Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.21, 2015

Phenotypic and Morphological Characterization of Indigenous Chicken Populations in Southern Zone of Tigray, Ethiopia

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Abstract
Phenotypic characterization of indigenous chicken resources is a prerequisite for their rational utilization. Data were collected from 210 randomly selected households (HHs) using structured questionnaires. Visual appraisal was conducted to study morphological traits of indigenous chicken populations. Quantitative data were collected on body weight, shank length, body length, chest circumference, back length, keel length, wingspan, comb height, comb length, and wattle length from a total of 720 chickens (237 male and 483 females) aged more than 6 month. Descriptive statistics, Frequency procedures, and General linear model of SAS 2008 were used to analyze the data. The results revealed that a total of eighteen distinct plumage colors were identified in which the predominant plumage colors were red (24.17%) followed by white (13.33%) and black (13.06%). The results also indicated that (57.08%) of chicken populations were rose combed followed by pea (27.36%), single (12.22%), walnut (2.5%), strawberry (0.56%) and cushion (0.28%) combs. Yellow was the major shank color (50.55%), followed by white (38.89%) and black (10.56%). The majority (40.28%) of chicken population exhibited white and red earlobe, followed by red (28.89%), white (26.94%) and yellow (3.89%). Males in all populations are heavier and taller than females. The mean body weight of indigenous male and female chickens was 1271±12.6g and 1034±8.05g, respectively. The present study suggests that indigenous chicken populations might possess useful genetic potentials for improved productivity under scavenging feed resource-based production systems. Therefore, efforts need to be made in services like health, husbandry, research, extension, training and credit interventions. In addition morphological and phenotypical variations have been observed among the indigenous chicken populations; hence an in-depth molecular evaluation is needed to prove the level of genetic differentiation and relationship among them.
Keywords: Households, indigenous chicken, productivity, qualitative trait, quantitative trait

Introduction

Identification and characterization of the chicken genetic resources generally requires information on their population, adaptation to a specific environment, possession of traits of current or future value and socio-cultural importance, which are crucial inputs to decisions on conservation and utilization (Weigend and Romanov, 2001).

Indigenous chickens in Ethiopia are found in large numbers distributed across different agro-ecologies under traditional scavenging management system indicating that they are important avian resources reared as a source of animal protein and income to many of the rural populations (Fisseha et al 2010). Thus, their widespread distribution indicates their adaptive potential to the prevailing environment, disease and other stresses. According to CSA (2012), the total chicken population in the country is estimated to be 44.89 million of which 43.3 million (96.46%) are indigenous chickens, indicating the significance of local chickens as potential resource of the country. Variations in major morphological trait such as body conformation and feather contours, plumage color, shank and earlobe color, comb type and productivity are common among the indigenous chicken populations (Teketel 1986; Tadelle 1996; Halima 2007; Aberra and Tegene 2011). These characteristics provide a basis for grouping according to their phenotypic and morphological appearances. However, the phenotypic diversity of the indigenous chicken resources in Ethiopia in general and in Tigray region in particular is not yet studied in detail.

Furthermore, the indigenous chickens are good scavengers and foragers, well adapted to harsh environmental conditions and their minimal space requirements make chicken rearing a suitable activity and an alternative income source for the rural Ethiopian farmers. The indigenous fowl population also is considered as gene reservoirs, particularly of those genes (naked neck) that have adaptive values in tropical conditions (Horst 1988). In addition, the local chicken sector constitutes a significant contribution to human livelihood and contributes significantly to food security of poor households. Despite their importance, indigenous breeds are under threat due to various factors such as introduction of exotic commercial chicken breeds and indiscriminate crossbreeding (Besbes 2009).

So far, several adaptation and morphological variations of Ethiopian indigenous chicken population have been reported by scholars namely, Reta (2006), Halima et al (2007), Nigussie et al (2010b), and Aberra and Tegene, (2011). These works focused on the characterization of indigenous chicken populations from different parts found at specific locations that may not necessarily represent the genetic resources of indigenous chickens distributed in the whole country in general and in Tigray region of Ethiopia in particular.

