

**EFFECT OF REARING ON THE ZOOTECHNICAL PERFORMANCES OF QUAIL
(*COTURNIX COTURNIX JAPONICA*) RAISED IN CÔTE D'IVOIRE**

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Abstract

This study was conducted at the Ismorel farm in the city of Adiaké in order to determine the influence of the breeding method on the zootechnical performance of the quail (*Coturnixcoturnix japonica*) in Ivory Coast. The quail's chicks, which numbered around 1960, were divided into two farming methods: cage farming and ground breeding on the litter. The experiment was replicated three times in the same year. The results showed a significant effect ($P < 0.05$) of the rearing method on the weight growth and spawning rate of the quail. The culture mode also showed a significant ($P < 0.05$) and highly significant ($P < 0.001$) difference for the hatching rate and embryo mortality, respectively. However, the rearing method had no significant effects ($P > 0.05$) on egg weight, egg fertility, quail appearance and quail mortality.

Keywords: Farming, Quail, Quail's Chicks, Zootechnical Performance

Introduction

The problem of food security persists in developing countries, especially the need for animal protein (Brouet *al.*, 2012). In order to solve this problem, Ivory Coast has been engaged in industrial poultry farming, occupying an important place in the sub-Saharan region of Africa (Pousgaet *al.*, 2005).

Among so many poultry production, quail farming remains out of the knowledge of some breeders. Even those who practice it do not master the reliable production system. The housing system is the most important factor affecting the performance of poultry (Roshdyet *al.*, 2010, Karousaet *al.*, 2015). Three systems are possible: pens, colony or individual cages and battery cages. Ground pens are less expensive, but have disadvantages such as egg contamination, inability to identify non-productive birds, and exposure to pests that cause disease (Peter *et al.*, 2003). Colony cages housed several females and males. This reduces

disease exposure and produce clean, easy-to-collect eggs. Individual cages provide the opportunity to kill unproductive or infertile birds, reduce fighting, kill and break eggs. This system is the most expensive because it requires a large workforce (Peter *et al.*, 2003). The cages are often made of several floors. However, this method is not recommended because it does not allow good aeration and causes stress in birds (RicardaMondry, 2016).

Padmakumaret *al.* (2000a), Ayorinde (1994), Sharma and Panda (1978) and Huqueet *al.* (1992) reported a non-significant effect of the housing system (cage versus litter soil) on weight gain and survivability, but reported varying results on food consumption and feed conversion. On the other hand, some researchers have observed a significantly high growth rate for the ground-based system compared to the cage system (Ojedapo and Amao 2014, Dogan and Tulin 2012). El-Shekhet *al.* (2016) reported that individual cages had better fertility and hatching rates than those raised in colony cages. Alamet *al.* 2008 reported that cage-grown quail had higher egg production than litter-raised litter. The breeding system of Japanese quail did not have a significant influence on the level of fertility (Arumugamet *al.*, 2014). Fertility rate was higher in Japanese ground-raised and low-cage quail (Farooq *et al.* 2001). Few researches have been undertaken about quails rearing in Côte d'Ivoire.

This work aims to promote two ways of quail's rearing such as cage farming and ground breeding on the litter. Specifically, the parameters of weight growth, reproduction, and mortality will need to be determined.

1. MATERIAL AND METHODS

1.1. Site of the study and experimental animals

The Ismorel farm is located 2 km from the city of Adiake (5 ° 17'06 "N of latitude and 3 ° 18'07" W of longitude) in Ivory Coast. The relative humidity and temperature during the test ranged from 75 to 95% and 23.5 to 31.3 ° C, respectively, while the annual precipitation was 1689.54 mm. The experiment was repeated three (3) times in the same year. Thus, 1960 one-day-old quail weighing 7.13 ± 0.5 g were used during start-up and growth of the quail. After sexing, a total of 900 quails were used for the rest of the experiment.

