



## Influence of egg weight on fertility and hatchability of backyard poultry varieties maintained under institutional farm conditions

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Received: 12 November 2015; Accepted: 11 January 2016

### ABSTRACT

The study was conducted to investigate the effect of egg weight on fertility and hatchability in Vanaraja and Gramapriya chicken at a particular age. Depending on weight of eggs of Vanaraja (592) and Gramapriya (657) varieties, eggs were divided in Gr.1 (large, weight  $\geq 65$  g), Gr. 2 (medium, weight  $\geq 52$  to  $< 65$  g) and Gr. 3 (small, weight  $< 52$  g) and incubated in 3 batches. The size of egg had a significant effect on fertility, hatchability and chicks' weight. The highest level of fertility was observed in medium sized eggs, followed by large and small sized eggs irrespective of variety. The hatchability on TES was higher in medium sized eggs as compared to small sized eggs. For large eggs, the weight was negatively correlated with hatchability on TES and on FES. In small sized eggs, egg weight was negatively correlated with hatchability on FES. The study indicated differential hatchability pattern in respect to egg weight and selection of medium to relatively higher sized egg, which would be beneficial for achieving better hatchability and future performance of the chicks of backyard poultry varieties.

**Key words:** Egg weight, Fertility, Gramapriya, Hatchability, Vanaraja

Vanaraja and Gramapriya varieties are popularized throughout India for backyard farming at low input production system to increase the availability of eggs and chicken meat in remote rural/tribal areas through Poultry Seed Project. The improved backyard variety of chicken produces relatively larger size of eggs (52–65 g) as compared to commercial layer birds at any point of laying period. The physical characteristics of egg influence the hatching performance, which ultimately influences the survivability and future performance of the chicks (Altan *et al.* 1995). Numerous studies have shown a strong positive correlation between pre-incubation egg weight, length of storage periods, hatchling weight and growth performance in different species of poultry (Farooq *et al.* 2001, Petek *et al.* 2003). Precise knowledge on fertility and hatchability in correlation to egg weight of a particular variety of birds can be helpful in logical selection of fertile eggs. Therefore, the present study was designed to determine the effect of egg weight on fertility, hatchability and chicks' weight in large, medium and small sized eggs of Vanaraja and Gramapriya chicken varieties.

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### MATERIALS AND METHODS

The experiment was conducted on Vanaraja and Gramapriya chicken varieties maintained under Poultry Seed Project. The layer stocks were maintained at deep litter system under intensive rearing with sex ratio of 8:1. Daily feeding and management was carried out in accordance with the standard feed restriction and breeding guidelines.

*Eggs collection and storage:* The eggs were collected from each variety at 50–52 weeks of age in 3 batches. The eggs were collected at morning and evening from the layer unit, cleaned properly with mild disinfectant and stored at 15–16°C for maximum 6 days before setting. The selection was done based on good shape, clean shell, no cracks and the weight of all hatchable eggs and recorded using digital electronic balance before setting. All the eggs were fumigated using potassium permanganate and formalin (1: 2) before transferring into egg storage room and again before setting for incubation. Each egg was candled manually, weighed in a digital weighing balance and labeled.

*Experimental design:* The experiment was conducted in 3 batches consisting of 592 Vanaraja and 657 Gramapriya eggs. Based on initial weight of all the hatching eggs, they were categorized (Table 1) in Gr. 1 (large type eggs, weight  $\geq 65.0$  g), Gr. 2 (medium type, weight  $> 52$  and  $< 65$  g), Gr. 3 (small type, weight  $\leq 52.0$  g). The eggs were incubated in a setter unit. The incubation was allowed at 99.7°F with humidity of 83.5% for 17 days. On day 18, the eggs were checked manually in an egg candler for determination of

fertility and weighed again for judging the weight loss. The fertile eggs were transferred to hatchery unit and incubated at 98.5 °F with humidity of 85% for another 3 days till completion of hatching.

**Observations:** Hatched out chicks from each batch were weighed and recorded using digital electronic balance. In all the 3 batches, the initial egg weight, weight of eggs after 18 days of incubation, fertility rate, hatchability on total egg set (TES) and hatchability on fertile eggs set (FES), weight loss during incubation and chicks weight at hatching were recorded. The percentage fertility and hatchability were estimated using the relationship below:

Fertility (%) = No of fertile eggs/ Total no of eggs set × 100.

