}/\text{L}$), whereas the PW×PW progeny had the lowest value ($2.89\times 10^{12}/\text{L}$). These values were lower than the $4.31\times 10^{12}/\text{L}$ reported by Agina et al.⁹ but higher than the $2.14\times 10^{12}/\text{L}$ reported by Sujata et al.¹⁰. At 6 weeks of age, the PW×CB progeny recorded the highest RBC count ($4.49\times 10^{12}/\text{L}$), which was comparable to the value of $4.31\times 10^{12}/\text{L}$ reported by Agina et al.⁹. Red blood cells play a vital role in transporting oxygen from the lungs to body tissues and returning carbon dioxide from the tissues to the lungs for excretion.

White Blood Cell (WBC) count differed significantly ($p<0.05$) among the progeny groups at both sampling periods. At 3 weeks of age, WBC values ranged from 227.83 to $247.63\times 10^9/\text{L}$, while at 6 weeks they ranged from 256.54 to $267.43\times 10^9/\text{L}$. The PW×CB progeny consistently recorded the highest WBC counts, with values of $247.63\times 10^9/\text{L}$ at 3 weeks and $267.43\times 10^9/\text{L}$ at 6 weeks, followed by the PW×PW progeny, which recorded $227.63\times 10^9/\text{L}$ and $256.54\times 10^9/\text{L}$, respectively. White blood cells are essential components of the immune system and contribute to the body's defence against infectious agents. The observed age-related increases in haemoglobin concentration, RBC count, WBC count and Packed Cell Volume (PCV) indicate normal physiological development from the chick stage to adulthood and are consistent with the findings of Talebi et al.¹¹.

Mean corpuscular haemoglobin concentration (MCHC) differed significantly ($p<0.05$) among the progeny groups at 3 weeks of age, with values ranging from 206.83 to 234.75 g/L . The PW×CB progeny recorded the highest MCHC value (234.75 g/L), followed by the PW×PW progeny (218.92 g/L). The values obtained in the present study (39.35 g/dL) differed from the value reported by Agina et al.⁹. This apparent discrepancy may be due to differences in the units of measurement (g/L versus g/dL) or variations in experimental conditions and analytical methods.

Platelet count differed significantly ($p<0.05$) among the progeny groups at both 3 and 6 weeks of age. Platelet values ranged from 40.25 to $55.88\times 10^9/\text{L}$ at 3 weeks and from 45.35 to $57.10\times 10^9/\text{L}$ at 6 weeks. The PW×PW progeny recorded the highest platelet counts at both sampling periods, with values of $55.88\times 10^9/\text{L}$ at 3 weeks and $57.10\times 10^9/\text{L}$ at 6 weeks, followed by the PW×CB progeny, which recorded $51.88\times 10^9/\text{L}$ and $53.47\times 10^9/\text{L}$, respectively. Platelets play a critical role in haemostasis by facilitating blood clot formation and preventing excessive blood loss. Therefore, the relatively higher platelet counts observed in the PW×PW and PW×CB progeny may indicate a greater capacity for maintaining normal blood clotting function.

CONCLUSION

The PW×CB progeny demonstrated superior fertility and hatchability, with lower mortality from the brooding to laying stages, compared with the other progeny groups. Therefore, the PW×CB progeny may be preferred for breeding purposes, followed by the CB×PW progeny. Haemoglobin concentration, RBC count, WBC count and haematocrit (PCV) generally increased with age, with lower values observed in chicks and higher values in adult birds across the progeny groups. The PW×PW progeny recorded the highest platelet count, followed by the PW×CB progeny. Since platelets play an important role in blood clotting and haemostasis, the relatively higher platelet counts observed in these progenies may contribute to effective prevention of excessive blood loss. Overall, the findings suggest that the PW×CB progeny could be recommended for selection and breeding to improve reproductive efficiency, reduce production costs and enhance economic returns in Japanese quail production.

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