

Phenotypic Characterization of Indigenous Chicken Ecotypes in Selected Districts of Bench Maji Zone, South West Ethiopia

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How to cite this paper: Yirmiedie Bayou, Elias Bayou, Dessalegn Genzebu, Hailu Assefa. (2022) Phenotypic Characterization of Indigenous Chicken Ecotypes in Selected Districts of Bench Maji Zone, South West Ethiopia. *International Journal of Food Science and Agriculture*, 6(3), 293-300.

DOI: 10.26855/ijfsa.2022.09.009

Received: June 16, 2022

Accepted: July 13, 2022

Published: August 11, 2022

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Abstract

This study was conducted in Meanit Goldiya and Meanit Shasha districts found in Bench Maji Zone south, Western Ethiopia to characterize phenotypic variation of indigenous chicken populations. Visual appraisal was conducted to study qualitative traits of local chicken. Quantitative data were collected on body weight and other linear measurements by employing field measurements. 660 (60 male and 600 female) chicken were taken for phenotypic trait studies. Both Statistical Packages for Social Sciences (SPSS) and Statistical Analysis System (SAS) software were used to analysis qualitative and quantitative data. Among morphological study showed, the normal feather morphology (91.4%) and normal feather distribution (87.7%) were the commonest characters of local chicken followed by Silky normal feather morphology and Naked neck feather distribution which are (8.6%) and (12.3%) respectively in the study area. The Single comb was the dominant (62.0%), followed by rose (25.5%) while pea was the least (12.6%). Yellow color was the most (48.8%) dominant, whereas white and grey had 25.2 and 16.7 percentages respectively, while black (5.0%) and blue (4.2%) shank colors existed in small proportions. In terms of earlobe color Chickens with red earlobe accounted for the largest (45.3%) followed by red white earlobe (21.5%), white (14.1%), yellow (12.3%), Grey (4.7%) and black (2.1%). In the same way pink and yellow skin colors having the same frequency of 28.6% followed by White (27.7%), Blue-black (10.6%) and black (4.4%) for local chicken in the study area. Predominantly 17.0, 13.0, 12.7, 12.0, 11.5, and 11.4% of the chicken had Kokima, Key, Brown, Netch, Gebshima, and light brown plumage colors respectively. The rest of studied chicken had Tikur (7.9 %), Yellow and Tikur-teterima almost in the same proportions (5.9 and 5.8% respectively) and Key-teterima (2.7%) in small proportion. The overall measured mean values of Body weight, chest circumference, Wingspan, keel length body length, neck length, shank length, shank circumference, comb length, comb width, wattle length and wattle width were 1.45kg, 25.87 cm, 44.24cm, 9.97cm, 37.10cm, 14.04cm, 7.43cm, 4.05cm, 3.64cm, 2.26cm, 2.63cm and 2.42cm, respectively in the study area. In addition, all the values estimated were lowest for female chicken. Qualitative and quantitative trait variations were identified among the studied local chicken; hence, detail molecular study is needed to prove the genetic difference among this chicken populations.

Keywords

Phenotypic, Characterization, Indigenous chicken, Bench Maji

1. Introduction

Rural poultry plays the significant role of improving nutritional status (good source of protein), income, food security, religious ceremonies, and livelihood of many poor rural farmers and landless communities [1, 2]. Ethiopia has at least 17 indigenous chickens' breeds [3] and with an estimated 59.49 million heads [4]. Out of the total population, 90.85 percent, 4.76 percent and 4.39 percent were indigenous, hybrid and exotic, respectively. The genetic dilution of indigenous chickens by the introduction different exotic chickens was detected [5, 1]. In light of these, and more broadly to the animal genetic erosion, conservation-based utilization programs is an important step, as it is a way for maintaining the existing local chicken populations that have been adapted to the local environment [5]. Indigenous chickens are also preferable than exotic chickens, because of their pigmentation, taste, flavor and leanness [6]. Characterization of indigenous livestock genetic resources are essential for planning national domestic animal diversity and conservation plans [7]. However, phenotypic characterization on the existing chicken ecotype of Meanit Shasha and Meanit Goldiya production environments on a comprehensive standard is not studied or documented.