1.2. Breeding mode

The experiment was subjected to two ways of raising quails, including cage culture and bedding on litter. These two farming methods were conducted in the breeding house.

1.2.1. Cage breeding

360 quails, which were divided into three compartments of 120 quail per cage. The dimensions of a cage were 4 m long, 0.75 m wide and 0.4 m high. The area occupied by a quail was 0.025 m². The cages were covered with 1 cm × 1 cm mesh. They were positioned 0.5 m above the ground. Sawdust was placed under the cages to collect the droppings. In each cage were placed five liters of drinkers and four rectangular feeders (0.6m × 0.12m × 0.1m).

1.2.2. Breeding on the ground with litter

In this mode, 540 quail were used to carry out the experiment. These animals were also divided into three groups of sailboats. Each group sailfish contained 180 quails. The sailboats were built using planks and covered with mesh 1 cm × 1 cm. The sailboat had dimensions of 3 m × 1.5 m × 2 m. The area occupied by a quail was also 0.025 m². Sawdust was poured to the ground at a height of 6 cm. Four 5-liter siphoid drinkers, four rectangular feeders (0.3 m × 0.15 m × 0.1 m) and six nest boxes (0.3 m × 0.15 m × 0.16 m) of three boxes each have used by sailfish in relation to this farming method.

1.3. Conduct and data collection

The quail was fed *ad libitum*. Table I contains the percentage mass composition of the feed at different stages of rearing. Every two weeks the bedding was replaced following cleaning and disinfection of the breeding house. The breeding pair of quails was composed of one (1) male for (3) females, whatever the mode used. Two days before the arrival of the chicks, the brooder was disinfected and preheated to 40 ° C. Subdivision in two, she received the animals according to the mode of breeding.

One group was heated on litter while the other on very fine mesh. The animals were transferred to the breeding house two weeks later. The quails were weighed as soon as they arrived. Then weighing was done every weekend until the fifth week. The average egg-laying rate was determined monthly by taking into account the number of females and eggs laid per month according to formula (1):

$$\text{Laying rate (TP)} = \frac{(\text{Total number of eggs laid})}{(\text{Number of live quail})} \times 100 \quad (1)$$

Eggs were collected every four months to determine their average weight. A collection of 840 eggs per culture mode was carried out for incubation to obtain the average hatching rate, fertility and embryo mortality respectively according to formulas (2) (3) and (4).

$$\text{Hatching rate (TE)} = \frac{(\text{number of eggs hatched})}{(\text{total number of eggs incubated})} \times 100 \quad (2)$$

$$\text{Fertility rate (TF)} = \frac{(\text{Total number of embryos})}{(\text{Total number of eggs incubated})} \times 100 \quad (3)$$

$$\text{Death rate (MT)} = \frac{(\text{Number of dead subjects})}{(\text{Number of subjects put in place})} \times 100 \quad (4)$$

Table I: Percentage Mass Composition Of The Quail Feed

Rawmaterial (%)	Breeding phases		
	Start-up	Growth	Clutch
Maize	58.9	59.8	48.2
Soy	20	16	16
Corn	15	18	25
Fish	1.1	1	2
Shell	0	0.2	3.8
premix	5	5	5
Total (%)	100	100	100

After hatching, the appearance of the quails was determined on each mode taking into account three factors: normal, crippled and weak chicks. Each rate at these three factors was determined relative to the total number of quails obtained.

Parameters such as egg-laying time, sexual maturity at 50% lay, nesting rate in nest boxes, broken egg rate, dirty egg rate (in contact with the droppings), and the appearance of eggs (low-shell eggs, rough eggs, shell-less eggs, very small eggs) were determined for both breeding methods.

