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Morphometric and Morphology of Indigenous Chicken Eggs Quality Parameters in East Shewa and West Arsi Zones of Oromia Regional State, Ethiopia

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Abstract

Egg of chicken becomes very concerned food in Ethiopia as local consumers highly attractive to eat them. It is rich with valuable proteins, vitamins and minerals. The external and internal quality parameters were the main determinant for consumption preference and hatching egg. On the other hand, egg of indigenous chicken was preferred among local consumers due to its flavour and tastes. However, there was limited information and, gap of standardized document on egg qualities indigenous chicken ecotypes in this area. This study was conducted East Shewa and West Arsi zones with objectives of evaluating egg quality parameters of indigenous chicken eggs and characterize external and internal egg quality traits to establish a base for indigenous chicken designing breeding program under smallholder farmers in selected districts of Oromia regional state, Ethiopia. A total of 1200 fresh egg were used in this study. The results of study revealed that overall mean egg weight indigenous chicken in this study was $41.28 \pm 3.4.8g$. The overall mean egg length and egg width in this study were $51.12 \pm 2.5mm$ and $37.82 \pm 1.6mm$ respectively. The egg shape index in current study was $74.15 \pm 3.6\%$. The egg shell weight of indigenous chickens in current study was $4.8 \pm 0.8g$ with shell ratio of $11.8 \pm 2.6\%$. The overall mean yolk weight and albumen weight of indigenous chickens' egg in this study area were $15.4 \pm 2.6g$ and $20.4 \pm 3.4g$ respectively with albumen ratio and yolk ratio of $38.12 \pm 5.4\%$ and $50.25 \pm 5.6\%$ respectively. The indigenous chicken egg in the current study showed a normal shape. On contrary, egg size of indigenous of this study was categorized under small size based on standard egg quality parameters set and thus, need further improvement for better productivity of indigenous chicken under prevailing production system.

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Keywords

Egg size, normal shape, quality traits, ratio

Introduction

The chicken egg is a biological structure proposed by nature for reproduction and providing a complete diet for the developing embryo [21]. On the other hand, it is one of poultry product used to reduce animal protein deficiency in the nutrition of smallholder farmers. Therefore it quality parameters were very important

hatching better quality chicks and human consumption. Quality of eggs and preserving that quality is a function of physical structure and chemical composition. The quality of an egg ascertains the success of a poultry business because it is associated with the acceptability among the consumers [19]. Egg quality traits are foremost selection standard in poultry. The egg quality is one of most important economic factor in poultry

industry for both hatching and table eggs [14]. Egg quality is a factor that contributes to the better economic price of fertile and table eggs. Smallholders' farmers in village keep chicken for different purpose and the main purpose and objective was for egg production to sell in local market [24]. Therefore it crucial to evaluate its external and internal quality parameters of egg. The quality of egg determined based on both external and internal quality parameters. The external and internal egg quality traits were influenced by factors such as agro-ecology, breeding, and their interaction [20]. External and internal egg quality traits are the determinant factors for the embryonic development of an egg and latter for the viability of the new hatched chick [18]. The external quality of the egg is determined by features such as the egg weight and shape of the egg, shell thickness, and strength of the shell [5]. Egg weight is also one of the important phenotypic traits that affects egg quality and reproductive fitness of the chicken [13]. Egg shape index is defined as the ratio of width to length of the egg, and it is an important criterion in determining egg quality. The shell thickness measure shell strength mainly for reduce egg shell breakages [6, 1]. The internal quality is measured based various internal components such as weight of yolk, albumen weight and its contents ratio and yolk color. As regards the internal egg quality characteristics, thick albumen is quite an important measure for the freshness of an egg [29]. The albumen weight was influenced by the agro-ecological variation [8]. Haugh unit is one internal egg quality that was considered as a typical measure of albumen quality. Haugh unit is also dependent on management system of birds, quality and quantity of feed, production environment and also storage condition of the eggs [2].

