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Effect of Age on Egg Quality Traits in Native Chicken at Different Age of Measurements under Intensive System in Himachal Pradesh

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ABSTRACT

The study was conducted during December, 2023–October, 2024 at University Poultry Farm, Palampur on Native chicken for studying the external and internal egg quality traits at different age of measurements. A total of 300 freshly laid eggs were collected at 28, 40, 52, 64 and 72 week of age. External and internal egg quality traits viz. egg weight, egg length, egg width, shape index, shell thickness, albumen length, albumen width, albumen height, albumen index, yolk height, yolk width, yolk index, Haugh unit were recorded using standard procedure. Most of the egg quality traits differed significantly at different age of measurements (p<0.05). Egg weight increased as the age of the bird progressed. Shape index estimate revealed that eggs were oval in shape and having optimum built. Albumen height and Haugh unit declined with advancement of age and maximum value was recorded at 28 week of age. Yolk index estimate indicated that eggs were falling under criteria of extra fresh. Haugh unit value ranged from 77.41 to 87.98 with overall mean of 82.65 indicated that eggs were of better albumen quality. Egg weight showed positive, moderate to high and highly significant correlation (p<0.01) with egg length, egg width, albumen length and albumen width at 72 week of age. Results of present study indicated that age of birds significantly affect the external and internal egg quality traits. The data generated from this study would be useful in characterization of Native birds of Himachal Pradesh.

KEYWORDS: Correlation, egg quality, egg weight, haugh unit, native

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Poultry farming is one of the important allied agricultural activity in Himachal Pradesh. Poultry eggs are a cheap source of animal protein to meet the dietary needs of expanding population (Cook and Briggs, 1986). Native chicken play an important role for the rural landless and poor section of the people with respect to their subsidiary income and also provide them with nutritious egg and meat for their own consumption (Padhi, 2016). Generally eggs with better external and internal quality are preferred by consumers and these are two crucial factors for egg's acceptance. Egg quality is characteristics of egg that affect its acceptability to consumers (Stadelman, 1977). Better quality eggs also command higher price from customers. Hence, it is important to maintain egg quality in a laying flock, which can fetch considerable economic return (Choudhuri et al., 2014). The egg size and its component are influenced by a number of genetic and non-genetic factors (Washburn, 1990). Various non-genetic factors like ambient temperature, relative humidity and laying season may also influence egg quality. Genotype has direct influence on egg weight and eggshell characteristics.

Native chickens play an important role in rural economies. Rural poultry farming has great potential to generate highly nutritious food items at minimal cost (Alders et al., 2009; Pica-ciamarra and Otte, 2010). Indigenous breed of chicken are known for hardiness, broodiness, mothering ability, disease resistance and better feed conversion ability for non-conventional feed sources (Yadav et al., 2017; Dinesh et al., 2018; Gheyas et al., 2021, Dinesh et al., 2024). Their long shank length and colorful plumage helps in protecting themselves against predators. (Agarwal et al., 2021). Although Native chickens are low egg producer but they fetch higher price than those of commercial layer and exotic breeds as eggs and chicken meat of Native birds have huge demand (Dinesh et al., 2018).

The chicken egg is a biological entity degigned by nature for reproduction and for providing a complete diet for the developing embryo (Shi et al., 2009). For better understanding of fertility, embryo development and diseases of the poultry require knowledge on the structure of the egg and its various quality parameters (Choudhuri et al., 2014). Egg quality characteristics are the main criteria for selection in poultry breeding (Singh et al., 2020). The quality of the egg is one of the important considerations for the consumers.

