Productivity, reproduction and egg quality of indigenous Chicken in Central Ethiopia

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Abstract

The study was conducted to assess productive and reproductive performance of indigenous chicken, and the egg quality traits of chicken in selected Districts, Central Ethiopia. A total of 264 village chicken owner households were selected randomly for the interview and 240 eggs were collected and transported to Hawassa University poultry farm for egg quality analysis. Egg production performance of indigenous chicken showed a significant difference across the study districts with higher potential in Sankura district. Egg weight, egg length, shell thickness, shell weight, shell weight percent, albumen weight, yolk weight were significantly higher in West Azernet. Haugh unit is the representative of egg freshness and egg quality parameters and the measure of corrected albumen quality for egg weight. The variations among different locations with respect to parameters are due to environmental differences. In addition, this difference might be due to differences in management (health care, feed type and feeding frequency) and the weather conditions in various districts might be different.

Key Words: Central Ethiopia; Egg quality; Indigenouse chicken, Performace

Introduction

According to FAO (2019), poultry production is one of the key livestock subsectors in Ethiopia. It plays important roles in terms of generating employment opportunities, improving family nutrition, and empowering women and it is a suitable business for poor households due to the small quantity of land needed and the low investment costs required to start up and run the operation (Fekede & Tadesse 2021). Chicken provides food and cash income and presents to strengthen social relationships and also play important socio-economic roles in developing countries (Bibi et al. 2021; Bekele et al. 2024). Chicken has a tremendous socioeconomic impact in Ethiopia, affecting food security, money generation, and religious and other uses (Gulilat et al. 2021; Yizengaw et al. 2022; Tadese et al., 2024). The internal and external egg quality traits were influenced by factors such as agro-ecology, breeding, nutrition (Menale et al., 2025) and their interaction (Serkalem et al. 2023).

Thus, identify and understanding the current status of productive and reproductive performance, constraints and egg quality traits of village chicken production might provide important and possible facts for critical entry points that need immediate attention to suggest possible solutions and to encourage better production and future improvement program of productive and reproductive performance, solve constraints and improving husbandry practice (feeding, housing, and health care and other management practices) in sustainable manner of village chicken production and updated and background information an essential pre-requisite to use as a secondary data for government organization, researchers, decision makers, and other stackholder or development programs in selected districts of Siltie Zone. Therefore, the study was conducted with the objectives; to identify Production and reproduction performances of indigenous chicken and egg quality traits of chicken under farmers' management condition.

Materials and methods

Description of the study area

The current study was conducted in Siltie Zone, Central Ethiopia Regional State. The main economic source of livelihood is based on mixed farming system (both crop and livestock production system).

Table 1 Descriptions of the study area

Siltie Zone Sub-Division of Woredas Agroclimatic Zone						
NO.	District	Agro-ecology	Climate	Altitude masl	Annual rainfall mm.	Average temperature (°C)
1	Worabe	Moist midland	Semi-humid	1500-2400	900-1400	23°C
2	Sankura	Dry midland	Semi-humid	1500-2400	< 900	25°C
3	West Azernet	Wet highland	cool and wet	2400-3200	>1400	17.5°C

Sampling technique and sample Size determination

Multi-stage sampling procedures (purposive and simple random sampling technique) weee used. West Azernet, Sankura and Worabe districts were selected based on potential of poultry production. For the interview, total of 264 chicken rearing farmers (66 from Worabe district, 110 from Sankura district and 88 from West Azernet district) were randomly selected following Yamane (1967) formula at 95% of confidence interval:

n= N/1+N*(e) ^{2} (Yamane, 1967) were used.

754/1+754*(0.05)^2=754/1+757*0.0025=754/2.885=264

n = the sample size; N = the population size; e = the acceptable sampling error

95% confidence level and p- value = 0.05

Data Collection on Egg Quality Parameters

For egg quality assessment, 240 (80 from each district) fresh eggs were collected and labeled in to their district and then transported to Hawassa University poultry farm and evaluated.

