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RESEARCH ARTICLE

Morphological and morphometric features of indigenous chicken in North Shewa zone, Oromia regional state, Ethiopia

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Abstract

This study was conducted in the Kuyu and Girar Jarso districts of north Shoa Zone Oromia regional state, Ethiopia, to generate information on the morphological and morphometric characterization of local chicken ecotypes. Multi-stage purposive random sampling technique was used to collect the data. Morph metric data were collected on body weight and other linear measurements and analyzed using the statistical analysis system's generalized linear model (GLM) procedures. A total of 576 (192 male and 384 female) chickens were considered for qualitative and quantitative traits studies. The results showed that all indigenous chicken in the study area possesses normal feather morphology where, as 99.5% normal and 0.5% crest feather distribution were found. The dominant skin color was yellow, 59.2%, followed by white, 31.6%. With regard to shank color, the yellow color was the dominant (47.6%), followed by white (29.3%) and gray (16.7%). Red (13%), white (11.8%), and Kohima (11.1%) were the predominant plumage colors observed in the study area. The overall mean of body weight, chest circumference, wing span, body length, and shank length for males and females were 1.7 and 1.2 kg, 28.7 and 27 cm, 40.4, 39.4, 37.5, 35.3, 8.4 and 8.2 cm respectively. In the present study, morphological and phenotypical variations have been observed among the indigenous chicken populations; hence, an in-depth molecular evaluation is needed to show the level of genetic variation and relationship among them.

Keywords: Indigenous chicken, Morphological, Morphometric, North shewa zone.

Introduction

Chicken production is a major component of the livestock sector in Ethiopia. Owing to the large population of about 60.04 million, of which 88., 6.25, and 5.25% of the total population were indigenous, hybrid, and exotic, respectively (CSA, 2018). Of this total population, 37.65% are chicks, followed by laying hens (33.83%). Pullets are also estimated to be about 6.43 million in the country. Cocks and cockerels are also estimated separately and are 5.75 million and about 3.39 million, respectively. The others are non-laying hens that makeup about 2.58% (1.55 million) of the total poultry population in the country. The total annual chicken egg and meat production in Ethiopia is estimated to be about 51,000 and 91,900 metric tons, respectively, from which local chickens contribute more than 90% of the national chicken meat and egg output (CSA, 2013).

The productivity of indigenous chicken is low as compared to exotic breeds, with average annual egg production of 60 eggs/hen (Fisseha *et al.*, 2010). On the other hand, the live weight of indigenous chicken is about 1.68 and 1.42 kg for males and females, respectively, at 6 months of age (Hailu & Aberra, 2018). The performance of indigenous chickens initiates the government to modernize poultry production by introducing exotic breeds in the 1990s (Abebe, 2006). This indiscriminate introduction of exotic genetic resources before the proper characterization, utilization, and conservation of indigenous genetic resources is the main cause of the loss of indigenous chicken genetic resources (Halima, 2007).

In general, different researchers characterize indigenous chicken at different times. Indigenous chickens are non-descriptive, with various morphological appearances

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(Halima, 2007; Mekonen, 2007). Addisu (2013) studied three indigenous chicken ecotypes up to 18 weeks of age, which were selected from eastern Amhara region, Ethiopia. Mearg *et al.* (2017) also studied phenotypic characterization of local chicken ecotypes in the Central Zone of Tigray in Northern Ethiopia—on-farm phenotypic characterization of indigenous chicken ecotypes in west Hararghe zone, Oromia region. Hailemichael (2013) studied the phenotypic and morphological characterization of indigenous chicken populations in the Southern Zone of Tigray, Ethiopia. Nigussie (2011) also examined morphological and genetic characterization of indigenous chickens in different parts of Ethiopia with regard to breeding practices and traits preference of farmers.

The study of morphologic variations of domestic indigenous chicken ecotypes and identification of economically important phenotypic traits of the study area was necessary to give important and feasible recommendations for further improvement of the system in a sustainable way. Therefore, the description of each of the above parameters, which was possible both by measurement and appraisal techniques, contributed to the morphology characterization. So this makes easier conservation of indigenous chicken genetic merit for sustainable utilization.

Materials And Method

Description of the Study Area

The study was undertaken in two districts of North Shoa, i.e., Kuyu and Girar Jarso of Oromia Regional State. Study sites were selected based on the potential for the indigenous chicken population and accessibility (Table 1).