Overall, the term egg quality refers to the internal and external qualities of egg. External quality of egg is defined by its color, shape, egg weight, shell cleanliness and shell thickness. The internal quality of egg refers to albumen and yolk quality. Albumen quality is defined by its shape, firmness, height and relative viscosity of albumen. Albumen quality is an important indicator for freshness of eggs (Bozkurt and Tekerli, 2009). Yolk quality can be identified by its strength, firmness, size of air cell and presence or absence of blood and meat spot (Behera et al., 2016). The integrity of the yolk is contingent upon the strength of the vitelline membrane, which is inversely correlated with the storage period. (Jones and Musgrove, 2005). Yolk quality deteriorates during longer period of storage because of absorption of moisture through shell pores, causing yolk rupture. The loss of carbon dioxide from egg shell caused by this absorption makes the albumen watery and transparent (Jinangrat et al., 2010; Duman et al., 2016). Difference in egg quality traits had been reported by many authors (Haunshi et al., 2011; Haunshi et al., 2013; Padhi, 2013; Rajkumar et al., 2014; Behera et al., 2016; Dinesh et al., 2022 Kumar et al., 2022). Though lot of work has been carried out on egg quality traits, however, no report was available on egg quality traits of Native birds in Himachal Pradesh. Hence the present study has been undertaken to study the effect of hen age on egg quality traits of Native birds and to estimate the correlation of egg weight with different egg quality parameters at different age of measurement.

2. MATERIALS AND METHODS

The study was conducted during December, 2023–October, 2024 on Native birds maintained at CSKHPKV Poultry Farm, Palampur, Himachal Pradesh, India. Himachal Pradesh, a western Himalayan state in northern part of India situated between 30°22 N and 33°12 N latitude and 75°47 E and 79°04 E longitude. Native chicks were produced through selective breeding of Native parental stock kept under All India Coordinated Research Project on Poultry Breeding. All chicks were reared under deep litter system and brooding was done up to 6 weeks of age. Chick feed was given up to 6 weeks, grower feed 7–18 week and layer feed 18 week onward. A total of 300 eggs were collected form Native birds at 28, 40, 52, 64 and 72 weeks of age (60 eggs at each age group) for evaluating the external and internal egg quality traits. An electronic balance was used to weigh the eggs with a precision of 0.01 g. Digital vernier calliper was used to measure the eggs' length and width. Shape index was computed as the ratio of egg width to length multiplied by 100. Eggs were subsequently broken on flat surface and digital vernier calliper was used to measure the albumen length, albumen width, yolk height and yolk length. Albumen height was recorded at 3 or 4 locations with the help of spherometer and averaged. Using screw gauze, the thickness of the shell was measured on four separate portions of shell: one each from the broad and narrow ends and two from the body

of the eggs and measurements were averaged. Haugh unit (H.U.) was computed by using the formula: H.U.=100 log (H+7.57–1.7$W^{0.37}$).

Where, H was albumen height in mm, recorded by spherometer and W was observed weight of the egg in g. The data were analysed by using SPSS 25.0 software. Significant differences between various age groups were tested by one way analysis of variance (ANOVA) (Snedecor and Cochran, 1994).

3. RESULTS AND DISCUSSION

3.1. External egg quality traits

External egg quality traits of Native birds viz. egg weight, egg length, egg width, shape index and shell thickness, depicted in Table 1.

3.1.1. Egg weight

Egg weight varied from 41.75 g at 28 weeks of age to 51.90 g at 64 weeks of age with overall mean of 47.84 g. Egg weight increased as the age of bird advanced. Egg weight at 28 and 40 weeks of age showed significant difference with egg weight at 52, 64 and 72 week of age (p<0.05). However, no significant difference was found in egg weight at 52, 64 and 72 weeks of age. In contrast, higher egg weight was observed by Choudhuri et al. (2014) in Nicobari fowl and its crosses at 50 weeks under intensive system (53.20 and 56.79 g). However, lower egg weight of 43.01 and 43.48 g was obtained in Nicobari and Nishibari fowl respectively at 50 weeks of age under backyard system of management in Andaman and Nicobar Islands, India. Likewise, Behera et al. (2016) observed higher egg weight of 46.25 g in indigenous Hansli chicken of Odisha at 40 weeks of age. Conversely, Agarwal et al. (2021) reported lower egg weight of 41.05 g in indigenous chicken of Jharkhand under intensive system of management at 30 weeks of age. In a similar study, Dinesh et al. (2023) observed higher egg weight of 40.35, 45.42, 45.15, 51.02 and 51.85 g at 24, 30, 36, 44 and 50 weeks of age in Himsamridhi chicken variety under intensive system. Result of present study were consistent with earlier report of Dinesh et al. (2024) who obtained egg weight of 45.33 g in Native chicken at 40 week of age.