Hatchability on fertile eggs (%) = No of eggs hatched out/Total no of fertile eggs × 100. Hatchability on set eggs (%) = No of eggs hatched out/Total no of eggs set × 100.

**Statistical analysis:** Data generated in present study were compared using SPSS statistical package. The experiment was performed in 2 by 3 factorial designs and the main effect of chicken variety (Vanaraja and Gramapriya) and weight of large, medium and small sized eggs and their interaction were compared in two-way ANOVA. All data

were presented as mean±SD. The correlation study was performed for each egg weight category following Pearson's method of correlation. The difference of mean values for all data analyzed with P<0.05 was considered as significant, whereas 0.05<P<0.10 was considered as tendency. Interactions were considered to be significant when P<0.10.

## RESULTS AND DISCUSSION

The average fertility rate (Table 2) in Vanaraja and Gramapriya varieties was 89.53 and 88.42%, respectively which was similar to the optimum fertility potential of other chicken varieties (Asuquo and Okun 1993). Although, the fertility was not influenced by the chicken variety but, it was subjected to variation in accordance with the egg size. The highest level of fertility was observed in medium size of eggs, followed by large and small size. The hatchability on total egg set (TES) varied from 74.15 to 88.15% in Vanaraja and 77.56 to 81.15% in Gramapriya. Alike fertility, the hatchability on TES was unaffected by the chicken varieties, but the effect of size was significant. It was higher in medium sized eggs as compared to small size eggs. However, hatchability on fertile egg set (FES) was statistically similar. Apparently, the medium and large sized

Table 1. Number and weight (g) of Vanaraja and Gramapriya eggs allocated in large, medium and small sized category

Particulars	Vanaraja			Gramapriya		
	Gr. 1 Large	Gr. 2 Medium	Gr. 3 Small	Gr. 1 Large	Gr. 2 Medium	Gr. 3 Small
Batch 1 (50 wks)	78 (66.93±0.27)	90 (58.72±0.32)	62 (50.44±0.23)	71 (68.21±0.37)	90 (58.44±0.41)	90 (50.37±0.15)
Batch 2 (51 wks)	49 (58.47±.36)	90 (49.50±1.00)	46 (67.99±0.32)	50 (57.71±0.34)	90 (47.83±0.31)	90 (66.72±0.25)
Batch 3 (52 wks)	58 (67.27±0.35)	90 (59.23±.30)	22 (51.20±0.25)	57 (68.11±0.40)	90 (58.66±0.29)	30 (48.85±0.48)
Total no of egg sets	185 (66.99±0.17)	270 (58.81±.19)	130 (50.23±0.38)	178 (68.12±.21)	270 (58.27±0.20)	210 (49.06±0.18)

Values in parenthesis indicate average weight of eggs in gram.

Table 2. Comparison of fertility and hatchability traits in large, medium and small sized eggs of Vanaraja and Gramapriya varieties

Particulars	Variety	Large	Medium	Small	Total
Fertility	Vanaraja	92.65±4.25	94.44±2.94	81.50±0.96	89.53±6.62
	Gramapriya	88.98±4.90	90.74±2.56	85.55±6.18	88.42±4.74
	Total	90.82±4.57 <sup>a</sup>	92.59±3.19 <sup>a</sup>	83.53±4.54 <sup>b</sup>	
Hatchability (TES)	Vanaraja	86.90±2.12	88.15±2.79	74.15±1.56	83.07±6.98
	Gramapriya	77.56±5.68	81.85±10.27	78.29±4.54	79.24±6.60
	Total	82.23±6.40 <sup>ab</sup>	85.00±7.56 <sup>a</sup>	76.22±3.79 <sup>b</sup>	
Hatchability (FES)	Vanaraja	93.85±2.07	93.34±1.76	90.98±1.82	92.73±2.10
	Gramapriya	87.16±4.00	90.04±8.91	91.60±2.40	89.60±5.39
	Total	90.51±4.64	91.69±6.02	91.29±1.93	
Weight loss (%)	Vanaraja	10.04±0.95	10.10±0.68	10.29±2.44	10.14±1.36
	Gramapriya	12.35±2.73	11.50±1.86	10.51±1.21	11.45±1.93
	Total	11.19±2.22	10.80±1.47	10.40±1.73	
Chicks weight	Vanaraja	43.44±0.80	37.36±0.65	32.95±1.04	37.92±4.62
	Gramapriya	44.05±0.31	37.58±0.93	31.85±0.85	37.83±5.33
	Total	43.75±0.64 <sup>a</sup>	37.47±0.73 <sup>b</sup>	32.40±1.04 <sup>c</sup>	

