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# Quality traits of indigenous geese eggs produced under traditional system of management in Assam, India

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**Abstract**
In the current study, a total of 63 numbers of indigenous geese eggs were procured from various geese rearers of Assam to evaluate external and internal quality traits. The eggs were obtained from geese between 12 and 13 months of age. The birds were housed at a ratio of 1 male: 2 females. The external egg qualities were found to be 117.00±1.395 g, 14.19±0.225 g, 0.54±0.006 mm, 72.22±0.283% and 1.09±0.001 for egg weight, shell weight, shell thickness, shape index and specific gravity, respectively. The internal egg qualities were observed to be 0.06±0.001, 59.79±0.726, 0.34±0.007 and 61.98±1.045 for Albumen Index, Haugh Unit, Yolk Index and yolk weight, respectively. In the present study defects like cracks, rough shells and dirty shell were recorded in very less number of eggs. The average grade for shell cleanliness, texture, soundness, shape, egg white and egg yolk may be given as good.

**Keywords:** Indigenous, geese, Assam, egg quality, traditional, management

## Introduction
Eggs are a rich source of macro and micronutrients, providing the essential components needed for embryonic development until hatching. Their balanced nutrient profile, high digestibility, and affordability make them a staple food for humans (Réhault-Godbert *et al*., 2019) [1]. While various poultry eggs are consumed as protein and amino acid sources (Polat *et al.*, 2013) [2], goose eggs are primarily used for hatching rather than human consumption. Evaluating the quality traits of goose eggs is crucial for both gosling production and their potential as a nutritional resource. The external and internal characteristics of eggs significantly influence hatchability and embryo development (Gogoi *et al*., 2021; Kucharska-Gaca *et al*., 2022) [3, 4]. In commercial settings and egg processing industries, egg quality traits directly impact pricing, with factors such as shell weight, albumen, and yolk composition determining product value (Amao and Olugbemiga, 2016) [5]. Research suggests that egg weight plays a critical role in gosling viability and early growth performance (Dawson and Clarck, 2000) [6]. Additionally, egg size affects hatchability, with medium-sized eggs yielding the best results (Kingori, 2011) [7]. Shell quality also influences hatchability, as thicker shells enhance survival rates by preventing bacterial infections and excessive moisture loss (Narushin and Romanov, 2002) [8]. A study on goose eggs produced under local Kashmiri conditions highlighted their potential, alongside duck eggs, to contribute to the expanding egg industry (Hamadani *et al*., 2016) [9]. Hence, with this background, the current study was planned with an objective of evaluating the external and internal quality traits of indigenous geese eggs produced locally under free range foraging and backyard conditions in Assam**.**

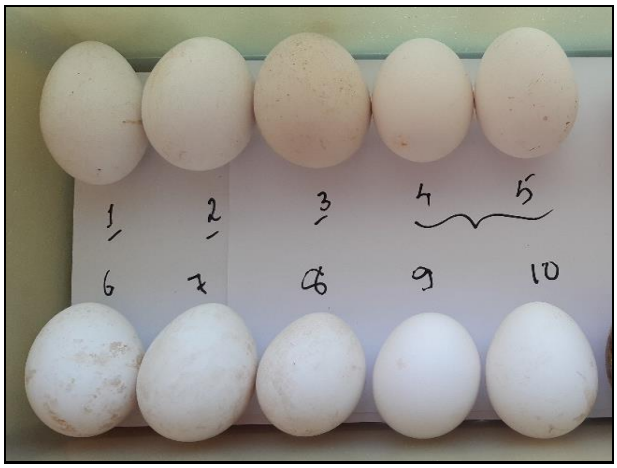
## Materials and Methods
### Ethics Statement
The current study was conducted according to protocols that were approved by the Institutional Animal Ethics Committee approval no. 770/GO/Re/S/03/CPCSEA/ FVSc/AAU/IAEC/20-21/882 dated 31.07.2021.

