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Effect of egg size on egg quality traits, fertility, hatchability and day-old chick weight

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ABSTRACT: An experiment was conducted on 500 Vanaraja eggs of different sizes *viz*., T_1 (40-45g), T_2 (45-50g), T_3 (50-55g), T_4 (55-60g) and T_5 (60-65g) to study the egg quality traits, fertility, hatchability and weight of day-old chicks in an organized farm. A minimum of 100 eggs per group were selected and incubated under optimum temperature, humidity and other conditions required for incubation was maintained in setter. Ten eggs from each group were selected to study different external and internal quality parameters. Candling was performed on 18th day of incubation to determine fertility of the eggs and fertile eggs were transferred to hatcher. Fertility (%) ranged from 71.30±4.67 per cent in T_1 to 84.00±7.00 per cent in T_4 group with significant ($P \leq 0.05$) differences and hatchability was also significant ($P \leq 0.05$) among the groups. The body weight of day-old chicks ranged from 27.67±1.49 in T_1 to 42.34±0.85 g in T_5 groups with significant ($P \leq 0.05$) differences among the groups. The dead germ (%) was significantly ($P \leq 0.05$) higher in T_1 (7.33±0.67) group than all other groups. The dead -in- shell (%) was significantly ($P \leq 0.05$) lowest in T_3 (14.50±1.50) and highest in T_1 group (19.25±1.15). The egg specific gravity (mg/dL) was ranged from 1.073±0.02 to 1.092±0.03. The albumen weight ranged from 24.31±0.87 to 38.59±1.12g with significant ($P \leq 0.05$) differences. The Haugh unit scores among the groups differed significantly ($P \leq 0.05$). From the present study it is concluded that the size of egg has significant effect on fertility, hatchability and dead-in-shell of Vanaraja parent stock eggs. The body weight of day-old chicks significantly ($P \leq 0.05$) increased linearly as the egg weight increased.

Key words: Chick weight egg quality, Fertility, Hatchability, Vanaraja

The size of eggs plays an important role in hatchability of eggs. The body weight of day-old chick is also an important factor for growth rate of the birds reared in the farms. The higher body weight at hatch grows faster than their counterpart of lower body weight. The performance of the chicken in terms of hatchability and chick hatch weight has been found closely associated to egg weight (Mbajiorgu and Ramaphala, 2026). If the birth weight i.e., weight of day old chick is optimum, then the chicks will grow at faster rate in the subsequent rearing period besides genetic, nutrition and other managemental factors. Fertility and hatchability plays significant role in profitability of the hatchery enterprise for small and medium-sized stakeholders (Kuda, 2023; Rathnayake *et al*., 2024). The flock age plays a pivotal role in both egg production and the hatchability of broiler eggs which is a multifaceted trait that changes with time (Peric *et al.,* 2022). The supply of day-old chick is highly influenced by fertility and hatchability of egg. Fertility refers to the percentage of incubated eggs that are fertile while hatchability is the percentage of fertile eggs that hatch. Therefore, it is important to understand the factors responsible or influence the fertility and hatchability of eggs. Egg size had a significant effect on fertility and hatchability traits. The medium egg size group had the highest percentages of hatchability and fertility, followed by the small and large sized egg (Kumar *et al.,* 2025). There are many factors contributing to the failure of a fertile egg to hatch, that includes lethal genes, insufficient nutrients in the egg and exposure to the conditions that does not meet the needs of the developing embryo (Mabotha *et al.*, 2025). The egg weight, shell thickness, porosity, shape index and the consistency of the contents are most influential egg parameters that influence hatchability. Although breed has little effect on fertility and hatchability of poultry eggs but higher fertility and hatchability in light breeds

of chicken have been reported (Gandhimathi *et al*., 2020). In most of the cases embryonic mortality that occurs during the incubation period, is related to inadequate incubation conditions rather than poor egg quality and an imbalanced diet of the breeder flock (Agbehadzi *et al.*, 2024). Egg weight directly affects hatchability, embryonic mortality, hatching weights, and subsequent performance of chicks (Fathi *et al*., 2022; Mbajiorgu and Ramaphala, 2026). Therefore, the present study was carried out to find out the ideal hatching egg size for better egg quality traits, fertility, hatchability, moisture loss and chick weight of Vanaraja chicken.