Therefore, the objective of this study was:

- To characterize the phenotypic characteristics of indigenous chicken ecotypes in Meanit Shasha and Meanit Goldiya districts.
- To observe morphological and phenotypical qualitative and quantitative trait difference among local chicken populations in the study districts.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out in two districts of Bench Maji zone (BMZ) of the Southern Nations Nationalities and Peoples Regional State (SNNPRS), in Southwest Ethiopia. BMZ is bordered with Keffa Zone at the North, Debu Omo at the North East, Sheka zone at the South West, and with Gambella and South Sudan Republic in south direction [8]. The area is located at distance about 561km from Addis Ababa and 842km from the regional capital Hawassa. Agro-ecologically, consists of 52 percent low land (500-1500 m.a.s.l), 43 percent intermediate highland (1500-2300 m.a.s.l) and 5 percent highland (> 2300 m.a.s.l). It has an altitude range from 500-2500 m.a.s.l. The mean annual temperature ranges from 15.1°C-27.5°C [8]. The mean annual rainfall ranges from 400-2000mm [8]. Administratively, BMZ has ten (10) districts and one (1) town administration namely: Sheko, Debu Bench, Semen Bench, Meanit Shasha, Meanit Goldiya, Bero, Maji, Shy Bench, Surima, Guraferda and Mizan Aman town respectively. Two districts, namely, Meanit Shasha and Meanit Goldiya were selected purposely for this study.

2.2. Sampling design and data collection procedures

2.2.1. Sampling design

Two districts (Meanit Shasha and Meanit Goldiya) were selected purposely for this study. A rapid reconnaissance survey was conducted in each district before the main survey to know the distribution and concentration of indigenous chickens of the study area to establish sampling framework. Discussions were held with zonal and district agricultural experts and development agents about the distribution and concentration of indigenous chickens. After further discussion with the district's livestock and fishery resource offices, agricultural development agents and key informants a total of 6 *kebeles* (4 from Meanit Goldiya and 2 from Meanit Shasha district) were selected based on their suitability for chicken production, market and road access and willingness of the farmers or agro-pastoralists to participate in the study. For body linear measurements a total of 660 adult chickens (600 female and 60 male) as judged by comb and wattle size was taken within the selected sites.

2.2.2. Data collection procedures

For qualitative and quantitative traits studies 660 adult chickens above one year age or above are adult chickens whose age are one year or above. The birds' age was determined by "recalling method" of interviewed farmers. Data was recorded on the prepared format adopted from the standard description list developed by [7]. Each sampled animal was identified by sex and site (district).

Data on the important quantitative traits such as plumage colour (PC), shank colour (SHC), comb type (CT), feather morphology (FM), feather distribution (FD), skin colour (SKC), ear-lobe colour (EL), comb size (CS), eye colour (EC) and Head Shape (HS), were collected by FAOs guide line for chicken genetic resources [7]. The attribute and code of morphological characters are described. Visual observations of the general features of the birds such as feather patterns, body morphology and specific traits such as naked-neck chicken type, and crested head were recorded as qualitative (categorical) traits according to the [7] guidelines.

For linear measurements of quantitative traits (cm) and body weight (kg) was taken on the samples of indigenous

chickens of both sexes using a tailor's tape and a hanging balance respectively. The linear measurements include body length (BL), chest circumference (CC), wing span (WS), neck length (LH), shank length (SL), shank circumference (SC), keel length (KL), body weight (BW), wattle length (WL), wattle width (WW), comb length (CL) and comb width (CW).

