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Original Research

Effect of Egg Weight on Hatchability and Subsequent Growth and Laying Performance of Japanese Quails (*Coturnix coturnix japonica*)

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Abstract

This study was conducted to determine the influence of egg weight on hatchability and subsequent growth performance of Japanese quails. A total of 108 eggs were shared in 3 egg weight groups of 36 eggs each: Small (S < 10 g), Medium (M 10 – 12.9 g), and Large (L13 -16 g). Each group was randomly subdivided into 3 replicates of 12 eggs each. After 18 days of incubation, the live hatch weights of chicks were recorded and were brooded for 3 weeks in the brooding unit and thereafter grown in battery wire cages for 3 weeks to evaluate the growth performance. Then, twelve birds (3 males: 9 females) were selected from each of the groups to determine egg production which was done from week 6 to week 12. Results showed that hatchability and survivability were respectively highest in M (91.66%; 86.11%) and lowest for S (66.66%; 52.78%). The highest mortality was recorded in the S group (13.88%). Chick weights and weight gain were significantly (p<0.05) affected by egg weights. Feed intake was directly proportional to the chick's weight. The highest number of eggs (318) was recorded in the M group, followed by L (298) and least by S (182). Medium-sized eggs constituted a majority (356) of all the eggs (798) produced. Therefore, hatchability and survivability are associated with egg weight. Quail producers may opt for medium-sized eggs since they could be good for the excellent sustainability of Japanese quail production.

Keywords: Egg Production Performance, Egg Weight, Growth Performance, Hatchability, Quail

Introduction

In most tropical countries like Cameroon, rural household incomes do not still allow to cover the essential household needs such as health care, education, and food supply. Hence, many families tend to assume a major role in the production of their foodstuffs. Since most governments in the tropics do not have the resources to guarantee even minimum food to all their citizens, there has been considerable interest in the development of non-conventional livestock farming (Niba *et al*., 2012) such as ducks, geese, snails, guinea pigs and quails as a strategy to diversify rural household livelihoods. The advantage of this type of production is that most of them are little-known animals with a promising economic future (NRC, 1994).

Quail farming is a special niche in poultry farming and it is becoming more popular for producing eggs and sometimes meat (Chidera, 2018). It is a well-established animal model because of its small body size, short generation interval, and high egg production. Japanese quails are hardy birds that thrive in small cages and are inexpensive to keep. They are affected by common poultry diseases but are fairly disease resistant. Japanese quails mature in about6 weeks and are usually in full egg production by50 days of age. Despite these potentials, breeding quails still have a few constraints that have undermined its contribution to animal protein supply in most countries. Several factors such as storage time, fertility, temperature, diseases, age, and egg size affect the hatchability and post-laying performance of chickens, turkeys, and ducks, and these same factors also tend to affect quails.

The performance in chickens in terms of hatchability and chick hatch weight may be closely related to the weight of the eggs because the main effect of egg size lies in the mass of the residual yolk sac that the chick retains at hatching (Olusoji, 2011). The commercial poultry sector in general faces the problem of availability and consistent supply of day-old chicks. However, day-old chicks' availability is paramount for the success and continuity of poultry farming. It has remained long unresolved the influence of egg weight on hatchability and growth performance of Japanese quail. Yet, it is expected that many of the common factors known to influence incubation success in commercial poultry eggs may affect quail egg hatchability (Gonzalez *et al*, 1999). This study was therefore designed to investigate the influence of egg weight on the hatchability and subsequent growth and laying performance in Japanese quails.

Materials and Methods

Study Site

This study was carried out at Busy Bees Cooperative farm, Mile III Nkwen. It is situated in Bamenda III Sub-division; Mezam Division of the North West Region of Cameroon. The area has a tropical transitional climate and a rainy season running from mid-March to mid –October and a dry season running from mid-October to mid-March. Latitude 5^{o} 45" and 9^{o} 9"N and longitude 9^{o} 13" and 11^{o} 13" E

Egg Management

One hundred and eight (108) quail eggs were carefully selected based on shape, free of shell cracks, and stored in a cold room for 7 days. The eggs were individually weighed, marked, and mainly categorized into 3 groups of 36 eggs each; Small (S < 10 g), Medium (M 10 – 12.9 g), and Large (L13 -16 g) and incubated for 18 days in a locally made fan-ventilated incubator. Eggs were turned 5 to 6 times daily to prevent sticking of the embryo to the shell. Incubation temperature ranged between 35.8° C to 38.5° C. Candling was done on day 10 to monitor the development of the embryo. The infertile eggs were identified, counted, and recorded. Chicks hatched on days 18 and 19, were counted and weighed on a sensitive scale with 0.01 g precision.