With current increasing human population of Ethiopia, the poultry products particularly egg was considered as future food concerns, due short generation and high reproductive rate of chickens. Furthermore, in the market consumers prefer indigenous chicken's eggs over eggs from exotic chicken. The market value of eggs from indigenous chicken is also relatively higher even its size is smaller than exotic chicken's eggs. Understanding the quality of eggs laid by chickens is essential as it serves as an indicator of productivity, overall chicken care, business success and embryonic development. However, there was no research work on identifying of egg quality parameters of indigenous chicken egg in this area. Therefore, it was conducted to identify egg quality parameters of indigenous chicken ecotype for genetic improvement of chicken genetic resources on sustainable basis for smallholder village poultry producers.

Materials and Methods

Description of the study area

The study was conducted in Bora, Adama and Lume districts from East Shewa zone and Siraro, Shashemene, Dodola and districts from West Arsi zone.

Bora district: The Bora district is located in the East Shewa Zone of the Oromia Region in Ethiopia within the Great Rift Valley. Its administrative center is the town of Bote. Its coordinates are roughly 8.30°N latitude and 38.95°E longitude. It is located about 238 kilometers South of Addis Ababa. Its features was a semi-arid climate and experiences warm, dry conditions with average daytime temperatures of 25°C to 27°C. The district receives an average annual rainfall of 700 mm to 800 mm and one main rainy season between June and September. The altitude of district generally ranges from 1,611 to 2,000 masl.

Adama district: The Adama district is found East Shewa Zone of the Oromia Region in Ethiopia. The administrative town, Adama is located 99 km southeast of the capital, Addis Ababa. The district features altitude ranges from 1,415 to 2,505 masl. The districts lies 8°14' N to 8°40' N and a longitude of 39°4' to 39°29' E. The Annual temperatures generally range from 15°C to 28°C. The weather is mostly hot and dry during the winter, and warm and sunny during the summer. The area receives an average of 700 to 800 mm of rain annually.

Lume district: The Lume district is located in the East Shewa Zone of the Oromia Region in Ethiopia. It is Located about 70 km southeast of Addis Ababa. Its latitude between 8°24' and 8°50' North and a longitude of 39°01' to 39°28' East. Its altitude ranges from 1,500 to 2,300 masl.

The district is generally warm, with average highs usually ranging between 23°C and 28°C throughout the year. The hottest months are typically from April to June. The annual rainfall typically falls between 700 mm and 850 mm. The main wet season (Kiremt) occurs during July and August.

Siraro district: Siraro is a rural district in the West Arsi Zone of Ethiopia's Oromia Region. It is located about 330 km south of Addis Ababa. It lies in the Great Rift Valley, with altitudes ranging from 1,500 to 2,750 masl. The district generally characterized by a semi-arid to sub-humid tropical climate.

Shashemene district: The Shashamane district found in the West Arsi Zone of the Oromia Region, Ethiopia. It located 250 kilometers south of Addis Ababa. Sitting in the Great Rift Valley, its geographic coordinates are 7°14' N latitude and 38°36' E longitude, at an elevation of 2,053 masl. The annual average temperatures of the district is between 20°C and 28°C.

Dodola district: Dodola District is located in the West Arsi Zone of the Oromia Region, southeastern Ethiopia. It sits at latitude and longitude 06° 59' N 39° 11' E and lies at an elevation of 2,362 to 2,493 masl. Dodola district experiences a mild highland climate, with average temperatures generally ranging from 9°C to 26°C (48°F to 79°F) year-round. The total rainfall of the district generally ranges between 1,000mm and 1,200mm annually.

Sampling and Data Collection

The egg quality parameters evaluation were taken from a total of 1200 (200 eggs purchased from six districts). A total of eight (12) Kebeles, (2) Kebeles per district were selected purposively based on potentiality of indigenous chicken population and accessibility to main road for ease data collection.

The fresh eggs were purchased from village households. The households were previously informed to prepare eggs laid within few days. Then eggs were purchased and transported to Adami Tullu Agricultural Research Center for taking egg quality parameters.