Values are presented as mean±SD; different superscript in a row indicates significant difference at P<0.05.

eggs had better hatchability than small sized eggs in Vanaraja and medium to small sized eggs in Gramapriya varieties. Overall, the hatchability on FES varied from  $87.16 \pm 4.00$  to  $93.85 \pm 2.07\%$ . Kalita (1994) observed that medium sized eggs of broiler parent line produced more hatchlings than small or large sized egg. Further, lowest fertility rate was also recorded in the small size eggs followed by medium, large and jambo sized eggs of quail (Petek *et al.* 2003). The relatively low hatchability of small eggs in this study can be explained by insufficient essential nutrients required for embryonic development which might result in increased embryonic mortality. Our result followed similar pattern with the report of Altan *et al.* (1995) and Anandh *et al.* (2012) who reported that percentage of infertile eggs decreased ( $P \leq 0.05$ ) as the weight of eggs increased in all weight groups. Side by side, the mean percentage of embryonic mortalities decreased significantly as the weight of eggs increased. This finding might be due to availability of more nutrients in heavy eggs to support the development of embryos compared to the lighter eggs. The effect of egg size on hatchability was explained by Deeming (1995) who stated that the effect of egg size on hatchability was due to a reduction in the surface area to volume ratio with increasing egg size, making the gas heat exchange more difficult. The highest fertility, hatchability on TES and FES was observed for medium size eggs, which is well supported by the reports of Asuquo and Okun (1993) who studied the effects of age in laying and egg size on fertility and hatchability of eggs and observed that the eggs of intermediate size range (45–56 g) would hatch better than small eggs. In contrary to our findings, Ramaphala and Mbajjorgu (2014) observed no difference in hatchability of COBB-500 eggs of large, medium and small category. Although, the chick weight was proportionate to the

egg weight.

The loss in egg weight ranged between 10.04 and 12.35% of egg weight during 18 days incubation in setter unit and was similar for all categories. Egg weight loss, an important parameter for incubation was used to estimate vital gas exchange and was correlated with embryo metabolism and development rates. The egg weight loss is equal to the amount of moisture that the egg has lost during incubation. Eggs that lose a high amount of moisture have a higher eggshell conductance than eggs that lose a low amount of moisture. The similarity in the results obtained on egg weight loss may suggest that the 3 egg size categories used for the study probably had equal proportion of pore areas and pore diameters regardless of the size of the eggs. The weight loss during incubation was within the permissible range as observed by Deeming (1995) who also asserted that the eggs, which lose less than 10% or over 20% of their initial mass were less likely to hatch.

Effect of egg size on chick's weight was significant in the study ( $F_{2,12} = 304.18$ ,  $P < 0.01$ ). Chicks' weight for both Vanaraja and Gramapriya varieties was proportionately higher in large size eggs followed by medium and small sized eggs. This result corroborated the findings of Abiola (1999) and Farooq *et al.* (2001) who also opined that hatching egg weight, chick weight and chick growth were interrelated and the size of hatching eggs typically affected hatchling mass more strongly than it affected hatching size in birds. It is because of the main effect of egg size, which lies in the mass of the residual yolk sac that the chick retained. Further, initial chick weight is a logical indicator of future growth performance. Small eggs produced smaller offspring with smaller body weight at 42 days of age compared to those from larger eggs (McLoughlin and Gous 1999).

Table 3. Correlation of fertility and hatchability traits of large size eggs in Vanaraja and Gramapriya varieties

Particulars	Egg weight	Fertility	Hatchability on TES	Hatchability on FES	Weight loss	Chick weight
Egg weight	1.0	-0.590	-0.872*	-0.748 <sup>B<math>\bar{O}</math></sup>	0.622	0.690
Fertility		1.0	0.773 <sup>B<math>\bar{O}</math></sup>	0.189	-0.881*	-0.577
Hatchability on TES			1.0	0.769 <sup>B<math>\bar{O}</math></sup>	-0.699	-0.488
Hatchability on FES				1.0	-0.196	-0.163
Weight loss					1.0	0.632
Chick weight						1.0

\*Correlation is significant at  $P < 0.05$  level (2-tailed); \*\*Correlation is significant at  $P < 0.10$  level (2-tailed).