Birds Management

In the second part, all chicks hatched from the same egg groups were marked and put together in the same group based on their initial treatment to evaluate their growth performance. The chicks were brooded in the nursery during which the litter material used was replaced every 1 week within 3 weeks to prevent the build-up of parasites. At the end of 3 weeks, they were transferred and housed in battery-wired cages measuring 100 x 60 x 50 cm. Each cage was provided with a feeder and water trough. Hatched chicks were reared on the same diet, but kept separately according to the initial treatment of the eggs. Feed and water were given to the birds *ad libitum*.

Then, twelve birds (3 males: 9 females) were selected from each of the groups to determine egg production which was done from week 6 to week 12 with layer mash fed to the birds.

Table 1: Composition of experimental diet for growing and laying Japanese quail

Ingredients	**Quantity in Kg**	
	Growing quails	**Laying quails**
Maize	44.45	37.13
Soybeans	25.93	26.98
Groundnut cake	12.97	13.49
Wheat brand	10.00	10.00
Fish meal	3.00	3.00
Bone meal	2.50	2.55
Limestone	0.55	6.10
Salt	0.30	0.30
Vitamin premix	0.25	0.25
Lysine	0.20	0.15
Methionine	0.10	0.10
Total	100	100
Calculated Proximate Composition		
Metabolisable energy kcal/kg	2,921	2,718
Crude protein (%)	23.00	23.00
Fat (%)	8.37	8.32
Crude fibre (%)	4.03	3.9
Ash (%)	3.99	3.98
Calcium (%)	1.11	3.39
Phosphorus	0.88	0.95
Lysine	1.27	1.29
Methionine	0.75	0.70

**Bio-mix premix supplied per kg diet-Vitamin A, 10,000 i.u;Vitamin D3 2,000.00 i.u; Vitamin E 23,000.00mg; Niacin 27.5mg;Vitamin B1 1,800mg; Vitamin B2 50mg; Vitamin B6 30mg; Vitamin B12 0.015mg; Vitamin K3 2.00mg; Pantothenic Acid 7,500.00mg; Biotin 0.06mg; Folic Acid 0.75mg; Chlorine Chloride 300.00mg; Cobalt 0.2mg; Copper 30mg; Iodine 1.00mg; Iron 200mg; Manganese 0.04mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg.*

Data Collection

$$\textbf{Percent Fertility} = \frac{Number\ of\ fertile\ eggs}{Total\ number\ of\ eggs\ in\ the\ incubator}\ X\ 100$$

$$\textbf{Percent hatchability on fertile eggs set} = \frac{Number\ of\ chicks\ hatched}{Total\ number\ of\ fertilized\ eggs\ set}\ X\ 100$$

$$\textbf{Percent dead in shell} = \frac{Number\ of\ dead\ in\ shell\ eggs}{Total\ number\ of\ eggs\ in\ the\ incubator}\ X\ 100$$

$$\textbf{Percent infertile eggs} = \frac{Number\ of\ infertile\ eggs}{Total\ number\ of\ eggs\ set\ in\ the\ incubator}\ X\ 100$$

Body Weight Measurements

The live weight of chicks was taken at hatching and recorded as initial weight then the live weight of birds was measured every week.

Feed Intake and Feed Conversion Ratio

A weighed quantity of feed was served to the birds once every day early in the morning and the left-overs were collected the next morning and weighed after removing external contaminants by visual inspection and handpicking. Then feed intake was calculated from the quantity served and leftover. Feed conversion ratio (FCR) was determined by dividing the feed intake by the weight gain

Egg Production

Eggs per treatment (small, medium, and large) were collected and counted every morning and numbers recorded weekly.

Data Analysis

The data collected were analysed using the Statistical Package for Social Sciences (SPSS) version 20.0. The Analysis of variance (ANOVA) with SPSS 20.0 was used to test the significant differences in the measured variables of the eggs and birds as described by Steel and Torrie, (1980). The least significant difference (LSD) was used to separate significant means at a 5% level of significance.