External egg quality parameters like egg weight, egg length, egg width, egg shell weight, eggs shell thickness and the internal egg quality parameters like yolk height, yolk diameter, yolk weight, yolk color, albumen weight and albumen height were determined. Egg weight was measured using a digital sensitive weighing balance. Egg length and egg width were measured using stainless hardened digital caliper in millimeters and egg shape index was calculated using the formula given below.

$$\text{Egg shell weight (\%)} = \frac{Dry\ shell\ weight}{Egg\ weight} * 100$$

$$\text{Egg shape index (\%)} = \frac{Width\ of\ egg}{Length\ of\ egg} * 100$$

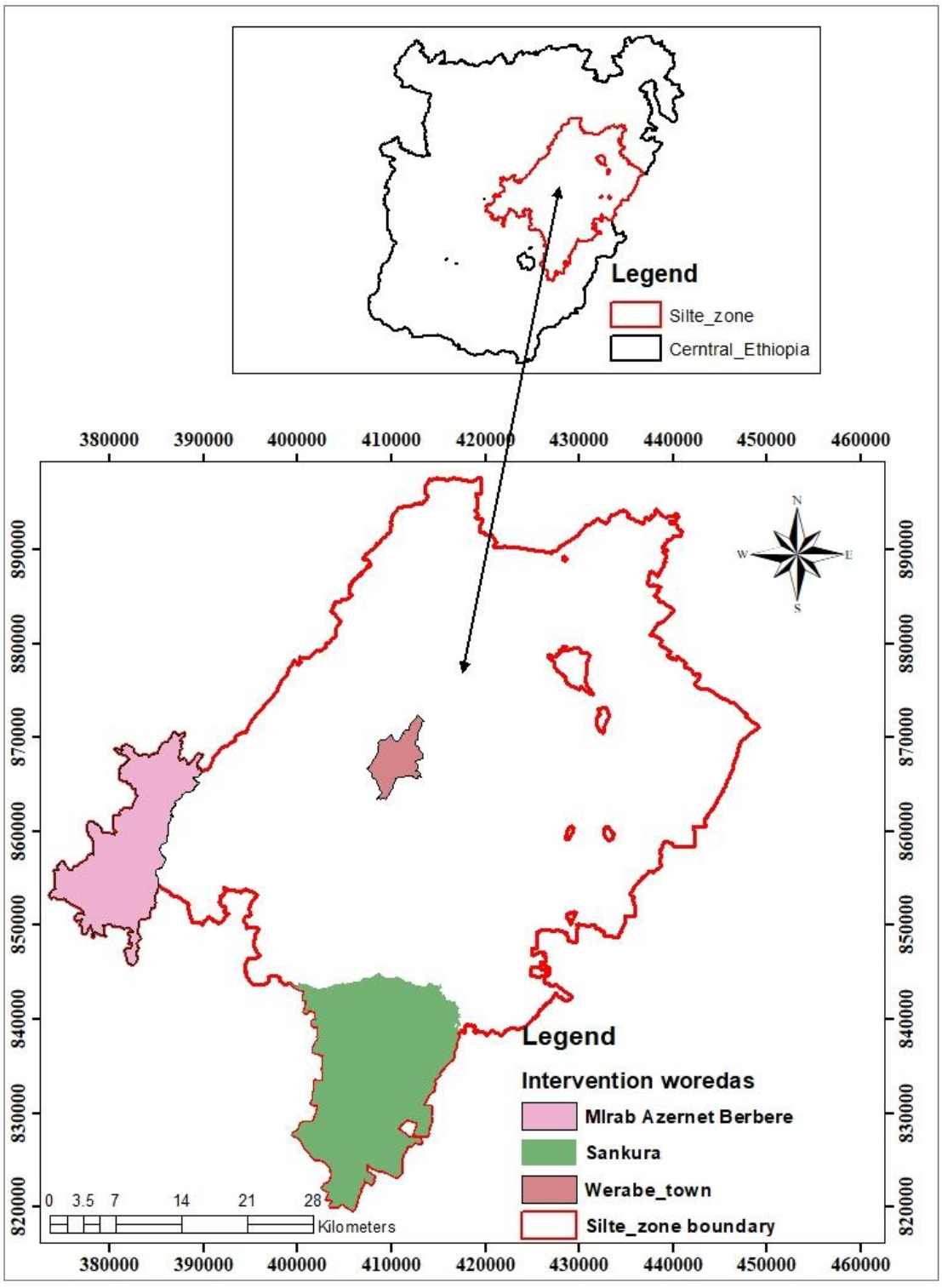


Fig 1. Map of study area

For internal egg quality traits individual egg samples were broken out on a flat mirror/glass on the table being cautious not to break the vitelline membrane that encloses the yolk. The parameters measured were as follows.
Yolk width was measured as the widest horizontal circumference with a digital caliper in millimeters.
Yolk height was measured as the height of yolk at the midpoint with a PAT.460176 Tripod Micrometer.
Yolk index = $\frac{\text{height of yolk}}{\text{width of yolk}}$(mm) Yolk height and diameter values were used to compute yolk index of the eggs.
Yolk Weight was measured yolk carefully separated from the albumen and weighed using a digital sensitive weighing balance (SF-400).
Albumen height was measured using PAT.460176 Tripod Micrometer which was made in Japan.
Albumen weight separated albumen from yolk and measured using a digital sensitive weighing balance (SF-400).

Albumen index=$\frac{\text{height of albumen}}{\text{width of albumen}}$

The egg shells were cleaned with tissue paper and removed the shell membrane by hand and then dried in the open air for 24 hours and weighed the eggshells without the shell membrane.
Then, the eggshell thicknesses were measured from the small end (lower), large end (upper) and middle position of the egg using a digital caliper and the average of the three places were used.
Haugh unit score of the eggs were estimated based on the albumen height and egg weight according the formula of Haugh, (1937).

$HU = 100\log (AH-1.7EW^{0.37}+7.6)$

Where:
HU= Haugh unit,
AH= Albumen height in millimeters, and
EW= Egg weight in gram

Yolk color was measured using Roche color fan consisting of a series of fifteen colored plastic strips used as a reference to determine yolk color.