Table 4. Correlation of fertility and hatchability traits of medium size eggs in Vanaraja and Gramapriya varieties

Particulars	Egg weight	Fertility	Hatchability on TES	Hatchability on FES	Weight loss	Chick weight
Egg weight	1.0	0.941**	0.918*	0.780*	0.173	-0.221
Fertility		1.0	0.838*	0.637	0.062	-0.223
Hatchability on TES			1.0	0.954**	0.191	-0.565
Hatchability on FES				1.0	0.234	-0.682
Weight loss					1.0	0.129
Chick weight						1.0

\*Correlation is significant at  $P < 0.05$  level (2-tailed); \*\*Correlation is significant at  $P < 0.01$  level (2-tailed).

Table 5. Correlation of fertility and hatchability traits of small size eggs in Vanaraja and Gramapriya varieties

Particulars	Egg weight	Fertility	Hatchability on TES	Hatchability on FES	Weight loss	Chick weight
Egg weight	1.0	0.152	-0.191	-0.829*	0.219	0.881*
Fertility		1.0	0.917*	-0.371	-0.256	0.241
Hatchability on TES			1.0	0.030	-0.441	0.015
Hatchability on FES				1.0	-0.398	-0.579
Weight loss					1.0	0.155
Chicks weight						1.0

\*Correlation is significant at  $P < 0.05$  level (2-tailed).

The correlation studies for large eggs (Table 3) revealed that, the egg weight was negatively correlated with fertility, hatchability on TES ( $P < 0.05$ ) and hatchability on FES ( $P < 0.10$ ) and positively correlated with weight loss (0.62) and chick's weight (0.69). In medium size eggs (Table 4), the egg weight was positively correlated with fertility ( $P < 0.01$ ), hatchability on TES ( $P < 0.05$ ), and on FES ( $P < 0.10$ ). Positive correlation was also noted between fertility and hatchability on TES ( $P < 0.05$ ) and on FES. Again the hatchability on TES and FES were highly correlated ( $P < 0.01$ ). In small sized eggs (Table 5), the egg weight was negatively correlated with hatchability on FES ( $P < 0.05$ ) and positively correlated with chick's weight ( $P < 0.05$ ) while, the fertility rate was positively correlated with hatchability on TES ( $P < 0.05$ ). The negative correlation of fertility, hatchability (TES and FES) with large egg as observed in our study was in accordance with the report of previous study, which stated that the egg weight was inversely correlated with hatchability (Farooq *et al.* 2001) and too large eggs must be discarded while setting in the incubator (Kalita 1994). Anandh *et al.* (2012) also found that the total hatchability, fertile egg hatchability and fertility percentage increased as per the weight of turkey egg. The positive correlation between egg weight and the hatching weight indicated the advantage of initial bigger size egg at the time of setting. This result followed the findings of Altan *et al.* (1995). Alabi *et al.* (2012) studying the effect of egg weight on hatchability and subsequent performance of chicks from 1 to 7 weeks of age found that the weight of eggs influenced all parameters measured except the mortality rate percentage, and also claimed that chickens which hatched from large-sized eggs had higher daily live weight gain and live weight at 7 weeks than those hatched from medium and small-sized eggs. Abiola *et al.* (2008) reported that dressing percentage of large chicks was higher compared to the small and medium sized chicks. The results on hatchability in our study conform to the earlier findings which recommended the setting of medium sized eggs for optimum hatching performance (Abiola *et al.* 2008). Unlike large and medium sized eggs, the small eggs produced proportionately smaller chickens, which mostly suffer from subsequent growth and production performance than chicks hatched from larger eggs (Farooq *et al.* 2001). From this study, it can be concluded that the medium to large sized eggs of Vanaraja and Gramapriya varieties are suitable for incubation for better fertility, hatchability and optimum

chick's weight at hatch as compared to small sized eggs.

#### ACKNOWLEDGEMENT

The authors acknowledge the Director, ICAR Regional Complex for NEH Region, Umiam for providing facilities to carry out the work. The work was carried out with the existing facilities of Poultry Seed Project.

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