At time of purchasing external cleanness and surface breakage of the egg was observed before purchased. Additionally, the freshness of eggs was also checked through pointing to sun light and observation physical feature.

Egg quality trait measurement

The weight egg of was measured using digital balance. The egg width and length was measured using digital caliper. For internal egg quality measurement traits, egg was gently broken on flat plate and albumen and yolk was carefully separated. The albumen weight and yolk weight were measured using sensitive balance. Shell thickness was measured using digital caliper after removal of the inner shell membrane. The egg shell thickness was measured on eggs taken from middle and both end points. The averages of the three points were used as the thickness of the egg. Albumen height and

yolk height was determined using tripod micrometer. Yolk color was recorded from Roche fan color (1–15) levels. Haugh unit was calculated by $100 \times \log [\text{albumen height} + 7.57 - 1.7 (\text{egg weight}^{0.37})]$ according to [12]. The egg shape index, egg shell ratio, yolk ratio and albumen ratio were calculated using the following formulae.

Egg shape index = $\text{Egg width (mm)} \times (100\%) / (\text{Egg length (mm)})$

Shell ratio(%) = $\text{shell weight (g)} \times (100\%) / \text{Egg weight (g)}$

Yolk Ratio = $\text{yolk weight (g)} \times (100\%) / \text{Egg weight (g)}$

Albumen ratio = $\text{Albumen weight (g)} \times (100\%) / \text{Egg weight (g)}$

Statistical Analysis

The data collected from egg quality parameters were analyzed using GLM procedures (SAS, 2012 version 9.3) by adjusting zones as independent variables. The parameters expressed in terms of ratio or percentage was first converted to target parameters using Microsoft Excel 2010.

Result and Discussion

Egg quality parameters

External egg quality

Egg weight

The results of current study revealed that the overall mean of egg weight in the study area was 41.28 ± 3.4 (Table 1). This result was similar with [11, 30] who reported average egg weight of $41.13 \pm 1.26\text{g}$ and $41.89 \pm 3.98\text{g}$ respectively. On contrary, egg weight value of present study was lower than findings of [27, 15] who reported average egg weight of indigenous chicken $43.9 \pm 4.7\text{g}$ and $49.41 \pm 4.45\text{g}$ in respectively.

Similarly, [29] reported egg weight higher than current study which was of $45.20 \pm 5.53\text{g}$ for local chicken in Hawasa town. This difference might be due to management; as chicken reared in town get better management thus laid relatively larger size egg than village chicken. Based on UNESE [2010] standard, the egg less than 53g weight was considered as small size. Based this standard, the egg weight of current study was classified under small size egg.

Egg length

The egg length in the current study was 51.12 ± 2.5 mm (Table 1). This result was slightly similar with findings of [9] who reported mean grand egg length of 51.76 ± 0.21 mm in western Oromia, Ethiopia. On the other hand, the result of presented study was slightly higher than findings of [28] who reported egg length of 49.84 ± 2.584 mm in Siltie zone, Ethiopia. However, the result of present study was lower than egg length of 53.25 ± 2.80 mm reported by [16].

Egg width

The overall egg width in the current study was 37.82 ± 1.6 mm (Table 1). This result was slightly lower similar with findings of [31] who reported average egg width of 38.24 ± 0.19 mm in Northern Ethiopia. On the other hand, the result of current study was slightly higher than egg width value of 36.74 ± 0.14 mm reported by [9] in Western Oromia, Ethiopia. On contrary, higher than present study result egg width of 40.31 ± 0.12 mm was reported by [23] for Indigenous Free Range Chicken Eggs in Lusaka, Zambia.

Egg shape index

The egg shape index in present study ($74.15 \pm 3.6\%$) (Table 1). This result was similar with findings of [26] who reported $74.10 \pm 0.45\%$ in Western Kenya. Higher than current study of $75.21 \pm 4.276\%$ egg shape index was reported by [28] in Siltie Zone of Ethiopia. On other hand, result of current study was higher than findings of [27] and [15] who reported of egg shape index 72.2% in Southern Ethiopia and 72.66 ± 4.95 in Sidama region of Ethiopia respectively. Eggs are categorized into three shape groups: Sharp (<72), normal (72-76) and round (>76). Based on this classification, the eggs of indigenous chicken's current in the study classified as normal shape.