### Collection of Data
To determine the egg quality traits, 63 numbers of eggs were obtained from geese between

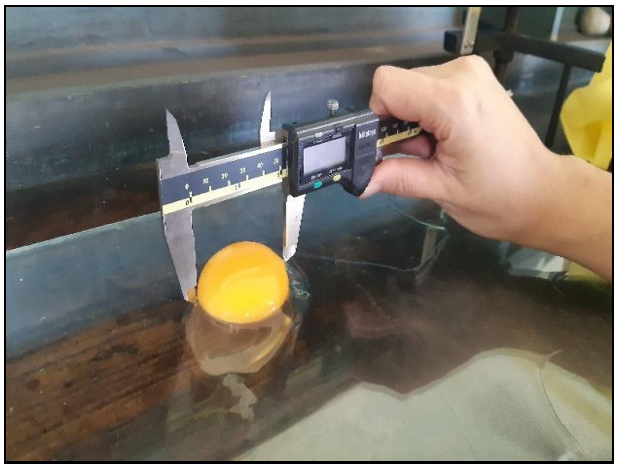
12 and 13 months of age from various households, across five districts of Assam; Dhemaji (27.4811° N, 94.5573° E), Dibrugarh (27.4705° N, 94.9125° E), Golaghat (26.5239° N, 93.9623° E), Lakhimpur (27.2064° N, 94.1514° E), and Sivasagar (26.9826° N, 94.6425° E). The various measurements were recorded using a digital scale (accuracy: 1 g) and a digital caliper (accuracy: 0.01 mm). The following procedures were followed for estimating the external and internal egg quality traits in indigenous geese eggs.

The following procedures were followed for estimating the external and internal egg quality traits in indigenous geese eggs.

| | | |
|---|---|---|
| Egg Weight (EW) | : | The egg weight obtained from adult birds was recorded in grams with the help of a digital scale (0.1 mg sensitivity) (Fig. 1). |
| Shell Weight (SW) | : | The shell weight in gram was recorded after it was first dried in hot air oven and then inner shell membrane was removed. |
| Shell Thickness (ST) | : | The shell membrane was removed and its thickness was measured via a digital micrometer by averaging the egg's blunt, middle, and narrow end and was expressed in millimeters (mm). |
| Albumen Index (AI) | : | The height of the thick albumen was recorded with the help of a spherometer and average width was measured with the vernier calipers (mm) with 0.01 mm precision. The albumen index was found as the ratio of height to average width and was expressed in percentage (Heiman and Carver, 1936) [10]. $\text{Albumen Index} = \frac{\text{Maximum height of thick albumen}}{\text{Mean width of thick albumen}}$ |
| Haugh Unit (HU) | : | The Haugh unit was calculated mathematically by using the formula H.U. = 100 log [h + 7.57-1.7 × $(W)^{0.37}$], where, h was the height of albumen in mm and W was the recorded weight of the egg in gram (Haugh, 1937) [11] |
| Yolk Index (YI) | : | The yolk index was estimated as the ratio of height of the yolk in mm measured with a spherometer to the average width of yolk (mm) measured with vernier caliper and was expressed in percentage (Funk, 1948) [12]. $\text{Yolk Index} = \frac{\text{Height of yolk}}{\text{Mean width of Yolk}}$ |
| Yolk Weight (YW) | : | The weight of yolk in grams was estimated after separating the thick and thin albumen and placing the yolk individually on the digital balance. |
| Shape Index (SI) | : | The shape index was estimated as ratio of whole egg breadth to length and multiplied to 100 and expressed in percentage (Shultz, 1953) [13]. $\text{Shape Index} = \frac{\text{Maximum width of egg}}{\text{Maximum length of egg}} \text{ X } 100$ |
| Specific Gravity (SG) | : | The Specific Gravity was calculated as the ratio of egg weight (g) to egg volume (ml) and was given by Harms *et al.* (1990) [14]. $\text{Specific Gravity} = \frac{\text{Weight of egg}}{\text{Volume of egg}}$ |
| Yolk Colour Grade | : | The yolk colour grade was estimated by Roche yolk colour fan which contained 1 to 15 shades in different individual leaves and the grade was assigned based on the colour of the yolk. The lightest colour was assigned score 1 and the darkest given a score of 15. It was recorded immediately after breaking the egg on table top. |
| Inclusion Bodies | : | After breaking the egg, presence of any unwanted bodies like blood spots were observed in the egg. |
| Egg Shell Colour | : | The colour of egg shell was observed individually and recorded. |




Shell Colour



Yolk Width


Egg Weight Yolk Colour Score

Shell Thickness Yolk Colour Score

**Fig 1:** Measurement of Various Egg Quality Traits

## Results

The LSM±SE and LSC for different egg quality traits as per districts along with the results of DMRT in native geese of Assam are presented in Table 1.