3.1.2. Egg length

Average egg length observed in native chicken was 54.36 mm and varied from 53.35 mm at 28 week of age to 55.65 mm at 64 week of age. Egg length at 28 week of age showed significant variation (p<0.5) with egg length at 64 week of age. However, there was no significant variation in egg length at 28, 40, 52 and 72 weeks of age. Result of current study were consistent with the report of Behera et al. (2016) who observed egg length of 52.08 mm in indigenous Hansli chicken of Odisha. In contrast to this, Choudhuri et al. (2014) reported higher estimate of egg length as 55.71, 56.94 and 56.94 mm in Nicobari, Nicorock and Nishibari fowl at 50 weeks of age under intensive system. In a similar study, Kumar et al. (2022) estimated egg length of 5.16 cm and 5.13 cm in Aseel and Kadaknath chicken respectively in mid laying phase. Likewise, Dinesh et al. (2023) observed egg length of 49.84, 52.32, 53.24, 54.69 and 55.26 mm at 24, 30, 36, 44 and 50 weeks of age respectively in Himsamridhi chicken variety.

3.1.3. Egg width

Average egg width ranged from 39.47 mm at 28 week of age to 40.54 mm at 64 week of age with overall mean of 40.11 mm. Egg width did not show significant variation at different age of measurements. Result of present study were in agreement with the study of Behera et al. (2016) who reported egg width of 39.41 mm in indigenous Hansli chicken of Odisha at 40 week of age. However, lower egg width than present study was observed by Choudhuri et al. (2014) in Nicobari fowl and its crosses and Agarwal et al. (2021) in indigenous chicken of Jharkhand. In a similar study, Dinesh et al. (2022) observed egg width of 36.57, 40.16, 40.42, 41.95 and 41.09 mm in Dahlem Red at 21, 28, 40, 52 and 64 weeks of age. In another study, Dinesh et al. (2023) revealed egg width of 37.23, 38.88, 40.51, 40.52 and 40.34 mm at 24, 30, 36, 44 and 50 weeks of age in Himsamridhi chicken variety.

3.1.4. Shape index

Shape index was ratio of width of egg to length of egg

Table 1: External egg quality traits of native birds at different ages

Traits	28 Week	40 week	52 week	64 week	72 week	Overall
Egg Weight (g)	41.75±0.83^{a}	45.20±0.60^{b}	48.80±.61^{c}	51.90±.97^{c}	51.57±.89^{c}	47.84±0.52
Egg Length (mm)	53.35±0.70^{a}	53.79±0.44^{ac}	54.21±0.39^{ac}	55.65±0.52^{c}	54.81±0.45^{ac}	54.36±0.24
Egg Width (mm)	39.47±0.62^{a}	39.83±0.25^{a}	40.31±0.17^{a}	40.54±0.24^{a}	40.41±0.24^{a}	40.11±0.16
Shape Index	73.88±0.93^{a}	74.14±0.80^{a}	74.41±0.56^{a}	72.94±0.62^{a}	73.31±0.71^{a}	73.73±0.33
Shell thickness (mm)	0.36±0.01^{a}	0.36±0.01^{a}	0.37±0.00^{a}	0.37±0.01^{a}	0.38±0.00^{a}	0.37±0.00