Shell weight

The mean egg shell weight in present study was 4.8 ± 0.8 g (Table 1). This result was slightly similar with findings of [16] who reported egg shell weight of 4.38 ± 0.66 g in Sidama region. On the other hand, slightly higher than current result of average shell weight of 5.10 ± 0.06 g and 5.33 ± 0.25 g were reported by [32] and [7]) in Northern and southwestern, Ethiopia respectively. On contrary, the result of this study was slightly higher than report of [28]

who reported egg shell weight of 3.42 ± 0.567 g in Siltie zone, Ethiopia.

Shell thickness

The egg shell thickness in the present study was 0.3 ± 0.04 mm (Table 1). This result was Similar with [20] who was reported average egg shell thickness of 0.31 ± 0.03 mm, 0.3 ± 0.02 mm and 0.32 ± 0.02 mm in Highland, midland and lowland respectively in Silte zone, Southern Ethiopia. On contrary, value higher than current study of 0.36 ± 0.01 mm and (0.37 mm) egg shell thickness were reported by [31] and [1] in Northern Ethiopia and Ethiopian naked neck chickens reared under improved production system respectively. On other hand, the shell thickness in the present study was slightly higher than findings of [10] who reported that 0.26 mm in Northwestern Ethiopia.

Shell ratio

The overall egg shell ratio in current study was $11.8 \pm 2.6\%$ (Table 1). This result was slightly higher than egg shell ratio of 10.55% reported by [9] in western Oromia, Ethiopia. On contrary, the result of present study was lower than findings of [23] who reported mean shell ratio of $12.78 \pm 0.06\%$ for free range indigenous chicken in Lusaka, Zambia. On the other hand, the value in the current study was higher than findings of [8] who reported mean shell ratio of $8.77 \pm 1.74\%$, 8.30 ± 1.20 and 9.15 ± 1.685 in lowland, midland and highland respectively agro ecology in Southern, Ethiopia.

Internal egg quality parameters

Yolk weight

The overall mean yolk weight in present study was 15.1 ± 2.6 g (Table 2). This result was similar with findings of [4] and [17] who reported average egg yolk weight of 15.06g and 15.21 ± 0.27 g in Kutaber district, South Wollo of Ethiopia and Gena Bossa district of Dawro zone respectively.

On the other hand, the result of current study was lower than findings of [16] who reported yolk of 17.86 ± 1.96 g in Sidama region of Ethiopia. Similarly, higher than current study results of 16.90 ± 2.60 g, 16.80 ± 2.00 g and 16.40 ± 2.17 g yolk weight were reported by [8] in lowland, midland and highland agroecology of southern Ethiopia respectively.

Yolk height

The overall yolk height in this study was 14.2 ± 1.2 mm (Table 2). This result was slightly similar to finding of [28] who reported yolk height of 14.97 ± 1.169 mm in Siltie Zone, Ethiopia. On other hand, the result of this study was lower than mean yolk height of 16.17 ± 2.24 mm in lowland, 15.70 ± 1.31 mm in midland and 16.80 ± 1.10 mm in highland reported by Legesse and Kefyalew, (2023) in Sidama region, Ethiopia. Similarly, mean yolk height of 15.69 ± 1.31 mm was reported by [15] in Sidama region, Ethiopia.

Yolk ratio

The overall mean yolk ratio in this study was 36.8 ± 5.5 % (Table 2). This result was similar with findings of [16] who reported yolk ratio of 36.17 ± 3.92 % in Sidama region, Ethiopia. Similarly, [8] was reported mean yolk ratio of 36.71 , 36.90 ± 2.60 , 16.80 ± 2.00 , 16.40 ± 2.17 and 5.84 % and 36.40 ± 4.81 % in lowland and highland respectively in southern Ethiopia. The same authors were reported lower present study value of 34.90 ± 4.46 % yolk ratio in midland agro ecology. On the other hand, the result of current study was higher than findings of [9] who reported yolk ratio of 34.99 % in western Oromia, Ethiopia. The result of current study was slightly lower report of [28] who reported egg yolk ratio of 38.96 ± 3.754 % in Siltie zone, Ethiopia.

