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Egg quality traits of different native chickens under organized farm conditions

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Abstract
A study was carried at Poultry Research Station, TANUVAS, Madhavaram Milk Colony in Chennai-51 to evaluate the egg quality traits of different native chicken breeds under farm conditions. Because, it is important of consumer preference for better quality eggs. The external egg quality traits like egg weight, length, width, surface area and yolk weight were significantly (p<0.01) higher in Aseel (T_1), Nicobari (T_3), Kadaknath (T_4) than Siruvidai (T_2), chicken egg respectively. The data on specific gravity was significantly (p<0.01) higher in Siruvidai, Aseel, Nicobari than Kadaknath chicken. The internal egg qualities like Albumen height were significantly (p<0.01) higher in Kadaknath, Aseel, Nicobari than Siruvidai chickens. The albumen weight and yolk width were significantly (p<0.01) higher in Aseel than Nicobari, Siruvidai and Kadknath. The Albumen index and yolk colour was significantly (p<0.05) higher in Nicobari, Kadaknath, Aseel than Siruvidai chicken. The yolk height and shell weight were significantly (p<0.01) higher in Aseel, Kadaknath, Nicobari than Siruvidai chicken. The shell thickness was significantly (p<0.01) higher in Nicobari, Aseel, Kadaknath than Siruvidai chicken. The per cent shell was significantly higher (p<0.01) in Kadaknath, Siruvidai, Aseel than Nicobari chicken. There was no significant difference was observed on shape index, Haugh unit, Albumen length, width, per cent albumen, yolk and yolk index of the different breeds. It was concluded that most of the external egg quality traits was better in Aseel than other native chickens and internal egg quality was better in Aseel, Nicobari chicken than Kadaknath and Siruvidai chicken under farm conditions.

Keywords: Chicken egg, Shape index, shell colour, albumen index, yolk index

1. Introduction
The poultry industry has reached remarkable growth in the last few decades in India. India ranks 3rd in the world in terms of total Egg production (FAO 2023) [8]. The country total egg production in the country is 138.38 billion numbers during 2022-23. The per-capita availability of egg is 101 eggs per annum. The total egg production from commercial poultry is 118.16 billion numbers and backyard poultry are 20.20 billion numbers contributing 85.40% and 14.60% of total production of egg respectively (BAHS 2023) [4]. The Annual Growth Rate for the year 2022-23 is registered as 6.77%. The largest producer of egg is Andhra Pradesh which produces (20.13%) followed by Tamil Nadu (15.58%) and Telangana (12.77%) of the total egg production in the country. Egg quality has been defined by Stadelman (1977) [31] as the characteristics of an egg that affect its acceptability to the consumers. The quality of the egg is one of the important considerations for the consumers and eggs of indigenous birds generally better price than eggs from commercial layer birds. Chicken egg quality may vary due to several factors like rearing temperature, relative humidity and season. Therefore, the present study was undertaken to evaluate the various egg quality characteristics in different indigenous chicken breeds under farm conditions.

2. Materials and Methods
The present study was conducted at Poultry Research Station, Chennai to assess the egg quality characteristics of different indigenous breeds of chicken like Aseel (T_1), Siruvidai (T_2), Nicobari (T_3) and Kadaknath (T_4) under farm condition. The totals of 80 eggs were collected on 46 weeks of age chicken were maintained under uniform farm management conditions.

2.1 Measurement of egg quality traits

The external egg quality traits like egg weight (g), length (mm) and width (mm) of the eggs were measured by digital Vernier callipers (least count 0.01 mm). After measuring the external quality traits, the eggs were break open on the egg breaking stand for measuring their internal qualities. The height of thick albumen and yolk were measured by using an Ames tripod stand micro meter. The length and width of the thick albumen and yolk were measured using a dial calliper. Thereafter, that the yolk was gently separated from the albumen by filter paper method and yolk weight was recorded. The egg shells were washed to remove the albumen and thickness was measured by shell thickness gauge. The differences between weight - (Shell weight + yolk weight) were arrived as albumen weight. The mean values were calculated for each trait to Snedecor and Cochran (1994) [30]. The egg qualities like shell colour, shell thickness, egg weight, shape index, albumen index, yolk index, yolk weight and albumen weight were estimated (Singh and Panda, 1987) [29]. Haugh unit score, a measure of internal quality of egg was also computed (Kondaiah *et al.*, 1983) [18]. Various indices of egg quality traits estimated are used the following formula.