Yolk Ratio and Albumen Ratio were estimated by following formula:

$$Yolk\ Ratio = \frac{Yolk\ weight}{Egg\ weight} * 100$$

$$\text{Albumen Ratio} = \frac{Albumen\ weight}{\text{Egg weight}} * 100$$

Based on the collected data, egg shape index, shell ratio, egg Haugh unit, yolk ratio, albumen ratio, and yolk index were calculated by using the given formulas.
Eggs were weighted to the nearest 0.01gm, egg length and width were measured at the midpoint using a digital caliper to the nearest point of 0.05mm and egg shape index was calculated.

Data Analysis

Survey data were analyzed by using Statistical Package for Social Sciences (SPSS) version-27. Collected data were described using descriptive statistics such as mean, frequency, Standard deviation and percentage were calculated and present in table. Means of quantitative data between districts were compared by employing one way analysis of variance (One-Way-ANOVA) with tye stastical model of

$Yij = \mu + \alpha i + \varepsilon ij$

Where Yij is chicken performance and egg quality parameter estimate for chicken j in i district, μ is the overall mean, αi is the fixed effect of district (i=3) and Ɛij is the residual error at significance level of $p<0.05$.

Results and discussion

Production and reproduction performances

Prodctive and reproductive performances of the studied chichen are presented in (Table 2). The mean pullet maturity at this study is in line with the reports of Assefa et al. (2019) and Matawork et al. (2019) who reported that sexual maturity of female indigenous chicken in Sheka zone was 25.2 weeks and sexual maturity of female indigenous chicken in Gena Bossa District of Dawro Zone was 24.1 weeks respectively; Serkalem et al. (2019) reported that sexual maturity of female indigenous chicken was 34.05 weeks around Boricha district of Sidama region.

The Mean egg production of eggs laid per hen per clutch of the this study is in close agreement with the report of the average egg production per clutch per hen around different parts of Ethiopia reported by Matawork et al. (2018); Tesfaye et al. (2018) and Tadele et al. (2018); as of 12.78 and 12.5 eggs per clutch per annum respectively.

The observed variations between different locations with respect to parameters are due to environmental differences. In addition, this difference might be due to differences in management (health care, feed type and feeding frequency) and the weather conditions in various districts might be different.

