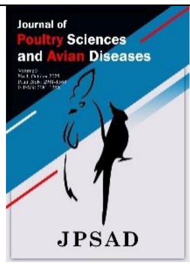
Journal of Poultry Sciences and Avian Diseases

Journal homepage: www.jpsad.com



Variation in Egg Quality Traits among Indigenous Chicken Ecotypes of Uganda

Muhammad Kiggundu[1*], Zulaikah Odaru[2], Zainah Nampijja[2], Henry Mulindwa[3], Rosette Nangonzi[3], Kanifa Kamatara[2], Vincent Lutwama[2]

[1] National Livestock Resources Research Institute, National Agricultural Research Organization, Kampala, Uganda. 2-National Semi-Arid Resources Research Institute, National Agricultural Research Organization, Soroti, Uganda
[2] Department of Agricultural Production, Makerere University, Kampala, Uganda
[3] National Livestock Resources Research Institute, National Agricultural Research Organization, Kampala, Uganda

*** Corresponding author email address**: muhammad.kiggundu@naro.go.ug

A r t i c l e   I n f o

Article type:
Original Research

How to cite this article:
Kiggundu, M., Odaru, Z., Nampijja, Z., Mulindwa, H., Nangonzi, R., Kamatara, K., & Lutwama, V. (2025). Variation in Egg Quality Traits among Indigenous Chicken Ecotypes of Uganda. *Journal of Poultry Sciences and Avian Diseases, 3*(4), 22-31.
http://dx.doi.org/10.61838/kman.jpsad.3.4.3

A B S T R A C T

Chicken eggs provide affordable, high-quality animal protein. Understanding egg quality traits is essential since they influence grading, pricing, chick weight and consumer preferences. This study examined egg quality variations among ecotypes from hens selectively bred for egg production and mature body weight. Birds had ad libitum access to a uniform layer diet, and daily egg collections allowed for detailed analyses of external and internal egg traits. Results revealed significant ecotype-based variation in external egg traits, with Apac hens laying the heaviest and longest eggs, while Gulu hens produced the lightest. Lira eggs had the highest shape index (SI), while Gulu's was lowest. Among eggshell characteristics, Gulu eggs had the thickest shells, while Katakwi eggs had the heaviest shells, shell index, and shell ratio. Internal egg traits, including yolk depth, yolk ratio, and yolk index, differed significantly across ecotypes, with Katakwi eggs having the highest values. Yolk colour was also variable, with Gulu eggs scoring highest and Lira eggs lowest. Significant differences ($p<0.01$) in albumen traits were observed; Apac and Lira eggs had the highest albumen depth, weight, and Haugh unit (HU) scores, with Katakwi eggs scoring the lowest. Egg weight positively correlated with length, shell and albumen weight, yolk depth, and Haugh unit but negatively with yolk ratio. Overall, these findings highlight ecotype-based quality differences suitable for selective breeding for egg weight to enhance egg quality in Uganda's IC without destructive testing.

Keywords: *Egg characteristics; Eggshell quality; Local chickens; Poultry genetics; Trait correlation*

Article history:
Received 06 July 2025
Revised 04 August 2025
Accepted 07 August 2025
Published online 01 October 2025

1 Introduction

Indigenous chickens (IC) are a vital component of rural livelihoods and food security in Uganda and across Africa (1, 2). Their eggs and meat are preferred over those from commercial strains due to their perceived superior taste and nutritional benefits (3, 4). However, in Uganda, despite this preference, the egg production potential of indigenous chickens particularly in terms of egg quality, remains poorly understood. Elsewhere, indigenous chicken phenotypes in the Africa have been reported to exhibit significant variation in egg quality. For example, several studies across Africa have documented significant differences in egg characteristics in countries such as Kenya (5), Ethiopia (6), Zambia (7) and Botswana (8). In Uganda, indigenous chickens exhibit great phenotypic and genetic diversity (9-11), which suggests potential variations in both external and internal egg traits. Understanding these variations is crucial, as egg quality not only influences consumer preferences but also directly affects food safety and economic returns in poultry production (12). Previous research in Uganda has predominantly focused on carcass traits of indigenous chickens (13), with less attention given to egg quality. Existing studies on egg production mostly address clutch size and egg numbers, overlooking the detailed quality traits that influence consumer choice and market demand (14). Yet, indigenous chicken eggs are increasingly recognized for their unique qualities compared to commercial strains (15). Although Beyihayo et al. (11) explored some external egg quality traits, comprehensive studies on both internal and external characteristics across different indigenous chicken ecotypes are lacking. Elsewhere in the tropics, breed have been reported to have a great influence on egg characteristics

This aim of this study was to assess the variation in external and internal egg quality traits across selected indigenous chicken ecotypes of Uganda. The findings are expected to provide critical insights for breeding programs targeting egg production quality and will help meet the growing demand for indigenous chicken eggs in niche markets. Additionally, this research offers a scientific basis for selecting ecotypes that produce eggs with superior quality traits, thereby accelerating the contribution of indigenous chickens to both household nutrition and the poultry industry.

2 Materials and methods

All experimental procedures were conducted in accordance with the National Agricultural Research Organisation (NARO) of Uganda's guidelines for animal care and use, which comply with Uganda's national legislation on the humane treatment of animals under the Animal Act of 2000 (16). The experiment was carried out at the Mukono Zonal Agricultural Research and Development Institute (MuZARDI), a facility of NARO.