Means with different superscripts within a row differ significantly (p<0.05)

multiplied by 100. Average value of shape index ranged from 72.94 at 64 week of age to 74.41 at 52 week of age with overall mean of 73.73. Shape index value did not vary significantly among different age group. Shape index in the current study fell within normal range of 72 to 76 which indicated better uniformity and homogeneity in egg which was essential for optimum hatchability and healthy chick production. Result of this study were consistent with report of Iqbal and Pampori (2008) who obtained value of shape index as 73.54 in indigenous chicken of Kashmir. Similarly, Kumar et al. (2022) observed almost similar value of shape index as 74.45 and 74.02 in Aseel and Kadaknath chicken respectively in mid laying phase. Likewise, Dinesh et al. (2022) estimated shape index value of 74.54, 74.82, 74.09, 73.59 and 73.0 at 21, 28, 40, 52 and 64 week of age respectively under intensive system of management in Dahlem Red chicken which was in agreement with current findings. Conversely, Padhi et al. (2013) reported higher value of shape index at 28 week (76.49), 40 week (75.29), 52 week (75.57), 64 week (76.0) and 72 week (77.45) in Vanaraja male line. Likewise, a higher value of shape index was revealed by Behera et al. (2016) in Hansli chicken of Odisha (75.84) and Agarwal et al. (2021) in indigenous chicken of Jharkhand (75.45). Contrary to this, Choudhuri et al. (2014) reported lower value of shape index as (66.15 and 69.03), (65.50 and 65.26) and (66.45 and 65.68) in Nicobari, Nicorock and Nishibari fowl under intensive and backyard system of management respectively in Andaman and Nicobar Islands.

3.1.5. Shell thickness

Average shell thickness from 28 to 72 weeks of age ranged between 0.36 mm to 0.38 mm with overall thickness 0.37 mm. Shell thickness did not reveal significant variation at different age of measurement. Higher shell thickness not only helped to prevent the damage to eggs during handling but also enhanced their keeping quality. Shell thickness observed in this study revealed that eggs of native birds have better shell strength for minimal handling and would not break during transportation. Result of present study were in agreement with Padhi et al. (2013) who observed value of shell thickness as 0.34, 0.37 and 0.38 mm at 28, 52 and 72 week of age respectively in Vanraja male line. Similarly, comparable value of shell thickness were reported by many authors; Dinesh et al. (2023) in Himsamridhi chicken variety (0.36 mm), Iqbal and Pampori (2008) in indigenous chicken of Kashmir (0.36 mm) and Agarwal et al. (2021) in indigenous chicken of Jharkhand (0.375). In contrast, lower value of shell thickness were reported by Kumar et al. (2022) in Aseel (0.35 mm) and Kadaknath (0.34) and Dinesh et al. (2023) in Dahlem Red (0.35 mm). Higher value of shell thickness as compared to present study was reported by Behera et al. (2016) in Hansli chicken of Odisha.

3.2. Internal egg quality traits

Internal egg quality parameters viz. albumen length, albumen width, albumen height, albumen index, yolk height, yolk width, yolk index and Haugh unit index are presented in Table 2.

3.2.1. Albumen length

Albumen length ranged from 72.16 mm at 28 week of age to 80.21 mm at 64 week of age with overall length of 77.88 mm. Albumen length at 28 week of age differed significantly ($p<0.05$) from albumen length studied at different ages. However, there was no significant difference in albumen length at 40, 52, 64 and 72 week of age. Albumen length observed in current study was found to be increased with increase in age. Result of present study were consistent with Dinesh et al. (2022) for albumen length at 28 week of age. However, he obtained low value of 72.50 mm, 76.35 mm and 77.22 mm for albumen length at 40, 52 and 64 weeks of age respectively in Dahlem Red. Likewise, Dinesh et al. (2023) observed low value of albumen length as 66.52, 72.26, 74.72, 72.89 and 76.68 mm at 24, 30,

