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Egg quality traits of indigenous chicken, duck and geese of Assam

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Abstract
The present study was carried out to evaluate the egg quality traits of indigenous chicken, duck and geese of Assam. Eggs were procured from different backyard poultry rearers from Kamrup (M) district of Assam. 95 numbers of eggs utilized for the study. Average egg weight, shape index, shell weight, shell thickness, specific gravity, albumin index, Haugh Unit and yolk index were found to be 40.34±0.39 g, 74.569±0.769, 4.001±0.045 g, 0.278±0.007 mm, 1.118±0.008, 0.088±0.003, 83.541±0.913 and 0.564±0.011 respectively in indigenous chicken; 55.060±1.159 g, 73.219±0.229, 6.078±0.129 g, 0.281±0.005 mm, 1.189±0.014, 0.141±0.006, 93.813±1.355 and 0.440±0.012 respectively in indigenous ducks and 117.847±1.954 g, 76.032±1.362, 17.349±0.283 g, 0.643±0.011 mm, 1.299±0.014, 0.133±0.004, 89.083±2.566 and 0.591±0.014 respectively in indigenous geese. Yolk colour was found to be orange and yellow in indigenous chicken and shades of yellow and light orange in indigenous duck and geese eggs. Egg shell colour was found to be mostly brown; white; and white and creamy white in indigenous chicken; duck; and geese.

Keywords: Egg quality traits, indigenous, duck, chicken, geese

1. Introduction
The nutritional density of eggs makes them a valuable contributor to the overall nutritional value of a balanced diet. Egg is also an economical source of protein for the low income families with elderly people, growing children and pregnant women. Eggs contribute to 10 to 20% of the dietary folate and 20 to 30% of vitamin A, E and B12. (Applegate, 2000) [1]

According to the Basic Animal Husbandry Statistics-2019 [2], India is the third largest egg producing country in the world with an estimated production of 103.3 billion eggs. The egg industry alone is a vital component of the poultry sector. The gross value added from eggs within the livestock sector across India amounted to over 238 billion Indian rupees in fiscal year 2019. The commercial poultry firms contribute 80.8% of the total egg production.

Egg quality includes several standards which define both internal and external quality. Good egg quality is defined as the characteristics of egg, which affect for consumer acceptability. Moreover, based on these quality parameters many egg-grading methods have been developed worldwide (USDA, 2000; Dudusola, 2010) [3, 4]. Among external characteristics; cleanliness of shell, soundness of eggshell, shape, egg weight, shell weight and freshness are the most important characteristics in marketing and preservation of eggs (Hrncar *et al*. 2014) [5]. Internal factors and functional quality parameters such as relative viscosity, foaming, gelling, yolk index, Haugh index, and chemical composition, firmness, free from foreign matters in yolk and albumen are important for egg products industry (Duan *et al*. 2018; Sheng *et al*. 2018) [6, 7]. Quality characteristics were measured by internal and external attributes as Haugh unit (HU), albumen and yolk pH, egg weight, weight loss, albumen and yolk height, yolk weight and diameter, yolk index, specific gravity and yolk colour (Feddern *et al*. 2017) [8]. Egg quality determines its adequacy for consumption and has significant impact on characteristics like grading, price, consumer preference, hatchability and chick weight (Stadelman, 1977; King'ori, 2012) [9, 10]. Therefore, there is an increasing focus on egg quality in the poultry breeding industry since it is highly essential for the success of backyard chicken farming (Bain, 2005) [11]. As a result, Sreenivas *et al*. (2013) [12] concluded that evaluating egg quality criteria is crucial for maintaining good quality egg production.

Undergoing the divergent evolution processes, eggs from different poultry species formed their unique properties from egg size to nutritional composition (Hoffmann, 2005) [13]. The variability in the quality and nutritional values of eggs has a significant impact on consumers' health.

The factors which effect the egg qualities include the breed and strain of layers (Kucukyilmaz *et al*. 2012) [14], dietary composition (Goldberg *et al*. 2012) [15], birds' health, environmental condition and storage, processing and handling of eggs (Khan *et al*. 2013) [16]. Keeping this into context, the present study has been planned to evaluate egg quality traits of important indigenous poultry such as chicken, duck and geese which were commonly reared by the farmers. Moreover, perusal of literature it has been found that geese were not getting much popularity like chicken and ducks and also very scanty works has been carried out related to egg quality traits of geese eggs.