1. Shape index = Maximum width / Maximum length x 100
2. Albumen index = Albumen height / Average albumen width x 100
3. Yolk index =Yolk height / Average yolk diameter x 100
4. Haugh unit $=100^{x}\log(H+7.57)-1.7^{x}W^{0.37)}$ Where H - height of the thick albumen, W- Egg weight
5. Surface area =12.6x length+width /4

2.2 Statistical analysis

All the collected data were analysed with the differences between treatments were analyzed using a one-way analysis of variance. Differences with a confidence level of 0.05 or less were considered to be significant.

3. Results and Discussion

The egg quality traits of different indigenous chicken were conducted by 46 weeks of age. The external egg quality parameters of various indigenous chicken was presented in Table 1.

3.1 External egg quality traits

3.1.1 Egg shell colour

The percent of egg shell colours of different indigenous chicken under intensive system are presented in Table1. The per cent brown shell was 55, 20, 45, 35, dark brown 40, 5, 30, 25, and tinted shell colours were 5.0, 75.0, 25.0 and 40.0 of Aseel, Siruvidai, Nicobari and Kadaknath chicken respectively. The present findings of light brown of Kadaknath chicken were similar to those reported by Sudhir *et al.* (2021) [32] of indigenous chicken (35.86). The above author also reported by brown coloured egg shell of Aseel and creaming / tinted egg shell colour in bidar district of Karnataka. Similarly, Vish *et al.* (2005) [35] in Nicobari fowl, Vij *et al.* (2007) [33] in Tellichery and Gopinath (2013) [9] in indigenous chicken of Mysore division. Few other shell colours were also recorded like dark brown, white and creamy white as reported by Paramar *et al.* (2006) [25] in Kadaknath, Vij *et al.* (2007) [33] in Tellichery and Kalita *et al.* (2012) [17] in indigenous chicken of Assam. The shell colour is a qualitative trait specific to breed and variations in colour are expected in the indigenous chicken.

Table 1: Per cent egg shell colour of various indigenous chicken under intensive system

Shell colour (%)	T_1 (A)	T_2 (S)	T_3 (N)	T_4 (K)
Brown (%)	55.0	20.0	45.0	35.0
Dark Brown (%)	40.0	5.0	30.0	25.0
Tinted (Light brown) (%)	5.0	75.0	25.0	40.0

T_1-Aseel, T_2-Siruvidai, T_3-Nicobari, T_4-Kadaknath

3.1.2 Egg weight

The mean egg weights of different native chickens were presented in Table 2. The mean egg weight (g) of Aseel (50.83±0.86) and Nicobari (48.66±0.54) was significantly (p<0.01) higher than Kadaknath (45.55±0.62) and Siruvidai (41.84±0.88) chicken. Similar result was recorded in Aseel and Kadaknath by (Haunshi *et al.*, (2013) [12], Choudhuri *et al.* (2014) [6] in Cross Nicobari, Sudhir *et al.* (2021) [32] in indigenous chicken, Kumar *et al.* (2013) [19] in Tellichery chicken was comparable to present Siruvidai chicken egg weight. However, in contrast with lower egg weight was observed by Haunshi *et al.* (2011) [10] in Aseel and Jaishankar *et al.* (2020) [15] in Kadaknath chicken.