Table 2: Internal egg quality parameters of native birds at different ages

Traits	28 Week	40 week	52 week	64 week	72 week	Overall
Albumen length (mm)	72.16±1.45^{a}	78.12±0.76^{b}	79.11±1.10^{b}	80.21±1.34^{b}	79.81±1.59^{b}	77.88±0.63
Albumen width (mm)	61.30±1.47^{a}	66.16±0.79^{b}	64.50±1.12^{ab}	66.47±1.24^{b}	66.64±1.42^{b}	65.01±0.58
Albumen height (mm)	6.78±0.10^{a}	6.59±0.17^{ac}	6.27±0.16^{ad}	5.72±0.13^{bd}	6.13±0.20^{bcd}	6.30±0.08
Albumen index	0.11±0.002^{a}	0.10±0.002^{a}	0.09±0.002^{b}	0.09±0.001^{b}	0.09±0.004^{b}	0.09±0.001
Yolk height (mm)	16.73±0.22^{a}	17.81±0.24^{bc}	17.92±0.21^{bc}	17.59±0.19^{ac}	17.20±0.32^{ac}	17.45±0.11
Yolk width (mm)	40.23±0.33^{a}	39.93±0.42^{a}	40.12±0.48^{a}	41.18±0.26^{a}	40.69±0.42^{a}	40.43±0.18
Yolk index	0.41±0.006^{a}	0.44±0.006^{bc}	0.44±0.004^{bc}	0.43±0.004^{ac}	0.42±0.006^{ac}	0.43±0.002
Haugh unit	87.98±0.65^{a}	85.56±1.01^{ac}	82.22±1.12^{cd}	77.41±1.04^{b}	80.09±1.43^{bd}	82.65±0.61

Means with different superscripts within a row differ significantly ($p<0.05$)

36, 44 and 50 week of age respectively in Himsamridhi chicken variety. Conversely, Kumar et al. (2022) observed albumen length of 83.73 mm and 82.27 mm in Aseel and Kadaknath respectively in their mid-laying phase, which was higher than the present study.

3.2.2. Albumen width

Albumen width increased from 61.30 mm at 28 week of age to 66.64 mm at 72 week of age with overall mean of 65.01 mm. Albumen width at 28 week of age differed significantly (p<0.05) from albumen width at 40, 64 and 72 week of age. However, there was no significant difference in albumen width of 28 and 52 week of age. Likewise, no significant difference in albumen width was observed at 40, 52, 64 and 72 week of age. Result of present study consistent with Kumar et al. (2022) who obtained albumen width of 65.40 mm and 64.80 mm in Aseel and Kadaknath chicken respectively in mid laying phase. Similarly, Dinesh et al. (2023) observed value of albumen width as 65.02 mm at 50 week of age which was comparable to present study. In contrast, higher value of albumen width was estimated by Behera et al. (2016) in indigenous Hansli chicken of Odisha (75.95 mm) and Singh et al. (2020) in indigenous chicken of Jammu and Kashmir (9.03 cm). However, Agarwal et al. (2021) revealed lower value of albumen width as 56.29 mm in indigenous chicken of Chotanagpur plateau of Jharkhand under intensive system of management at 30 week of age.

3.2.3. Albumen height

Overall mean of albumen height in this study was 6.30 mm and ranged from 5.72 mm to 6.78 mm. Albumen height at 28 week of age differed significantly (p<0.05) from albumen height at 64 and 72 weeks of age. However, no significant difference in albumen height was found at 28, 40 and 52 week of age. Higher the albumen height, better the albumen quality. Generally, higher albumen height was noticed in newly laid eggs of younger birds. Albumen height in the current study decreased as the age of bird advanced and indicate better albumen quality in younger aged bird. Lower albumen height was observed by Kumar et al. (2022) in Aseel (6.02 mm) and Kadaknath (5.52 mm), Behera et al. (2016) in Hansli chicken of Odisha (6.10 mm), Choudhuri et al. (2014) in Nicobari and its crosses (5.26–5.64 mm) and Singh et al. (2020) in indigenous chicken of Jammu and Kashmir (4.43 mm). However, higher value of albumen height was estimated by Agarwal et al. (2021) in indigenous chicken of Jharkhand and Dinesh et al. (2022) in Dahlem Red. In a similar study, Dinesh et al. (2023) recorded value of albumen height as 6.65, 5.86, 6.23, 5.96 and 6.77 mm at 24, 30, 36, 44 and 50 week of age respectively in Himsamridhi chicken variety.