2.3. Statistical Analysis

Distinct measurements on the qualitative morphological traits were analyzed using frequency procedure PROC FREQ in Statistical Analysis System [9]. Chi-square(χ^2) test was employed to assess the presence of significance among categorical variables. Quantitative characters (body weight and linear body measurements) were analyzed using the Generalized Linear Model (GLM) procedures of the Statistical Analysis System [9].

For adult chickens, sex, and districts was fitted as fixed independent variables while body weight and linear body measurements was fitted as dependent variables. Least square means with their corresponding standard errors was calculated for each body trait over district and sex.

The statistical models used for the study was:

$$Y_{ij} = \mu + D_i + S_j + e_{ijk}$$

Where: Y_{ij} = the observed (body weight or linear body measurements in the i^{th} district and j^{th} sex

μ = overall mean

D_i = fixed effect of i^{th} district (1 = Meanit Shasha, 2 = Meanit Goldiya)

S_j = fixed effect of j^{th} sex ($j=1$ = male 2 = female)

e_{ijk} = random residual error

3. Result and Discussion

3.1. Morphological Variations of Indigenous Chicken

3.1.1. Feather morphology, Feather distribution and Comb type

Table 1 shows percentage of morphological characteristics in chickens in the study area. There was no significant ($P < 0.05$) differences in rate of occurrence of feather morphology between study districts but, there was significant ($P < 0.05$) differences in case of feather distribution (normal vs. naked neck). Among morphological study showed, the normal feather morphology (91.4%) and feather distribution (87.7%) were the commonest characters of local chicken followed by Silky feather morphology and Naked neck feather distribution which are (8.6%) and (12.3%) respectively in the study area. The Single comb was the dominant (62.0%), followed by rose (25.5%) while pea was the least (12.6%).

The observed proportion normal feather morphology and feather distribution in the study is supported by reports of [1] for Sidama chicken. Lesser values 53, 52, 66, 64 and 54% of Farta, Mandura, Horro, Konso and Sheka indigenous chickens respectively showed normal feather morphology which was differs with current result [1]. Consistent and higher normal feather distributions were reported by [10] for Sheka chickens and [1] for different southern Ethiopian local chickens.

The proportion of Naked-neck chicken population (3.33%) reported by [1] and (10.1%) by [10] were not similar with this finding. The attribution of naked-neck chickens to the low land environment might be shows that the genes of this type chickens desires the tropical environment [10]. Naked-neck gene is described as one of the major genes in indigenous chickens of the tropics that possess desirable effect on heat tolerance [11]. This finding indicates naked-neck chicken population found in small proportions need an attention to conserve.

The high proportion of single followed by rose comb for North Gonder zone local chickens reported by [12] and for Sheka chicken [10] were agreement with the current result.

3.1.2. Shank, skin and earlobe colors distribution

Significant ($P < 0.01$) differences was existed in percentage occurrence of shank color (Table 1). Yellow color was the most (48.8%) dominant, whereas white and grey had 25.2 and 16.7 percentages respectively, while black (5.0%) and blue (4.2%) shank colors existed in small proportions. [10] concluded that the distribution of white shank color was dominant character for Sheka chickens that disagreement with the reported value of in this study area.

In terms of earlobe color Chickens with red earlobe accounted for the largest (45.3%) followed by red white earlobe (21.5%), white (14.1%), yellow (12.3%), Grey (4.7%) and black (2.1%). According to the reports of [13] in Fogera indigenous chicken populations and [12] for North Gonder indigenous chickens showed prominent earlobe color was red that agreed with current study.

In the same way pink and yellow skin colors having the same frequency of 28.6% followed by White (27.7%), Blue-black (10.6%) and black (4.4%) for local chicken in the study area. As the contrary report of [13] showed dominant chickens of Horro chickens possess white (77%) skin color followed by yellow (22.07%) and bluish black (0.9%).

The change of gene expression attributed to the local chicken skin colorations over time due to the availability of diversified feed resources might causes for dominancy differences between these findings [10].