3.1.3 Egg length

The mean egg lengths (mm) of different native chicken were presented in Table 2. The egg length (mm) of Aseel (54.99±0.51) and Nicobari (53.20±0.43) was significantly (p<0.01) higher than Kadaknth (52.06±0.61) and Siruvidai (50.28±0.61) chicken. The present findings of egg length were similar to those reported by Niranjan *et al.* (2008) [22] in Aseel chicken (54.5mm), Chatterjee *et al.* (2007) [5] of brown Nicobari (53.6±0.06), Gramapriya chicken (52.9mm) was comparable to Kadaknath and Agarwal *et al.* (2021) [2] was reported in indigenous chicken of (50.98±0.33) similar to that of Siruvidai chicken.

3.1.4 Egg width

The egg width (mm) of different native chicken is presented in Table 2. The egg width of Aseel (42.31±0.84), Nicobari (41.16±0.54) were significantly (p<0.01) higher than Kadaknath (39.50±0.21) and Siruvidai (38.68±0.30) chicken. Similar report was observed by Niranjan *et al.*(2008) [22] in Gramapriya chicken (42.0mm), Vanaraja chicken at 38 week of age (41.2mm) and Gramapriya at 40 weeks of age (41.1mm). Agarwal *et al.* (2021) [2] reported by desi birds under farm condition was (38.45±0.023) and Balamurugan *et al.* (2024) [3] by Siruvidai chicken mean value of (3.66±0.01 cm) similar values of present findings of Siruvidai chicken. The egg width of Kadaknath of present study is similar to Kumar *et al.* (2022) [21].

3.1.5 Specific gravity

The specific gravity of Siruvidai (1.10±0.0114), Aseel (1.09±0.0098), Nicobari (1.08±0.0083) were significantly (p<0.01) higher than Kadaknath (1.02±0.0187) chickens. Similarly, findings were observed by Yadav *et al.* (2009) [42] chicken was maintained under backyard system. However, earlier studies were reported by Haunshi *et al.* (2011) [10] higher specific gravity of (1.1038±0.0008) in Kadaknath chicken than present findings.

3.1.6 Shape index

The shape index of present study is presented inTable2. No significant difference was observed in the shape index of different native chickens. However, the shape index of the present study was slightly lower in Kadaknath than other

chickens. The shape index of present study is agreement with findings of Rajkumar *et al.*, (2014) [32] reported by Aseel (77.07). Chatterjee *et al.* (2007) [5] reported by white Nicobari chicken was (77.40±1.51). Which was close agreement of Nicobari chicken in the present findings. The present study of the Siruvidai chicken is close agreement with that of Sirividai chicken (75.42±0.48) of Tiruvannamali district in Tamil Nadu (Balamurugan *et al.*, 2024) [3], Kadaknath chicken of (76.39±0.57) was reported by (Haunshi *et al.*, 2011) [10]. But, in contrast Choudhari *et al.* (2014) [6] report by shape index was lower in Nicobari fowl (66.15±0.17) than the present findings.

3.1.7 Haugh unit

The Haugh unit value was presented in Table 2. The present study of the Haugh unit value was not significant difference observed among the different native chickens. However, HU value was higher in Nicobari followed by Aseel, Kadaknath and Siruvidai chicken respectively. Parmar *et al.* (2006) [28] was observed a wide range of HU scores from 62.6 to 90.0 in Kadaknath chicken under field conditions were lower than the present findings. The HU values obtained from present study was lower than Nicobari and Cross Nicobari eggs were (above 70) reported by (Choudhuri *et al.*, 2014) [6]. Haunshi *et al.* (2011) [10] reported by Aseel and Kadknath chicken was (75.43±0.84 and 74.99±0.69) respectively and HU value of Kadaknath chicken was (87.28±1.85) obtained by Jaishankar *et al.* (2020) [15]. The above value was lower than the present study. Similarly, Balamurugan *et al.* (2024) [3] reported by HU scores were in Sirividai chicken as 84.65±0.57. This value was closely related to the present findings. The variable HU scores may be due to varied albumen quality in different chicken varieties.

