Quantitative Morphological Traits as a Measure of Genetic Diversity for Two Indigenous Chicken Ecotypes in Ethiopia

***Eskinder Aklilu*[1], Grum Gebreyesus[1] Kefelegn Kebede[2] and Tadelle Dessie[1]**
[1]International Livestock Research Institute; [2]Haramaya University

ABSTRACT: Phenotypic characterization of indigenous chicken ecotypes managed under scavenging system in two districts of Ethiopia was studied. A total of 448 indigenous chickens of both sexes were selected randomly to describe quantitative morphological traits. Generalized Linear Model (GLM) procedures and multivariate statistics were used to analyze the data. Long legs, large combs and wattle could be indicative of better heat dissipation of birds in tropical hot environment. Discriminant analysis identified shank length, body length, comb width, body weight, wingspan and comb height to have more discriminating power causing morphological variation between chicken ecotypes. The correlation between the first canonical variable and the two chicken ecotypes is moderate (0.55), canonical variables being highly significant based on the Wilks lambda test. Hundred nineteen chickens (86.2%) that belonged to Horro ecotype were correctly classified with 13.8% rate of error while 123 chickens (80.4%) that belonged to Jarso ecotype were correctly classified leaving 19.6% error rate.
Key Words: Discriminant analysis**;** indigenous chicken**;** quantitative morphological traits.

Introduction

Indigenous breed is a general terminology to describe those birds kept in the extensive system, scavenging in the free-range, have no identified description, multipurpose and unimproved (Horst (1989)). Indigenous chickens are reported to have variable morphological identity carrying genes that have adaptive values to their environment and diseases. According to Horst (1989), indigenous chickens can be considered as gene reservoir, particularly, for those genes that have adaptive values in the tropical conditions. In Ethiopia chickens are the most widespread where almost every rural family owns chickens, which contribute greatly to supply of eggs and meat (Tadelle (2003); Alemu and Tadelle (1997)) which shows a large variation in body conformation, plumage color, comb type and productivity (Tadelle (1996); Halima (2007)). However, there is little information available on the diversity of different chicken ecotypes. Moreover, no real efforts have been made to conserve these chicken genetic resources. The present and future improvement and sustainable utilization of indigenous chickens are dependent upon the availability of these genetic variations (Benitez (2002)).Researchers have used a characterization method based on morphological traits that are easy to measure, low cost and provide valuable information (Duguma (2010); Halima (2007)). Hence, the study was undertaken to phenotypically characterize local chicken populations in Horro and Jarso districts of Oromia regional state of Ethiopia by taking quantitative morphological traits.

Materials and Method

Location of study area: The study was conducted in two districts, i.e. Horro and Jarso, of Oromia regional state of Ethiopia representing two different indigenous chicken ecotypes.

Measurement of quantitative morphological traits: A total of 448 indigenous chickens of both sexes: 224 chickens (86 male and 138 female) from Horro and 224 chickens (68 male and 156 female) from Jarso, managed through traditional scavenging system, were selected randomly for this study. Quantitative morphological traits (i.e., shank length, comb height, comb width, body length, breast circumference, back length, keel length, wattle length, wingspan and body weight) were recorded following the recommended descriptors for chicken genetic resources (FAO (2011)).

Data analysis: SAS-program version 9.2 was used for all statistical analysis in this study.

Quantitative Morphological Traits

Univariate Analysis: Quantitative morphological traits were subjected to analysis of variance using the general linear model procedure (PROC GLM) of SAS to determine the effects of district (Horo and Jarso), sex and their interaction. Significant means were separated using the Duncan's New Multiple Range Test.

Multivariate analysis: The stepwise discriminant analysis procedure (PROC STEPDISC) was run to rank the quantitative morphological traits by their discriminating power. Selected significant traits from PROC STEPDISC were then subjected to canonical discriminant analysis (PROC CANDISC) and discriminant function analysis (PROC DISCRIM) to ascertain the existence of population level phenotypic differences between the districts. The analysis was performed taking individual birds as a unit. In order to avoid potential sampling bias due to low number of males in the study, only female birds were considered in discriminant analysis.

Result and Discussion

Quantitative Morphological Traits. The average body weight of local adult hens in Horro and Jarso were 1.29 kg and 1.12 kg respectively (Table 1) which is higher than the reported values for the central highlands of Ethiopia (1.04 kg) by Alemu and Tadelle (1997) and that reported (0.85kg) by Halima (2007) in northwest Ethiopia. The corresponding values for mature cock were 1.69 kg and 1.41 kg which were closer to the values reported for central highlands of Ethiopian chicken (1.5 kg) (Alemu and Tadelle (1997)) and lower than the average weight of indigenous chicken in north-west Ethiopia (2.05 kg), (Halima (2007)). The body weight variation in the present study compared to the literature could be attributed to the ecotype differences among various indigenous chicken populations of Ethiopia. Shank length of males from Horro and Jarso district were11.32 cm and 9.99 cm, respectively which are comparable with the reported value (9.8 cm) by Bogale (2008) and with that of (10.31 cm) reported by Halima (2007) in other parts of Ethiopia. Among the local hens, chickens from Horro had longer shank length (9.22 cm) than their Jarso counterpart (8.51 cm). These values are higher than that of (7.25 cm) reported by Bogale (2008). In this study long legs, large combs and wattle were observed, which could be important morphological traits that allow better heat dissipation in the tropical hot environment. The comb and wattles play important role in sensible heat losses. This specialized structure accounts for about 40% of the major heat losses, by radiation, convection and conduction of heat produced from body surfaces at environmental temperature above 26.7^{0}C (Nesheim et al. (1979)).