Sampling Design

In order to learn more about the genetic variety of indigenous chicken in the study area, important informants and zonal livestock and fisheries resource experts were engaged before sampling. In order to establish the distribution of local chicken breeds in the study area and to provide a framework for sampling, a fast field survey was carried out. A purposive random sampling technique was used to determine the number of Kebles and households to cover in two districts. Accordingly, 3 Keble's from Girar Jarso and 5 Keble's from Kuyu districts were purposively selected where exotic breeds were not distributed. The districts were selected based on the prevalence of the indigenous chicken in the area, and the information of which was obtained from the authorities of the Bureau of Fishery and Livestock Development. From each Keble, 24 households that possess a minimum of 5 matured (one year and above) chickens were selected by purposive random sampling technique. The total numbers of households considered therefore were 192. From each household, three matured chickens (1 male and 2 Females) were sampled. A total of 576 chickens were considered for qualitative and quantitative traits studies.

Table 1: Description of the study area

Description	*Kuyu district*	*Girar Jarso district*
Geographical location	9o, 36'34"-9o 56'56"N and 38o 05'00"-38034'13»E	90 35'-100 00'N and 380 39'-380 39'E
Annual rainfall (mm)	637.3–1759	801–1200
Temperature (°C)	4.8–28.5°C	11.5 and 35°C
Altitude (m.a.s.l.)	2515 and 2547	1300 and 3419

Source: - WFEDO, 2014

Data Collection

Quantitative morphological data

Morphometrical data were collected from the indigenous chickens according to FAO (2012) guidelines. Indigenous chickens of both sexes from each district were randomly selected, and their quantitative morphological traits were considered. Measuring tapes and a spring balance were used to collect morphometrical data.

Qualitative Morphological data

Discrete or qualitative variables data (feather morphology, feather distribution, plumage color, comb type, shank color, earlobe color, eye color, and head shape) were collected from individual chickens by visual appraisal as outlined by FAO (2012).

Statistical Model and Data Analyses

Statistical model

A general linear model was used to evaluate the effect of sex and districts on the quantitative.

Traits of each prevailing local chicken type at each district separately.

$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + e_{ijk}$

Where Y_{ijk}: the corresponding quantitative trait of local chicken in i^{th} districts (i=2, Kuyu and Girar Jarso)

μ: overall population mean for the corresponding quantitative trait

A_i: Effect of i^{th} districts

B_j: effect of j^{th} sex (j=2, male and female)

AB_{ij}: districts and sex interaction effect and e_{ijk}: residual error

Data analyses

All qualitative data were analyzed using Statistical Package for Social Sciences (SPSS 21.0 for Windows, release 21.0, 2012), whereas the collected quantitative data were statistically analyzed using the generalized linear model (GLM) procedures of the statistical analysis system (SAS Institute Inc., 2009). Chi-square (X^2) test was also employed to test the association of different categorical variables included in this study. Correlation analyses were also done to test the relationship between variables.

Results and Discussion

Morphological Variations of Indigenous Chicken

The feather morphology of all studied chicken populations was normal across the two study districts. This result is in line with the findings of Hailemichael (2013), who reported normal feather morphology in all of the local chicken populations in the Southern Zone of Tigray, Ethiopia. Similarly, Hailu and Aberra (2018) reported that 93.5% of the chicken in Sheka Zone, South Western Ethiopia, showed normal feathers morphology which was good in accordance with the current result. However, Niguse *et al.* (2010) reported 52 to 66% and 34 to 48% of Ethiopia's five local chicken ecotypes were normal and silky feathers, respectively, which is different from this study finding. This variation might be attributed to differences in breed type among the local chicken ecotypes in Ethiopia (Figure 1 and Table 2)

Feather Distribution

All of the sampled chicken in kuyu and about 98.5% of the chicken in Girar Jarso showed normal feather distribution. In agreement with this result, Nigussie *et al.* (2010) revealed that 96% of the Sheka chickens were normal feather distribution. However, Hailu and Aberra (2018) reported 86.7% of normal feather distribution in Sheka Zone, which was lower than the current result. Naked neck chickens were not observed in study areas. The reason might be due to the difference in breed type and the agroecology of the birds' environment. Nigussie *et al.* (2010) also reported that the distribution of Naked-necks were attributed to the lowland environment.