1.4. Statistical analysis

The statistical analyzes of the data were carried out using the statistical software R version 3.1.3. The comparison of the different experimental batches and the distribution of the data obtained (weightings and measurements) were carried out with the Agrostino-Pearson test. Mean quail weights, average egg-laying rates, and mean egg weight were compared using the one-way ANOVA test followed by Turkey's multiple comparison test. The factor of the study was the mode of rearing. Nonparametric data were analyzed with the Kruskal-Wallis test followed by the Dunn comparison test. The results of the weightings and measurements are expressed on average with the standard deviations. The value of P is set at the 5% threshold of the Turkey test and that of Dunn with a 95% confidence interval (CI).

2. RESULTS

2.1. Effect of rearing mode on quail weight growth

Mean weights on the first day of arrival of the quails (W0) (7.12 ± 0.64 and 7.13 ± 0.50 g) and the fifth week (W5) (163.79 ± 12.63 and 159.57 ± 9.06 g) showed no difference for cage and ground quail, respectively (Table II). However, those of quail observed respectively in week1 (24.05 ± 2.14 ; 22.02 ± 2.04 g), week 2 (49.99 ± 5.11 ; 46.14 ± 4.47 g), week 3 (102.17 ± 6.18 ; 99.51 ± 6.81 g) and week4 (124.82 ± 4.88 ; 120.08 ± 6.07 g) showed a significant difference ($p < 0.05$), respectively for cage and ground quail. Caged-grown quail had a higher average weight of 1.04 times that on litter. The culture mode had a significant effect ($p < 0.05$) on quail weight growth.

Table II: Evolution Of The Average Weight Of Quail Per Week According To The Mode Of Rearing

Average weight per week (g)								
Breeding mode	W ₀	W ₁	W ₂	W ₃	W ₄	W ₅	Average	
Cage	7.12 ± 0.64^a	24.05 ± 2.14^a	49.99 ± 5.11^a	102.17 ± 6.18^a	124.82 ± 4.88^a	163.79 ± 12.63^a	94.39 ± 6.32^a	±
	7.13 ± 0.50^a	22.02 ± 2.04^a	46.14 ± 4.47^a	99.51 ± 6.81^a	120.08 ± 6.07^a	159.57 ± 9.06^a	90.89 ± 5.79^b	±
Ground	0.50^a	±	±	6.81^b	$± 6.07^b$		5.79^b	
		2.04^b	4.47^b					

The average values indicated in columns with the different letters (a and b) differ significantly at $p < 0.05$ on the ANOVA test; Wn: Week

2.2. Effect of rearing mode on the spawning rate of quail

The spawning peak is reached in the second month (M2) of egg production for both rearing methods (Table III). There was no significant difference ($p > 0.05$) in the mean oviposition rate between cage-grown and littered-floor quail at month 1 (57.11 ± 30.11 ; 52.30 ± 33.78 g), month 3 (83.76 ± 3.09 ; 81.94 ± 4.40 g) and month 7 (74 ± 2.67 ; 73.37 ± 3.48 g), respectively. In contrast, a significant ($p < 0.05$) difference in mean egg-laying rate was observed at month 2 (86.67 ± 4.06 ; 84.11 ± 2.84 g), month 4 (79.79 ± 2.98 ; 77.06 ± 3.18 g), month 5 (76.06 ± 2.73 ; 74.22 ± 2.43 g), month 6 (74.86 ± 3.58 ; 72.83 ± 3.97 g) , month 8 (73.51 ± 2.63 and 70.02 ± 2.53 g), month 9 (72.62 ± 2.53 ; 70.41 ± 2.13 g) and month 10

(71.25 ± 2.17 ; 69.98 ± 2.23 g) between the two breeding methods. Quail reared in cages showed a higher lay rate of 1.03 times than litter. In sum, the rearing method demonstrated a significant effect (p <0.05) on the spawning rate of quail.