2.1 Location of MuZARDI

Mukono Zonal Agricultural Research and Development Institute (MuZARDI) is situated in Ntawo village, Mukono district, approximately 20 km East of Kampala and 20 km off the Jinja-Kampala highway. It lies within the Lake Victoria Crescent Agro-ecological zone, with geographical coordinates of N0°22'23.5452" and E32°43'43.284".

2.2 Experimental birds

The experimental birds used in this study included five populations of indigenous chicken ecotypes from the districts of Apac, Gulu, Lira, and Katakwi in Uganda, along with a flock from the National Semi-Arid Resources Research Institute (NaSARRI) selected for increased egg production. The average age of the laying birds was 35 weeks, and data were collected over an 8-week period. While the NaSARRI birds came from an established egg production flock at the institute, the birds from the field were purchased from individual households in the selected districts and then assembled at the poultry facility in MuZARDI. These assembled birds formed the foundation stock of each ecotype, with separate groups maintained according to their district of origin.

2.3 Experimental design and bird husbandry

2.3.1 Management of experimental birds

The experiment was designed as a completely randomized design (CRD), with five chicken ecotypes serving as independent variables (treatments). A total of 150 hens, 30 per ecotype, were recruited and housed in group pens with 10 hens per pen, with three replicates per ecotype. Deep litter pens measuring 2.0 m^2, were used. The pens were equipped with chicken mesh to allow interaction between birds in neighbouring pens. The coffee husk litter was regularly turned to maintain friability. The hens were kept under a 12 h natural light and 12 h dark photoperiod, using coarse wood shavings for bedding. Each pen housed 10 birds, all of which had free access to a uniform layer mash (crude protein 17% and 2866 Kcal/kg) and clean drinking water ad libitum. Eggs were laid in trap nests, and each egg was identified by ecotype, hen identification (ID), and the date of laying. Sampling of freshly laid eggs occurred three times a week—on Monday, Wednesday, and Friday.

2.3.2 *Measurement of egg quality traits*

The external egg quality traits measured for each egg included egg weight, egg length, the width (breadth) at the middle, top, and bottom axes, shell thickness, and shell weight. Egg weight, shell weight, and yolk weight were measured using a digital platform weighing scale with a precision of 0.01 g (Satorius). Egg weight is indicator of egg size, market value, and potential hatchability. Heavier eggs generally contain more nutrients and are preferred by consumers. Meanwhile, shell weight reflects shell strength and integrity which in turn influence egg safety and storage. breadth and length were measured using a digital vernier calliper as proxies for evaluation of egg shape. After recording egg weight, breadth, and length, the eggs were broken open on a flat plate. The yolk was separated from the albumen and weighed using the electronic scale. The height (depth) of both the yolk and albumen was measured with a digital vernier calliper as indicators of egg freshness. Yolk colour was evaluated using a portable Digital YolkFan™ sensor connected to a tablet (Android) for data capture. Shell weight and thickness were measured after cleaning the shells of albumen and allowing them to air dry for 24 hours.

2.4 *Calculated parameters*

Other egg quality parameters were calculated using the formula that is indicated.

$$Albumen\ weight = Egg\ weight - (Yolk\ weight + Shell\ weight)$$

The Albumen weight: egg weight- (Yolk weight + shell weight).

The Haugh unit (HU) an international standard for assessing internal egg equality especially freshness, was calculated using the equation of Haugh (17):

$$HU = 100 \times \log(h - 1.7w^{0.37} + 7.6)$$

Where HU = Haugh unit (HU), h = height of the albumen in millimeters, w = weight of egg in grams

Shape index (SI) was calculated based on the equation of SI =: $SI = \frac{w}{l} * 100$

Where SI= shape index, w= egg width, l = egg length Panda (18). Shape index is used to categorize egg morphology with a desired range of 72 to 76% (19).

Yolk index (YI) was calculated based on equation proposed by Sharp and Powell (20):

$$YI = \frac{h}{d}$$

Where YI = Yolk index, h = yolk height/depth, d = yolk diameter

$$Shell\ ratio = \frac{Shell\ weight}{Egg\ weight}$$

Shell ratio: shell weight divided by the egg weight

$$Shell\ index = \frac{Shell\ weight}{Egg\ surface\ area}$$

Shell index: Shell weight divided by egg surface area where $Egg\ surface\ area = 4.67 \times (Egg\ weight)^{2/3}$Egg surface area = 4.67 × (egg weight) $^{2/3}$

$$Albumen\ ratio = \frac{Albumen\ weight}{Egg\ weight}$$

$$Yolk\ ratio = \frac{Yolk\ weight}{Egg\ weight}$$

Albumen and yolk ratios: Individual weights as the percentage of total egg weight.

2.5 *Data analysis*

All data processing and analysis were performed using SAS software (SAS Institute, Inc., Cary, NC, USA). The experiment followed a completely randomized design, and data were analysed using Analysis of Variance (ANOVA) through the PROC GLM procedure in SAS 2006. For significant effects, least square means (LSMEANS) were separated using the PDIFF option, with differences considered significant at $p<0.05$. Where significant differences were found, means were further separated using Duncan's multiple range test in SAS. Spearman's correlation coefficient was used to establish correlations. All graphs were generated using R software.

3 Results

3.1 *External egg traits*

Chicken ecotype had a significant ($p<0.05$) effect on all egg quality traits (Table 1). Eggs laid by hens from Apac were significantly ($p<0.05$) heavier and had greater egg length compared to those from other ecotypes (Figure 1).