Thus, the indigenous chicken populations in Tigray regional state in general and southern zone of

Tigray in particular are not defined phenotypically in their inhabitancy. So, their genetic potential is not properly known, forming a major barrier for the development and implementation of suitable genetic improvement strategies at a national level. Therefore, the objective of this study was to identify, characterize and describe the phenotypic variation of indigenous chicken populations in southern zone of Tigray, Ethiopia.

Material and Methods

Description of the Study Area

The study was conducted in Northern Ethiopia; southern zone of Tigray in randomly selected districts namely the Raya azebo, Endamehoni and Ofla. These areas are situated at the range of 12°15'N to 13°00'N and 39°10'E to 39°50'. It has an altitude ranging from 930 to 3925 m.a.s.l. The mean annual temperature varies from 9 ^{0}C to 28 ^{0}C. The coldest months are October, November and December and the mean annual rainfall ranges from 400 to 912 mm (SZT, 2012).

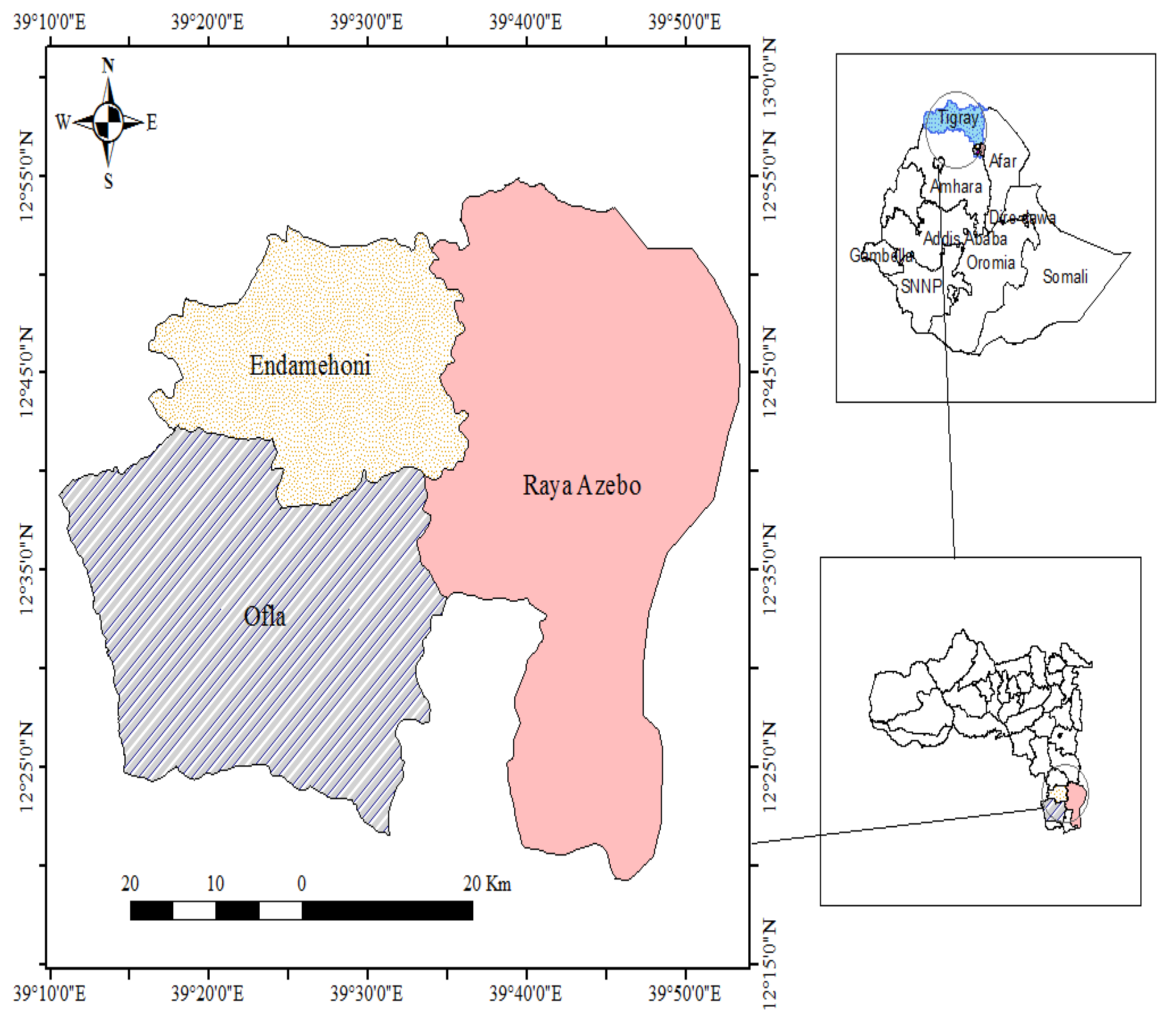

Figure 3. Map of the study area

Procedures of data collection and analysis

Sampling technique

This study was carried out using structured questionnaires, focal group discussions and field surveys in three districts and nine peasant associations (PAs) (three PAs from each selected district) found in the zone. The districts found in the zone were stratified based on the indigenous chicken population size obtained from the respective OARD of each district as: large, medium and small population size. The field survey covered 210 randomly selected households (HHs) who keep two or more indigenous chickens within the HH.

Qualitative (Morphological) traits

A structured questionnaire was designed to collect data both on poultry production system of the zone and variations in basic phenotypic and morphological traits. Before the commencement of the survey, the questionnaires were pretested using sample HHs and appropriate adjustments were made on specific contents. The interviews were conducted at farmers' houses with the assistance of local agricultural extension officers drawn from each district. Moreover, visual appraisal on the appearance of indigenous chicken populations and their typical morphological features were conducted together with the farmers, agricultural extension experts and four employee of this research project (graduate of Agricultural Technical, Vocational Educational and Training College). Special training was given to the employees by the researcher on basic phenotypic and morphological traits of poultry. Moreover, the researcher was actively involved in all field survey activities throughout the study period.