Table III: Evolution Of The Average Laying Rate Of Quails Per Month According To The Breeding Mode

Average laying rate per month (%)											
Breeding mode	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	M ₁₀	Average
Cage	57.11	86.67	83.76	79.79	76.06	74.86	74 ±	73.51	72.62	71.25	74.96 ±
	±	±	±	±	±	±	2.67 ^a	±	±	±	5.66 ^a
Ground	30.11 ^a	4.06 ^a	3.09 ^a	2.98 ^a	2.73 ^a	3.58 ^a		2.63 ^a	2.53 ^a	2.17 ^a	
	52.30	84.11	81.94	77.06	74.22	72.83	73.37	70.02	70.41	69.98	72.62 ±
	±	±	±	±	±	±	±	±	±	±	6.09 ^b
	33.78 ^a	2.84 ^b	4.40 ^a	3.18 ^b	2.43 ^b	3.97 ^b	3.48 ^a	2.53 ^b	2.13 ^b	2.23 ^b	

The average values indicated in columns with the different letters (a and b) differ significantly at p <0.05 on the ANOVA test; Mn: Months

2.3. Effect of rearing mode on the weight of quail eggs

Egg weight has increased over time regardless of rearing pattern (Table IV). Caged quail had a higher mean egg weight (11.04 ± 0.94 g) than litter-based ground (10.87 ± 0.98 g). However, this difference was not significant (p > 0.05). The rearing method did not show a significant difference (p > 0.05) on the weight of the quail eggs.

Table IV: Evolution Of The Weight Of Quail Eggs Over Time According To The Mode Of Rearing

Average weight of eggs (g)						
Breeding mode	M ₁	M ₄	M ₈	M ₁₂	Average	
Cage	10.09	± 10.90±	11.75±	11.42 ±	11.04 ± 0.94 ^a	
	0.56 ^a	0.91 ^a	1.19 ^a	1.11 ^a		
Ground	9.89	± 10.99±	11.37	± 11.27±	10.87 ± 0.98 ^a	
	0.97 ^a	0.78 ^a	1.21 ^b	0.95 ^a		

The average values indicated in columns with the different letters (a and b) differ significantly at p <0.05 on the ANOVA test; Mn: Months

2.4. Effect of rearing mode on hatching, fertility and embryo mortality rates

The hatching rate was higher in quails treated in cages (79.52%) compared to those on litter (67.14%) (Table V). The difference in the hatching rate between these two rearing methods was significant (Khi-2 = 5.07, dof = 1, p = 0.02 < 0.05). The rearing mode influenced the quail hatching rate.

Table V: Average Hatching Rate Of Quail Eggs By Rearing Mode

Breeding mode	n	Eggshatched	Hatching rate %	Khi-2	P- Valeur	Sign<0,05 = *
Cage	840	668	79.52	5.07	0.02	*
Ground	840	564	67.14			

*: Significant difference (P < 0.05)

A slight difference in fertility was found between quails raised in cages (96.69%) and those raised on litter (97.62%) (Table VI). However, no significant difference (Khi-2 = 0.02, dof = 1, p = 0.88 > 0.05) was found for these two breeding methods. Thus, the rearing method did not affect the fertility rate of quail eggs.

TABLE VI: Average Fertility Rate By Breeding Mode

Breeding mode	n	Eggs with embryos	Fertility rate (%)	Khi-2	P- Value r	Sign<0,05 = *
Cage	840	812	96.67	0.02	0.88	NS
Ground	840	820	97.62			

NS: Not significant difference (P > 0.05)

Embryo mortality was lower for quail eggs from cages (17.15%) than for litter-based litter (30.48%) (Table VII). Statistical analysis showed a highly significant difference (Khi-2 = 24.39, dof = 1, p = 0.00 < 0.001) when treating the two groups of animals studied. As a result, the rearing method had an effect on the embryonic mortality of quail.