MATERIALS AND METHODS

A total of five hundred (500) hatching eggs comprising of one hundred (100) eggs of each size category: T_1 (40-45g), T_2 (45-50g), T_3 (50-55g), T_4 (55-60g) and T_5 (60-65g) were selected which were clean and defect free, oval in shape and set into five trays. All eggs were weighed by Denver XP-300 electronic balance corrected to 0.1 grams. Average egg weight of each tray having 100 hatching eggs (experimental eggs) was calculated. These five trays of each egg size category were randomly placed with broad end up to the top, middle and lower part of the setter machine (model ISI, having capacity of 2000 eggs) to account for possible environmental difference caused by position in incubator. The setter was operated at a temperature of 99.5°F and a relative humidity of 55-60% during the first 18 days of incubation and eggs were turned after every three-hour interval. Candling of eggs performed on 18th day of incubation to determine number of fertile and infertile eggs. After candling the fertile eggs of each replicated tray were transferred to separate hatching trays and placed in a hatcher. The hatcher was operated at a temperature 98°F and a relative humidity of 65-70%. After 21 days of incubation all hatched chicks were taken out of hatcher and shifted to chick room of hatchery. The hatchability parameters were studied during and after incubation period like fertility, hatchability, dead germ, dead in shell, moisture loss, shell weight and body weight of day-old chicks were recorded. Ten eggs from each group were selected randomly and subjected to study the external and internal egg quality traits. Statistical analysis was performed using one-way analysis of variance (ANOVA) to compare group means, and the significance of differences among treatments was tested at the 5% probability level using IBM SPSS Statistics (Version 30.0; IBM Corp., Armonk, NY, USA, 2023).

RESULTS AND DISCUSSION

External egg quality traits

The average egg weight (g) was 42.16±0.34, 48.09±0.55, 52.65±0.47, 57.98±0.41 and 63.34±0.68 respectively for T_1, T_2, T_3, T_4 and T_5 groups which differed significantly ($P<0.05$). The egg shape index (%) ranged from 74.54±1.74 to 76.69±1.65 which are within the normal range of optimum shape of egg. Similar shape index was also reported by Sheikh *et al.* (2018) in indigenous chicken eggs, Jaishankar *et al.* (2020) in Kadaknath eggs (73.64%), Kumar *et al.* (2022) in Aseel (74.75±0.47%) and Kadaknath eggs (74.02±0.46%), and Suresh *et al.* (2025) in Vanaraja chicken eggs. The lower values of shape index in Vanaraja eggs were reported by Sheikh *et al.* (2018). The egg specific gravity (mg/dL) ranged from 1.061±0.06 in T_2 to 1.092±0.03 in T_5 group. The egg shell colour score was same for all the groups (2.00).

Internal egg quality traits

Shell thickness (mm) ranged from 0.281±0.02 in T_1 to 0.308±0.01 in T_5 group. Slightly higher shell thickness was reported by Suresh *et al.* (2025). Shell weight (g) ranged from 4.53±0.31 in T_1 to 6.81±0.51 in T_5 group with significant ($P\leq0.05$) differences among the groups. Similar result regarding shell weight was also reported by John-Jaja *et al*. (2016). Albumen diameter (mm) ranged from 85.56±3.75 in T_1 to 93.38±5.02 in T_5 group. Significantly ($P\leq0.05$) highest albumen weight (g) was recorded in T_5 (38.59±1.12g) and lowest in T_1 (24.31±1.87g) group. Yolk diameter (mm) and yolk height (mm) ranged from 42.24±1.66 in T_1 to 46.32±2.03 in T_3 and 15.91±2.45 in T_2 to 18.08±1.71in T_5 group, respectively. Yolk weight (g) ranged from 13.30±0.51g in T_1 to 17.91±0.65g in T_5 group. Yolk diameter, yolk height and yolk weight differed

significantly (P≤0.05) among the groups. Yolk index ranged from 0.353±0.05 to 0.404±0.07 which is lower than reported by Sheikh *et al.* (2018) in Vanaraja eggs. The Haugh unit (HU) score is the measure of albumen quality which determines the quality of the egg, and it ranged from 69.87±4.03 in T_1 to 73.09±3.21 in T_3 group with significant (P≤0.05) differences among the groups. Similar results were also reported by Sheikh *et al.* (2018) in crossbred chicken eggs. However, higher values of HU score was reported by Jaishankar *et al.* (2020) in Kadaknath eggs (87.28±1.85), Supasini *et al.* (2024) in indigenous chicken eggs in Srilanka, Suresh *et al.* (2025) in Vanaraja eggs (84.88±0.49) and lower HU score was reported by Gautam *et al.* (2021) in large sized Vanaraja eggs (58.91±3.63). Shell thickness, albumen height (mm), albumen index and yolk index did not differ significantly (P>0.05) among the groups. Ukwu *et al.* (2017) also found that yolk index did not differ significantly (P>0.05), with different egg weights.