Phenotypic and morphological variations were studied based on feather morphology, feather distribution, plumage color, skin color, shank color, shank feather, comb type, earlobe color and head shape. Data were recorded for a total of 720 (237 male and 483 females) randomly selected indigenous chickens whose age was six month or above following the FAO descriptors for chicken genetic resources (FAO, 2011). Descriptions of comb types were based on illustrations presented by Somes (2003).

Quantitative traits

During field visits, quantitative data were collected on live weight, shank length, comb height, comb length, body length, chest circumference, back length, keel length, wattle length and wingspan. These measurements were taken from 720 (237 male and 483 females) randomly selected indigenous chickens whose age was six month or above. The birds' age was determined by "recalling method" of interviewed farmers. Women farmers can easily recall the age of their chickens because of the long time interval between two consecutive clutches in the indigenous chickens. Live body weight was taken using digital weighing balance and the other body linear measurements were taken using digital calipers to the nearest of 0.05 mm.

Statistical analysis

Statistical analysis system (SAS) was used to carry out descriptive statistics on qualitative and quantitative data of the identified indigenous chicken populations. Qualitative data from individual observation were analyzed following the frequency procedures of SAS version 9.2 (2008) and compared as percentages using Chi-square test. General linear model procedures (PROC GLM) of the SAS were used to analyze the analysis of variance of the quantitative data. Sex and location of the experimental indigenous chickens were fitted as fixed independent variables. When differences were significant, comparisons of means were done by using Tukey`s studentized range test method. All statements of statistical differences in quantitative data were based on $p < 0.05$.

Results and Discussions

Phenotypic and morphological variations in qualitative traits

Feather morphology and distribution

Feather morphology of the studied chicken populations was normal (Table 2). This is similar with the findings of Bogale (2008) who reported normal feather morphology in all of the local chicken populations in Fogera woreda, Ethiopia. The studied chicken populations had only normal and crest feather distribution. The normal feather distribution was observed dominantly in Endamehoni and Ofla chicken populations while crest feather was dominant in Raya-azebo chickens (Table 2). According to Aberra and Tegene (2011), 83.2% of the chicken populations in southern region of Ethiopia had normal feather distribution followed by Naked-neck (7.9%), crested (5.6 %), feathery shank and feet (2.0%) and muff and beard (1.3%). However, in the current study chickens with the Naked-neck, shank and feet feathery, and muff and beard feather distributions were not observed. The reason might be due to the difference in breed type and the agro-ecology of the environment in which the birds inhabited.