Head Shape

About 96.5% of the chicken in the study area showed plain-type heads, whereas 3.5% were crest (guys). The variation might be attributed to differences in breed type among the local chicken ecotypes in Ethiopia.

Shank color

About 49.4, 26.7, 15.8, 3.3 and 4.7% of the chicken in the kuyu district showed yellow, white, gray, black, and blue shank colors, respectively, while in the Girar Jarso district, 44.4, 33.8, 18.1, and 3.7% of the chicken showed yellow, white, gray and black shank colors respectively. As a result, revealed yellow shank color was slightly higher in the Kuyu district. This might be due to the presence of herbage feed sources for the formation of carotenoid pigments in Kuyu, as suggested by (Aberra & Tegene, 2011; Eskindir *et al.* 2013 and Addisu, 2013).

Earlobe Color

Six earlobe colors, namely red, white, red-white, gray, black, and yellow, were observed with frequencies of 35.4, 28.3, 27.6, 3.6, 3.6, and 1.4%. The difference in earlobe colors observed in the study area might be due to the chickens inherited earlobe color from their parents (Cabarles *et al.,* 2012), the nutritional status of birds (Aberra & Tegene, 2011), and the specific traits of the breed. Different scholars like Aberra and Tegene (2011) in the southern region, Addisu *et al.* (2013) in North Wollo, Mearg *et al.* (2017) in the Central Zone of Tigray, and Eskindir *et al.* (2013) also reported that red earlobe color was the dominant color in their findings which is inconsistent with the present study finding.

Skin Color

There was a significant difference ($p < 0.01$) between skin color and district. As a result, revealed, the yellow shank was relatively higher in Kuyu than in the Girar Jarso district. This difference might be due to changes in gene expression attributed to the skin colorations over time due to the availability of diversified feed resources for chickens. The current result was in line with Addisu *et al.* (2013), who reported the majority of yellow skin color in North Gondar. Contrary to the current result, Eskindir *et al.* (2013) and Getachew (2016) reported the majority of the chicken possess white skin color in the Horro district and Bench Maji zone.

Comb Type

The majority of the chickens possessed single comb type (45.5%), followed by rose (30.2%), pea (22.2%), and walnut (2.1%). Consistent with the current result, Addisu *et al.* (2013), Emabet (2015and Mearg *et al.* (2017) reported that the majority of local chicken found in the North Gondar Zone, South West Showa, and Gurage zones, and Central Zone of Tigray, respectively, possessed single followed by rose comb. Banerjee (2012) and Cabarles *et al.* (2012) showed that single comb is the most common comb type in tropical regions. This could be because the presence of a single comb helps to reduce 40% of body heat (Duguma, 2006).

Eye Color

The dominant eye color was orange (55.6%), followed by red (28.3%), brown (13.4%), and gray (2.8%) in the study area. Similarly, Mearg *et al.* (2017) and Bogale *et al.* (2019) reported orange as the major eye color observed in the Central zone of Tigray and in the west Hararghe zone of the Oromia region, respectively. In contrast to the current result, Duguma (2009) reported Horro, Tepi, and Jarso ecotypes had black (100%) type of eye coloration. Addisu (2013) also reported 95.7 and 92% red eye color in the Eastern and North Gonder Zone Amhara region, Ethiopia, respectively, which disagrees with the current findings. This variation might be a breed's-specific trait, nutritional status, genotype, and reflected adaptation fitness to their environment (Aberra & Tegene, 2011) from the Southern Region of Ethiopia.

Plumage color descriptions of indigenous chickens in study districts

There was a significant difference ($p<0.05$) in plumage color between districts. The results indicated that red (12.9%), kokima (12.1%), white (10.8%), and black (7.5%) were the

Table 2: Morphological features of indigenous chicken populations reared in study districts