**Table 1:** Least-Squares Means Along with Their Standard Errors (Se) and the Least Squares Constants for Different Egg Quality Traits as Per Districts Along with the Results of Duncan's Multiple Range Tests in Native Geese of Assam

| Sub-Class | N | Parameter | Egg Weight (g) | Shell Weight (g) | Shell Thickne-Ss (mm) | Albumen Index | Haugh Unit | Yolk Index | Yolk Weight (g) | Shape Index (%) | Specific Gravity | Yolk Colour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| µ | 63 | LSM±SE | 117.00±1.395 | 14.19±0.225 | 0.54±0.006 | 0.06±0.001 | 59.79±0.726 | 0.34±0.007 | 61.98±1.045 | 72.22±0.283 | 1.09±0.001 | 9.31±0.060 |
| Districts | | | | | | | | | | | | |
| D1 | 16 | LSM±SE | 117.06±2.715 | 14.12±0.437 | 0.55±0.012 | 0.05±0.001 | 59.01±1.412 | 0.35±0.013 | 61.87±2.033 | 71.31±0.552 | 1.09±0.003 | 9.38±0.287 |
| | | LSC | 0.06 | -0.06 | 0.01 | -0.00 | -0.78 | 0.01 | -0.11 | -0.91 | 0.00 | -0.07 |
| D2 | 15 | LSM±SE | 114.40±2.804 | 14.47±0.452 | 0.53±0.012 | 0.05±0.001 | 58.90±1.458 | 0.32±0.014 | 62.47±2.100 | 71.98±0.570 | 1.09±0.003 | 9.20±0.327 |
| | | LSC | -2.60 | 0.28 | -0.02 | -0.00 | -0.88 | -0.02 | 0.49 | -0.24 | 0.00 | 0.11 |
| D3 | 12 | LSM±SE | 115.83±3.135 | 14.25±0.50 | 0.56±0.014 | 0.06±0.001 | 58.40±1.630 | 0.31±0.015 | 60.17±2.347 | 72.27±0.638 | 1.09±0.003 | 9.17±0.344 |
| | | LSC | -1.17 | 0.06 | 0.01 | -0.00 | -1.39 | -0.03 | -1.82 | 0.04 | -0.00 | 0.14 |
| D4 | 10 | LSM±SE | 121.20±3.434 | 13.80±0.55 | 0.55±0.015 | 0.06±0.002 | 61.04±1.786 | 0.36±0.017 | 63.80±2.571 | 72.99±0.699 | 1.09±0.004 | 9.50±0.373 |
| | | LSC | 4.20 | -0.39 | 0.01 | 0.002 | 1.25 | 0.02 | 1.82 | 0.76 | 0.00 | -0.19 |
| D5 | 10 | LSM±SE | 116.50±3.434 | 14.30±0.55 | 0.54±0.015 | 0.05±0.002 | 61.58±1.786 | 0.34±0.017 | 61.60±2.571 | 72.57±0.698 | 1.09±0.003 | 9.30±0.335 |
| | | LSC | -0.50 | 0.11 | -0.01 | 0.001 | 1.80 | 0.00 | -0.38 | 0.34 | -0.00 | 0.01 |

µ = Overall Mean; N = Number of observations

NB. Sub-class means in a column with at least one superscript in common do not differ significantly ($p$<0.05)