Table 2 Productive and reproductive performance of village chickens in three districts

Indigenous chicken performances	District				
	WD	SAD	WAD	Overall Mean	P-value
	N=66	N=110	N=88	N=264	
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
Pullets age of maturity in weeks	18.85±1.68^{c}	19.12±2.32^{b}	21.03±2.13^{a}	19.69±2.31	0.000
Cockerels age at first mate in weeks	22.09±2.14^{b}	22.30±2.34^{b}	23.07±1.97^{a}	22.51±2.20	0.011
Clutch lengths in days	23.01±3.94^{a}	23.64±4.60^{a}	21.92±3.70b	22.90±4.21	0.016
Number of clutches in a year	5.29±1.12^{a}	5.38±1.21^{a}	4.89±1.24^{b}	5.20±1.23	0.018
Number of eggs/clutch/hen	0 ±2.23^{a}	13.35±2.60^{a}	12.39±2.09^{b}	12.94±2.38	0.016
Average number of eggs lay per hen/year	4±11.30^{b}	71.07±18.19^{a}	59.67±13.31^{c}	65.86±15.86	0.000

WD=Worabe district; SAD=Sankura district; WAD= West Azernet District and SD Standard Deviation

Table 3 External Egg quality parameters in three districts of Siltie Zone, Central Ethiopia

Egg quality parameters		District			
	WD	SAD	WAD		
	Mean ±SD	(Mean ±SD)	(Mean ±SD)	Overall mean	P-value
Egg weight (gm)	40.4±4.41^{b}	39.24±3.90^{b}	42.9±5.31^{a}	40.84±4.81	<0.001
Egg length (mm)	51.83±2.20^{a}	49.57±1.89^{b}	52.89±2.00^{a}	51.42±2.45	<0.001
Egg width (mm)	37.80±1.67	38.03±1.59	38.21±1.83	38.01±1.70	0.299
Shell weight (gm)	4.0±0.477^{b}	3.81±0.69^{b}	4.50±0.50^{a}	4.10±0.635	<0.001
Shell thickness (mm)	0.286±0.01^{c}	0.292±0.029^{b}	0.306±0.014^{a}	0.2948±0.022	<0.001
Shell Weight (%)	10.03±1.65^{b}	9.69±1.29b^{c}	10.58±1.24^{a}	10.10±1.45	<0.001
Egg shape Index (%)	73.0±3.26^{b}	76.75±2.21^{a}	72.27±2.34^{c}	74.01±3.29	<0.001

Where as WD=Worabe District; SAD=Sankura District; WAD= West Azernet District and SD =Standard Deviation; % = Percentage gm =gram and mm=millimeter

External egg quality parameters

External egg quality traits are presented in Table 3. The mean egg weight in the current study was 40.4±4.41gm; 39.24±3.90gm and 42.09±5.31gm for Worabe, Sankura and West Azernet districts respectively. External egg quality of indigenous chicken in the study area indicated that egg weight in the West Azernet district was significantly higher than that of Worabe and Sankura districts respectively ($p<0.05$). The current result is in line with values presented by Welelaw et al. (2018) who revealed that average egg weight of indigenous chicken 43.9gm at different areas of Southern Ethiopia.

The egg length (52.885±2.00mm) in the West Azernet district was significantly higher than that the remaining dstricts. The result is not in agreement with the report of Yusuf and Kefyelew (2024) who reported that the egg length of indigenous chicken was 49.84±2.584mm in Siltie Zone, Central Ethiopia.

Internal egg quality parameters

The internal egg quality parametrs are indicated in Table 4. The overall mean of albumen height in three studied districts is reported as 4.60±0.61mm. Albumen height in the Worabe district was significantly higher than that of Sankura and West Azernet districts respectively ($p<0.05$). The current study was in line with Legesse and Sunkurta (2024) and Yusuf and Kefyelew (2024), reported that the albumen height of indigenous chicken were 4.96±1.19mm and 4.59±0.749mm respectively in different parts of the country.

Yolk weight of indigenous chicken in the study area are 16.89±2.10, 16.30±2.30 and 17.70±1.01gm for Worabe, Sankura and West Azernet districts respectively, and with the overall mean yolk weight of 16.98±1.97gm. This is in consistence with Yusuf and Kefyalew (2024) reported that overall mean yolk weight of the indigenous chicken in highland and in midland agro-ecology was 14.95±0.323.

Correlation among external egg quality parameters

Correlation of external egg quality parameters of indigenous chicken presented in Table 5. The result indicated that there was a positive and very strong correlation of egg weight with egg length and egg width.