	Districts				
Traits	*Kuyu*	*Girar Jarso*	*Overall*	*X2*	*p-value*
	N (%)	N (%)	N (%)		
Feather morphology					
Normal	360 (100)	216 (100)	576 (100)		
Feather Distribution				5.026	0.025
Normal	360 (100)	213 (98.6)	573 (99.5)		
Crest	-	3 (1.4)	3 (0.5)		
Skin color				28.402	0.000
Yellow	201 (55.8)	140 (64.8)	341 (59.2)		
White	108 (30)	74 (34.3)	182 (31.6)		
Black	42 (11.7)	2 (0.9)	44 (7.6)		
Pink	8 (2.2)	-	8 (1.4)		
Shank color				13.702	0.008
Yellow	178 (49.4)	96 (44.4)	274 (47.6)		
White	96 (26.7)	73 (33.8)	169 (29.3)		
Gray	57 (15.8)	39 (18.1)	96 (16.7)		
Black	12 (3.3)	8 (3.7)	20 (3.5)		
Blue	17 (4.7)	0	17 (3)		
Earlobe color				4.867	0.432
Red	122 (33.9)	82 (38)	204 (35.4)		
Red white	105 (29.2)	58 (26.9)	163 (28.3)		
White	100 (27.8)	59 (27.3)	159 (27.6)		
Black	11 (3.1)	10 (4.6)	21 (3.6)		
Gray	17 (4.7)	4 (1.9)	21 (3.6)		
Yellow	5 (1.4)	3 (1.4)	8 (1.4)		
Head shape				0.497	0.481
Plain	346 (96.1)	210 (97.2)	556 (96.5)		
Crest (gutye)	14 (3.9)	6 (2.8)	20 (3.5)		
Eye color				7.279	0.064
Orange	191 (53.1)	129 (59.7)	320 (55.6)		
Red	101 (28.1)	62 (28.7)	163 (28.3)		
Brown	54 (15)	23 (10.6)	77 (13.4)		
Gray	14 (3.9)	2 (0.9)	16 (2.8)		
Comb type				3.896	0.273
Rose	106 (29.4)	68 (31.5)	174 (30.2)		
Pea comb	74 (20.6)	54 (25)	128 (22.2)		
Single	174 (48.3)	88 (40.7)	262 (45.5)		
Walnut	6 (1.7)	6 (2.8)	12 (2.1)		

X^2= Chi square, (-) = not applicable N= number of house hold, number in bracket is percentage

predominant color for females in the Kuyu district. In the same district, red (14.2%), kokima (10%), white (10%), and black (8.3%) were the predominant color for males. In Girar Jarso, predominant colors were white (16%), red (12.5%), kokima (8.3%), and black (8.3%) for females and kokima (15.3%), red (12.5%), white (9.7%), black (9.7%) are the predominant colors observed on males. The great variability of phenotypes may mean at the chickens are not selected for their particular purpose.

The overall predominant colors in the current study were Red, White, Kokima, and Black. Mearg *et al.* (2017) reported that the predominant plumage color of the local chicken population in central Tigray was red, followed by grayish, brownish/banana, which agrees with the red plumage color to the current findings. Contrary to the current result, Emabet *(*2015) reported brown (32.8%), gray mixture (14.4%), and red-brownish with black (14.4%) as the predominant plumage color of the local chicken population in southwest Shewa and Gurage zones of Ethiopia. The occurrence of different varieties of plumage colors might be due to the segregation of alleles from random mating among birds possessing different plumage patterns (Liyanage *et al.*, 2015). Maintaining this plumage color diversity is indicative of many genes governing the trait in such a way that these colors are certainly due to the presence of genes with major effects and interactions between some of them (Hailu & Aberra, 2018). Multiple uncontrolled crossbreeding over several decades between animals with different plumage colors gives birth to other combinations, probably those found in small proportions (Khadidja *et al.*, 2014) (Table 3).

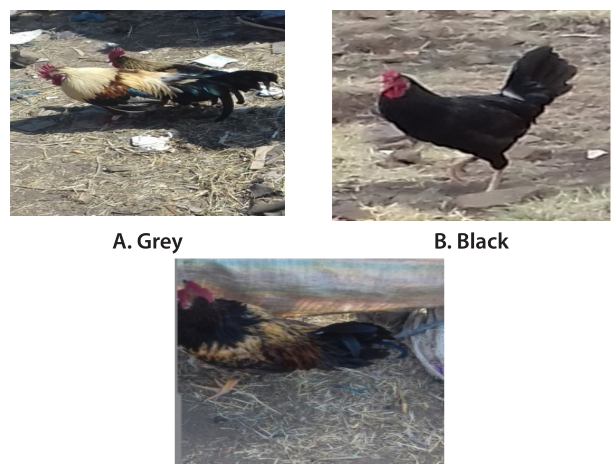

Figure 1: Sample pictures of different plumage colors of indigenous male chickens in the study area