2. Materials and Methods

A total of ninety five numbers of eggs were utilized for the study. Thirty five numbers of eggs each from indigenous chicken and duck, and twenty five numbers of eggs from indigenous geese were obtained from backyard poultry rearers belonging to Kamrup (M) district of Assam. It was attempted to collect freshly laid eggs only. The eggs were evaluated for the external and internal egg quality traits. Different egg quality traits studied were egg weight, shape index, shell weight, shell thickness, specific gravity, albumin index, Haugh Unit and yolk index. The laboratory work pertaining to egg quality traits was conducted in the Department of Livestock Products Technology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22, Assam. Description of different methods used for estimation egg quality traits are given in Table 1.

Table 1: Methods utilized for estimation of different egg quality traits

Traits	Description
Egg weight	Recorded with the help of digital weighing balance and expressed in gram.
Albumen index	Measured as per the method of Heiman and Carver (1936). $\text{Albumen Index} = \frac{\text{Height of the thick albumen(mm)}}{\text{Mean width of the thick albumen(mm)}}$
Yolk index	Estimated as per the method of Funk (1948). $\text{Yolk Index} = \frac{\text{Height of the yolk (mm)}}{\text{Mean width of the yolk (mm)}}$
Haugh unit	Calculated as per the method of Raymond Haugh (1937). Haugh unit = 100 log (H +7.57– 1.7 W0.37) where, H = height of the thick albumen (mm) W = weight of the egg (g)
Shell weight	Recorded in grams after removing the shell membrane from the shell and drying and weighing it with the help of an electronic balance.
Shell thickness	After removing the shell membranes from the shell, shell thickness was measured at three places *viz.* equatorial region, narrow end and broad end with the help of Vernier Callipers and average value was taken. This was expressed in mm.
Shape index	Calculated as per the method described by Shultz (1953), $\text{Shape index} = \frac{\text{Egg width (mm)}}{\text{Egg length(mm)}} \text{X } 100$
Specific gravity	Calculated as per the method of Harms *et al.* (1990). $\text{Specific gravity} = \frac{\text{Weight of egg (g)}}{\text{Volume of egg (ml)}}$
Yolk colour	Direct observation of yolk.
Egg shell colour	Observed directly at the time of collection of the egg and recorded.

After recording all the above parameters, the mean along with standard errors were calculated out.

3. Results and Discussion

The average egg weight, shape index, shell weight, shell thickness, specific gravity, albumin index, Haugh Unit and yolk index were found to be 40.34±0.39 g, 74.569±0.769, 4.001±0.045 g, 0.278±0.007 mm, 1.118±0.008, 0.088±.003,83.541±0.913 and 0.564±0.011 respectively in indigenous chicken; 55.060±1.159 g, 73.219±0.229, 6.078±0.129 g, 0.281±0.005 mm, 1.189±0.014, 0.141±0.006, 93.81±1.355 and 0.440±0.012 respectively in indigenous ducks and 117.847±1.954 g, 76.032±1.362, 17.349±0.283 g, 0.643±0.011 mm, 1.299±0.014, 0.133±0.004, 89.083±2.566 and 0.591±0.014, respectively in indigenous geese. The egg weight ranged from 35.450 to 41.520 g, 51.130 to 56.250 g and 91.710 to 140.140 g; shape index ranged from 71.000 to 78.080, 70.300 to 75.560 and 72.830 to 77.610; shell weight ranged from 3.070 to 4.990 g, 5.940 to 7.140 g and 13.640 to 20.950 g; shell thickness ranged from 0.254 to 0.38 g, 0.21 to 0.32 g and 0.51 to 0.763 g; specific gravity ranged from 1.110 to 1.290, 1.167 to 1.191 and 1.190 to 1.311; albumin index ranged from 0.040 to 0.160, 0.100 to 0.180 and 0.059 to 0.195; Haugh Unit ranged from 79.340 to 83.740, 89.270 to 110.800 and 85.920 to 91.870; and yolk index ranged from 0.460 to 0.690, 0.390 to 0.771 and 0.500 to 0.657 in indigenous chicken, duck and geese, respectively. The yolk colour of chicken eggs was found to be orange and yellow; and egg shell colour was found to be mostly shades of brown. The colour of yolk of duck eggs was observed to have shades of yellow followed by a few having shades of orange; the shell colour was dominated by white and few having tinge of brown. In case of indigenous geese, the colour of yolk of geese egg was mostly shades of yellow with a few having orange colour while the egg shell colour was observed to be white or creamy white.