3.2.4. Albumen index

Albumen index at different ages varied from 0.09 to 0.11 with overall mean of 0.09. Albumen index at 21 and 28 week of age differ significantly (p<0.05) from albumen index at 52, 64 and 72 week of age. However, there was no significant difference in albumen index at 52, 64 and 72 week of age. In present study, albumen index decreased as the age of bird progressed. It was measure of quality and freshness of egg. Albumen index decreased as the egg deteriorates due to more spread of albumen. It was indicator of firmness and viscosity of eggs. In contrast, low value of albumen index than the present study was reported by Iqbal and Pampori (2008) in indigenous chicken of Kashmir (0.071), Behera et al. (2016) in Hansli chicken of Odisha (0.08±0.002) and Singh et al. (2020) in indigenous chicken of Jammu and Kashmir (0.086±0.002). However, higher estimate for albumen index was reported by Agarwal et al. (2021) in indigenous chicken of Jharkhand (0.12), Dinesh et al. (2022) in Dahlem Red (0.12) and Dinesh et al. (2023) in Himsamridhi chicken variety (0.11) under intensive system of management. Result of present study were consistent with Kumar et al. (2022) who obtained value of albumen index as 0.09 in Aseel. However, he reported lower estimates for albumen index in Kadaknath chicken (0.08).

3.2.5. Yolk height

Mean value of yolk height ranged from 16.73 mm at 28 week of age to 17.92 mm at 52 week of age with overall mean of 17.45 mm. Yolk height at 28 week of age differ significantly (p<0.05) from yolk height at 40 and 52 week of age. However, no significant difference was observed for yolk height at 64 and 72 week of age. Result of present study were in agreement with Behera et al. (2016) who reported yolk height as 17.82 mm at 40 week of age. Similarly, Agarwal et al. (2021) observed value of yolk height as 17.85 mm in indigenous chicken of Jharkhand under intensive system of management at 30 week of age which was comparable to present study. Conversely, Choudhuri et al. (2014) obtained low value of yolk height in Nicobari fowl and its crosses under intensive and backyard system of management in Andaman and Nicobar Islands. Likewise, lower value of yolk height was revealed by Singh et al. (2020) in indigenous chicken of Jammu and Kashmir (16.3 mm), Kumar et al. (2022) in Aseel and Kadaknath (15.30 and 14.26 mm) and Dinesh et al. (2023) in Himsamridhi (16.27 mm). However, Dinesh et al. (2022) obtained higher estimate of 18.97, 18.78 and 18.70 mm at 40, 52 and 64 week of age respectively in Dahlem Red under intensive system of management.

3.2.6. Yolk width

Average yolk width ranged from 39.93 mm at 40 week

of age to 41.18 mm at 64 week of age with overall mean of 40.43 mm. Yolk width did not differ significantly at different age of measurement. Result of present study aligned with the report of Behera et al. (2016) who estimated yolk width of 39.98 mm in indigenous Hansli chicken of Odisha at 40 week of age. Likewise, Singh et al. (2020) estimated yolk width of 40.3 mm in indigenous chicken of Jammu and Kashmir which was comparable to present study. Lower value of yolk width than the present study were reported by Agarwal et al. (2021) in indigenous chicken of Jharkhand; Dinesh et al. (2022) in Dahlem Red and Dinesh et al. (2023) in Himsamridhi chicken variety. In a similar study, Kumar et al. (2022) observed yolk width of 40.10 and 38.97 mm in Aseel and Kadaknath chicken respectively.