Table 1. Morphological features of indigenous chicken populations reared in the study area

Factors	Districts			Test	
	Meanit Goldiya N (%)	Meanit Shasha N (%)	Overall N (%)	X ²	P-value
Feather morphology				0.86	.769
Normal	401(91.1)	202(91.8)	603(91.4)		
Silky	39(8.9)	18(8.2)	57(8.6)		
X ² between color groups		451.69***			
Feather distribution				26.4	.000
Normal	406(92.3)	173(78.7)	579(87.7)		
Melata/Naked neck	34(7.7)	47(21.4)	81(12.3)		
X ² between color groups		862.39***			
Comb type				4.97	.174
Roes/double	119(27.0)	49(22.3)	168(25.5)		
Single	266(60.5)	143(65.0)	409(62.0)		
Pea	55(12.5)	28(12.7)	83(12.6)		
X ² between color groups		660.12***			
Shank color				8.72	.120
White	117(26.6)	49(22.3)	166(25.2)		
Grey	76(17.3)	34(15.5)	110(16.7)		
Yellow	208(47.3)	114(51.8)	322(48.8)		
Black	14(3.2)	14(6.4)	28(4.2)		
Blue	25(5.7)	9(3.6)	34(5.0)		
X ² between color groups		561.03***			
Earlobe color				5.09	.404
White	70(15.9)	23(10.5)	93(14.1)		
Red	190(43.2)	109(49.5)	299(45.3)		
Grey	22(5.0)	9(4.1)	31(4.7)		
Black	9(2.0)	5(2.3)	14(2.1)		
White red	97(22.0)	45(20.5)	142(21.5)		
Yellow	52(11.8)	29(13.2)	81(12.3)		
X ² between color groups		484.83***			
Skin color				7.20	.126
Yellow	124(28.2)	65(29.5)	189(28.6)		
Blue-black	48(10.9)	22(10.0)	70(10.6)		
Black	22(5.0)	7(3.2)	29(4.4)		
Whit	132(30.0)	51(23.2)	183(27.7)		
Pink	114(25.9)	75(34.1)	189(28.6)		
X ² between color groups		178.42***			
Head shape				4.03	.133
Crest	111(25.2)	47(21.4)	158(23.9)		
Plain	329(74.8)	173 (79.6)	502 (76.1)		
X ² between groups		444.21***			
Eye color				13.17	.004
Dark	113(25.8)	51(23.2)	164(24.8)		
Brown	242 (55.0)	145(65.9)	387(58.6)		
Orange	85(19.3)	24(10.9)	109(16.5)		
X ² between color groups		328.60***			

N=number of chicken

3.1.3. Head shape and eye colors distribution

Plain (76.1%) and Crest (23.9 %) head shape were found in the study area. This result shows disagreement with finding of [3] who reported that plain head shape (70.4%) was dominant in North Gonder zone, Ethiopia.

There was significant difference in eye colors between two districts ($P<0.05$). Three eye colors namely brown (58.6%), dark (24.8%) and orange (16.5%) were observed in the studied local chicken. This finding is contradictory with [15] who reported that 81.84% chicken population in Horro and 72.48% of chicken population in Jarso had orange eye colour whereas 9.01 and 23.31% of chicken population had red eye colour in Horro and Jarso, respectively.

3.1.4. Plumage color descriptions of indigenous chickens

Predominantly 17.0, 13.0, 12.7, 12.0, 11.5, and 11.4% of the chicken had Kokima, Key, Brown, Netch, Gebsuma, and light brown plumage colors respectively (Table 2). [10] observed indigenous chickens to be dominantly Kokima, Key and Netch which was similar to this finding. But the same scholars reported that about twenty one plumage color patterns were observed in chicken populations reared in Sheka zone, which contradicts the current study that found only ten plumage types.

The great variability of phenotypes might show that the animals are not subjected to selection for their specific function [10].

3.2. Morphometric measurement variation of indigenous chicken

Table 3 presents the least square means (LSM) for the different trait measurements taken in native chicken populations of the study districts. The main source of variation in live body weight and linear body measurements were district and sex.