3.1 Chicken

Singh *et al.* (2000) [17]; Ahlawat and Padhi (2001) [18] and Ramappa *et al.* (2004) [19] reported a similar egg weight as compared to present finding in Aseel chicken (41 g); Nicobari fowl (42±0.70 g) and indigenous chicken of Karnataka (43 g), respectively. The specific gravity (1.110±0.01) and egg shell colour of Daothigir chicken in Kamrup district of Assam as reported Sapcota (2007) [20] corroborated with present finding; however in contrary, observed higher egg weight (at 40 weeks and 60 weeks of age as 52±0.48 g and 58±0.76 g, respectively); shell thickness (0.41±0.01 mm); shape index (84.09±0.91) and Haugh unit (92±1.55). Further, Baishya *et*

al. (2008) [21] in Giriraja chicken recorded similar shape index (75.88±0.76); shell thickness (0.29±0.003 mm); albumin index (0.08±0.002) and lower yolk index (0.38±0.006). Iqbal and Pampori (2008) [22] reported similar shell thickness (0.36±0.03 mm); albumin index (0.071); yolk index (0.455); higher egg weight (46.06±3.96 g); and lower Haugh unit (71%) in indigenous chicken of Kashmir. Ahlawat *et al.* (2009) [23] observed a comparable egg weight in Daothigir chicken (38–45 g). Haunshi *et al.* (2009) [24] reported similar shape index (75.23±0.36, 76.43±0.53 and 75.25±0.57); specific gravity (1.1019±0.001, 1.0849±0.001 and 1.0901±0.001) and lower Haugh unit (69.94±1.54, 69.10±1.41 and 67.41±2.71) in Miri, Gramapriya and Vanaraja chicken. Haunshi *et al.* (2011) [25] in Aseel and Kadaknath stated comparable shape index (77.36±0.36 and 76.39±0.57) and specific gravity (1.0096±0.0012 and 1.1038±0.0008). A similar egg weight in Pakistani deshi chicken (44.41±0.88 g) was recorded by Khawaja *et al.* (2012) [26]. Jha *et al.* (2013) [27] in indigenous chicken *viz.*, Hazra, Kadaknath and Aseel, reported comparable shape index (74.24, 73.56 and 74.17); lower albumin index (6.86±0.14, 6.25±0.14 and 6.97±0.13%) and lower Haugh Unit (72.89±0.65, 71.23±0.68 and 72.57±0.64%). The egg weight in local chickens in Ghana was found to be 41.3 g by Hagan *et al.* (2013) [28] which is in conformity with the present finding. A comparable shape index (80.40±1.19) and shell thickness (0.53±0.003 mm) was recorded in eggs from indigenous chicken from Karachi by Hussain *et al.* (2013) [29]. Usman *et al.* (2014) [30] reported higher egg weight (57.52±0.5 and 54.03±0.7 g); similar Haugh unit (82.76±0.95 and 81.95±1.12) in Naked neck and indigenous Aseel chicken of Pakistan. They also observed that the yolk index in the eggs from Naked-neck, Lakha, Mianwali, Mushki and Peshawari chicken of Pakisthan as 0.47±0.005, 0.44±0.004, 0.46±0.008, 0.46±0.008 and 0.46±0.003 respectively which was found to be in conformity with present report. Kumar *et al.* (2016) [31] reported similar egg weight in indigenous chicken of Kerala (40.74 g). Vij *et al.* (2016) [32] reported similar egg weight (42.43±0.07 g); shell thickness (0.36±0.01 mm); albumin index (0.07±0.01) and yolk index (0.38±0.01) in Kaunayen chicken in Manipur however recorded a comparatively lower Haugh Index (76.88±2.35). The egg weight of Desi chicken of Assam was found to be 42.06±0.07 g as observed by Saikia *et al.* (2017) [33] which was in conformity with present report. Sogunle *et al.* (2017) [34] reported higher egg weight in Nigerian desi chicken (62.68±0.71 g). Mohanta *et al.* (2018) [35] observed a similar shell thickness (0.32±0.02 mm) and Haugh unit (80.45±0.51) whereas a lower egg weight (27.95±0.55 g); albumin index (6.55±0.11%); and yolk index (34.51±0.39) in indigenous dwarf chicken of Odisha. In contrary, Patel *et al.* (2018) [36] reported higher albumen index (0.14±0.004 in deep litter, 0.15±0.01 in semi-intensive and 0.14±0.001 in backyard system) in Vanaraja birds. Sun *et al.* (2019) [37] reported higher eggshell weight (5.63±0.46 g) in case of White Leghorn layer (40 wk old) whereas Talukdar (2019) [38] reported similar egg weight in Daothigir chicken of Assam (42.19±0.19 g) along with comparable shape index (75.33±0.98); shell thickness (0.33±0.001 mm); specific gravity (1.10±0.016) and shell colour. However, yolk index (0.39±0.005) was found to be comparatively lower than the present study. Islam (2021) [39] reported similar egg weight (40.54±0.63); shell thickness (0.323±0.003 mm); albumen index (0.077±0.003); yolk index (0.502±0.003) and shape index (75.725±0.407) in indigenous chicken of Assam. Kumar *et al.* (2022) [40] reported a comparable shape index in Aseel and Kadaknath chicken (74.75±0.47 and 74.02±0.46); shell weight (4.28±0.08 g), shell thickness (0.25±0.40) and albumen index (0.085±0.27) in Kadaknath chicken; and Haugh unit (82.88±0.95) in Aseel; however yolk index was found to be lower in both Aseel and Kadaknath (0.383±0.95 and 0.366±0.92) and shell weight and shell thickness was higher in Aseel (4.67±0.06 g and 0.33±0.00 mm).