Table 1. Variation in external egg traits from selected indigenous chicken ecotypes

Traits	Apac	Gulu	Katakwi	Lira	NaSARRI	*p*-value
Egg length (mm)	55.37[a]	54.88[ab]	53.72[c]	53.93[bc]	53.74[c]	0.001
Bottom Breadth (mm)	31.50[b]	31.35[b]	32.23[ab]	32.84[ab]	33.47[a]	0.04
Middle Breadth (mm)	40.76[ab]	39.93[c]	40.26[bc]	41.22[a]	40.76[ab]	<0.001
Top Breadth (mm)	34.20[ab]	33.25[b]	33.85[ab]	35.11[a]	34.80[a]	0.02
Shape index	73.71[bc]	72.92[c]	75.09[ab]	76.56[a]	76.04[a]	<0.001

a, b, c Means within the same row with different superscripts letters are significantly different at $p<0.05$

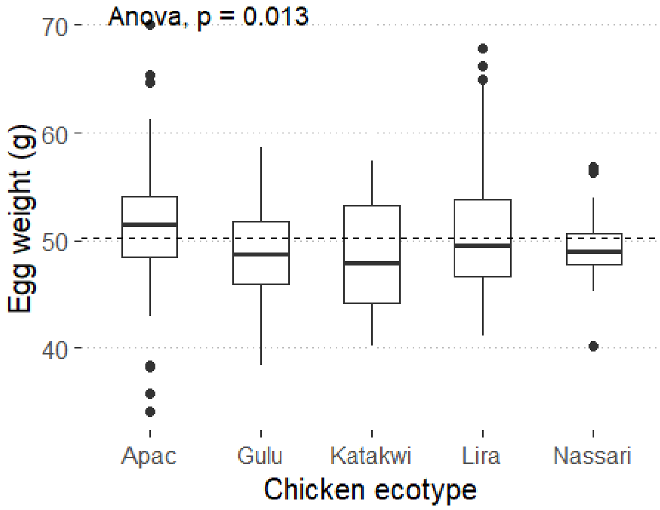


Figure 1. Variation in egg weight from selected indigenous chicken ecotypes

Significant differences ($p<0.05$) were observed in egg length, breadth, and shape index across the chicken ecotypes (Table 1). Egg length was longest in eggs from Apac chickens (55.4 mm) and shortest in eggs from Katakwi (53.7 mm). Eggs laid by hens from NaSARRI were significantly ($p<0.05$) wider at both the bottom and top, while those from Lira were wider in the mid-section. The shape index was highest in eggs from Lira and NaSARRI, with Lira showing the widest mid-section. In contrast, Gulu eggs had the lowest shape index.

3.2 Egg shell traits

Significant differences ($p<0.05$) in eggshell traits were observed across the ecotypes (Table 2). Eggs from Gulu hens had significantly thicker shells ($p<0.05$) compared to all other ecotypes, while those from Katakwi birds had heavier shells, along with the highest shell index and shell ratio. Apac birds produced eggs with the largest surface area. Except for Katakwi, shell weight was similar across all ecotypes ($p<0.05$), and the same pattern was seen with shell index and shell ratio, where only Katakwi eggs were significantly different ($p<0.05$). Although there was more variation in surface area, eggs from Gulu and Katakwi did not differ significantly ($p<0.05$), with Gulu eggs having the largest surface area.

Table 2. Variation in eggshell traits from selected indigenous chicken ecotypes

Traits	Apac	Gulu	Katakwi	Lira	NaSARRI	*p*-value
Shell thickness (mm)	0.21[b]	0.24[a]	0.19[b]	0.21[b]	0.20[b]	0.03
Shell weight (g)	6.24[b]	6.19[b]	8.65[a]	6.17[b]	6.32[b]	<0.001
Surface Area	64.57[a]	62.54[c]	62.48[c]	62.26[ab]	62.83[bc]	0.01
Shell index	9.64[b]	9.94[b]	13.95[a]	9.59[b]	10.05[b]	<0.001
Shell ratio	12.12[b]	12.71[b]	17.91[a]	12.09[b]	12.80[b]	<0.001

a, b, c Means within the same row with different superscripts letters are significantly different at $p<0.05$

3.3 *Internal egg traits*

Eggs laid by hens from Katakwi showed significant ($p<0.05$) differences in yolk depth and yolk index compared to the other ecotypes (Table 3). Similarly, only eggs from Gulu hens significantly ($p<0.05$) differed in yolk colour (Figure 2). Yolk ratio exhibited significant variation, with eggs from Katakwi hens having the highest score.

Egg yolk colour intensity measured using the digital YolkFan was highest for Gulu eggs but comparable to the other ecotype (Figure 2).

Table 3. Variation in egg yolk traits from selected indigenous chicken ecotypes

Traits	Apac	Gulu	Katakwi	Lira	NaSARRI	P-value
Yolk depth (mm)	15.26^{b}	14.61^{b}	16.01^{a}	14.59^{b}	14.76^{b}	<0.001
Yolk diameter (mm)	37.83^{a}	38.38^{a}	38.66^{a}	37.84^{a}	38.60^{a}	0.34
Yolk weight (g)	16.88^{a}	16.69^{a}	17.28^{a}	16.48^{a}	16.62^{a}	0.42
Yolk ratio	32.70^{b}	34.23^{ab}	35.35^{a}	32.49^{b}	32.94^{b}	0.003
Yolk index	40.71^{ab}	38.59^{b}	41.54^{a}	38.86^{b}	38.57^{b}	0.013

a, b, c Means within the same row with different superscripts letters are significantly different at $p<0.05$