Results

Effects of Egg Weight on Hatchability, Survival, and Pre-hatch Parameters

Total fertility was 94.44 % with the highest fertility recorded in the M and L treatments of 97.22 % relative to 88.89% for small. The percentage hatchability and survivability of chicks were significantly ($p<0.05$) high in the medium egg group compared with the small sized eggs. The group with small egg weight recorded a significantly ($p<0.05$) high percentage of dead in shell and infertile. The relatively low hatchability of small eggs was also associated with increased potential chick mortality (Table 2).

Table 2: Effects of egg weight on percentage hatch, dead in shell, infertile, and survival

Egg weight	Characteristics			
	% Hatch	**% Dead in shell**	**% Infertile**	**% Survival**
Small	66.66 ± 1.84^c	22.22 ± 1.87^a	66.07 ± 2.09^a	52.78 ± 0.32^b
Medium	91.66 ± 1.19^a	5.55 ± 0.87^b	16.67 ± 1.09^b	86.11 ± 0.32^a
Large	86.10 ± 1.20^b	5.50 ± 0.89^b	16.59 ± 1.05^b	80.56 ± 0.22^a

^{a,b,c}*means with different superscript in the same column are significantly (p<0.05) different; n= 108*

Effects of Egg Weight on Chick Hatched Weight and Feed Conversion Ratio

The live hatch weight significantly ($p<0.05$) increased as the weight of eggs also increased. However, the feed conversion ratio reduced significantly ($p<0.05$) as the weight of eggs decreased (Table 3).

Table 3: Influence of egg weight on chick hatch weight and FCR

Egg weight	Characteristics	
	Chick hatch weight	**FCR**
Small	5.56 ± 0.09^c	3.04 ± 1.03^c
Medium	6.56 ± 0.08^b	3.64 ± 0.53^b
Large	8.86 ± 0.06^a	3.82 ± 0.59^a

^{a,b,c}*means with a different superscript in column are significantly (P<0.05) different; FCR- feed conversion ratio*

Effects of Chick Weight on Feed intake

The feed consumption generally augmented as the age of birds increased. Yet, the quantities of feed intake varied amongst the treatment groups, with the resulting birds from the large treatment consuming the highest, followed by the medium group and then the small group (Figure 1).

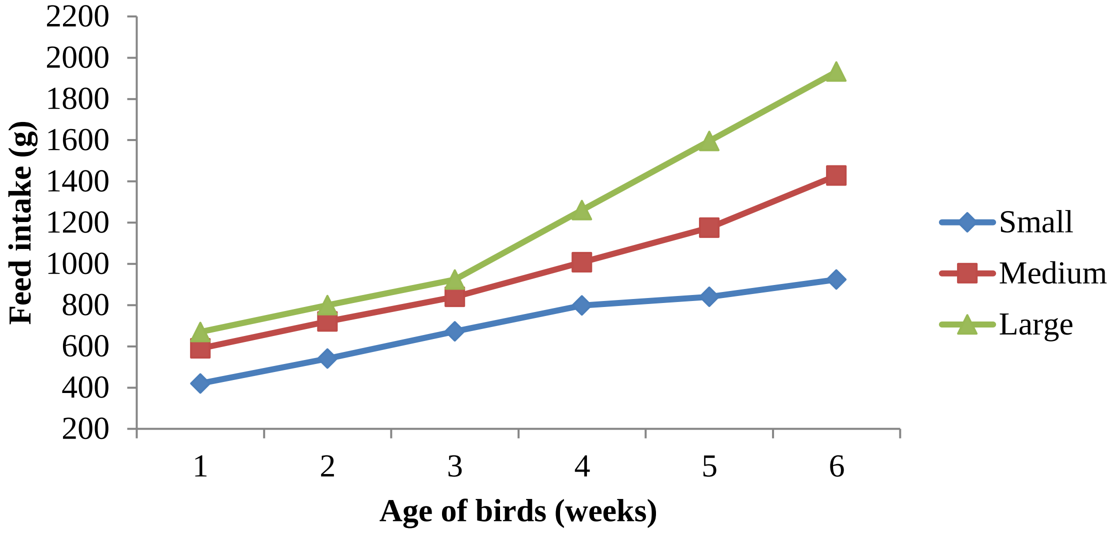

Figure 1: Influence of chick weight on feed intake of Japanese quails

Effects of Chick Weight on Weight Gains (WG)

The weight gain generally increased in the 1st three weeks in all treatments before dropping from week 4 till the end, especially in the small and large egg weight group. However, the weight gain increased faster in birds from the medium egg weight group, followed by birds from the large group, and then last in the small egg weight group (Figure 2).