## Discussion

### External egg qualities

The present study revealed that the shell colour of eggs of native geese from Lakhimpur, Dhemaji, Sivasagar, Dibrugarh and Golaghat were mostly white but sometimes off-white colour was also observed. This is in agreement with the findings of Hamadani *et al.* (2016) [9] in Kashmir Anz geese, Hoque (2021) [15] in indigenous eggs from Assam, and Kucharska-Gaca *et al.* (2022) [4] in White Koluda geese. However, Upadhaya and Saikia (2012) [16]

reported light creamy white or ivory coloured eggs in Cotton-Pygmy goose of Assam and Banerjee (2013) [17] found cream coloured shell in eggs from local geese of West Bengal. The overall mean egg weight in the present investigation was found to be 117.00±1.395 g. This finding was in close proximity with the observations of Buckland and Guy (2002) [18] in Chinese geese (120 g); Sari *et al.* (2019) [19] in Lindovskaya geese (122.09±1.23 g); Gogoi *et al*. (2021) [3] in native geese of upper Assam (114.80±11.20 g) and Hoque (2021) [15] in indigenous geese from different districts of Assam (115.45±2.32 g). Buckland and Guy (2002) [18] reported higher egg weight in most of the exotic breeds of geese: Czechoslovakian white (140 g), Embden (170 g), Huoyan goose (120 to 210 g), Kuban (150 g), Landes (170 g), Pilgrim (165 g), Pomeranian (170 g), White Hungarian (160 g), White Italian (160 to 180 g). Higher egg weights were also reported in the studies of Tilki and Inal (2004a) [20] in Armutlu, Tatlicak, Bagkuyu and INRA geese breeds and reported values were 145.10, 148.50, 147.20 and 144.20 g respectively. Tilki and Inal (2004b) [21] found average value for egg weight of 154.9±0.80 g in native geese of Turkey. Isguzar (2005) [22] found respective mean values for white, black, yellow and piebald geese as 147.8, 150.5, 148.4 and 150.9 g, respectively in Turkish geese. Hamadani *et al.* (2016) [9] stated average egg weight as 136.65±2.10 g in Kashmir Anz geese. Islam *et al.* (2016) [23] noted overall mean of 131.85±1.70 g in local geese of West Bengal. Sun *et al.* (2019) [24] reported value for egg weight as 139.37±10.51 g in Yangzhou White geese. Pesmen and Yonetken (2020) [25] recorded egg weight of 137.37±9.21 g in native geese of Afyonkarahisar in Turkey. Akin and Celen (2022a) [26] observed values of 140.70±5.439 g in Chinese and 153.72±6.641 g Mamut geese eggs. Akin and Celen (2022b) [27] found egg weight for domestic geese of Turkey from three provinces as 140.40±1.806 g in Usak, 146.89±1.617 g in Afyon and 146.74±1.363 g in Kutahya. Kucharska-Gaca *et al.* (2022) [4] studied the egg quality traits in White Koluda geese in different reproduction season 1st, 2nd, 3rd and 4th with values of 151.1±7.0, 171.1±9.1, 190.4±8.8, 207.4±8.4 g, respectively. However, much lesser egg weight was revealed in the observations of Banerjee (2013) [17] in local geese of West Bengal (69.80±1.80 g in white and brown variety, and 66.70±1.40 g in white variety). Amao and Olugbemiga (2016) [5] also observed lower egg weight of 63.49±1.82 g in native geese of Nigeria. The overall mean for shell weight in current study was found to be 14.19±0.225 g, which was in agreement with the findings of Sari *et al.* (2019) [19] in Lindovskaya geese (14.46±0.19 g) and Sun *et al.