Plumage color

The indigenous chicken populations studied in the three districts exhibited a total of eighteen distinct plumage colors in which the predominant plumage colors were red (24.17%) followed by white (13.33%) and black (13.06%). Excluding those listed main phenotypes above, plumage diversity was higher (Table 1). The possible explanation for this is that a number of genes determining feather colors and patterns (Crawford, 1990) and in the absence of selection on a preferred phenotype, they do segregate in the population (Lauvergne *et al*., 1993). The plumage colors found in the current study are in harmony with previous reports by Reta (2006); Halima (2007); Bogale (2008) and Eskinder (2013) for the Ethiopian indigenous chicken.

Ambesuma male

Gebesema male

Kuarichama (sendekma) male

Key teteruma female

Lebework female

Wheaten female

Figure 2. Some body plumage color of local chicken ecotypes in the study area

Table 2. Plumage color variation of indigenous chicken ecotypes in the study districts

Plumage color (frequency, (%))	Districts								
	Endamehoni			Ofla			Raya-azebo		
	M(78)	F(162)	Total	M(87)	F(153)	Total	M(72)	F(168)	Total
Ambesuma[1]	1(1.28)	-	1(0.42)	4 (4.60)	-	4(1.67)	2(2.78)	-	2(0.83)
Black	10(12.82)	27(16.67)	37(15.42)	2(2.30)	22(14.38)	24(10)	2(2.78)	31(18.45)	33(13.75)
Brown	-	32(19.75)	32(13.33)	-	14(9.15)	14(5.83)	-	24(14.29)	24(10)
Brownish black	-	6(3.70)	6(2.50)	-	8(5.23)	8(3.33)	-	9(5.36)	9(3.75)
Gebsima[1]	9(11.54)	-	9(3.75)	10(11.49)	-	10(4.17)	17(23.61)	-	17(7.08)
Grey	-	2(1.23)	2(0.83)	-	1(0.65)	1(0.42)	-	1(0.60)	1(0.42)
Key teteruma[1]	3(3.85)	7(4.32)	10(4.17)	9(10.34)	19(12.42)	28(11.67)	-	13(7.74)	13(5.42)
Kokima[1]	-	10(6.17)	10(4.17)	-	5(3.27)	5(2.08)	-	4 (2.38)	4(1.67)
Lebework[1]	-	8(4.94)	8(3.33)	-	15(9.80)	15(6.25)	-	17(10.12)	17(7.08)
Multicolor	-	3(1.85)	3(1.25)	-	1(0.65)	1(0.42)	-	14(8.33)	14(5.83)
Nech teteruma[1]	-	8(4.94)	8(3.33)	1(1.15)	3(1.96)	4(1.67)	-	2(1.19)	2(0.83)
Kuarichama[1]	3(3.85)	-	3(1.25)	12(13.79)	-	12(5.00)	4(5.56)	-	4(1.67)
Red	47(60.26)	17(10.49)	64(26.67)	40(45.98)	18(11.76)	58(24.17)	33(45.83)	19(11.31)	52(21.67)
Tikur gebsat[1]	2(2.56)	-	2(0.83)	3(3.45)	-	3(1.25)	5(6.94)	-	5(2.08)
Tikur teteruma[1]	-	11(6.79)	11(4.58)	-	12(7.84)	12(5.00)	1(1.39)	1(0.60)	2(0.83)
Wheaten	-	2(1.23)	2(0.83)	-	6(3.92)	6(2.50)	-	3(1.79)	3(1.25)
White	3(3.85)	29(17.90)	32(13.33)	6(6.90)	24(15.69)	30(12.5)	8(11.11)	26(15.48)	34(14.17)
Zigirama[1]	-	-	-	-	5(3.27)	5(2.08)	-	4(2.38)	4(1.67)
$X^2 = 78.85^*$									

Ambesuma= Greyish yellow with varying mixture; Gebsima = Greyish with varying mixture; Kuarichama = white with red strips; Libework = White with golden breast color; Key teteruma = Red with white or black spots; Netch teteruma = white with black or red spots; Tikur teteruma = black with white or red spots; Tikur gebsat = black with wheaten or red strips; Kokima = grayish strips on brown background; Zigrama = black and white spotted feather

1Names of plumage colors are in Amharic, Official Working Language of Ethiopia.