Table VII: Mean Embryonic Mortality Rate By Breeding Mode

Breeding mode	n	Embryonicdeaths	Embryomortality rate (%)	Khi-2	P- value	Sign<0,05 = *
Cage	812	144	17.15	24.39	0.00	****
Ground	820	256	30.48			

****: Highly significant difference (P < 0.001)

2.5. Effect of rearing mode on the appearance of the quail

The normal rate of quail was greater (95.21%) in those raised in cages than those raised on litter (91.49%) (Table VIII). In both breeding methods, crippled chick count rates are substantially similar (values for each mode). With regard to the low quagmire rate, it was higher in litter-based bedding (5.67) than in cage culture (1.80). Although, differences in the appearance of the quails were observed, these were not significant ($P > 0.05$). The rearing method therefore had no influence on the appearance of the quail.

Table VIII: Average Rate Of Normal, Crippled And Weak Chickens According To The Mode Of Rearing

Breeding mode	Sample	Aspect of the quail%				Khi-2	P-value	Sign<0,05 = *
	n	Normal	Cripple	Low				
Cage	668	95.21	2.99	1.80	3.34	5.99	NS	
Ground	564	91.49	2.84	5.67				

NS: Not significant difference ($P > 0.05$)

2.6. Effect of rearing mode on quail mortality

The mortality rate of the different phases of the breeding did not show any significant difference ($P > 0.05$). In fact, the rearing method had no influence on the quail mortality rate (Table IX).

Table IX: Quail Mortality Rate In Different Rearing Phases According To The Rearing Mode

Breeding phase	Breeding mode	Total workforce	Dead people	Mortality rate %	Kh-2	P-value	Sign<0.05 = *
Start-up	Cage	760	12	1.58	2.40	0.12	NS
	Ground	1200	32	2.67			
Growth	Cage	748	4	0.53	1.32	0.25	NS
	Ground	1168	12	1.03			
clutch	Cage	360	8	2.22	0.43	0.51	NS
	Ground	540	16	2.96			

NS: Not significant difference ($P > 0.05$)

2.7. Other reproduction parameters according to the mode of raising quails

Laying was 40 days old in caged quail against 45 in litter-based ground. However, the age of sexual maturity was pronounced at 50% egg production, including 51 and 56 days

respectively for cage quail and litter soil. Quails reared on the ground were laid in layers. It was found that 42.06% of the average spawning rate came from the litters versus 57.94% from the litter. Quail raised on the litter had an average broken egg rate of 2.41% whereas those raised in the cages gave an average broken egg rate of 0.73%. In terms of appearance of eggs (low-shelled eggs, rough eggs, unshelled eggs, very small eggs) the average rate was 3.87% and 4.1%, respectively, for quail grown on litter and cages. A large variation was observed in the average level of dirty eggs, including 20% for litter quail and 1% for cage quail.

3. DISCUSSION

Mean body weight was higher for cage-grown quail (94.39 ± 6.32 g) than for litter-grown ground (90.89 ± 5.79 g). The results showed that this difference is significant ($p < 0.05$) for caged quails. The rearing method therefore had an influence on the body weight of the quail. This could be explained by the fact that cage-raised quail feeds more without distraction, while those on the ground take their time playing in the litter. These results are in agreement with those of Padmakumaret *al.* (2000), Roshdyet *al.* (2010), Jatoiet *al.* (2013) and Razzeet *al.* (2016) who observed a significant difference between cage-grown quail and litter-based soil. On the other hand, these results are opposite to those of Dogan and Tulin (2012) and Ojedapo and Amao (2014) who showed the significant effect of the weight gain of the quail in favor of the quails raised on the ground compared to those raised in cage.

Statistical analyzes showed a high average spawning rate of cage-grown quail ($74.96 \pm 5.66\%$) compared to litter-based ($72.62 \pm 6.09\%$) litter. The rearing mode has a significant effect on the spawning rate of quail. The high cage-laying rate can be justified by the fact that the females are not in contact with the litter and the droppings, which allows them to avoid diseases such as coccidiosis, salmonellosis and many other diseases, which would reduce egg laying. Such observations have been made by Avci *al.* (2005), Gandhimathiet *al.* (2014), Konteckaet *al.* (2014), Arumugamet *al.* (2015) and Karousaet *al.* (2015). In fact, these authors found a cage-raised egg production on the ground in quail. On the other hand, our results differ from those of Roshdyet *al.* (2010) who observed a higher spawning rate in litter-based quail than those raised in cages.