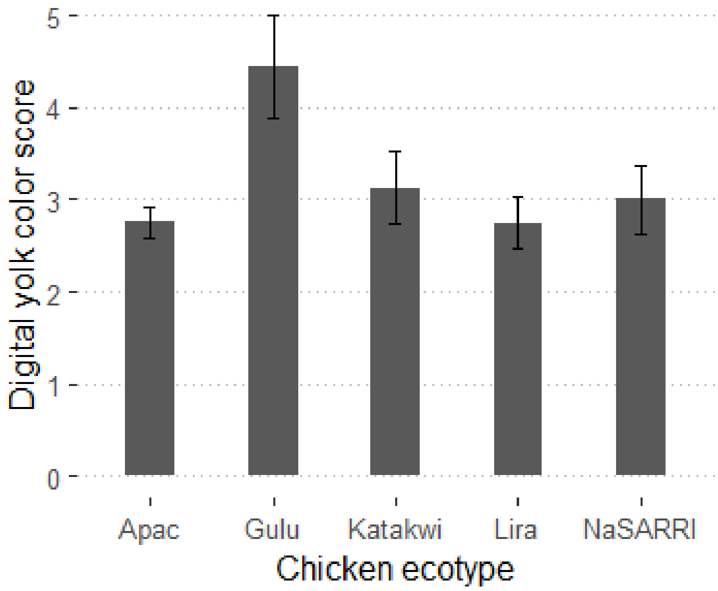


Figure 2. Variation in egg yolk colour from selected indigenous chicken ecotypes

The albumen traits analysed included albumen depth, Haugh unit, albumen weight, and albumen ratio, as shown in Table 4. Significant differences ($p<0.001$) were observed between ecotypes for albumen traits. Eggs from Apac and Lira had the highest and comparable values for albumen depth, weight, and Haugh unit scores. While the albumen ratio was consistent across ecotypes ($p>0.05$), it was notably lower ($p<0.001$) in eggs from Katakwi birds. Specifically, eggs from Lira and Apac hens had significantly higher ($p<0.05$) albumen depth and Haugh unit. The albumen ratio was lowest ($p<0.05$) in eggs from Katakwi but comparable for the other ecotypes. Although albumen weight varied among the ecotypes, eggs from Apac and Lira did not differ significantly from each other in this trait.

Table 4. Variation in egg albumen traits from selected indigenous chicken ecotypes

Traits	Apac	Gulu	Katakwi	Lira	NaSARRI	*p*-value
Albumen depth	4.36^{a}	3.91^{ab}	3.33^{b}	4.47^{a}	3.63^{b}	0.0012
Haugh unit	70.59^{a}	65.92^{ab}	60.93^{b}	71.66^{a}	63.97^{b}	0.0010
Albumen weight	28.56^{a}	25.98^{b}	22.94^{c}	28.33^{a}	26.98^{ab}	<0.0001
Albumen ratio	55.62^{a}	53.75^{a}	46.34^{b}	55.89^{a}	54.24^{a}	<0.0001

a, b, c Means within the same row with different superscripts are significantly different at $p<0.05$

3.4 *Correlation between external egg quality traits*

Egg weight showed a strong, significant positive correlation with both egg length and breadth, but a weak correlation (r^2=0.15) with shell weight (Figure 3). A moderate positive correlation was observed between egg length and breadth (r^2=0.39), while a weak positive correlation existed between egg breadth and shell weight (r^2=0.12). Additionally, egg breadth had a weak positive correlation with shell thickness.