Table 2: External egg quality traits of various indigenous chickens (Mean±S.E)

Parameters	T_1 (A)	T_2 (S)	T_3 (N)	T_4 (K)	F-Value
Egg weight (g) **	50.83±0.86^a	41.84±0.88^c	48.66±0.54^a	45.55±0.62^b	27.9804
Egg length (mm) **	54.99±0.51^a	50.28±0.61^b	53.20±0.43^a	52.06±0.61^b	13.1629
Egg width (mm) **	42.31±0.84^a	38.68±0.30^b	41.16±0.54^a	39.50±0.21^b	9.4260
Shape index (SI) NS	77.13±1.86	77.04±0.67	77.41±1.10	76.04±0.88	0.2439
Specific gravity **	1.09±0.01^a	1.10±0.01^a	1.08±0.01^a	1.02±0.02^b	7.8909
Surface area (cm^2) **	72.75±1.42^a	60.96±1.09^b	68.49±1.17^a	64.36±0.87^b	19.5267
Haugh unit NS	92.12±1.62	89.59±1.27	92.98±1.10	91.76±1.58	1.0367

**Significant (p<0.01), NS-Non-significant

Mean value within each row bearing common superscript do not differ significantly (p>0.05)

3.2. Internal egg quality traits

3.2.1 Albumen quality

Different albumen quality was present in Table-3

3.2.1.1 Albumen height

The average height of the albumen was 8.22±0.21, 8.14±0.30, 8.14±0.21 and 7.12±0.23 in Kadaknath, Aseel, Nicobari and Siruvidai chicken respectively. The albumen height was significantly (p<0.01) higher in Kadaknath, Aseel, Nicobari than Siruvidai chicken. The albumen height found in the present study was in agreement with the reports of other workers by Olawumi and Ogunlade (2008) [23] in exotic Isa brown layer breeder (8.60 mm) and Zang *et al.* (2005) [37] in brown egg dwarf layer. However, while lower heights were reported by Balamurugan *et al.* (2024) [3] in Siruvidai chicken (5.54±0.08mm), Choudhuri *et al.* (2014) [6] in Nicobari chicken (5.60±0.03), Kumar *et al.* (2022) [20] in Kadaknath (5.52±0.18) and Vijh *et al.* (2005) [34] reported in Kalasthi chicken was (4.28 mm) respectively.

3.2.1.2 Albumen Index

The mean albumen index values were recorded as 0.130±0.006, 0.128±0.004, 0.118±0.005, and 0.109±0.006 in Nicobari, Kadaknath, Aseel and Siruvidai chicken respectively. The albumen index was significantly (p<0.05) higher in Nicobari, Kadknath, Aseel than Siruvidai chicken. The present value was close related to findings of Agarwal *et al.* (2021) [2] in indigenous chicken, Chatterjee *et al.* (2007) [5] in barred desi and Brown Nicobari, Abhijeet *et al.* (2020) [1] in Hansli x CSML birds, Prakash *et al.* (2020) [26] in Aseel Peela x CARI Red (0.117), Jaishanker *et al.* (2020) [15] in Kadaknath chicken. However, in contrary, to the findings of present study, the mean lower albumen index was recorded by Balamurugan *et al.* (2024) [3] in Sirividai chicken (0.07±0.002), Rajikumar *et al.* (2014) [28] in Aseel (0.079), Ezhil Valavan *et al.*, (2016) [7] and Pathak *et al.*, (2018) [24] reported by albumen index was (0.072) and (0.075) respectively in Kadaknath chicken.