Moisture loss, fertility and hatchability

During the incubation process, moisture loss creates an air cell, essential for the growing embryo to breathe. The moisture loss (%) was recorded to be ranged between 10.08±0.02 in T_1 and 11.46±0.15 in T_5 groups, as size of egg increased the moisture loss also increased without any significant (P>0.05) difference which might be due to diffusion of water

Table 1: External egg quality traits of Vanaraja chicken eggs of different sizes

Parameters	T_1 (40-45g)	T_2 (45-50g)	T_3 (50-55g)	T_4 (55-60g)	T_5 (60-65 g)
Egg weight (g)	42.16^{a}±0.34	48.09^{b}±0.55	52.65^{c}±0.47	57.98^{d}±0.41	63.34^{e}±0.68
Egg shape index (%)	76.69±1.65	75.33±2.72	75.06±1.97	74.54±1.74	74.81±1.83
Egg specific gravity (mg/dL)	1.073±0.02	1.061±0.06	1.084±0.01	1.076±0.02	1.092±0.03
Egg shell colour score	2.00	2.00	2.00	2.00	2.00

Means across columns in a same row bearing different superscript differ significantly (P≤0.05)

Table 2: Internal egg quality traits of Vanaraja chicken eggs of different sizes

Parameters	T_1 (40-45g)	T_2 (45-50g)	T_3 (50-55g)	T_4 (55-60g)	T_5 (60-65 g)
Shell thickness (mm)	0.281±0.02	0.292±0.01	0.302±0.02	0.295±0.01	0.308±0.01
Shell weight (g)	4.53^{a}±0.31	4.94^{a}±0.29	5.39^{a}±0.40	5.68^{ab}±0.38	6.81^{b}±0.51
Albumen diameter (mm)	85.56^{a}±3.75	87.34^{ab}±2.96	90.74^{b}±5.61	89.90^{b}±4.08	93.38^{c}±5.02
Albumen height (mm)	2.82±0.21	2.75±0.19	3.15±0.27	2.99±0.16	3.24±0.25
Albumen index	0.033±0.004	0.032±0.003	0.034±0.003	0.033±0.002	0.034±0.003
Albumen weight (g)	24.31^{a}±0.87	28.12^{ab}±0.58	31.57^{bc}±0.94	35.0^{c}±1.08	38.59^{c}±1.12
Yolk diameter (mm)	42.24^{a}±1.66	43.97^{ab}±1.89	46.32^{b}±2.03	45.68^{b}±1.80	44.73^{b}±2.16
Yolk height (mm)	16.45^{a}±2.52	15.91^{a}±2.45	$17.20a^{b}$±2.77	16.12^{a}±1.60	18.08^{b}±1.71
Yolk index	0.389±0.06	0.361±0.05	0.371±0.04	0.353±0.05	0.404±0.07
Yolk Weight (g)	13.30^{a}±0.54	15.00^{a}±0.66	15.68^{ab}±0.42	17.26^{b}±0.81	17.91^{b}±0.75
Haugh unit scores	69.87^{a}±4.03	70.62^{a}±3.65	73.09^{b}±3.21	72.51^{b}±3.01	70.11^{a}±2.76

Means across columns in a same row bearing different small case superscript differ significantly (P≤0.05)

Table 3: Effect of Egg size on hatching performance and Day-Old Chick Weight in Vanaraja chicken

