



Understanding the interplay between egg size and embryo development, hatch window using *Japanese quail* as a model

MOHD MATIN ANSARI*, MARTINA K, GAUTHAM KOLLURI, JAGBIR SINGH TYAGI, JAYDIP ROKADE, PRASHANT BHUTEKAR AND ADNAN NAIM

Division of Avian Reproduction and Physiology
ICAR-Central Avian Research Institute Izatnagar

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ABSTRACT

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The aim of this study was to delineate the relationship between the egg size and weight, embryo development and hatch window using Japanese quail as a model organism. The Japanese quail (*Coturnix coturnix japonica*) has emerged as a popular model organism for studying this relationship, owing to its small size, short incubation period, and relatively simple reproductive biology. Research has shown that egg size can influence various aspects of embryo development, including hatchability, chick growth, and survival rates. A total 400 eggs were categorised into 3 groups; small (7.5-8.5 grams), medium (10-11 grams) and large (13.5-14.5 grams), based on their weight. These eggs of the three groups were incubated at 37.8°C and 65% humidity and were studied for their embryonic development on the 9th and 15th day of setting to further analyze the morphologic difference in embryonic development. Post transfer of the incubated eggs to hatcher, we monitored the external pipping and the difference in timing of the first and last hatch of the chick in the entire group. The preliminary results suggest that the small size eggs have faster embryo development at 9th and 15th day of embryonic development as compared to the large size eggs. However, hatching was poor in the small size and large size eggs compared to medium size eggs.

Keywords: Japanese quail, Egg-weight, Egg-size, Embryonic development.

INTRODUCTION

The intricate relationship between egg size and embryo development has long fascinated researchers, with significant implications for our understanding of reproductive biology and avian development (Romanoff, 1960; Carey, 1980). Understanding the relationship between egg size and embryo development, as well as the factors influencing the hatching window, is crucial for optimizing breeding programs and improving reproductive efficiency in avian species (Adeyanju *et al.*, 2014; Etches, 1998; Decuypere & Michels, 1992; Bai *et al.*, 2016; Bhagat *et al.*, 2012). The hatch window refers to the time period difference between the first hatch of the chick and the last hatch of the chick in a particular set of incubated eggs. Mixed type of egg size (small, medium & large) generally leads to a wider hatch window, meaning chicks from larger eggs will hatch over a longer period of time compared to smaller eggs, as larger eggs require more time to fully develop and hatch due to their increased mass and developmental needs; essentially, the bigger the egg, the longer the incubation period and potential hatch window (Rahn and Ar 1974; Deeming 2002)

Quail, particularly the Japanese quail (*Coturnix coturnix japonica*), has emerged as a valuable model organism in a variety of research fields, including

developmental biology, genetics, neurobiology, and behavioural science. Their unique characteristics, such as rapid growth, short generation times, and ease of husbandry, make quail an attractive alternative to more commonly used avian models like chickens. Quail possess a well-characterized genome and exhibit complex behaviours that offer insights into evolutionary biology and physiology. Additionally, their ability to produce fertile eggs in a relatively short period facilitates experiments in embryonic development, allowing researchers to investigate processes such as organogenesis and the effects of environmental factors on development (Marks, 1975). Rashid *et al.*, 2014 found that high incubation temperature adversely affects the hatchability in Japanese quail. The current study was designed with an aim to standardize the selection of eggs based on their size for incubation and to study the differential embryonic development in different egg sizes.

MATERIALS AND METHODS

Ethics approval

The current study was approved by Institute Animal Ethics Committee.

Experimental design

A total of 400 Japanese quail (CARIUTTAM) eggs were procured from the breeder flock of 10-25 weeks of

*Corresponding author Email: matin.ansari1@gmail.com

age maintained at CARI, Izatnagar. All the eggs were weighed and sorted into three different groups i.e. small (7.5-8.5 grams), medium (10-11 grams) and large (13.5-14.5 grams) according to the weight. The eggs were stored in cold room with temperature maintained at 16°C, before setting them for incubation.

Egg setting and management

Sorted and grouped eggs were incubated (Setter, DAYAL MAKE, India) at 37.8°C with 65% relative humidity and automatic turning.

Egg break analysis

Egg weighing and eggs break analysis were done on Embryonic Development Day (EDD) 9 and 15, and embryonic weight was estimated. The images were captured by arranging the embryos on a single platform using a digital camera. Yolk was observed and measured in terms of percentage internalization on 15th day of incubation.