Skin color

Regarding skin color only white and yellow skin colors were observed. Among these the white skin was the most dominant in all the three indigenous chicken populations. The yellow or white skin is the results of the presence or absence of carotenoids pigments (Eriksson et al 2008). Yellow skin color is the result of the expression of carotenoid pigments in the skins of birds (Smyth, 1990) and according to Eriksson et al (2008), it is generally considered to be associated with the individual's adaptive fitness reflecting its nutritional status or health which, in turn, is indicative of its foraging efficiency and immune status.

Comb type

On the investigated chicken populations six comb types were observed in which more than half (57.08%) of the sampled chicken populations were rose combed, followed by pea comb (27.36%) and single comb (12.22%). These frequencies contradicts with findings of, Halima (2007) and Nigussie et al (2010) who reported 50.72% and 53% chicken populations having pea comb in North West Ethiopia and other different parts of Ethiopia, respectively. Results shown in the current study also contradicts with the findings of, Badubi et al (2006) who reported about 90% of the indigenous chickens in Botswana to be single combed, while very low proportion were rose (4.9%) and pea (1%) combs.

Earlobe color

In the current study four earlobe colors were observed on the sampled chicken populations. The white and red earlobe was the commonest color in Endamehoni (54.58%) and Ofla (32.92%) whereas the white (35.83%) earlobe was dominant in Raya-azebo. The proportion of chickens with red earlobe was almost comparable among studied districts. In contrast, the yellow earlobe was observed with a very low proportion in all sampled chicken populations of the study area. According to Nigussie et al (2010), the proportion of indigenous chickens showing white, red and yellow earlobe was 40%, 52% and 8%, respectively, which are higher than those found in the current study. In line with the present findings, Aberra and Tegene (2011) reported white earlobe ranging from 30.4% to 34.9%. The same authors reported a large proportion of chickens with red earlobes, which is higher than those found in the current study. In agreement with the present study, white and red earlobe shows 41.4% and 49.5% in Horro and Jarso ecotypes, respectively (Eskinder, 2013).

Shank color

Three shank colors were observed in both the studied indigenous chicken populations. The proportion of chickens having yellow shanks was dominant in Ofla (68.33%) and in Endamehoni (47.08 %). This agrees with the findings of Nigussie et al (2010) and Halima et al (2007) who reported yellow shank as the most prevalent trait in indigenous chicken populations found in other parts of Ethiopia. White shank (47.92%) was predominant in chicken populations of Raya-azebo. Even though it was relatively low in proportion, black shank was observed in all chicken populations of the study area. This result contradicts with the findings of Egahi et al (2010) who reported 42.2% black shank in Nigerian indigenous chickens. According to Bell (2002), the shanks and most of the feet are covered with scales of various colors. Yellow is due to dietary carotenoid pigments in the epidermis when melanic pigment is absent. Varying shades of black are the result of melanic pigment in the dermis and epidermis. When there is black pigment in dermis and yellow in epidermis, the shanks have greenish appearance. In the complete absence of both of these pigments, the shanks are white.

Head shape

In terms of the head shape more than half of the chicken populations in Endamehoni (56.25%) and Ofla (57.92%) had plain head while chicken populations in Raya-azebo (53.33%) had crested head (Table 2). The populations were showed significant difference within and among each other in terms of head shape characteristics. This probably suggests that head shape could be considered as one of the most important morphological characteristics to discriminate between different populations of indigenous chickens.