Figure 2: Sample pictures of different plumage colors of indigenous male chickens in the Study area

Table 3: Plumage color description of chicken population in the study area

Districts Test							
	Kuyu		*Girar Jarso*		*Overall*	*X2*	*p-value*
Plumage color	Female N=240	Male N=120	Female N=144	Male N=72	N=576	41.702	0.014
Red (kei)	31 (12.9)	17(14.2)	18(12.5)	9 (12.5)	75(13)		
Kokima (reddish brown)	29 (12.1)	12 (10)	12 (8.3)	11(15.3)	64(11.1)		
Netch(White)	26 (10.8)	12 (10)	23 (16)	7 (9.7)	68(11.8)		
Brown	10 (4.2)	6 (5)	3 (2.1)	5 (6.9)	24(4.2)		
Tikur	18 (7.5)	10(8.3)	12 (8.3)	-	40(7)		
Zigrima	10 (4.2)	5(5.2)	5 (3.5)	7 (9.7)	27(4.7)		
Netch Gebsima	10 (4.2)	4(3.3)	3 (2.1)	5 (6.9)	22(3.8)		
Light brown	1 (0.4)	1(0.8)	9 (6.3)	3 (4.2)	14(2.4)		
Tikur teterma (black with white tips)	12 (5.0)	6(5.0)	9 (6.3)	3 (4.2)	30(5.2)		
Dark brown	7 (2.7)	4 (3.3)	6 (4.2)	5 (6.9)	22(3.8)		
Golden red	9 (3.8)	1 (0.8)	8 (5.6)	1 (1.4)	19(3.3)		
Netch-teterma	4 (1.7)	5 (4.2)	7 (4.9)	3 (3.2)	19(3.3)		
Deep red	4 (1.7)	1 (0.8)	3 (2.1)	-	8(1.4)		
Tikur Gebsima	7 (2.9)	2 (1.7)	5 (3.5)	6 (8.3)	20(3.5)		
Zagolima	8 (3.3)	5 (4.2)	6 (4.2)	2 (2.8)	21(3.6)		
White pointed	3 (1.3)	3 (2.5)	1 (0.7)	-	7(1.2)		
Key teterma (red with white tips)	11 (4.6)	7 (5.8)	6 (4.2)	1 (1.4)	25(4.3)		
Wosera (yellowish brown)	12(5)	5(4.2)	7(4.9)	3(4.2)	27(4.7)		
Anbesima (multicolor)	14(5.8)	8(6.7)	4(2.8)	6(8.3)	32(5.6)		

The Chi-square values denote significant differences between populations/districts ($p < 0.05$), Kei = complete red plumage; Tikur = complete black plumage; Netch = complete white plumage; Seran = white with red strips; Gebsima= mixture of grayish and white plumage; Netch-Gebsima = mixtures of white and black with varying shades of whit dominant; Tikur-Gebsima = mixtures of white and black with varying shades of black dominant; Kokima = grayish strips on brown or reddish background; Zigrima = black and white spotted feathers on red background; Zagolima= white speckles on black background; NetchTeterima= white with black or red tins; keyTeterima= red with white trips; TikurTeterima= black with white tips. Names of plumage colors are in Amharic, the Official Working Language of Ethiopia.

Sample pictures of different plumage colors of indigenous female chickens in the study area

Sample pictures of different plumage colors of indigenous male chickens in the study area is shown in Figure 2.

Morph metric Characteristics of Indigenous Chicken.

District effect

Body weight, chest circumference, wing span, body length, neck length, keel length, beak length, and wattle length varied significantly ($p < 0.05$) across districts. The rest of the linear body measurements did not show a significant ($p > 0.05$) difference between the study districts. Therefore, better values of body weight (1.40 ± 0.02), chest circumference (27.8 ± 0.10) and wing span (40.44 ± 0.02) were obtained in Kuyu district while keel length (10.5 ± 0.09) and neck length (14.68 ± 0.12) were better in Girar Jarso district. This variation might be due to attributed to environmental influence and genetics (Table 4).

Sex effect

The current study observed wide variations in body weight and other traits between males and females. In all parameters, male shows higher values than female. This might associate with gonad development and secretion of sex hormones of the respective sexes, as suggested by Ige *et al.* (2012).