Hatch window observation

After the transfer of the eggs from each group in separate boxes and trays in hatcher (DAYAL MAKE, India), and observed for hatching each hour manually by glass window of hatcher. After all the chicks were hatched, hatchability was calculated in each group.

Hatchability=Number of chicks hatched/total number egg setX100

Egg yolk sac internalization

The estimation of the yolk internalization was done based on the observation where full yolk sac outside the embryo or chick body was considered as 100% no internalization. The percent of yolk sac coming outside the chick body upon thumb pressing the abdomen was used to calculate the yolk internalization.

RESULTS AND DISCUSSION

The hatch window is an important concept in avian biology as it impacts several aspects of poultry production, including embryonic development, synchronization of hatch, chick quality, economic viability, and responses to environmental conditions. Previous study found that the egg size or weight influences embryonic development and hatchability (Marks, 1975). Several studies have investigated the relationship between egg size and hatchability using Japanese quail as a model (Grzegorzó *et al.*, 2019; Ghany *et al.*, 1966).

Figure 1 and 2 shows the classification of Japanese

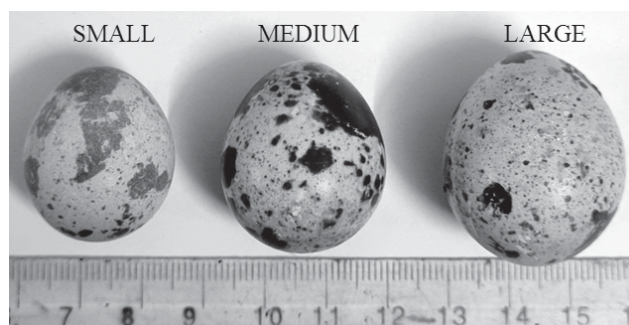


Fig 1: Categorizing the eggs according to their weight (Small, Medium and Large)

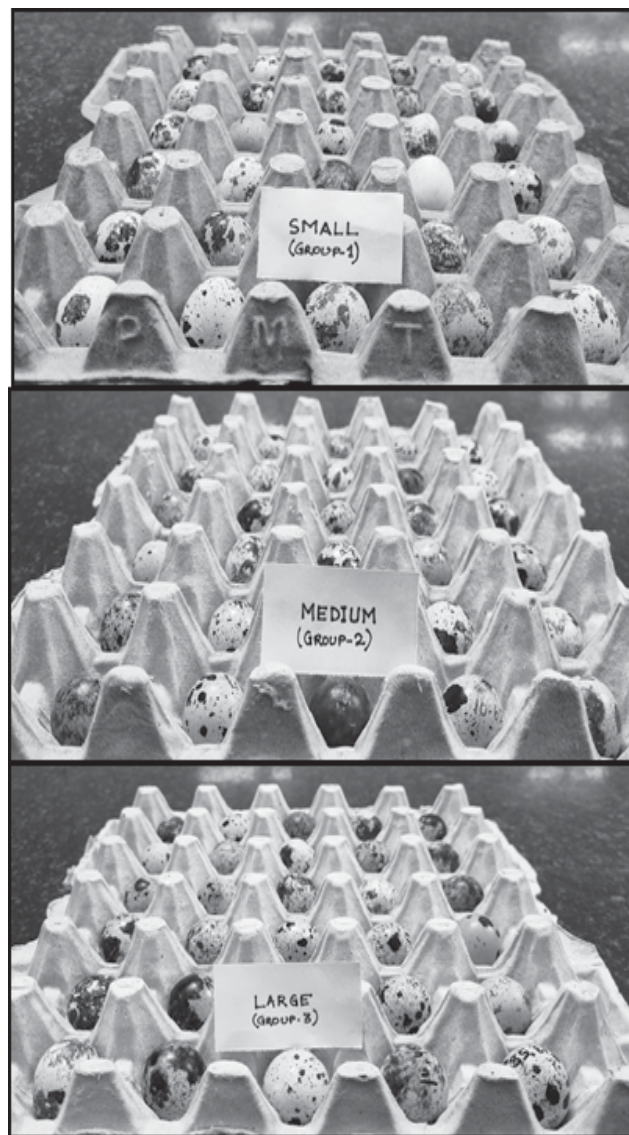


Fig. 2: Arrangement of eggs in three groups

Table 1: Embryo to egg weight percent at 9th day and 15th day, and percent yolk internalization on 15th day of incubation in different categories of eggs