Quail litter-raised quail (10.87 ± 0.98 g) had a low average egg weight compared with caged (11.04 ± 0.94). However, this difference in mean weight is not significant ($P > 0.05$). The rearing method had no effect on the weight of the quail eggs. This could be due to fair food consumption in both modes. These results are in contradiction with those of Yildizet *al.*

(2004), Yesilbag (2007) and Arumugamet *al.* (2015) who reported a significantly higher mean egg weight for ground quail than in cage.

The hatching rate of cage-grown quail (79.52%) was statistically higher than that of litter-grown quail (67.14%) ($P < 0.05$). Quail eggs raised in cages are less exposed to feces while those raised on the ground have eggs that are in contact with droppings and the movement of quails that have characteristics that are harmful to eggs. This situation would have had a detrimental effect on the hatching rate of quail eggs raised on the litter. Arumugamet *al.* (2014) and Rajiet *al.* (2014) made these same observations during their various works. Indeed, these authors observed a high hatching rate of quail eggs raised in cages compared to that of quail raised on the litter. Unlike these early authors, Meizaret *al.* (2008), Roshdyet *al.* (2010) and Karousaet *al.* (2015) found no significant difference ($P > 0.05$) between quail grown in cages and on the ground.

Fertility rates were almost similar for both breeding methods (96.67% cage culture and 97.62% litter farming). No significant difference ($P > 0.05$) was observed. This non-significant difference could be explained by the sex ratio of the breeding pair that was one male to three females and the acceptance of females to be copulated. These results are in agreement with those of Roshdyet *al.* (2010), Rajiet *al.* (2014) and Arumugamet *al.* (2014) who showed a non-significant effect of rearing method on the fertility of quail eggs. On the other hand, a significant difference was found by Farooq *et al.* (2001), Meizaret *al.* (2008) and Karousaet *al.* (2015). The results of these authors differ from those of this work in that quails may have problems of consanguinity and infertility.

Quail eggs from ground-based rearing showed a higher embryo mortality rate (30.48%) than eggs from cage culture (17.15%). This highly significant difference ($P < 0.001$) could be due to quail eggs contaminated by litter and droppings that have infectious pathologies of eggs from the soil. These results are in agreement with those of Naraharriet *al.* (2002) and contradict those of Chidanadaet *al.* (1986), Abdul Mujeer (1992), Akramet *al.* (2000) and Roshdyet *al.* (2010).

Normal chicks were largely for eggs from cage-grown quail. On the other hand, weak quails from eggs from ground-grown quail showed a high rate of quail eggs. This insignificant difference ($P > 0.05$) could be explained by the contact of the eggs with the droppings, which would lead to bacterial infections having negative effects on hatchets at hatching. Indeed, similar results were found on both modes compared to lame cripples.

During the start-up phase, ground-raised chicks exhibited a higher mortality rate than those raised in cages.

During growth and spawning, ground-grown quail has consistently shown a high mortality rate compared with high cage kills. However, these differences were not significant ($P > 0.05$). These results are explained by the hygiene provided to the quail during the experiment. These results are in agreement with those of Razeet *al.* (2016) who did the same work.

CONCLUSION

At the end of this study, the mode of rearing had influenced the weight growth, the oviposition rate, the hatching rate and the embryonic mortality rate. This influence has been positive for improving breeding conditions. The observed differences were in favor of cage-grown quail compared with litter-based ground. However, no significant effects were observed on average egg weight, fertility rate, quail appearance and quail mortality rate during rearing. In short, cage farming requires more than the one on the ground. But, this one has a high cost of production. As a result, cage farming requires more financial resources.

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