3.2.1.3 Albumen weight

The Albumen Weight (g) was significantly (p<0.01) higher in Aseel than Nicobari, Siruvidai and Kadknath chicken as 27.45±1.29, 24.70±0.57, 21.88±0.50, and 21.71±0.45 respectively. The present study was in agreement with the reports of Prakash *et al.* (2020) [26] in CARI Red X Aseel Peela chicken (27.248), Chatterjee *et al.*, (2007) [5] in Barred desi chicken (24.41), Brown Nicobari (23.46), and Pathak *et al.*, (2018) [24] in Kadaknath chicken was (21.83). The mean albumen weight was 24.35±0.37g in Tellichery chicken (Kumar *et al.*, 2013) [19] was close to Nicobari albumen weight of the present study. However, Islam *et al.* (2001) [14] reported by lower albumen weight (20.7g) in naked neck birds. In contrary to the findings of present study, higher albumen weight was recorded by Choudhuri *et al.* (2014) [6] in Nicobari chicken (31.41), Haunshi *et al.* (2013) [12] reported the albumen weight of Aseel and Kadaknath chicken was (29.63) and (25.84). Jena *et al.* (2018) [16] was reported albumen weight of (26.38±0.02g) in Kadaknath chicken. The albumen weight of indigenous chicken was (23.99) reported by Rajkumar *et al.*, (2013) [27].

3.2.1.4 Albumen length, width and per cent Albumen

The Albumen length, width and per cent albumen were did not show any significant difference was observed between different chickens. However, the Albumen length and width was higher in Aseel compared to other indigenous chicken. Albumen per cent was higher in Nicobari chicken. Similar, trend was observed in Aseel and Kadaknath chicken reported by (Haunshi *et al.*, 2011) [10] and Haunshi *et al.* (2013) [12].

Table 3: Albumen quality parameters of various indigenous chickens (Mean ± S.E)

Parameters	T1 (A)	T2 (S)	T3 (N)	T4 (K)	F-Value
Albumen height (mm) **	8.14±0.30[a]	7.12±0.23[b]	8.14±0.21[a]	8.22±0.21[a]	4.8265
Albumen length(mm) NS	94.18±2.44	93.21±2.32	93.18±2.33	92.09±2.05	0.1812
Albumen width (mm) NS	70.15±2.03	66.91±2.09	63.82±1.73	65.25±1.90	1.9626
Albumen Index *	0.118±0.005[a]	0.110±0.006[b]	0.130±0.006[a]	0.128±0.004[a]	2.97
Albumen weight (g) **	27.45±1.29[a]	21.88±0.50[b]	24.70±0.57[b]	21.71±0.45[b]	12.13
Albumen (%)NS	54.53±0.41	54.13±0.55	54.73±0.38	54.59±0.48	0.3090

**Significant (p<0.01) *Significant (p<0.05), NS- Non -significant
Mean value within each row bearing common superscript do not differ significantly (p>0.05)

3. 3 Yolk quality traits

The different yolk quality traits were presented in Table 4.

3.3.1 Yolk height

The yolk height of the present study was significantly (p<0.01) higher in Aseel, Kadaknath, Nicobari than Siruvidai chicken of (21.30±0.33, 20.45±0.52, 20.13±0.25 and 19.26± 0.49 mm). The findings of the present study were higher than Kumar *et al.* (2022) [20] in backyard Aseel chicken (15.30mm) eggs from Haryana, Choudhuri *et al.* (2014) [6] in Nicobari, Kadaknath chicken was (12.50 and 11.80 mm) and Balamurugan *et al.* (2024) [3] in Siruvidai chicken was (15.89±0.14mm) respectively.

3.3.2 Yolk width

The yolk width of different native chicken was significantly (p<0.01) higher in Aseel, Nicobari than Siruvidai and Kadaknath chicken. The present value was close agreed with the findings of Hrncar *et al.* (2016) [13] in RIR chicken (41.14) and New Hampshire chicken (41.26), Orvaka chicken (40.98), Aseel (40.27) reported by Rajkumar *et al.*, (2014) [28] and Chaudhuri *et al.*, (2014) [6] reported by Nicocork chicken was 40.89±0.67. In contrary, Niranjen *et al.*, (2008) [22] was reported yolk diameter of (38.71±0.14 mm) in Nicobari, Aseel yolk width was (39.19 mm) reported by Rajkumar *et al.* (2014) [28]. Balamurugan *et al.* (2024) [3] Siruvidai chicken was (38.13±0.21mm) which was lower than the present findings.