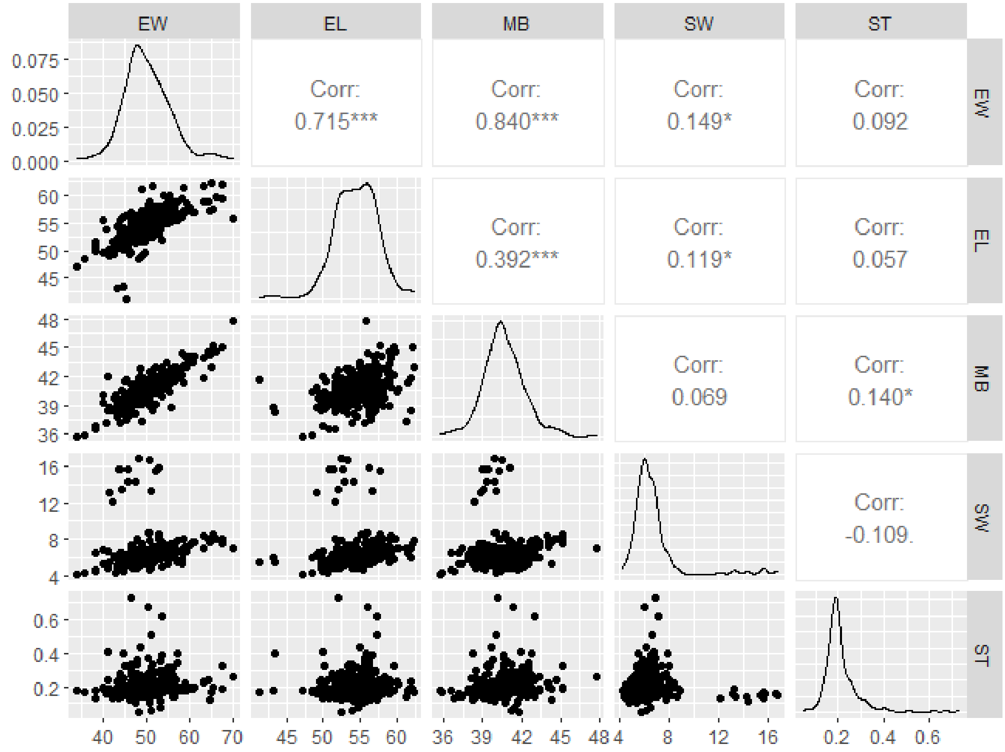


Figure 3. Relationship between measured external egg quality traits

The correlations between internal egg characteristics measured in this study are presented in Figure 4. Yolk depth showed weak but positive correlations with yolk weight, albumen depth, and Haugh unit (r=0.23 for each). A moderately strong positive correlation was observed between yolk diameter and yolk weight (r=0.48). Albumen weight also showed a weak correlation with Haugh unit (r=0.29). However, a very strong correlation was observed between Haugh unit and albumen depth (r=0.99), while albumen depth exhibited a weak association with albumen weight (r=0.29).

Table 5. Correlation between egg weight and internal egg quality traits

	EW	YD	YDia	YW	AD	HU	AW	AR	YR
EW	1.00	0.34***	0.23***	0.56***	0.26***	0.25***	0.81***	0.31***	-0.25***
YD		1.00	-0.04	0.23***	0.21**	0.21**	0.06	-0.18**	-0.07
YDia			1.00	0.50***	-0.04	-0.03	0.02	-0.15*	0.34***
YW				1.00	0.05	0.05	0.15*	-0.31***	0.62***
AD					1.00	0.99***	0.30***	0.26***	-0.17*
HU						1.00	0.29***	0.26***	-0.17*
AW							1.00	0.82***	-0.61***
AR								1.00	-0.69***
YR									1.00

***- Significant (*p*<0.0001), ** - significant (*p*<0.01), * - significant (*p*<0.05). EW, egg weight, YD yolk depth; YDia yolk diameter; YW yolk weight; AD albumen depth; HU Haugh unit; AW albumen weight; AR albumen ratio; YR yolk ratio.

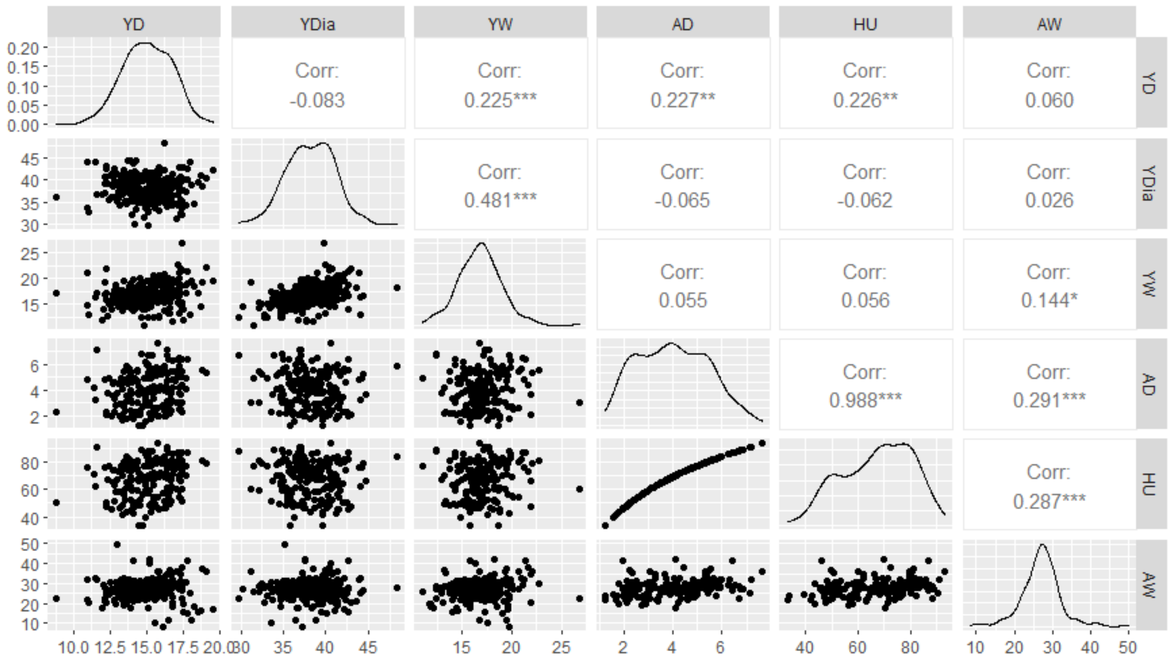


Figure 4. Relationship between internal egg quality traits

The correlation between egg weight, a readily measurable and non-destructive traits, and internal egg quality traits is shown in Table 5. All correlations between egg weight and internal traits were positive, except for yolk ratio which was negatively correlated (r^2=0.-0.25). The strength of the positive relationships varied between traits. A strong correlation was observed between egg weight and albumen weight (r^2=0.81), while moderate correlations were noted with yolk weight (r^2=0.56) and yolk depth (r^2=0.34). significantly weak correlations were seen with yolk diameter, albumen depth, and Haugh unit. Egg weight was significantly related to all internal egg quality traits, with relatively weak correlations with yolk depth (r^2=0.33), yolk diameter (r^2=0.23), and albumen depth (r^2=0.26). However, the correlation with yolk weight was moderately strong (r^2=0.56), and the strongest relationship was with albumen weight (r^2=0.81).