Table 2. Morphological characteristics of indigenous chicken ecotypes in the study districts

Traits	Districts			
	Endamehoni (N (%))	Ofla (N (%))	Raya-azebo (N(%))	X^2
Feather morphology				-
Normal	240(100)	240(100)	240(100)	
Feather distribution				7.11^{*}
Normal	135(56.25)	139(57.92)	112(46.67)	
Crest	105(43.75)	101(42.08)	128(53.33)	
Comb type				43.7^{*}
Rose	147(61.25)	159(66.25)	105(43.75)	
Pea	54(22.50)	48(20.0)	95(39.58)	
Strawberry	-	3(1.25)	1(0.42)	
Walnut	8(3.33)	7(2.92)	3(1.25)	
Cushion	-	-	2(0.83)	
Single	31(12.92)	23(9.58)	34(14.17)	
Shank color				53.29^{*}
White	102(42.5)	63(26.25)	115(47.92)	
Yellow	113(47.08)	164(68.33)	87(36.25)	
Black	25(10.42)	13(5.42)	38(15.83)	
Earlobe color				52.3^{*}
Red	74(30.83)	69(28.75)	65(27.08)	
White	31(12.92)	77(32.08)	86(35.83)	
Yellow	4(1.67)	15(6.25)	9(3.75)	
White and red	131(54.58)	79(32.92)	80(33.33)	
Head shape				7.11^{*}
Plain	135(56.25)	139(57.92)	112(46.67)	
Crest	105(43.75)	101(42.08)	128(53.33)	
Skin color				7.58^{*}
White	187(77.92)	160(66.67)	172(71.67)	
Yellow	53(22.08)	80(33.33)	68(28.33)	
Hen spur				1.92^{ns}
Present	114(47.5)	108(45.0)	99(41.25)	
absent	126(52.5)	132(55.0)	141(58.75)	

Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.21, 2015

Crest (‘*gutena*’) head

Rose comb type

Spur (‘*merget*’)

Yellow shank color

Figure 3. Some morphological characteristics of local chicken ecotypes in the study districts

4.2.1. Multiple correspondence analysis

To evaluate the typical features of indigenous chickens genetic resource in each district morphologically, multiple correspondence analysis was carried out on qualitative traits which were significantly ($p<0.05$) different between the sampled chicken population in the three districts. Figure 3 shows a bi-dimensional graph representing the associations among the categories of the analyzed qualitative traits. The association is based on points found in approximately the same direction from the origin in approximately the same region of the space. From the figure, it can be shown that 29.85% of the total variations are explained by the first two dimensions (19.49% by the first and 10.36% by the second dimensions). On the identified dimensions, the sampled indigenous chicken populations from Endamehoni district were closely associated with normal feather distribution and plain head shape. Chicken populations from Ofla were also clustered with a rose comb, yellow skin and shank, red and yellow earlobe. Similarly, chicken population in Raya-azebo district were closely associated with crest feather distribution, crested head, black shank, pea and cushion comb type.

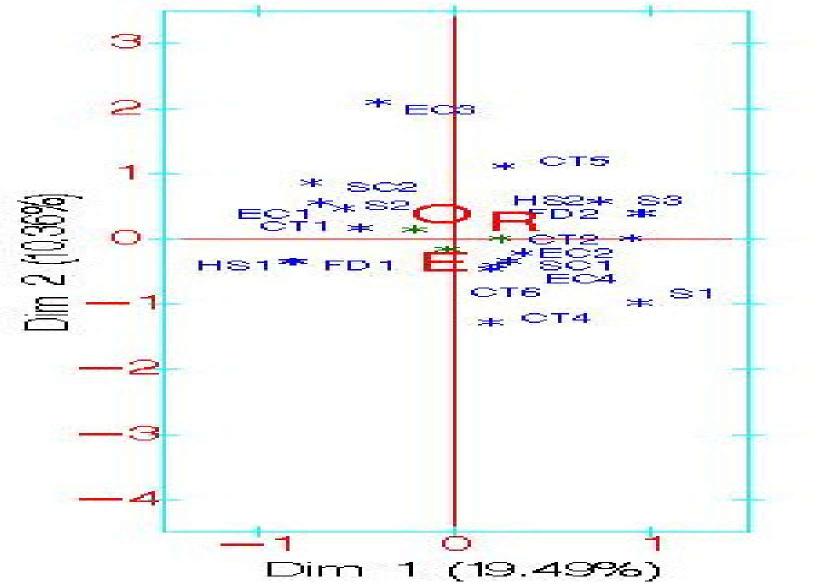

Figure 4. Bi-dimensional plot showing the associations among the categories of the different morphological variables considered