3.2.1. District effect

Body weight, chest circumference, neck length and wattle length were varied significantly ($P<0.05$) across districts. The rest of linear body measurements does not showed significant ($P>0.05$) difference among the study districts. Therefore, better values of body weight ($1.49\pm.40$) and chest circumference ($26.20\pm.34$) were obtained in Meanit Goldiya district while neck length ($14.41\pm.12$) and wattle length ($2.93\pm.07$) were better in Meanit Shasha district. The variation among basic body traits such as body weight and chest circumference might be due to better availability of grain supplements in Meanit Goldiya district because; households were practicing crop livestock production, while in Meanit Shasha district agro-pastoral farming system was common. But, neck length and wattle length were higher at Meanit Shasha district this might be attributed to environmental variations.

The findings of [1] for chickens reared in SNNPRS in southern Ethiopia, [14] for Horro and Jarso chickens, [12] for North Gonder chicken and south part of Ethiopia and [10] for Sheka chicken reported that body weight and most of linear body measurements were affected by district ($P<0.05$).

Table 2. Description of plumage colors of indigenous populations of chickens in the study area

Variable	Districts			Test	
	Meanit oldiya N (%)	Meanit Shasha N (%)	Total N (%)	X ²	P-value
Plumage color				25.5	.004
Netch	67(15.2)	12(5.5)	79(12.0)		
Key	62(14.1)	25(11.4)	87(13.0)		
Kokima	73(16.6)	39(17.7)	112(17.0)		
Gebsuma	45(10.2)	31(14.1)	76(11.5)		
Key- teterima	8(1.8)	10(4.5)	18(2.7)		
Tikur	34(7.7)	18(8.2)	52(7.9)		
Tikur- teterima	19(4.3)	19(8.6)	38(5.8)		
Yellow	26(5.9)	13(5.9)	39(5.9)		
Brown	52(11.8)	32(14.5)	84(12.7)		
Light-brown	54(12.2)	21(9.5)	75(11.4)		
X ² between color groups		184.26***			

The chi-square values indicate significant differences between chicken populations ($p<0.05$), N=chicken number. The name plumage colors are in Amharic, official working language of Ethiopia as denoted as: key=red plumage, Tikur=black plumage, Netch=white plumage, Gebsuma=mixture of grayish and white plumage, Kokima=grayish strips on brown or reddish background, Key Teterima=red with white strips, Tikur Teterima=black with white tips.



a. Tikur-teterima, Netch/white and black/Tikur plumage type hens from left to right.



b. Buff/yellow, Kokima and light brown plumage type hens from left to right.



c. Brown plumage type, Gebshima and naked neck feathered type hen from left to write.



d. Red plumage type, red naked neck and black naked neck types of male chicken from left to right.

Figure 1. Sample pictures of different plumage colors of indigenous chickens in Meanit Goldiya and Meanit Shasha districts.

Table 3. Least squares means (LSM) ± standard error (SE) for the main effect of district and sex and sex by district