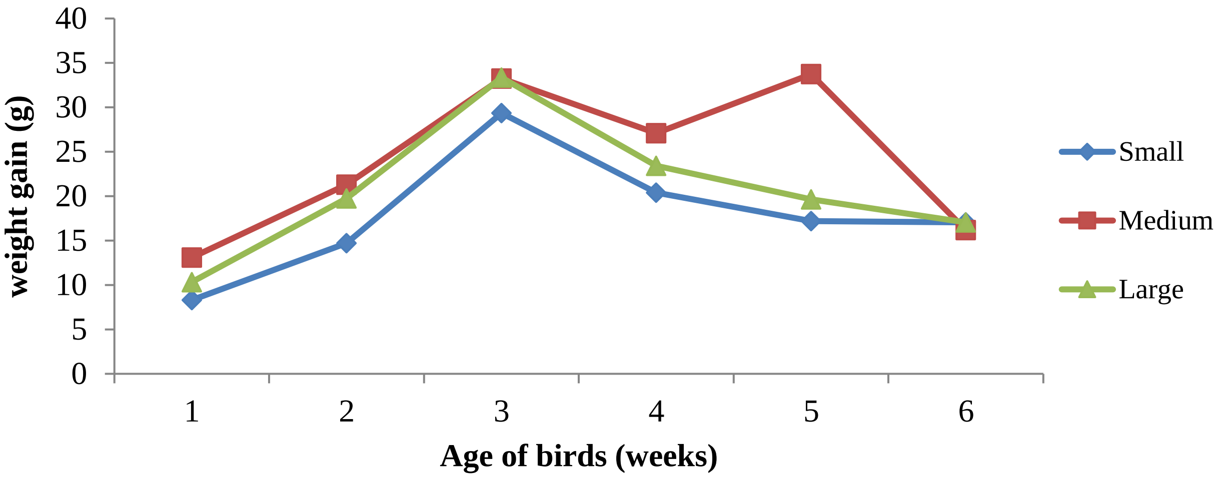

Figure 2: Influence of weight gain evolution according to the age of Japanese quails

The average egg weight at the first lay of Japanese quails was not significantly ($p>0.05$)affected by chick weight. The values obtained for the effect of chick weight on the average egg weight at first lay for small, medium, and large-sized chicks were 6.79g, 7.21g, and 7.98g, respectively. All treatments produced small-sized eggs with total numbers of 1, 3, and 2 at first lay respectively (Figure 3). Though the chick weight did not affect the age at first lay and size of the egg at first lay, hen day production from treatment groups was significantly ($p<0.05$) affected. The hen day egg production increased with the increasing age of the birds with more medium eggs being produced. It increased from 3.18% for week 1 to 87.83% for week 12.