3.2 Duck

Mahanta *et al.* (1998) [41] in case of Chara and Chemballi ducks from Kerala reported similar average for shape index (75.45±0.42; 75.17±0.40) and yolk index (0.451±0.004 and 0.443±0.005); higher values for egg weight (69.69±0.47 and 68.08±0.45 g) and shell thickness (0.38±0.002 and 0.38±0.002 mm); whereas lower values for specific gravity (1.096±0.002 and 1.093±0.002) and Haugh Unit (91.38±0.67 and 91.29±0.65). The egg shell colour in Chara and Chambelli was observed to be white, similar to the present study. Das *et al.* (2000) [42] in indigenous ducks of Assam observed a similar values for egg weight 54.57±0.81 g), shape index (73.01±0.21), shell thickness (0.289±0.001 mm), albumin index (0.126±0.003), yolk index (0.408±0.002) and a lower Haugh unit (82.15±0.36). Corroborating with the present study, Banerjee *et al.* (2003) [43] and Murugan *et al.* (2009) [44] reported white colour egg shell in Muscovy ducks of West Bengal and Keeri variety of ducks of Tamil Nadu respectively. Rahman *et al.* (2010) [45] observed a similar egg weight in Deshi duck of Bangladesh (58.39 g), shell weight (6.17 and 6.13 g) and shape index (71.29 and 71.59) in Khaki Campbel and Deshi duck of Bangladesh. They further observed a similar yolk index (0.40, 0.44 and 0.43); lower Haugh unit (80.34, 86.80 and 87.68) and higher shell thickness (0.3573, 0.3383 and 0.327) in Khaki Campbel, Jinding and Deshi duck of Bangladesh. Sharma *et al.* (2014) [46] reported a similar shape index (71.956±0.534), specific gravity (1.099±0.001), yolk index (0.430±0.002) whereas a higher egg weight (62.450±0.454 g), shell thickness (0.395±0.002) along with lower albumin index (0.071±0.001) and Haugh unit (73.123±0.419) in Nageswari ducks. Nahardeka *et al.* (2016) [47] in Pati ducks of Assam reported a similar egg weight (56.83 g) and higher shell weight (7.28 g) in Pati duck of Assam. In case of indigenous ducks of Tamil Nadu, similar values compared to the present study were reported in case of egg weight (54.78±0.90 g), shape index (74.23±0.59) and yolk index (0.48±0.01) higher Albumin index (0.19±0.00), Haugh unit (99.64±0.87) and shell thickness (0.40±0.02 mm) by Kavitha *et al.* (2017) [48]. They also found similar yolk index (0.41±0.01), higher values of egg weight (59.03±0.94 g), shape index (75.63±0.70) and shell thickness (0.47±0.24 mm) whereas lower values in case of albumin index (0.13±0.00) and Haugh unit (84.20±1.2) in case of Peckin duck reported. Sogunle *et al.* (2017) [34] observed a similar albumin index (0.15±0.01); higher egg weight (63.49±0.98 g), shell thickness (0.40±0.01 mm) and a lower haugh unit (67.73±1.47) and yolk index (0.27±0.01) in indigenous ducks of Nigeria. Contrary to present finding, Tamzil and Indarsih (2017) [49] revealed that egg shell colour of Sasak duck of Indonesia as greenish blue. Das *et al.* (2018) [50] reported a slightly lower specific gravity of 0.995 g/dl in eggs of indigenous ducks of Manipur. Devi (2019) [52] in indigenous ducks of Manipur reported higher egg weight (61.13±1.31 g) and lower albumin index (0.08±0.002). Phookan *et al.* (2018) [51] observed a similar egg weight (58.03