4 Discussion and Conclusion

Characterizing indigenous chicken eggs is essential for evaluating the suitability of various populations to meet consumer demands and for supporting breeding programs aimed at enhancing egg quality and hatching success rates (21). This study found significant variations in egg weight among ecotypes, with Apac hens producing the heaviest eggs and Gulu hens the lightest. Such differences may be attributed to variations in the body weight of mature hens, as heavier birds tend to lay larger eggs (22, 23). The average egg weights observed were higher than the 41.1 g reported by Beyihayo et al. (11), likely due to the broader sampling in their study compared to the more focused approach in the present study where we assembled the chicken flock from only few selected study districts. Additionally, management practices and hen age differences could explain variations; for example, Beyihayo et al. (11) used eggs from a semi-intensive system, whereas our study involved hens raised in an intensive deep litter system, which may reduce maintenance energy demands and allow for greater energy allocation to egg production.

The findings suggest that Apac chickens could be particularly valuable in breeding programs aimed at improving egg production traits. Their larger egg size correlates with greater egg length and a positive relationship with chick hatch weight (24), indicating that heavier Apac eggs may yield chicks with higher hatch weights. Although the egg weights in this study (ranging from 45 to 55 g) are lower than those reported for improved Kuroiler (57.1 g) and Sasso (55.8 g) breeds raised under similar conditions (25), they fall within the optimal range for high hatchability and embryonic survival, as reported in Koekoek chickens (26). Moreover, the average shape index for eggs from different ecotypes conformed to the standard range of 72–76% for normally shaped eggs (27) as cited by Dunman et al. (19), indicating desirable structural characteristics.

Eggshell quality is a critical economic trait in poultry production, as cracked or damaged eggs result in significant financial losses for both table and hatching egg markets. Since eggshell thickness directly influences breakage resistance, it is a vital focus in breeding programs aimed at improving egg quality. This study found that eggs from the Gulu ecotype had significantly thicker shells compared to other ecotypes, suggesting more efficient calcium mobilization and deposition during shell formation. This genetic variation in eggshell thickness among indigenous chicken ecotypes presents an opportunity for breeding efforts aimed at enhancing shell quality. The observed eggshell thickness was approximately half of that reported by Guni et al. (25) for Kuroiler and Sasso breeds, and lower than the 0.35 mm reported by Sun et al. (28) for Hyline layers. These differences illustrate the substantial genetic influence on eggshell traits, underscoring the need to select breeds with optimal shell quality for commercial egg production and hatching. Additionally, eggshell weight varied significantly among ecotypes, consistent with Osei-Amponsah et al. (29), who noted similar variations between Sasso and Ghanaian local breeds. The higher eggshell weight and eggshell-to-egg ratio in Katakwi chickens suggest this ecotype is more efficient in calcium mobilization and deposition for shell formation. Moreover, the shell weights and ratios observed in this study were notably higher than those reported by Osei-Amponsah et al. (30), highlighting the impact of genetic differences on eggshell characteristics .

This study revealed significant variation in internal egg quality traits, particularly yolk depth and yolk ratio, across chicken ecotypes, indicating a notable genotype effect. While yolk weight did not significantly differ among ecotypes, Katakwi eggs tended to have a higher yolk weight, consistent with Osei-Amponsah et al. (29, 30) who reported similar yolk weights in Ghanaian local chickens. They noted distinct yolk weight differences between Sasso and local chickens, likely due to Sasso's larger body size. The observed variation in yolk ratio aligns with findings from Osei-Amponsah et al. (29, 30) and falls within the ranges reported by Guni et al. (25) and Liswaniso et al. (7, 21), further highlighting the genotype's impact on yolk composition. In contrast, Guni et al. (25) found no significant difference in yolk ratio between Kuroiler and Sasso chickens, potentially due to the similar performance traits of these hybrid breeds.

Yolk colour scores were highest in Gulu chickens, demonstrating a genotype influence on this trait, which corroborates observations by Bekele et al. (31) in Ethiopian chicken ecotypes. As hens cannot synthesize carotenoids de novo and must acquire them through diet (32, 33), the differences in yolk colour among ecotypes may reflect variations in carotenoid extraction and accumulation efficiency, linked to genetic factors influencing xanthophyll uptake (32) and carotenoid bioavailability (34). Thus, we hypothesize that a genetic mechanism may be involved in the pigmentation of egg yolks across various indigenous chicken ecotypes.

This study demonstrated significant genetic influences on internal egg traits, particularly albumen characteristics, among different chicken ecotypes (35). These findings are consistent with previous research by Osei-Amponsah (29, 30) and Guni et al. (25), highlighting breed-based differences. The Haugh unit, a key measure of internal egg quality and freshness (17), was notably higher in eggs from the Lira and Apac ecotypes, indicating superior quality (36, 37). All ecotypes produced eggs with Haugh unit values above 60, qualifying them as grade A in the USDA grading system (38, 39). However, the values recorded here were lower than those reported by Tadesse et al. (36) for commercial layers, underscoring the genetic and environmental influences on egg quality traits.