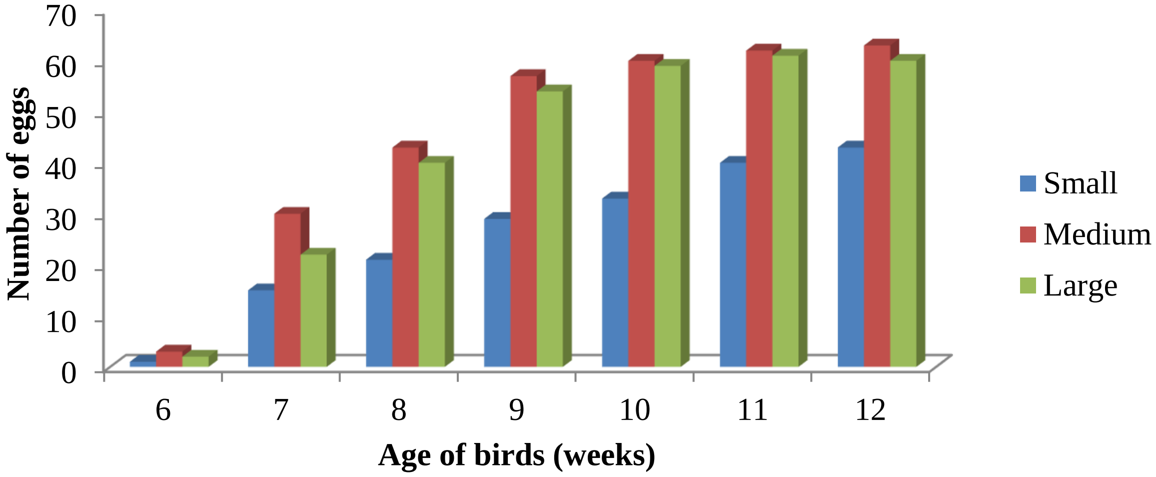

Figure 3: Egg production according to the weight of chicks of Japanese quails

Discussion

Egg sizes recorded in this study for small (8.96-9.87 g), medium (10.44-12.92 g), and large (13.11-15.64 g) were similar to those recorded by Petek *et al*. (2003) and Ibrahim *et al*. (2005) who reported different categories of small (<10.51g); medium (10.51-11.50 g); large (11.51-12.50 g). Differences in egg size may arise due to the variations in climatic conditions and differences in their feed compositions.

The results obtained indicated a non-significant difference (p>0.05) between egg size and fertility. This is in line with the work of Uddin *et al*., (1994) who studied the effect of egg weight (8.59, 9.52, 10.56 g) and storage (1, 4, 7, 10 days) on hatching parameters. Their results showed that except for fertility, all parameters were affected by egg weight (p<0.05). Higher percent hatchability was obtained in the medium sized eggs compared to the other groups. These results confirm some earlier findings which recommended the setting of average sized eggs for purpose of incubation (Alabi, Ngambi, Norris, & Mabelebele, 2012; Asuquo & Okon, 1993; Gonzalez et al., 1999). Abiola *et al*. (2008) reported that up to 96.67% hatchability was obtained for medium sized eggs while large eggs had the lowest value of 82.88% hatchability in broilers.

The high percent survival and low mortality of chicks hatched from medium and large sized eggs could be a result of better adaptation of the medium and large sized chicks to the environment. The adequate food reserve in the body of the heavier chicks hatched from large eggs could also be due to higher amounts of nutrients that may be available in the heavier yolk. This indicates that large sized eggs may enhance better survival followed by the medium which was far more than the small sized chicks. It therefore implies that, high hatchability, high percent survival and faster growth rate is enhanced by increased egg weight. The observed generally low mortality during the experimental period (1-6 weeks) in this study supports the earlier report that quails are hardy and perhaps less disease-prone than other poultry birds (Maurice & Gerry, 2006).

Egg weight could be a major determinant of chick weight at hatch. In this study, the egg weight significantly (p<0.05) affected chick weight in Japanese quails. This corroborates the findings of Ayorinde *et al*., (1994), who reported that, chicks hatched from large sized eggs were superior in body weight over those hatched from small and medium sized eggs in guinea fowl. This also agrees with the findings of Abiola *et al*., (2008), who reported that small chicks were hatched from small eggs, medium chicks from medium eggs and large chicks from large eggs.

The low feed intake for the first week was due to the small sizes of the birds. This gradually increased with increase in age of birds because of increase need for nutrients for growth and development. Weight gain increased with age and feed intake. This supports the result of Dowarah and Sethi, (2014) who reported that Japanese quail fed with 26% CP recorded the highest feed intake at 4-5weeks of age. Increase chick weight was influenced by increase egg weight with more nutrient content and yolk mass. The observed significant (p<0.05) effect of chick weight on average daily weight gains of the birds of large sized eggs could be as a result of the increased vigour of larger weight chicks and early adaptation at hatch compared to medium and small sized chicks. This enabled them to spend more time eating thereby enhancing their average daily weight gains compared with the medium and small sized chicks. This is in accordance with the findings of Olusoji, (2011). At 6 weeks, quails average daily feed intake varied between 11, 17 and 23 g for the treatments S, M and L respectively. At the same age, these values were quite different from the average feed intake of quails (14.4 g /day) reported by Djouvinov and Mihailov, (2005). Animal feed intake varies with many factors such as their age (Almeida, Oliveira, Ramos, Veiga, & Dias, 2002), the feed chemical composition (Ulmer-Franco *et al*., 2010; Mohiti-Asli *et al*., 2012; Morrissey *et al*., 2014), the ambient temperature (Shit *et al.*, 2012; Alagawany *et al*., 2017) and their sizes (Petek *et al.*, 2003; Adeyanju *et al*., 2014).