3.3.3 Yolk index

The mean yolk index value of present study was no significant difference. However, the value was higher in Kadaknath chicken (0.51±0.02) followed by Aseel (0.49±0.01), Nicobari (0.48±0.01) and Siruvidai chicken (0.47±0.01). The present values were slightly lower than the findings of Jaishankar *et al.* (2020) [15] in Kadaknath chicken (0.44), Haunshi *et al.*(2012)[11] in Aseel (0.44), Nicobari chicken (0.30) and Balamurugan *et al.*(2024) [3] in Siruvidai chicken was (0.42±0.001).

3.3.4 Yolk Colour

The mean yolk colour of the present study was significantly higher (p<0.05) in Nicobari, Kadaknath, Aseel chicken than Siruvidai chicken. This value was close agreed with yolk colour of Kadknath (6.34) under intensive system of rearing (Haunshi *et al.*, 2013) [12]. However, the higher values were reported than present study by Rajkumar *et al.* (2014) [28] in Aseel chicken at 32weeks of age was (7.35) and Balamurugan *et al.* (2024) [3] reported in Siruvidai chicken was (9.18±0.10) under backyard system management of Tamil Nadu.

3.3.5 Yolk weight

The yolk weight of present study was significantly higher (p<0.01) in Aseel, Nicobari than Kadaknath and Siruvidai chicken. Similar findings were observed by Rajkumar *et al.* (2014) [28] in Aseel and Jaishankar *et al.* (2020)[15] in Kadaknath, Prakash *et al.* (2020) [26] in CARI Shyma (KN X CR), Chaudhuri *et al.*, (2014) [6] white Nicobari chicken was (16.10±0.26) and Kumar *et al.* (2013) [19] in Tellichery chicken was (13.21±0.21) which was close to the present value of Siruvidai chicken.

3.3.6 Per cent Yolk

The per cent yolk was no significant difference was observed. The values were ranged from (33.01 to 33.74). The yolk per cent in Kadaknath chicken (33.80±1.02) was close agreed with Jaishankar *et al.* (2020) [15], Haunshi *et al.* (2011) [10] in Aseel (33.12±0.42), Nicobari chicken was (33.74±0.36) reported by Chateerjee *et al.* (2007) [5]. The present study was lower than Haunshi *et al.* (2012) [11] reported in Aseel and Kadaknath chicken was (35.21±0.37, 34.52±0.29) respectively.

3.3.1 Yolk height

The yolk height of the present study was significantly (p<0.01) higher in Aseel, Kadaknath, Nicobari than Siruvidai chicken of (21.30±0.33, 20.45±0.52, 20.13±0.25 and 19.26± 0.49mm). The findings of the present study were higher than Kumar *et al.* (2022) [20] in backyard Aseel chicken (15.30mm) eggs from Haryana, Choudhuri *et al.* (2014) [6] in Nicobari, Kadaknath chicken was (12.50 and 11.80 mm) and Balamurugan *et al.* (2024) [3] in Siruvidai chicken was (15.89± 0.14mm) respectively.

3.3.2 Yolk width

The yolk width of different native chicken was significantly (p<0.01) higher in Aseel, Nicobari than Siruvidai and Kadaknath chicken.The present value was close agreed with the findings of Hrncar *et al.* (2016) [13] in RIR chicken (41.14) and New Hampshire chicken (41.26), Orvaka chicken (40.98), Aseel (40.27) reported by Rajkumar *et al.*, (2014) [28] and Chaudhuri *et al.*, (2014) [6] reported by Nicocork chicken was 40.89±0.67. In contrary, Niranjen *et al.*, (2008) [22] was reported yolk diameter of (38.71±0.14 mm) in Nicobari, Aseel yolk width was (39.19 mm) reported by Rajkumar *et al.* (2014) [28]. Balamurugan *et al.* (2024) [3] Siruvidai chicken was (38.13±0.21mm) which was lower than the present findings.