Significant positive correlations among external egg quality traits align with findings from other studies, suggesting that selecting for egg mass could simultaneously enhance these traits in Uganda's indigenous populations (25). Similar correlations were observed for internal egg quality traits, indicating that improvements in one trait may lead to enhancements in others. Furthermore, this study confirmed strong correlations between egg weight and internal quality parameters, establishing egg weight as a reliable predictor of internal quality. Specifically, it strongly correlated with albumen weight ($r=0.81$) and moderately with yolk weight ($r=0.58$). Weaker, yet significant, correlations were found with other internal characteristics, suggesting that egg weight primarily influences albumen and yolk weights. These findings support previous research by Moula et al. (40) and Osei-Amponsah et al. (29, 30) regarding egg weight as an indicator of internal quality attributes.

This study reveals significant differences in egg quality traits among indigenous chicken ecotypes of Uganda, highlighting the potential for selective breeding to enhance egg quality. Hens from Apac produced larger and heavier eggs, while Gulu and Lira ecotypes exhibited better egg yolk colour and albumen quality, respectively. Egg weight was significantly positive correlated to both external and internal egg quality traits. These findings suggest that selective breeding based on egg weight and external traits can enhance overall egg quality in indigenous chicken populations without the need for destructive testing.

Acknowledgements

The authors are grateful for the support from the poultry technicians at the Mukono Zonal Agricultural Research and Development Institute (MuZARDI) for the routine management of the experimental chicken flock and for their active participation in the data collection.

Conflict of Interest

The authors declare no competing interests.

Author Contributions

M.K, and Z.N study conceptualization; M.K, and Z.N developed the methodology; M. K and O. Z data collection; M. K, and K.K carried formal data analysis; H. M and M.K funding and resource mobilization; data curation, M.K, Z.N., R.N and V. L; O. Z, Z.N and M.K writing original manuscript draft; writing—review and editing M.K, O.Z, Z.N, R.N, K.K and L.V.; data visualization, M.K and K.K.; project administration, H.M and R.N. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

All data analyzed during this study are included in this article. Any other data are available from the corresponding author upon reasonable request.

Ethical Considerations

All animal care and handling during data collection was undertaken in compliance with statutory animal care, welfare and prevention of cruelty under the Animal Act of Uganda 2000 (41).

Funding

This work was carried out with funding from USAID under the Feed the Future, Agriculture Research Activity (ARA) Project Ref. C-108-19.

References

1. Mujyambere V, Adomako K, Olympio SO, Ntawubizi M, Nyinawamwiza L, Mahoro J, et al. Local chickens in East African region: Their production and potential. Poultry Science. 2022;101(1):101547.[PMID: 34844110] [PMCID: PMC8633685] [DOI]
2. Manyelo TG, Selaledi L, Hassan ZM, Mabelebele M. Local chicken breeds of Africa: their description, uses and conservation methods. Animals. 2020;10(12):2257.[PMID: 33266253] [PMCID: PMC7760642] [DOI]
3. Augustine I, Shukla R. A study of consumer preferences and market potential for poultry products in Kumi district of Uganda. International Journal of Current Microbiology and Applied Sciences. 2017;6(10):2800-13[DOI]
4. Oloo B, Mahungu S, Kahi A. Descriptive sensory quality of Kenya's indigenous chicken meat from different ecotype-clusters reared under an intensive system. African Journal of Food, Agriculture, Nutrition and Development. 2018;18(1)[DOI]
5. Wambui C, Njoroge E, Wasike C. Characterisation of physical egg qualities in indigenous chicken under free range system of production in Western Kenya. 2018
6. Edmew W, Melesse A, Beyan M, Taye M. Assessing the performance, egg quality, and carcass characteristics of indigenous chickens reared under traditional management system. International Journal of Research Studies in Agricultural Sciences. 2018;4(10):27-35
7. Liswaniso S, Qin N, Shan X, Chimbaka I, Sun X, Xu R. Quality characteristics, phenotypic correlations and principal component analysis of indigenous free range chicken eggs in Lusaka, Zambia. Int J Environ Agric Res. 2020;6:29-35
8. Kgwatalala P, Molapisi M, Thutwa K, Sekgopi B, Selemoge T, Nsoso S. Egg quality characteristics and phenotypic correlations among egg quality traits in the naked neck, normal and dwarf strains of Tswana chickens raised under intensive management system. International Journal of Environmental & Agriculture Research. 2016;2(8):96-105
9. Yussif I, Kugonza DR, Okot MW, Amuge PO, Costa R, Dos Anjos F. Uganda chicken genetic resources: I. phenotypic and production characteristics. Frontiers in Genetics. 2023;13:1033031.[PMID: 36761692] [PMCID: PMC9902952] [DOI]
10. Beyihayo GA, Kugonza DR, Ndyomugyenyi EK, Echodu R, Okot MW, Anjos FD. Genetic and phenotypic parameter estimates for selection within Ugandan indigenous chickens. Tropical Animal Health and Production. 2023;55(2):100.[PMID: 36840813] [DOI]
11. Beyihayo GA, Ndyomugyenyi EK, Echodu R, Kugonza DR. In-situ morphological characterization of indigenous chicken Ecotypes in Uganda. Ecological Genetics and Genomics. 2022;24:100129[DOI]
12. King'ori A. Poultry egg external characteristics: egg weight, shape and shell colour. Res J Poult Sci. 2012;5(2):14-7[DOI]
13. Magala H, Kugonza D, Kwizera H, Kyarisiima C. Influence of varying dietary energy and protein on growth and carcass characteristics of Ugandan local chickens. Journal of animal production Advances. 2012;2(7):316-24
14. Ssewanyana SN, Ahmadi-Esfahani FZ. Household food security in rural Uganda: a statistical analysis. Ecology of food and nutrition. 2001;40(2):93-125[DOI]
15. Ndenga C, Kabuage LW, Bett EK. Economic Analysis of Consumer Demand for Indigenous Chicken Eggs in Kenya. Economic Analysis. 2018;9(17):21-8