In the current result, the body weight for adult males (1.70 ± 0.04 kg) was higher than 1.46 kg for males in north Gonder (Addisu, 2013), 1.27 kg for males in southern Tigray (Hailemichael, 2013) and smaller than 2.049 kg in North West Ethiopia. This result was slightly comparable with the 1.63 kg Getu *et al.* (2014) reported in North Gonder. While the values for an adult female (1.24 ± 0.01 kg) was in line with 1.24 kg reported by Getachew *et al.* (2015) in south bench, Ethiopia, and higher than 1.289 kg in Horro and 1.116 kg in Jarso (Eskindir *et al.*, 2013)

The mean value of chest circumference for male and female were 28.65 ± 0.13 and 27.03 ± 0.09 cm. This result was

Table 4: Least squares mean (LSM) ± standard error (SE) for the main effect of district and sex by district interaction on the live body weight (Kg) and other body measurements (cm) of indigenous chicken in the study areas.

Levels	N	BW	BL	CC	WS	NL	CL	SL	CH	SC	KL	WL	WW	BKL	SL	HB
		LSM									± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE LSM ± SE	L SM ± SE	L SM ± SE	L SM ± SE	LSM ± SE	LSM ± SE
Overall	576	1.4 ± 0.02	36.0 ± 0.12	27.57 ± 0.08	39.7 ± 0.14	14.4 ± 0.09	3.4 ± 0.06	8.2 ± 0.019	1.7 ± 0.04	4.1 ± 0.011	9.9 ± 0.06	2.2 ± 0.41	2.0 ± 0.44	3.2 ± 0.01	7.7 ± 0	27.7 ± 0.06
CV		24.7	7.6	6.3	8.03	14.5	10.5	5.4	40.2	u	14.1	26.9	31	9.6	5.3	3.6
R2		0.28	0.15	0.17	0.1	0.097	0.60	0.07	0.43	0.08	0.155	0.63	0.65	0.11	0.39	0.61
District		*	**	*	NS	**	**	NS	NS	NS	***	**	NS	*		
Kuyu	360	1.4 ± 0.02	36.4 ± 0.16	27.8 ± 0.1	40.4 ± 0.21	14.7 ± 0.12	3.3 ± 0.07	8.2 ± 0.02	1.6 ± 0.05	4 ± 0.16	9.6 ± 0.08	2.2 ± 0.05	2 ± 0.06	3.3 ± 0.02	7.8 ± 0.03c	27.8 ± 0.12a
Girar Jarso	216	1.37 ± 0.03	35.4 ± 0.2	27.4 ± 0.08	38.5 ± 0.06	14 ± 0.13	3.5 ± 0.1	8.2 ± 0.03	1.8 ± 0.05	3.9 ± 0.03	10.5 ± 0.09	2.4 ± 0.06	2.0 ± 0.07	3.2 ± 0.01	7.7 ± 0.02b	27.8 ± 0.10a
															**	**
Sex		***	*	***	***	**	***	***	***	**	***	**	***	***		
M	192	1.7 ± 0.04	37.5 ± 0.23	28.7 ± 0.13	40.4 ± 0.27	15.29 ± 0.17	5.0 ± 0.09	8.4 ± 0.035	2.5 ± 0.07	5.0 ± 0.3	10.5 ± 0.13	3.3 ± 0.04	3.2 ± 0.05	3.4 ± 0.03	8.2 ± 0.08	29.7 ± 0.2
F	384	1.2 ± 0.01	35.3 ± 0.13	27.03 ± 0.09	39.4 ± 0.16	14.01 ± 0.1	2.5 ± 0.04	8.2 ± 0.02	1.3 ± 0.02	3.5 ± 0.02	9.6 ± 0.05	1.7 ± 0.03	1.4 ± 0.02	3.2 ± 0.01	7.2 ± 0.01	25.5 ± 0.01
															**	**
Sex* districts		***	NS	*	NS	**	**	NS	NS	*	**	***	**	NS		
M by K	120	1.8 ± 0.04	37.85 ± 0.29	28.66 ± 0.2	41.4 ± 0.4	15.6 ± 0.23	4.6 ± 0.11	8.2 ± 0.05	2.4 ± 0.1	5.3 ± 0.05	10.0 ± 0.18	3.4 ± 0.52	3.3 ± 0.065	3.4 ± 0.38	8.7 ± 0.09a	30.2 ± 0.17a
M by G	72	1.6 ± 0.06	36.9 ± 0.18	28.6 ± 0.11	38.8 ± 0.11	14.8 ± 0.25	5.6 ± 0.98	8.3 ± 0.05	2.7 ± 0.1	4.6 ± 0.07	11.4 ± 0.07	3.3 ± 0.073	3.0 ± 0.11	3.4 ± 0.037		
F by K	240	1.21 ± 0.16	35.7 ± 0.17	26.8 ± 0.12	40	14.22 ± 0.13	2.6 ± 0.05	8.2 ± 0.03	1.2 ± 0.03	3.4 ± 0.033	9.4 ± 0.07	1.55 ± 0.04	1.4 ± 0.034	3.2 ± 0.018	7.3 ± 0.02a	25.7 ± 0.08a
															8.0 ± 0.13b	30.1 ± 0.39b
F by G	144	1.3 ± 0.01	34.6 ± 0.34	27.4 ± 0.09	38.33 ± 0.05	13.7 ± 0.13	2.5 ± 0.04	8.1 ± 0.04	1.3 ± 0.3	3.6 ± 0.02	10.0 ± 0.18	1.9 ± 0.04	1.5 ± 0.03	3.1 ± 0.018	7.2 ± 0.02a	25.7 ± 0.05a