3.3.3 Yolk index

The mean yolk index value of present study was no significant difference. However, the value was higher in Kadaknath chicken (0.51±0.02) followed by Aseel (0.49±0.01), Nicobari (0.48±0.01) and Siruvidai chicken (0.47±0.01). The present values were slightly lower than the findings of Jaishankar *et al.* (2020) [15] in Kadaknath chicken (0.44), Haunshi *et al.* (2012) [11] in Aseel (0.44), Nicobari chicken (0.30) and Balamurugan *et al.* (2024) [3] in Siruvidai chicken was (0.42±0.001).

3.3.4 Yolk Colour

The mean yolk colour of the present study was significantly higher (p<0.05) in Nicobari, Kadaknath, Aseel chicken than Siruvidai chicken. This value was close agreed with yolk colour of Kadknath (6.34) under intensive system of rearing (Haunshi *et al.*, 2013) [12]. However, the higher values were reported than present study by Rajkumar *et al.* (2014) [28] in Aseel chicken at 32weeks of age was (7.35) and Balamurugan *et al.* (2024) [3] reported in Siruvidai chicken was (9.18±0.10) under backyard system management of Tamil Nadu.

3.3.5 Yolk weight

The yolk weight of present study was significantly higher (p<0.01) in Aseel, Nicobari than Kadaknath and Siruvidai chicken. Similar findings were observed by Rajkumar *et al.* (2014) [28] in Aseel and Jaishankar *et al.* (2020) [15] in Kadaknath, Prakash *et al.* (2020) [26] in CARI Shyma (KN X CR), Chaudhuri *et al.*, (2014) [6] white Nicobari chicken was (16.10±0.26) and Kumar *et al.* (2013) [19] in Tellichery chicken was (13.21±0.21) which was close to the present value of Siruvidai chicken.

3.3.6 Per cent yolk

The per cent yolk was no significant difference was observed. The values were ranged from (33.01 to 33.74). The yolk per cent in Kadaknath chicken (33.80±1.02) was close agreed with Jaishankar *et al.* (2020) [15], Haunshi *et al.* (2011) [10] in Aseel (33.12±0.42), Nicobari chicken was (33.74±0.36) reported by Chateerjee *et al.* (2007) [5]. The present study was lower than Haunshi *et al.* (2012) [11] reported in Aseel and Kadaknath chicken was (35.21±0.37, 34.52±0.29) respectively.

Table 4: Yolk quality parameters of various indigenous chickens (Mean±S.E)

Parameters	T1 (A)	T2 (S)	T3 (N)	T4 (K)	F- Value
Yolk height (mm) **	21.30±0.33^a	19.26±0.49^b	20.13±0.25^a	20.45±0.52^a	4.1032
Yolk width (mm)**	43.10±0.51^a	40.70±0.52^b	41.94±0.45^a	40.18±0.68^b	5.7729
Yolk index NS	0.49±0.01	0.47±0.01	0.48±0.01	0.51±0.02	1.8952
Yolk colour *	5.45±0.37^a	4.90±0.26^b	6.55±0.45^a	6.45±0.53^a	3.6881
Yolk weight (g) **	17.06±0.37^a	14.08±0.34^b	16.40±0.25^a	15.04±0.32^b	17.2447
Yolk (%)NS	33.55±0.44	33.68±0.53	33.74±0.36	33.01±0.47	0.5320

**Significant (p<0.01) *Significant (p<0.05), NS- Non -significant

Mean value within each row bearing common superscript do not differ significantly (p>0.05)

3.4. Shell quality traits

The different shell quality traits were presented in Table 5.