3.2.7. Yolk index

Overall mean of yolk index was found to be 0.43 and ranged from 0.41 at 28 week of age to 0.44 at 52 week of age. Significant difference was found in yolk index value at 28 week of age with 40 and 52 week of age (p<0.05). However, yolk index value at 28 week of age revealed no significant difference with yolk index value at 64 and 72 week of age. The yolk index provided an indication on the freshness of the eggs. Eggs with yolk index above 0.38 were considered as extra fresh, those ranging from 0.28 to 0.38 are considered as fresh and below 0.28 are regular. Result of present study indicated that eggs are extra fresh. Result of present study aligned with findings of Behera et al. (2016) who obtained yolk index value of 0.44 in Hansli chicken of Odisha at 40 weeks of age. In a similar study, Padhi et al. (2013) estimated yolk index as 0.41, 0.37, 0.43, 0.39 and 0.35 at 28, 40, 52, 64 and 72 weeks of age respectively in Vanaraja male line (PD1). Lower value of yolk index was recorded by Choudhuri et al. (2014) in Nicobari fowl and its crosses (0.30), Singh et al. (2020) in indigenous chicken of Jammu and Kashmir (0.40) and Kumar et al. (2022) in Aseel (0.38) and Kadaknath (0.36). Conversely, Iqbal and Pampori (2008) and Dinesh et al. (2022) reported higher value of yolk index (0.455 and 0.45) in indigenous chicken of Kashmir and Dahlem Red respectively. Likewise, Agarwal et al. (2021) recorded a very high value of yolk index as 0.48 in indigenous chicken of Jharkhand.

3.2.8. Haugh unit

Average value of Haugh unit in this study ranged from 77.41 to 87.98 with overall mean of 82.65. Haugh unit at 28 week of age differ significantly (p<0.05) from Haugh unit at 52, 64 and 72 week of age. Haugh unit in this study show declining trend as the age of bird progresses up to 64 week of age and then increases at 72 week of age. However, there was no significant difference in Haugh unit value at 64 and 72 week of age. It was measure of egg protein quality based on the height of albumen. It was most common and widely used method to determine the internal quality of egg particularly albumen quality. Better Haugh unit score means better internal egg quality and better albumen quality. The overall mean of Haugh unit (82.65) in this study showed higher quality of eggs. Result of present study were consistent with finding of Singh et al. (2020) who observed Haugh unit value of 82.92 in indigenous chicken of Jammu and Kashmir. In a similar study Padhi et al. (2013) recorded Haugh unit value of 80.76, 81.38, 87.50, 78.43 and 75.49 at 28, 40, 52, 64 and 72 week of age respectively in Vanaraja male line (PD1). In contrast, lower estimate for Haugh unit were recorded by Iqbal and Pampori (2008) in indigenous chicken of Kashmir (71), Choudhuri et al. (2014) in Nicobai fowl (76.13), Rajkumar et al. (2014) in Aseel (75.98), Behera et al. (2016) in Hansli chicken (81.79), Ukwu et al. (2017) in Isa brown layer (70.30), Kalita et al. (2018) in crossbred chicken (78.44) and Jayanaik et al. (2021) in indigenous chicken (68.89). Likewise, Kumar et al. (2022) reported lower estimate of Haugh unit in Kadaknath (79.82). However, Haugh unit estimate for Aseel chicken (82.88) was comparable to present study. Conversely, higher estimate than this study was reported by Agarwal et al. (2021) in indigenous chicken of Jharkhand, Dinesh et al. (2022) in Dahlem Red and Dinesh et al. (2023) in Himsamridhi chicken variety.

3.3. Correlation coefficient between egg weight and different egg quality parameters

Correlation coefficient between egg weight and different egg quality parameters, depicted in Table 3. Correlation coefficient between egg length and egg weight at 28 and 40 weeks of age was negative and low in magnitude. There was positive and highly significant (p<0.01) correlation between egg length and egg weight at 52 and 72 week of age. Egg weight at different age of measurement showed moderate to high positive correlation with egg width except at 40 week of age. Correlation coefficient between egg width and egg weight was highly significant (p<0.01) at 72 week of age. Correlation coefficient between egg weight and shape index was negative at 40, 52 and 64 weeks of age and positive at 72 week of age. Shape index showed positive and highly significant (p<0.01) correlation with egg weight at 28 week of age. Egg weight at 40, 64 and 72 week of age was found to be negatively correlated with shell thickness. However, correlation coefficient was low in magnitude. Correlation coefficient between albumen length and egg weight was found to be low and negative at 40 and 64 week of age and positive at 28 and 52 week of age, but low in magnitude. However, albumen length showed moderate to high positive and