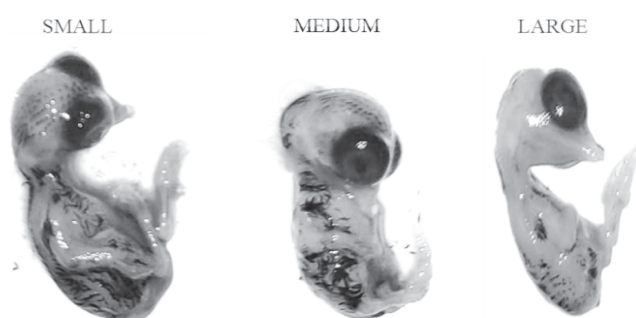
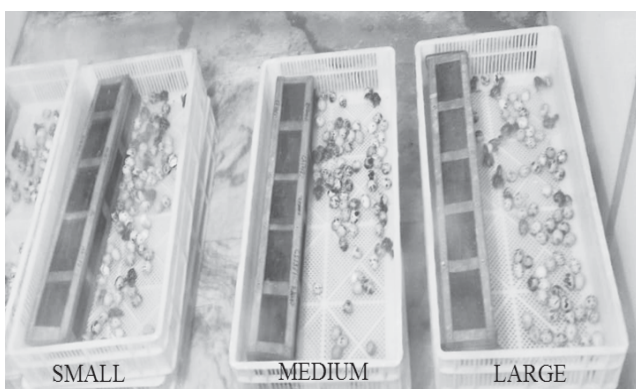
Parameters	Groups		
	Small	Medium	Large
Embryo to egg wt% at 9 th day	17±1.11	14±0.96	10±0.91
Embryo to egg wt% at 15 th day	69±2.16	63±2.91	50±1.64
Percent yolk internalization on 15 th day	86±2.18	60±2.95	15±2.63

Data are shown as Means±SE

Table 2: Percent hatchability (Means $\pm$ SE), time of hatch in different categories of eggs

Parameters	Groups		
	Small	Medium	Large
Percent hatchability	47 $\pm$ 1.53	54 $\pm$ 1.74	40 $\pm$ 1.83
Time of first chick hatch	372 hr	379 hr	388 hr
Time of last chick hatch	381 hr	387 hr	396 hr

quail fertile eggs based on their weight. As shown in Figure 3 and Table 1, our results suggested that at EDD 9, the smaller size eggs have significantly ($p \leq 0.05$) faster embryonic development (embryo to egg wt %) than the medium and large size eggs, similarly on EDD 15, as

**Fig. 3:** Development of embryo in three different groups of eggs at embryonic development day (EDD) 9**Fig. 4:** Transfer of eggs to the Hatcher**Fig. 5:** Hatching of eggs in different groups

shown in table 1 the smaller size eggs have significantly ($p \leq 0.05$) faster embryonic development than the large size eggs. However, according to Hegab and Hanafy (2019) large sized eggs are preferred for enhanced hatchability, and minimum embryonic mortality, compared with smaller eggs of Japanese quails which is in contrast to our findings. As shown in table 1 the percent internalization of yolk on 15th day in small, medium and large size egg was 86, 60 and 15 percent respectively. Figure 4, 5 and table 2 shows that on EDD 15, eggs in three different groups were transferred to hatcher and external pipping was observed first in the small size eggs (372 hr), then in medium size eggs (379hr) and lastly hatch came from the large size eggs (388 hr). And the last chick hatch from small, medium and large group was on 381 hr, 387 hr and 396 hr, respectively. As mentioned in table 1, the mean percent hatchability in small, medium and large sized egg group was 47, 54 and 40 respectively; similar to our results the mean percent hatchability is lower in large sized chick egg however the hatchability was higher in small size chick egg group (Iqbal *et al.*, 2016). This may be due the difference in the poultry species used. Kruenti *et al.*, 2022 found that the hatchability was highest in medium size of Japanese quail eggs compared with the small and large size egg group which is in consistent with our results.

CONCLUSION

In conclusion, the egg weight which is co-related to the weight and age of Japanese quail is an essential factor influencing embryonic development and hatchability. It was observed that small size eggs are associated with faster embryonic development rates as compared to medium and large size eggs. But the hatchability is lower than that of medium size eggs. So, considering the hatchability, medium size eggs are the best selection for hatching. Our experiment findings suggest that the optimal egg weight for Japanese quail appears to be between 10-11 grams based on hatchability.

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CONFLICT OF INTEREST

The authors have expressed no conflict of Interest.

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