3.4.1 Shell thickness

The shell thickness of the present study was significantly (p<0.01) higher in Nicobari than Aseel, Kadaknath and Siruvidai chicken. Similarly, the mean shell thickness was (0.34mm) in Aseel (Rajkumar *et al.*, 2014) [28], and Balamurguan *et al.* (2024) [3] was reported by Siruvidai chicken in Tiruvannamali district of Tamil Nadu was (0.311±0.004) comparable to the shell thickness of the present study. Chouduri *et al.*, (2014) [6] reported that the shell thickness of Nicobari was (0.39±0.04) lower than the present findings. In contrary, the higher shell thickness was reported by Agarwal *et al.* (2021) [2] of indigenous chicken in Jharkand was (0.375±0.0040). However, lower shell thickness was observed by Parmer *et al.* (2006) [25] in Kadaknath and Nicobari was (0.31mm) and (0.33mm) respectively than the present findings.

3.4.2 Shell weight (g)

The shell weight of Aseel, Kadaknath was significantly (p<0.01) higher than Nocobari and Siruvidai chicken. The present shell weight of Aseel (6.05±0.12g), Kadaknath, (5.65±0.12), Nicobari (5.60±0.08) and Siruvidai chicken was (5.09±0.11) respectively. Similarly, the shell weight of Aseel was in close confinement with findings of Gramapriya chicken (6.01±0.009) reported by Kumar *et al.* (2020) [21], Jaishankar *et al.* (2020) [15] by Kadaknath chicken of (6.01± 0.16g), Choudhuri *et al.* (2014) [6] in Nicorock (5.59±0.20 g) of Nicobari chicken and Niranjan *et al.* (2008) [22] in Gramapriya chicken (5.01) of Siruvidai chicken of the present study. In contrast, the lower shell weight of (4.94±0.08) was reported by Haunshi *et al.* (2011) [10] at 40 weeks of age in Aseel chicken, Haunshi *et al.* (2012) [11] and Jena *et al.* (2018) [16] of (4.34±0.04, 4.36±0.04 g) respectively in Aseel and Kadaknath chicken. Choudhuri *et al.* (2014) [6] in Nicobari chicken of (4.74±0.25) and Sudhir *et al.*, 2021 [32] reported by indigenous chicken was (3.86±0.27).

3.4.3 Shell (%)

The shell per cent was significantly higher (p<0.01) in Kadaknath, Siruvidai, Aseel than Nicobari chicken. The shell per cent of Kadaknath chicken in the present study was (12.40±0.17). This value was closely agreement with findings of Jaishankar *et al.* (2020) [15] in Kadaknath, Choudhuri *et al.* (2014) [6] reported by Nicobari chicken (11.96±0.69). The present study of Aseel chicken the shell per cent was recorded (11.91±0.16). This value was higher than reported by of Aseel Haunshi *et al.* (2011) [10], Rajkumar *et al.* (2014) [28] and Haunshi *et al.* (2013) [12] chicken was (10.00±0.13), (10.88) and (9.20±0.10) respectively. Similarly, lower shell per cent of Kadaknath chicken (10.18±0.06) was observed by Jena *et al.* (2018) [16].

Table 5: Shell quality parameters of various indigenous chickens (Mean ± S.E)

Parameters	T_1 (A)	T_2 (S)	T_3 (N)	T_4 (K)	F-Value
Shell thickness (mm)**	0.342±0.01^b	0.329±0.01^b	0.441±0.01^a	0.332±0.00^b	48.9835
Shell weight (g)**	6.05±0.12^a	5.09±0.11^c	5.60±0.08^b	5.65±0.12^a	13.335
Shell (%)**	11.91±0.16^a	12.19±0.13^a	11.53±0.16^b	12.40±0.17^a	5.7326

**Significant (p<0.01)

Mean value within each row bearing common superscript do not differ significantly (P>0.05)

4. Conclusion

The results of present study concluded that most of the external egg quality traits were better in Aseel than other native chickens and internal egg quality was better in Aseel, Nicobari than Kadaknath and Siruvidai chicken under farm conditions.

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