* (2019) [24] in Yangzhou White geese (14.03±1.63 g). The present findings were in close proximity with the observations of Gogoi *et al*. (2021) [3] in native geese of upper Assam (15.20±1.92 g) and Hoque (2021) in indigenous geese of Assam (16.76±0.28 g). The higher values for shell weight were reported by Tilki and Inal (2004a) [20] in Armutlu, Tatlicak, Bagkuyu and INRA geese breeds (19.40, 21.60, 20.00 and 18.70 g, respectively), Tilki and Inal (2004b) [21] in native geese of Turkey (19.0±0.10 g), Akin and Celen (2022a) [27] in Chinese (19.75±1.584 g) and Mamut geese breeds (22.84±2.170 g), and Akin and Celen (2022b) [26] in domestic geese of Turkey from three locations (22.21±0.311 g in Usak, 22.74±0.367 g in Afyon and 22.06±0.322 g in Kutahya). However, lesser shell weight of 6.20±0.02 g was reported by Amao and Olugbemiga (2016) [5] in eggs of Nigerian geese. In the present study overall mean for shell thickness was recorded to be 0.54±0.006 mm. This finding was in harmony with the observations of Tilki and Inal (2004a) [20] in Armutlu, Tatlicak, Bagkuyu and INRA geese breeds (0.54, 0.58, 0.55 and 0.55 mm), Hamadani *et al.* (2016c) [9] in Kashmir Anz geese (0.53±0.31mm), and Gogoi *et al*. (2021) [3] in native geese of upper Assam (0.54±0.09 mm). Higher values were reported in the studies of Hoque (2021) [15] in indigenous geese of lower Assam (0.56±0.09 mm), Akin and Celen (2022a) [27] in Chinese geese (0.58±0.012 mm) and Mamut geese (0.60±0.011 mm). On the other hand, lesser egg shell thickness was seen in the studies of Amao and Olugbemiga (2016) [5] in geese of Nigeria (0.42±0.01 mm), Sari *et al.* (2019) [19] in Lindovskaya geese (0.48±0.19 mm), and Sun *et al.* (2019) [24] in Yangzhou White geese (0.447±0.047 mm). The lower number of eggs produced by local geese could be a contributing factor to the increased shell thickness, as fewer eggs may allow for greater deposition of calcium and other minerals in each shell. A higher shell thickness can enhance the shelf life of eggs and reduce breakages during transportation. However, it may also necessitate specialized incubation practices to facilitate timely pipping, ultimately improving hatchability. The overall mean for shape index was found to be 72.22±0.283% in native geese from five studied districts of Assam. The lesser shape index results in elongated appearance in these native geese eggs. This finding was in close agreement with the findings of Hamadani *et al.* (2016) [9] in Kashmir Anz geese (71.05±0.70%), and Hoque (2021) [15] in indigenous geese from four districts of lower Assam (70.48±1.12%). However, lower shape index was reported in the observations of Tilki and Inal (2004a) [20] as 67.10% in Armutlu, 70.30% Tatlicak, 66.70% in Bagkuyu and 68.0% in INRA geese breeds. Similar findings were also reported by Tilki and Inal (2004b) [21] in local geese of Turkey (68.2±0.16%), Sari *et al.* (2019) [19] in Lindovskaya geese (66.34±0.33%), Pesmen and Yonetken (2020) [25] in native geese of Afyonkarahisar in Turkey (67.04±2.94%), Gogoi *et al.* (2021) [3] in indigenous geese of Assam (69.60±5.20%), Akin and Celen (2022a) [27] in Chinese and Mamut geese breeds (65.23±0.955% and 67.59±3.842%), Akin and Celen (2022b) [26] in geese from three provinces of Aegean region (68.18±0.432, 70.98±0.532, 69.63±0.308%), and Kucharska-Gaca (2022) [4] in White Koluda geese in four reproduction seasons (65.5±5.2, 63.8±3.4, 64.2±2.8, 65.5±3.1%). The overall mean specific gravity was found to be 1.09±0.001 g/dL in native geese eggs of Assam, which was in conformity with the observation of Hamadani *et al.* (2016c) [9] in Kashmir Anz geese (1.09±0.01 g/dL). However, Hoque (2021) [15] reported higher specific gravity of 1.285±0.017 g/dL in indigenous geese from four districts of Assam.