The significant differences ($p<0.05$) in the initial weights of chicks were found to be as a result of differences in weights of the eggs, from which the chicks were hatched. Tullet and Burton, (1992) noted that egg weight could be a major determinant of chick weight at hatch. Weekly weight gain increased with age, with maximum weight gains observed in all treatments at 3 weeks. The gradual fall and inconsistent weight gain thereafter could imply that birds attained optimum growth between 3 and 5 weeks of age. The superiority in the final body weight of large sized chicks over their medium and small sized counterparts may be as a result of initial body weight differences. The large sized chicks maintained their comparative size advantage up to six weeks of the study period. This is supported by the findings of Ayorinde *et al*. (1994) that body weight difference between chicks from large, medium and small eggs remained significant up to 12 weeks of age. The observed significant ($p<0.05$) effect of chick weight on feed conversion ratio among treatment groups was an indication that small chicks utilised feed more efficiently for growth and maintenance of body size than medium and large chicks.

The age at first lay of 42 days recorded in the present study is in not in line, with the findings of Bawa *et al*., (2011) who reported the range of 25-37 days as age at first lay in the quail. The values obtained for the effect of chick weight on egg production did follow a pattern as large treatment group birds produced more large eggs and the size of egg decreased from large to, small with medium and small groups respectively. Also, this finding is not supported by those observed by Olusoji, (2011) who reported that medium weight chicks laid bigger eggs followed by small and then large weight chicks.

In relation to the hen day production and laying performance, small birds produced least number of eggs with highest proportion of small eggs. This could be due to the slow reproductive development and maturity. The large and medium categories had no significant difference in this aspect though the medium produced numerically more eggs than the large with the heavier chicks producing more large eggs. This is not in line with Lacin *et al*., (2008) who reported higher egg production in the light group (1400-1500g) Lohman White layers compared to the medium (1500-1600g) and heavy hens (above 1600g). Birds of all the categories laid eggs with sizes of small, medium and large. The trend expected was increase in the size and number of the eggs, but this was irregular. This could be as result of the birds taking a break in the production phase for some days to gain weight and revive their strength and laying ability. Varyhense, (2002) reported that, for quail hens to be under good production, the birds must skip 1-3 days within a week in order to regain body weight. Kaye *et al*., (2017) also stated that egg number was increased by clutch size but negatively related to the number of clutches, number of pauses in lay, days paused and pause length.

Flock totals for the study period were 166, 340 and 216 for small, medium and large eggs produced. The variations observed in the number of small, medium and large eggs were supported by earlier workers (Bawa et al., 2011; Olusoji, 2011). The initial hen day production of 3.18% observed in the first week of lay, 55.03% and 54.07%in the 3rd and 4thweeks of lay is contrary to the reports of Kaye, (2005) who reported that a week after quail hens started laying, they attained 71% egg production which was maintained to the 10thand 12th week of lay with a peak production of 86%. The peak in hen day production of 87.83% observed six weeks after point of lay in this study is similar to the report of Ehoche (2010), who reported that Japanese quails reached their peak of production 7 weeks from point of lay with 91.86% hen day production.

Conclusion

Hatchability of quail eggs is greatly influenced by the egg weight. This increases with increasing weight of eggs. Therefore, the medium range (10 – 12.9 g) and large (>13g) is suitable for high hatchability in quail farming. Small birds efficiently used the small quantity of feed they consumed yet low final live weight and less egg production potential. They are therefore not good for egg production and even meat production as they will take a longer time before attaining good weight for consumption as meat. Large sized eggs would be preferable for incubation and raising quail for meat rather than egg production as they attain heaviest final live weights within 6 weeks. Medium sized birds should be used for purpose of egg production as this study reveals their highest hatchability, efficiency in feed conversion to heavier weights (growth performance) and at the same time best egg production performance. These ranges would guarantee survivability and better performances in quail farming.

Conflict of Interests

There is no conflict of interest.

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