Key

District=R, E, O	R=Raya-azebo M=Endamehoni O=Ofla
Feather distribution= FD	FD1= Normal, FD2= Crest
Head shape=HS	HS1= Plain, HS2= Crest
Shank color=S	S2= Yellow shank, S3= Black shank
Skin color=SC	SC2= Yellow skin
Comb type=CT	CT1= Rose comb, CT2= Pea, CT5= Cushion
Earlobe color=EC	EC1= Red earlobe, EC3= Yellow earlobe

Variations in Quantitative Traits

Live Body Weight

The average body weight of adult males and females varied significantly ($p < 0.05$) among the investigated indigenous chicken populations (Table 3). Males and females in Raya-azebo were significantly heavier compared to their counterparts in Endamehoni and Ofla chicken populations. The body weight for adult males were 1332 g, 1246 g and 1241 g in Raya-azebo, Endamehoni and Ofla district, respectively, which is lower than 2049g for males in Northwest Ethiopia (Halima 2007), 1690 g for Horro and 1420 g for Jarso male ecotypes (Eskinder 2013). While the values for adult females were 1081 g, 1011 g and 1007 g in Raya-azebo, Endamehoni and Ofla districts, respectively which is in line with the values reported for the Central Highlands of Ethiopia (1035 g) by Alemu and Tadelle (1997) but higher than the value reported for Northwest Ethiopia (847.77 g) by Halima (2007) and lower than the value reported for Horro (1289 g) and Jarso (1116 g) by Eskinder (2013).

Shank length

The average shank length of adult males and females in Raya-azebo were significantly ($p<0.05$) different from the other districts. Males and females in Raya-azebo have significantly longer shanks compared to their counterparts in the other two districts. The average shank length of males found in this study is comparable with the reported average value of 9.1cm for the five chicken ecotypes in Ethiopia (Nigussie et al 2010) but shorter than the reported 11.3 cm in Horro and 10cm in Jarso ecotypes, by Eskinder (2013). Similarly, the female shank length is in line with the range of shank length (6.6-7.8 cm) in five ecotypes of Ethiopia (Nigussie et al 2010) but shorter than 9.2 cm in Horro and 8.5 cm in Jarso ecotypes (Eskinder 2013).

Comb length, Comb height and Wattle length

The comb length, comb height and wattle length also varied significantly among the districts. Significantly long legs, large combs and wattles were observed in Raya-azebo male and female chicken populations, which are important morphological traits that allow better heat dissipation in the tropical hot environment. The comb and wattles have a large role in sensible heat losses. This specialized structure makes up about 40% of the major heat losses, through radiation, convection and conduction of heat produced from body surfaces at the environmental temperature above $26.7^0{}_C$ (Nesheim et al 1979).

Table 3. Morphometric variation of indigenous chicken ecotypes in the study districts