Table 4 Internal egg quality parameters of the study districts

Egg quality parameters		District			
	WD	SAD	WAD		
	(Mean ±SD)	(Mean ±SD)	(Mean±SD)	Overall Mean	P-value
Albumen weight (gm)	22.72±2.81	21.93±2.97	22.90±3.49	22.50±3.12	0.116
Albumen height (mm)	4.91±0.73[a]	4.67±0.24[b]	4.25±0.56[c]	4.60±0.61	<0.001
Yolk weight (gm)	16.89±2.10[b]	16.30±2.30[c]	17.70±1.01[a]	16.98±1.97	<0.001
Yolk height (mm)	15.45±0.50[a]	14.16±1.06[c]	14.9±0.83[b]	14.83±0.985	<0.001
Yolk diameter (mm)	36.21±2.17	36.88±5.40	36.24±1.43	36.45±3.46	0.387
Yolk Roche fun color	10.55±1.36[a]	9.17±1.36[b]	10.70±1.01[a]	10.14±1.42	<0.001
Yolk ratio (%)	41.89±3.78	41.57±4.20	41.70±4.24	41.72±4.06	0.882
Albumen ratio (%)	56.28±3.78[a]	55.85±4.34[a]	53.61±6.42[b]	55.25±5.09	0.002
Haugh unit (%)	76.22±6.13[a]	73.93±3.29[b]	69.94±4.14[c]	73.37±5.33	<0.001
Yolk index (%)	42.78±2.31	39.33±6.65	41.2±2.95	41.10±4.61	0.094

WD=Worabe District; SAD=Sankura District; WAD= West Azernet District; % = Percentage gm =gram and SD =Standard Deviation; mm=millimeter

Table 5 Correlation (Pearson's) external egg quality parameters in three districts

	Egg/w	Egg/l	Egg/wi	Shell/w	Shell/t	Shape/i	Shell %
Egg/w	1						
Egg/l	0.8326	1					
Egg/wi	0.9033	0.5705	1				
Shell/w	0.4813	0.5609	0.2903	1			
Shell/t	0.1464	0.2859	-0.0066	0.4881	1		
Shape/i	0.0105	-0.5204	0.4039	-0.3291	-0.3405	1	
Shell %	-0.2817	-0.0420	-0.4281	0.6970	0.4115	-0.4043	1

Where as w= weight; l= lenght; wi= width;t= thickness;i= index and %=percent

Correlation between internal egg quality parameters

Correlation of internal egg quality parameter results indicated in Table 6. There was a strong positive correlation of albumen height with albumen weight, yolk height, albumen ratio and haugh unit of indigenous chicken unlikely negetive correlation with the yolk weight. This is in agreement report of Markos et al. (2017) who stated that a strong positive correlation between albumen weight and yolk weight in highland, midland and lowland ecotypes of Tigray chickens.

Haugh unit is the representative of egg freshness and egg quality parameters and the measure of corrected albumen quality for egg weight. In the current study Huagh unit was strongly and positively correlated with the albumen height and negatively correlated with egg yolk weight and yolk diameter, like as of the report of (Rafea, 2019; Yusuf and Kefyalew, 2024).

Table 6 Correlation (Pearson's) internal egg quality parameters

	A /height	Y/weight	A/weight	Y/diamete	Y/height	R/scale	Y/Ratio	A/ ratio	H/unit
A/height	1								
Y/weight	-0.1643	1							
A/weight	0.4959	0.1514	1						
Y/diameter	-0.102	0.5921	0.022	1					
Yolk height	0.2358	0.1361	0.3483	-0.4009	1				
R/scale	0.1195	-0.0474	0.2032	0.0066	0.1755	1			
Y/ ratio	-0.3632	0.3743	-0.5941	0.3164	-0.1209	-0.1914	1		
A/ ratio	0.4846	-0.481	0.624	-0.2838	0.2052	0.0934	-0.3083	1	
H/ unit	0.7835	-0.3001	0.0529	-0.1417	0.0784	0.07	0.1028	0.4361	1

Where as Y=yolk, A=albumen, H= haugh and R=roach

Conclusion

Chicken production plays a great role as a prime supplier of eggs and meat in rural and urban area and as a source of income. The indigenous chickens had low productive and reproductive potential but they can resist harsh environment, diseases and poor management conditions than exotic chickens. There was a variation among the study districts that may offer a chance of selection for further improvement of production and productivity of chicken at the given site.

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