*Internal egg qualities*

In the present study on internal egg qualities for Albumen Index, Haugh Unit and Yolk Index were found to be 0.06±0.001, 59.79±0.726, 0.34±0.007 respectively. The current findings were in close agreement with the observations of Gogoi *et al*. (2021) [3] in local geese of upper Assam and the reported values for albumen index, Haugh unit and yolk index were 0.058±0.009, 60.00±9.54, 35.15±6.08, respectively. The higher values for the respective egg quality traits *viz.* Albumen Index, Haugh Unit, Yolk Index and yolk weight (g) were reported in the

studies of Tilki and Inal (2004b) [20] in native geese of Turkey (58.9±0.45, 0.07±0.00, 34.5±0.11); Hamadani *et al.* (2016c) [9] in Kashmir Anz geese (0.09±0.01, 71.31±1.84, 0.38±0.01); Sari *et al.* (2019) [19] in Lindovskaya geese (5.02±0.09, 81.86±1.02, but lesser yolk index of 31.69±0.49); Hoque (2021) [15] in indigenous geese of Assam (0.075±0.001, 64.66±1.20 and 0.362±0.006). Akin and Celen (2022a) [27] noted higher Albumen Index, Haugh Unit and Yolk Index in Chinese geese eggs (7.97±0.482, 9.30±1.276, 36.14±1.975) and in Mamut geese eggs (37.83±2.165; 85.79±4.121, 93.53±2.335). Likewise, Akin and Celen (2022b) [26] found more values for these egg traits as 6.30±0.085, 76.20±0.532, 34.98±0.449 in Usak; 6.50±0.165, 76.49±0.751, 35.50±0.350 in Afyon and 6.18±0.063, 75.88±0.538, 35.48±0.450 in Kutahya provinces for local geese eggs in Turkey. Kucharska-Gaca *et al.* (2022) [4] revealed higher Haugh Unit in White Koluda geese egg as 74.1±5. 2 in first, 68.3±22.1 in second, 65.4±20.2 in third and 66.3±20.7 in fourth reproductive season. The yolk weight in present study was found to be 61.98±1.045 g which was more than the observed values of Sun *et al.* (2019) [24] in Yangzhou White geese eggs (52.79±4.88 g) and Sari *et al.* (2019) [19] in Lindovskaya geese eggs (45.95±0.57 g). The yolk colour varied from orange to yellow in different intermediate shades in the present study which was in agreement with the observations of Hoque (2021) [15] in indigenous geese of lower Assam. The yolk colour grade by Roche scale was found to be 9.31±0.060 in the present study, which was in conformity with the findings of Akin and Celen (2022a) in Chinese geese eggs (9.50±0.973). However, higher colour grades were reported by Sari *et al.* (2019) in Lindovskaya geese eggs (12.66±0.09) and, Akin and Celen (2022a) [27] in Mamut geese eggs (11.16±0.912). Lesser colour grade were reported in the findings of Hamadani *et al.* (2016c) [9] in Kashmir Anz geese eggs (4.18±0.37) and Akin and Celen (2022b) [26] in domestic geese of Turkey raised in three different provinces (7.15±0.262, 6.15±0.191, 6.78±0.098). Yolk color is primarily determined by the presence of carotenoids, which must be obtained from the diet, as they are synthesized de novo only by plants, certain bacteria, and fungi. The orange to yellow yolk color observed in indigenous geese is a clear indication of their foraging behavior. In free-ranging systems, these birds have access to grass, insects, and worms in addition to their basic diet, which enhances the carotenoid content and enriches the visual appeal of the yolk. In the present study no inclusion bodies were found, similar to the findings of Hamadani *et al.* (2016c) [9] in eggs of Kashmir Anz geese breed.

## Conclusion

The native geese egg weight was found to be 1.98 times greater than that of local Pati duck eggs and 3.48 times more than desi chicken eggs, potentially compensating for their lower egg production (Gogoi *et al.*, 2021) [3]. However, implementing good management practices and a balanced feeding regimen could further enhance egg production. One of the greatest advantages of geese rearing is their minimal input requirements, as they are naturally foragers and thrive in free-range systems. Unlike chickens, geese do not compete with humans for grains, making them a sustainable alternative. Based on these findings, geese show promise as an alternative species for backyard poultry meat production. The values obtained in this study may serve as a reference point for future research. Additionally, the evaluation of production traits contributes to the development of breed descriptors for this valued native germplasm.

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