		District			
	Sex	Endamehoni	Ofla	Raya-azebo	Overall mean
Parameter (mean ± SE)					
Body weight (gm)	M	$1246.0{\pm}24.1^b$	$1241.0{\pm}15.9^b$	$1332.0{\pm}24.5^a$	$1271.0{\pm}12.6^*$
	F	$1011.0{\pm}13.7^b$	$1007.0{\pm}15.1^b$	$1081.0{\pm}12.4^a$	$1034.0{\pm}8.05^*$
Comb height (cm)	M	$1.95{\pm}0.04^a$	$1.53{\pm}0.03^b$	$2.05{\pm}0.05^a$	$1.82{\pm}0.03^*$
	F	$0.65{\pm}0.02^b$	$0.58{\pm}0.01^c$	$0.76{\pm}0.02^a$	$0.67{\pm}0.01^*$
Comb length (cm)	M	$5.13{\pm}0.1^b$	$5.11{\pm}0.07^b$	$5.52{\pm}0.11^a$	$5.24{\pm}0.06^*$
	F	$2.14{\pm}0.03^a$	$1.85{\pm}0.03^b$	$2.18{\pm}0.04^a$	$2.06{\pm}0.02^*$
Wattle length (cm)	M	$3.01{\pm}0.08^a$	$2.93{\pm}0.07^b$	$3.19{\pm}0.09^a$	$3.04{\pm}0.04^*$
	F	$0.67{\pm}0.01^b$	$0.66{\pm}0.02^b$	$0.73{\pm}0.01^a$	$0.69{\pm}0.01^*$
Body length (cm)	M	$37.6{\pm}0.21^b$	$37.2{\pm}0.17^b$	$38.7{\pm}0.19^a$	$37.8{\pm}0.12^*$
	F	$32.2{\pm}0.1^b$	$32.0{\pm}0.12^b$	$33.0{\pm}0.13^a$	$32.4{\pm}0.07^*$
Back length (cm)	M	$19.3{\pm}0.11^b$	$19.1{\pm}0.1^b$	$20.1{\pm}0.17^a$	$19.5{\pm}0.08^*$
	F	$17.2{\pm}0.06^b$	$17.1{\pm}0.08^b$	$17.6{\pm}0.09^a$	$17.3{\pm}0.05^*$
Breast circumference (cm)	M	$26.7{\pm}0.16^b$	$26.6{\pm}0.11^b$	$27.7{\pm}0.22^a$	$27.0{\pm}0.10^*$
	F	$25.0{\pm}0.13^b$	$25.1{\pm}0.1^b$	$25.5{\pm}0.13^a$	$25.2{\pm}0.07^*$
Wing span (cm)	M	$74.7{\pm}0.23^b$	$74.4{\pm}0.28^b$	$75.8{\pm}0.26^a$	$74.9{\pm}0.15^*$
	F	$62.9{\pm}0.19^b$	$62.7{\pm}0.19^b$	$64.0{\pm}0.15^a$	$63.2{\pm}0.11^*$
Shank length (cm)	M	$8.69{\pm}0.06^b$	$8.52{\pm}0.05^b$	$8.89{\pm}0.07^a$	$8.69{\pm}0.04^*$
	F	$6.96{\pm}0.04^b$	$6.88{\pm}0.03^b$	$7.35{\pm}0.04^a$	$7.07{\pm}0.02^*$
Keel length (cm)	M	$13.6{\pm}0.09^b$	$13.6{\pm}0.08^b$	$13.9{\pm}0.09^a$	$13.7{\pm}0.05^*$
	F	$11.9{\pm}0.06^b$	$11.8{\pm}0.05^b$	$12.2{\pm}0.05^a$	$12.0{\pm}0.03^*$

^{a,b,c} Means in a row with different superscript letters denote significant differences between populations or sampling districts ($p < 0.05$) and asterisks (*) within a column indicate significant differences between males and females for each parameter at the 5% level of probability.

Generally a wide range of morphological measurement, phonotypical and other performance variations of indigenous chicken populations are observed in this study which might be attributed to many factors, mainly to the variations in management practices between households, the effect of breed type and the availability of scavenging feed resources and feed supplements. Thus the presence of variations in both morphologies and phenotypes among the indigenous chickens indicates an opportunity for genetic improvement through selection of the indigenous chicken genetic resources.

Conclusion

The indigenous chicken populations studied showed heterogeneity in most of morphological and phenotypical traits considered. Thus, on-farm monitoring supported with an in-depth molecular evaluation should be undertaken to prove the level of genetic differentiation and relationships among this indigenous chicken populations.

ACKNOWLEDGEMENTS

First, I would like to express my sincere and heartfelt gratitude to my wife Girmanesh and my daughter Adyam for their understanding, encouragement and endurance at all stages of my work. Secondly , my greatest debt also goes to my family members, especially, my father Nigussie Bahita, my mother Amete Berhe and all my brothers and sisters and the rest all my friends and relatives for their devotion, inspiration, unlimited material and moral support and affection.

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