	N	BW	CC	WS	KL	BL	NL	SL	SC	CL	CW	WL	WW
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	600	1.45±.40	25.8±.19	44.2±.37	9.9±.13	37.1±0.6	14.1±.18	7.4±.18	4.1±.12	3.6±.08	2.3±.60	2.6±0.1	2.4±0.2
R ²		0.33	0.40	0.45	0.41	0.36	0.40	0.32	0.36	0.37	0.47	0.46	0.39
CV		5.08	7.20	6.12	10.04	14.03	6.24	9.14	10.21	13.03	12.43	10.10	15.03
District		*	*	NS	NS	NS	*	NS	NS	NS	NS	*	NS
Meanit G	440	1.5±.40	26.2±.34	44.9±.40	10.1±.14	37.2±.70	13.6±.24	7.4±.18	4.1±.20	3.6±.09	2.3±.06	2.3±.13	2.2±.13
Meanit S.	220	1.4±.36	25.5±.05	43.5±.34	9.8±.13	37.0±.15	14.4±.12	7.5±.17	4.0±.03	3.7±.07	2.3±.06	2.9±.07	2.6±.07
Sex		***	***	***	***	***	***	***	***	***	***	***	***
Male	60	1.6±0.3 ^a	27.6±.31 ^a	48.5±0.6 ^a	10.8±0.2 ^a	38.7±0.2 ^a	14.5±0.3 ^a	8.4±0.3 ^a	4.4±.08 ^a	4.7±.01 ^a	3.4±0.9 ^a	3.8±0.2 ^a	3.6±0.2 ^a
Female	600	1.3±0.1 ^b	24.1±0.8 ^b	39.9±0.9 ^b	9.1±0.7 ^b	35.5±.6 ^b	13.5±.07 ^b	6.5±.05 ^b	3.7±.16 ^b	2.5±.06 ^b	1.1±.03 ^b	1.4±.04 ^b	1.2±.1 ^b

a,b, means within row between districts with different superscripts were significantly different ($p < 0.05$), SE=standard error; NS= non significant; * Significant ($P < 0.05$); ** significant ($P < 0.01$); *** significant ($P < 0.001$); M=male and F=female.

3.2.2. Sex effect

Comparison of the different body measurements between sexes of these chicken indicate that male chicken were significantly ($P < 0.05$) heavier and bigger in all traits than female chicken (Table 3). This might associate with gonad development and secretion of sex hormones' of the respective sexes [16]. Furthermore, sex effects on body weight and other measurable traits obtained in this result was good agreement with the report of [1, 12, 10], stated that male chickens had better than female.

3.2.3. Overall estimated body weight and linear body measurements

The overall mean values of body weight, chest circumference, wingspan, keel length, body length, neck length, shank length, shank circumference, comb length, comb width, comb length, were 1.45kg, 25.87 cm, 44.24cm, 9.97cm, 37.10cm, 14.04cm, 7.43cm, 4.05cm, 3.64cm, 2.26cm, 2.63cm and 2.42 cm, respectively in the study area. The average weight of local hen's ranges from 0.6kg to 2.1kg and local cock's ranges from 0.6 to 2.5kg at selected districts of North Western Amhara region [17] was similarly greater than this finding when aggregated. The recorded average body length of the current study was higher than reported by [3] for chickens reared in North Gonder and but lower than Sheka chicken [10]. The recorded mean wing span of Sheka chicken populations was 44.24cm which is smaller value than the findings of [18] for chickens reared in the Southern highlands of Tanzania and [10] for Sheka chicken. However, the wing span values in the current study were much higher than those reported by [12] in North Gonder zone. Environmental and genetic factors will be causative agents for the variation/differences chicken body measurements in different areas. The study conducted by [12] in North Gonder recorded smaller value (3.81cm) shank circumference measurement than the current result (4.05cm).

4. Conclusion and Recommendations

Two different phenotypic groups were identified as naked neck and normal feathered chicken types in this finding. Normal feather morphology, normal feather distribution, single comb, Yellow color shank color, red earlobe ear lobe, pink and yellow skin colors, plain head shape and brown eye color were the commonest morphological characters of local chicken in this finding. Predominantly 17.0, 13.0, 12.7, 12.0, 11.5, and 11.4% of the chicken had Kokima, Key, Brown, Netch, Gebsuma, and light brown plumage colors respectively. The most important quantitative traits such as body weight, chest circumference and neck length wattle length were varied significantly ($p < 0.05$) across districts. Both of qualitative and quantitative variations show the existence of phenotypic trait differences in the studied chicken population. Therefore, this finding likely to recommend that; the heterogeneity was existed in most morphological traits and generally phenotypical variations were detected between studied local chickens; therefore, detail genetic or molecular study is needed to ensure genetic differences between found indigenous chicken populations in the study area.

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