16. ULII. The Animals (preventions and cruety) Act [Internet]. Uganda Legal Information Institute; 2000. Available from: http://www.ulii.org/node/23790.
17. Haugh R. The Haugh unit for measuring egg quality. 1937
18. Panda P. Shape and texture in text book on egg and poultry technology. New Delhi. 1996
19. Duman M, İekeroğlu A, Yıldırım A, Eleroğlu H, Camcı Ö. Relation between egg shape index and egg quality characteristics. European Poultry Science. 2016;80:1-9[DOI]
20. Sharp PF, Powell CK. Decrease in interior quality of hens' eggs during storage as indicated by the yolk. Industrial & Engineering Chemistry. 1930;22(8):908-10[DOI]
21. Liswaniso S, Qin N, Xu R. Quantitative analysis of egg quality traits of indigenous free-range chickens in kabwe, zambia. J Entomol Zool Stud. 2020;8(2):603-8
22. Lacin E, Yildiz A, Esenbuga N, Macit M. Effects of differences in the initial body weight of groups on laying performance and egg quality parameters of Lohmann laying hens. Czech J Anim Sci. 2008;53(11):466-71[DOI]
23. Pérez-Bonilla A, Novoa S, García J, Mohiti-Asli M, Frikha M, Mateos G. Effects of energy concentration of the diet on productive performance and egg quality of brown egg-laying hens differing in initial body weight. Poultry science. 2012;91(12):3156-66[PMCID: 23155026] [DOI]
24. Iqbal J, Khan SH, Mukhtar N, Ahmed T, Pasha RA. Effects of egg size (weight) and age on hatching performance and chick quality of broiler breeder. Journal of applied animal research. 2016;44(1):54-64[DOI]
25. Guni F, Mbaga S, Katule A, Goromela E. Effects of breed and management system on egg quality traits of two improved dual-purposes chicken breeds. Livestock Research for Rural Development. 2021;33(12):552-5
26. Molapo S, Motselisi M. The effect of egg size (weight) on the egg shell thickness, egg yolk and hatchability in Koekoek chickens. Online J Anim Feed Res. 2020;10(6):278-81[DOI]
27. Sarica M, Erensayin C. Poultry products. Bey-Ofset, Ankara-Turkey (in Turkish). 2004;2:100-60
28. Sun C, Chen S, Xu G, Liu X, Yang N. Global variation and uniformity of eggshell thickness for chicken eggs. Poultry Science. 2012;91(10):2718-21.[PMID: 22991562] [DOI]
29. Osei-Amponsah R, Kayang B, Manu H, Naazie A. Egg quality traits of local Ghanaian chickens and influence of storage period. Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales. 2014;55:93-9[DOI]
30. Osei-Amponsah R, Kayang B, Naazie A. Phenotypic and genetic parameters for production traits of local chickens in Ghana. Animal Genetic Resources/Resources Génétiques Animales/Recursos Genéticos Animales. 2013;53:45-50[DOI]
31. Bekele G, Goshu G, Esatu W, Melesse A, Dessie T. Phenotypic characterization of indigenous chicken ecotypes and analysis of their egg quality in Gambella Regional State, Ethiopia. Livestock Research Results. 2022:697-708
32. Jlali M, Graulet B, Chauveau-Duriot B, Godet E, Praud C, Nunes CS, et al. Nutrigenetics of carotenoid metabolism in the chicken: a polymorphism at the β, β-carotene 15, 15'-mono-oxygenase 1 (BCMO1) locus affects the response to dietary β-carotene. British journal of nutrition. 2014;111(12):2079-88.[PMID: 24642187] [DOI]
33. Chen Q, Wang Z. A new molecular mechanism supports that blue-greenish egg color evolved independently across chicken breeds. Poultry Science. 2022;101(12):102223.[PMID: 36283143] [PMCID: PMC9597111] [DOI]
34. Desmarchelier C, Borel P. Overview of carotenoid bioavailability determinants: From dietary factors to host genetic variations. Trends in Food Science & Technology. 2017;69:270-80[DOI]
35. Lordelo M, Cid J, Cordovil CM, Alves SP, Bessa RJ, Carolino I. A comparison between the quality of eggs from indigenous chicken breeds and that from commercial layers. Poultry Science. 2020;99(3):1768-76.[PMID: 32111337] [PMCID: PMC7587768] [DOI]
36. Tadesse D, Esatu W, Girma M, Dessie T. Comparative study on some egg quality traits of exotic chickens in different production systems in East Shewa, Ethiopia. African Journal of Agricultural Research. 2015;10(9):1016-21[DOI]
37. Stadelman WJ. Quality identification of shell eggs. Egg science and technology: CRC Press; 2017. p. 39-66
38. Jones D. Haugh unit: gold standard of egg quality. Natl Egg Qual Sch Proc. 2012;7:47-51
39. USDA A. United States standards, grades, and weight classes for shell eggs, ams 56. USDA Washington, DC; 2000.
40. Moula N, Antoine-Moussiaux N, Decuypere E, Farnir F, Mertens K, De Baerdemaeker J, et al. Comparative study of egg quality traits in two Belgian local breeds and two commercial lines of chickens. European Poultry Science. 2010;74(3):164-71[DOI]
41. Ulii. The Animals (preventions and cruety) Act 2000