g), shell thickness (0.33 mm); lower shape index (70.21), albumin index (0.07) and Haugh unit (79.48) in Pati ducks. Sun *et al*. (2019) [37] reported higher values for egg weight (74.28±4.67 g), shell thickness (0.356±0.024 mm) and egg shell weight (7.43±0.57 g) in case of 50 week old Jinding duck. Nath *et al.* (2021) [52] reported a comparable values for egg weight (54.57±0.81 g); shape index (73.23±0.40), specific gravity (1.287±0.0034), albumin index (0.144±0.006), yolk index (0.413±0.024) and a higher shell thickness (0.391±0.013) and Haugh Unit (100.73±0.56) in Pati ducks of Assam.

3.3 Geese

Tilki and Inal (2004) [53] reported lower values for yolk index (34.5±0.11%), Haugh Unit (58.9±0.45), albumen index (6.76±0.05%), shape index (68.0%), shell thickness (0.55 mm) and higher shell weight (18.7 g) in eggs from Turkish Geese. The average egg weight of black feathered, white feathered, piebald and yellow feathered Native Turkish geese was comparatively higher than the present study (147.85±1.38 g, 150.49±1.66 g, 142.95±1.30 g and 150.88±1.68 g) as per observation of Saatci *et al*. 2009) [54]. Upadhyaya and Saikia (2012) [55] coincide with the present study. Banerjee *et al.* 2013 [56] observed white egg shell in cotton Pygmy geese of Assam and indigenous geese of West Bengal, respectively. The average egg weight of Kashmiri geese (116-157 g) reported by Hamadani *et al.* (2016) [57] corroborated with present result. They observed a lower shape index (71.05±0.70), shell thickness (0.53±0.31 mm), specific gravity (1.09±0.01 g/dl), albumin index (0.09±0.01%), Haugh Unit (71.31±1.84) and yolk index (0.38±0.01). They further stated that the yolk colour was found to be orange to yellow and egg shell was white in colour. In Lindovskaya (Linda) geese of Turkey similar egg weights were reported as 119.60±2.44 and 120.97±1.36 g on 60th±5 day and 75th±5 days of the laying period (Sari *et al*. 2019) [58]. They also reported a low shell weight (14.83±0.30 g), Haugh unit (82.57±2.00), shape index (65.82±0.49), albumin index (5.10±0.19) and yolk index (35.45±0.68). Karabulut, 2021 [59] reported the average egg weight to be (159.9 g) in native, Chinese and Linda geese eggs of Aksaray Province to be higher whereas lower shell thickness (0.511 mm), shell weight (14.88 g), shape index (67), and specific gravity (1.11 g/dl). A comparable egg weight (114.80±11.19 g), shell weight (15.2±1.92 g) and lower shell thickness (0.54±0.09 mm), shape index (69.60±5.20), albumin index (0.058±0.009%), yolk index (35.15±6.08%) and Haugh Unit (60.00±9.54) was found in geese of Upper Assam (Gogoi *et al*. 2021) [60].

4. Conclusion

The study revealed that most of the traits under study had higher average value for the eggs from indigenous geese as compared to chicken and duck. Most importantly the weight of geese egg was much higher than that of chicken and duck. The result indicated baseline information of egg quality traits for different poultry species commonly reared by the farmers of Assam.

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