SE=standard error; NS= non significant; * Significant (p<0.05); **significant (p< 0.01); *** significant (p< 0.001); M = male and F = female, K = kuyu, G = Girar

higher than the report of Agide (2015) who reported 24.98 cm for female and 25.06 cm for male of chicken sampled from north Shoa Amhara regional state and slightly smaller than the report of Abebe *et al.* (2017) showed 31.3 for males and 27.4 for female from Guji Zone of Oromia Region. Hailu and Aberra (2018) and Eskindir *et al.* (2013) reported 39.7 cm for cock from Sheka zone and 40 cm for Horro chicken which are higher than the current result. Agide (2015) from north Shoa, Amhara reported 36.57 cm for adult female chicken, which is higher than the current result. Emabet (2015) also reported a smaller value (27.84 cm) for female chickens from South West and South parts of Ethiopia.

The average shank length for males was 8.4 cm, and for females, 8. 2 cm. This result was higher than the reports of Agide (2015), who reported 6.41, 6.24, and 6.36 cm in males and 6.45, 6.27, and 6.36 cm in females of Kowet, Menze Gera Mider, and Moretina Jiru districts of north Shoa Amhara regional state. Nigussie *et al.* (2010) also reported a range of shank length of (6.6–7.8 cm) in five ecotypes of Ethiopia that were smaller than the current finding. Contrary to this, Emabet (2015) reported that chickens reared in South West and South parts of Ethiopia had a shank length of 10.21 cm for males and 8.58 cm for females, which is higher than the current results obtained from the current study. Hailu

Table: 5 Correlation relationship among linear body measurements in the study areas

Male=192		BW	CC	WS	BL	SL	SC	KL	NL	CL	CH	WL	WW
	BW	1	0.68**	0.38**	0.38**	0.46**	-0.05ns	0.35**	0.42**	0.08ns	0.11ns	0.14*	0.18*
	CC	0.76**	1	0.25**	0.37**	0.45**	-0.20*	0.26 **	0.34**	0.24**	0.13 *	0.14*	0.17*
	WS	0.34**	0.15**	1	0.43 **	0.40**	0.19**	-0.18*	0.48**	-0.34 **	-0.19 *	0.10ns	0.02ns
	BL	0.16*	0.06ns	0.33**	1	0.47**	-0.05 ns	-0.14*	0.58**	-0.10ns	-0.04ns	0.19 **	-0.08ns
	SL	0.35**	0.24**	0.24**	0.27**	1	0.06ns	0.11ns	0.41**	0.25**	0.10 ns	0.22**	0.25 **
	SC	0.60**	0.51**	0.18**	-0.06ns	0.28**	1	-0.10ns	0.01ns	-0.12ns	-0.04ns	-0.04ns	-0.09ns
	KL	0.67**	0.49**	0.12*	-0.01ns	0.29**	0.56**	1	-0.16*	0.39**	0.23**	0.05ns	0.21**
	NL	0.19**	0.17*	0.46**	0.40**	0.23**	0.11*	0.15*	1	-0.16	0.03ns	0.26**	0.02ns
	CL	0.16*	0.06ns	-0.02ns	0.10ns	0.03ns	0.01ns	-0.09ns	0.03ns	1	0.32**	0.19**	0.29**
Female=384	**CH**	0.18**	0.05ns	0.07ns	0.10ns	0.03ns	0.05ns	0.05ns	-0.01s	0.25**	1	0.27**	0.19 **
	WL	0.27**	0.16*	-0.13*	-0.10ns	-0.03ns	0.23**	0.17**	-0.11*	0.20**	0.22**	1	0.31**
	WW	0.20**	0.13*	-0.03ns	-0.01ns	0.07ns	0.07ns	0.11*	0.01ns	0.21**	0.15*	0.16*	1
	BKL	0.15*	0.01ns	0.08ns	0.07ns	0.09ns	0.04ns	0.09ns	0.06ns	0.02ns	0.05ns	0.05ns	0.05ns