Parameters	T_1 (40-45g)	T_2 (45-50g)	T_3 (50-55g)	T_4 (55-60g)	T_5 (60-65 g)
Average Egg weight (g)	43.51^{a}±1.27	47.62^{b}±1.37	52.53^{c}±2.03	57.62^{d}±1.58	62.53^{e}±1.86
Moisture loss (%) during incubation	10.08+0.02	10.56+0.29	10.95± 0.25	11.02±0.10	11.46± 0.15
Fertility (%)	71.30^{a}±4.67	78.00^{b}±8.00	83.50^{c}±8.50	84.00^{c}±7.02	8.10^{bc}±3.10
Hatchability TES (%)	49.00^{a}±4.10	58.00^{b}±6.31	65.50^{c}±4.85	64.50^{c}±5.50	54.70^{b}±2.75
Hatchability FES (%)	68.00^{a}±8.00	73.90^{b}±4.76	76.70^{b}±3.68	76.40^{b}±3.74	66.50^{a}±3.15
Dead germ (%)	7.33^{c} ±0.67	3.50±0.49^{a}	3.57±0.53^{a}	4.50±0.58^{ab}	5.75±1.05^{b}
Dead in Shell (%)	19.25^{b}±1.15	18.50^{b}±1.58	14.50^{a}±1.50	15.00^{a}±1.23	18.70^{b}±4.25
DOC weight (g)	27.67^{a} ±1.49	30.96^{ab} ±1.20	34.65^{b} ±0.77	38.00^{c} ±1.40	42.34^{d} ±0.85

Means across columns in a same row bearing different small case superscript differ significantly (P≤0.05)

through the shell (Tona *et al.,* 2001). The egg white contains proportionately almost double the amount of water compared to yolk and large eggs have a greater proportion of albumen thus greater moisture content than small eggs (Abanikannda *et al.,* 2011). Yousaf *et al.* (2024) reported that total egg water loss of ~12% of initial fresh mass during incubation results in highest hatching success. The fertility (%) ranged from 71.30±4.67 in T_1 to 84.00 ±7.02 in T_4 group. Hatchability on TES (%) ranged from 49.00±9.00 in T_1 to 65.50±8.50 in T_3 group and on FES (%) was from 66.50±3.15 in T_5 to 76.70±3.68 in T_3 group. The fertility and hatchability were better in T_3 and T_4 groups with significant ($P \leq 0.05$) differences and this result is in agreement with the findings of Nowaczewski *et al*. (2022) who also observed that the eggs of intermediate size range would hatch better. However, Patel *et al.* (2018) reported higher fertility (86.31±0.23%) and higher hatchability (%) on TES (64.18±0.71) and FES (74.36±0.63) in Vanaraja eggs and Jaishankar *et al.* (2020) reported higher fertility (91.11±0.77%) and higher hatchability on TES (73.89±1.43%) and FES (80.95±1.19%) in Kadaknath chicken eggs. These differences might be due to different environmental and managemental conditions. The dead-germ (%) was significantly (≤ 0.05) highest in T_1 (7.33±0.67) and lowest in T_2 and T_3 (3.50±0.49). Nowaczewski *et al*. (2022) and Kumar *et al.* (2024) also reported that the embryonic mortality was highest in large-sized and very small sized eggs. Dead-in-shell (%) ranged from 14.50±0.50 in T_3 to 21.70±4.25 in T_5 group with significant ($P \leq 0.05$) differences among the groups. Mabotha *et al.* (2025) also observed similar dead-in-shell rates in broiler breeders. The day-old chick weight (g) was significantly ($P \leq 0.05$) highest in T_5 (42.34±0.85) and lowest in T_1 (27.67±1.49) group. A significant ($P \leq 0.05$) linear increase in day old chick body weight was observed with increasing egg weight which might be due to larger eggs contained more nutrients than small eggs so that developing embryos from heavier eggs tended to have more nutrients for their growth requirements during incubation, hence heavy chicks hatched from large eggs (Williams, 1994). Chicks hatched from smaller eggs exhibited lower body weight compared to those originating from larger eggs; similar finding indicating a strong relationship between egg weight and chick hatch weight were reported by Ewonetu and Kasaye (2018).

CONCLUSION

The present study revealed that egg size is a significant factor in determining egg quality traits, hatchability performance, embryonic mortality, and day-old chick weight in Vanaraja chicken. Medium sized eggs (50-60g) had better external and internal quality attributes, along with higher fertility and hatchability percentages and lower dead-in-shell rates compared to smaller and larger eggs. Day-old chick weight had a positive linear relationship with egg weight. The chicks with higher body weight at hatch grows faster than their counterpart of lower body weight which is an important factor in poultry farming. Based on the results, it can be concluded that the optimal weight range of 50-60g is the best choice for better hatchery performance in Vanaraja chicken.

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