Table 3: Correlation coefficient (r) between egg weight and different egg quality traits at different ages of measurement

Traits	28 Week	40 week	52 week	64 week	72 week
Egg length	-0.036	-0.080	0.686**	0.018	0.814**
Egg width	0.396	-0.168	0.439	0.552*	0.648**
Shape index	0.580**	-0.046	-0.419	-0.393	0.162
Shell thickness	0.020	-0.258	0.210	-0.180	-0.184
Albumen length	0.057	-0.114	0.080	-0.313	0.672**
Albumen width	0.036	-0.146	-0.122	-0.306	0.705**
Albumen height	0.035	0.138	0.104	-0.074	-0.124
Albumen index	-0.162	-0.177	0.099	-0.116	-0.178
Yolk height	-0.179	-0.323	0.121	0.119	0.010
Yolk width	0.127	0.259	0.195	-0.229	0.423
Yolk index	-0.465	-0.420	-0.238	0.273	-0.250
Haugh unit score	-0.394	-0.064	-0.113	-0.442	-0.311

*Significant (p<0.05); **Highly significant (p<0.01)

highly significant correlation (p<0.01) with egg weight at 72 week of age. Similar result was noticed for albumen width except weak negative correlation at 52 week of age. Correlation coefficient between albumen height and egg weight was found to be positive at 28, 40 and 52 week of age and negative at 64 and 72 week of age. Albumen index and yolk index showed negative correlation with egg weight at 28, 40 and 72 week of age. Yolk height was observed to be negatively correlated with egg weight at 28 and 40 week of age and showed low positive correlation with egg weight at 52, 64 and 72 week of age. Low to moderate positive correlation was observed between yolk width and egg weight except negative correlation at 64 week of age. Correlation coefficient between egg weight and Haugh unit was found to be negative at different age of measurements. In a similar study, Padhi et al. (2013) studied the correlation coefficient between egg weight and different egg quality traits at different age of measurement in Vanaraja male line and reported that shape index and egg weight negatively correlated up to 52 week of age. Further, he revealed that albumen index showed positive correlation with egg weight up to 52 weeks of age whereas, yolk index showed positive correlation with egg weight. Sreenivas et al. (2013) recorded moderate to high positive, phenotypic and genetic correlation between egg weight and different egg quality parameters in White Leghorn. Result of this study consistent with Behera et al. (2016) who recorded negative correlation of egg weight with shape index and Haugh unit at 40 week of age in Hansli chicken of Odisha. Agarwal et al. (2021) observed positive correlation of egg weight with egg length, egg width, albumen width, albumen height, yolk width and yolk height in indigenous chicken of Jharkhand reared under intensive system of management at 30 weeks of age. However, he revealed that egg weight was negatively correlated with shape index, albumen index, yolk index, shell thickness and Haugh unit. Likewise, Dinesh et al. (2022) observed that correlation coefficient of egg weight with egg length, egg width, albumen length, albumen height and yolk width was positive in Dahlem Red. Albumen index and Haugh unit was found to be negatively correlated with egg weight at 21, 52 and 64 week of age. In another study, Dinesh et al. (2023) reported that egg weight was negatively correlated with shell percentage and Haugh unit at 30, 44 and 50 weeks of age in Himsamridhi chicken variety. Whereas, egg weight was positively correlated with egg length, egg width, albumen length, albumen width and yolk width.

4. CONCLUSION

Egg quality traits of Native chicken was good above 40 week of age for hatching of good quality chicks. Age had significant effect on external and internal egg quality traits. Most of traits showed significant variation at different ages. Egg length, egg width, albumen length and albumen width showed positive, moderate to high and highly significant correlation with egg weight at 72 week of age. Data generated from study would be helpful in characterization of Native birds of Himachal Pradesh.

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