Yolk color

The overall mean yolk color indigenous chickens in this study were 5.18 ± 1.3 (Table 2). This result was much lower yolk color of 9.22 ± 0.83 and 8.37 ± 0.15 reported by [28] and [17]) in Siltie Zone, Ethiopia and in Gena Bossa district of Dawro zone, South Ethiopia respectively. The difference in yolk color might be due to availability of green feed as affected by season. In current study, there was higher yolk color value observed in East Shewa zone than West Arsi zone. This might be due to indigenous in from East Shewa zone more access to green feed scavenging.

Albumen weight

The overall mean albumen weight in this study were 20.4 ± 3.4 g (Table 2). This result was similar with finding of [30] who reported average egg white weight of 21.45 ± 1.71 g for Konde chicken ecotype in Centre East in Burkina Faso. On contrary, much higher than current of study result of 28.13 ± 0.58 g albumen weight was

reported by [22] from indigenous chicken of India. This difference might be due to ecotype breed difference and others management aspects.

Albumen height

The average albumen height in this study was 5.24 ± 2.8 mm (Table 2). This results was slightly nearby to the results of [3] who reported (5.79 mm) albumen height for local Kei chicken raised in Gurage zone.

On the other hand, [28] and [9] who were reported albumen height of 4.59 ± 0.749 mm and 4.48 ± 0.07 mm which was slightly lower than this study in Siltie Zone and western Oromia of Ethiopia respectively. On contrary, the result of current study was lower than albumen height value of 6.26 ± 1.03 mm reported by [16] in Sidama region, Ethiopia.

Albumen ratio

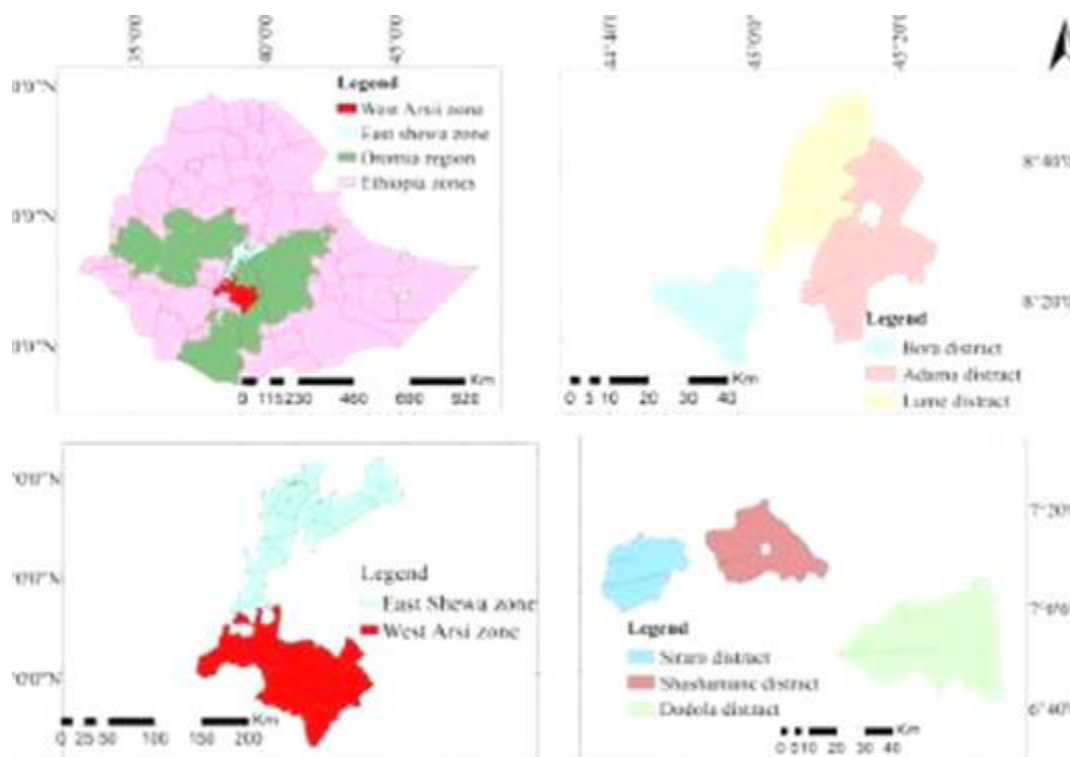
The overall mean albumen ratio in this study was 50.25 ± 5.6 % (Table 2). This result was similar to result of Berhanu *et al.*, (2022) who reported egg albumen ratio of 50.92 ± 5.74 and 50.60 ± 6.69 % in midland and highland of Southern Ethiopia.