*P<0.05; ** P<0.01; NS= non-significant; BW = Body Weight; CC= Chest circumference; WS=wingspan; BL=Body Length; SL=shank length; SC= shank circumference; KL=Keel length; NL=neck length; CL= comb length; CH= comb height; WL= wattle length; WW= wattle width; BkL= beak leng

and Aberra (2018) also reported 9.4 cm of shank length for males, which is larger, and 7.6 cm for females, which is smaller than the current results from Sheka Zone, Southern Ethiopia. The shank length is regarded as a good indicator of skeletal development, which is related to the amount of meat a chicken can carry (Aberra & Tegene, 2011).

The overall body length of the male was 37.5 cm, and that of the female was 35.3 cm. The result was comparable to values from North Gonder (Addisu, 2013) reported that the overall length of the local chicken ecotype was 35.79 cm. Hailu and Aberra (2018) and Eskindir *et al.* (2013) reported 39.7 cm for males from the Sheka zone and 40 cm for Horro chicken which is higher than the current result. Agide (2015) from north Shoa, Amhara reported 36.57 cm for adult female chicken, which is higher than the current result. Emabet (2015 also reported a smaller value (27.84 cm) for female chickens from South West and South parts of Ethiopia. The observed high body length with high body weight in chickens reared in the study area suggests the existence of a positive relationship between these two traits, as reported by Addisu (2013). Least squares mean (LSM) ± standard error (SE) for the main effect of district and sex by district interaction on the live body weight (Kg) and other body measurements (cm) of indigenous chicken in the study areas (Table 4).

District by Sex Effect

Sex by district interaction had a significant effect ($p<0.05$) on body weight, chest circumference, keel length, neck length, shank circumference, comb length, wattle length, and wattle width, while wingspan, body length, shank length, comb height, and beak length are not significantly affected ($p>0.05$) by district by sex interaction, for females large body weight, chest circumference, keel length, neck length, shank circumference, comb length, wattle length, and wattle width value were recorded in the Girar Jarso district, while large body weight, chest circumference, body length, wing span, neck length, shank circumference, wattle length, wattle width were recorded for male in Kuyu district (Table 4).

Correlation relationship among linear body measurements

The high correlation of linear body measurements with body weight implies that these measurements can be used as indirect selection criteria to improve live weight (Solomon, 2007). The highest correlation (0.76) between body weight and chest circumference, followed by a correlation (0.67) between keel length and body weight, and (0.60) between body weight and shank circumference were estimated for female chickens. Similarly, for males high correlation (0.68) between body weight and chest circumference followed by (0.46) between body weight and shank length and (0.38) between body weight and body length were also estimated. Faruque *et al.* (2010) also reported a strong positive correlation of shank length with body weight in intensively managed native chickens of Bangladesh. High phenotypic and genotypic correlations of body weight and shank length were also reported in Ghana (Osei-Amponsah *et al.*, 2013) (Table 5).

Conclusion

Normal feather morphology, normal feather distribution, plain head shape, yellow shank color, red-white earlobe, single comb type, and orange eye color were the predominant phenotypic traits of indigenous chickens in the study area. The most prevalent plumage color in the study area was Kei/red, followed by white and Kojima. The average body weight of females and males was 1.2 and 1.7 kg, respectively. A high correlation between body weight and chest circumference was recorded. In general, such basic information on the nature of indigenous chicken production environments, factors of production, the importance of chickens, farmers' trait preferences, and their phenotypic variations were important for initiating the new breeding, management improvement, and conservation programs.

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