Similarly, [28] who also reported albumen ratio of 50.06 ± 4.838 % in in Siltie Zone, Ethiopia. The result of this study was lower than finding of [9] who were reported gran mean albumen ratio of 54.71 % for unimproved Horro chicken ecotype in Western Oromia.

In conclusion, Egg quality parameters of indigenous were influenced by several factors such as production environment, time of data collection, type scavenging feeds, management practices and chicken ecotype.

The present study was identified major external and internal egg quality parameters of indigenous in the study area and outlined baseline for future indigenous chicken improvement on sustainable basis under village production system. In general indigenous chickens egg in the study area had a normal shape that fit for hatching, however, they were small size based on standard set.

Therefore, any genetic breeding program design can be considered parameters identified in the current study as baseline. Furthermore, weight egg should be improved through systematic selection for improving another external and internal quality traits indigenous chicken in the study area.

Figure.1 Map of study area**Table.1** External egg quality traits of indigenous chicken in the study area

Parameters (Mean±SD)	Study zones		Overall
	East Shewa	West Arsi	
Egg weight (g)	40.96±4.6	41.5±5.2	41.28±3.4
Egg length (mm)	51.53± 2.6	50.64± 2.9	51.12±2.5
Egg width (mm)	38.22±1.8	37.44±1.6	37.82±1.6
Shape index (%)	74.2±3.7	73.9±4.1	74.15±3.6
Shell weight (g)	5.0±0.02	4.4±0.73	4.8±0.8
Shell thickness (mm)	0.30±0.04	0.31 ±0.04	0.31±0.03
Shell ratio (%)	12.4±1.4	11.4±1.5	11.8±2.6

mm = millimeter, g = gram, %, = percent

Table.2 The internal egg quality traits of indigenous chicken in the study area

Parameters (Mean±SD)	Study zones		Overall
	East Shewa	West Arsi	
Yolk weight (g)	16.2±2.5	15.0±2.8	15.4±2.6
Yolk ratio (%)	39.6±5.5	36.5±5.6	38.12±5.4
Yolk height (mm)	14.0 ±1.2	14.4± 1.2	14.2 ±1.2
Albumen weight (g)	19.8±3.9	21.6±4.0	20.4± 3.4
Albumen height (mm)	5.23±1.24	5.18±1.26	5.24±2.8
Albumen ratio (%)	48.4±4.3	52.1±6.0	50.25±5.6
Yolk color	6.4±1.8	3.8±1.3	5.18±1.3

mm = millimeter, g = gram, % = percent

Abbreviations

Masl - meter above sea level
mm - Millimeter
g - gram
SD - Standard deviation

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Author Contributions

Usman Abdulkadir: Conceptualization, Writing – original draft, Resources, Investigation, Data curation, formal Analysis, Validation. Beshir Hussein: Resources, Data curation, Validation, Data curation. Tesfa Geleta: Conceptualization, Resources, Data curation, Validation. Nebi Husen: Resources, Project administration, Data curation, Validation

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare there was no conflict of interest.

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