Multivariate analysis. The stepwise discriminant analysis identified six of the ten quantitative traits (Table 2) to have more discriminating power in assessing morphological variation between the chicken populations sampled from the two districts.

Table 1 Effect of sex and district on the quantitative morphological traits of indigenous chicken ecotypes

Traits(mean ± SE)*	Sex	District	
		Horro	Jarso
CW(cm)	M	5.88 ± 0.17^{a}	5.64 ± 0.2^{a}
	F	2.37 ± 0.06^{a}	2.53 ± 0.06^{a}
CH(cm)	M	2.16 ± 0.1^{a}	2.31 ± 0.14^{a}
	F	0.77 ± 0.04^{a}	0.84 ± 0.04^{a}
WL (cm)	M	3.51 ± 0.13^{a}	2.95 ± 0.12^{b}
	F	0.81 ± 0.03^{a}	0.74 ± 0.03^{a}
KL(cm)	M	16.55 ± 0.2^{a}	14.92 ± 0.3^{b}
	F	13.46 ± 0.16^{a}	12.72 ± 0.17^{b}
WS (cm)	M	77.87 ± 0.6^{a}	70.96 ± 0.91^{b}
	F	66.95 ± 0.46^{a}	62.59± 0.49^{b}
BL (cm)	M	39.97 ± 0.34^{a}	36.13 ± 0.44^{b}
	F	35.17 ± 0.26^{a}	32.66 ± 0.25^{b}
SH (cm)	M	11.32 ± 0.13^{a}	10 ± 0.15^{b}
	F	9.22 ± 0.06^{a}	8.51 ± 0.07^{b}
BC (cm)	M	30.47 ± 0.38^{a}	28.85 ± 0.38^{b}
	F	27.82± 0.24^{a}	27.22± 0.22^{a}
BaL(cm)	M	22.07 ± 0.30^{a}	20.96 ± 0.35^{b}
	F	19.27 ± 0.18^{a}	18.62± 0.17^{b}
BW (Kg)	M	1.69 ± 0.04^{a}	1.42 ±0.04^{b}
	F	1.29 ± 0.02^{a}	1.12± 0.02^{b}

^{a,b} When different superscripts are indicated in the same row it means that the difference are significantly different (P < 0.05) between Jarso and Horro.
CW, Comb Width; CH, Comb Height; WL, Wattle Length; KL, Keel Length; WS, Wing span; BL, body length; SL, shank length; BC, breast circumference; BaL, back length; BW, Body Weight.

Table 2 Significant traits that discriminated chicken ecotypes

Variable entered*	Partial R^2	F Value	P-value	Wilks' Lambda	ASCC
SL	0.17	60.20	<0.0001	0.83	0.17
BL	0.10	31.06	<0.0001	0.75	0.25
CW	0.04	10.82	0.0011	0.72	0.28
BW	0.02	6.04	0.0146	0.71	0.30
WS	0.01	2.58	0.1092	0.70	0.30
CH	0.01	2.31	0.1293	0.69	0.31

*SL, shank length ; BL, body length; CW, Comb Width; BW, Body Weight; WS, Wing span; CH, Comb Height.

The univariate ANOVA results from the Canonical Discriminant Analysis indicate that highly significant district effect exist for all the explanatory variables except 'comb height' (Table 3). By comparing the F-value and the P-value statistics for each significant explanatory variable, we can conclude that 'shank length' has the highest amount of significant discriminative potential, while 'comb width' has the least significant discriminative power in differentiating the chicken populations sampled from the two districts**.** The relatively large significant P-values obtained for the five explanatory variables (Table 3) indicate the fact that these predictors have high discriminatory power in classifying the two chicken populations sampled. The total-sample standardized canonical coefficients (Table 4) indicate the partial contribution of each variable to the discriminant function, controlling for other attributes entered in the equation. Accordingly, the total sample standardized canonical coefficients given in the table indicate that the explanatory variables, shank length, body length, body weight and wingspan contributed significantly in that order to the first canonical variable (CAN1). The correlation between CAN1 and the chicken populations sampled from the two districts was moderate (0.55), with the canonical variables being statistically highly significant based on the Wilks lambda test (P-value <0.0001). The standardized mean values of comb width and comb height for the Horro chicken ecotype are relatively lower than that of the Jarso chicken, while the mean values of wingspan, body length, shank length and body weight for the Horro chicken are relatively higher than their Jarso counterparts (Table 5**).** Thus, in general, these canonical variables successfully discriminate the two chicken ecotypes; this is in agreement with Deeve et al. (2013) which reported discriminant analysis may become an important tool for identifying variation in morphological linear measurements between populations.

Table 3 Univariate Test Statistics

Variable	Pooled STD	Between STD	F Value	P-value
CW	0.9957	0.1552	3.54	0.0611
CH	0.9988	0.1071	1.67	0.1969
WS	0.9363	0.5018	41.78	<0.0001
BL	0.9294	0.5267	46.74	<0.0001
SH	0.9113	0.5862	60.20	<0.0001
BW	0.9316	0.5189	45.14	<0.0001

CW, Comb Width; CH, Comb Height; WS, Wing span; BL, body length; SL, shank length; BW, Body Weight.

Table 4 Total-sample standardized canonical coefficients

Nr.	Variable	CAN1
1	Comb Width	-0.3045
2	Comb Height	-0.2061
3	Wingspan	0.2270
4	Body Length	0.459 1
5	Shank Length	0.5406
6	Body Weight	0.3777

Table 5 Total-Sample Standardized Class Means

.Variable*	Horro	Jarso
CW	-0.12	0.1
CH	-0.08	0.07
WS	0.37	-0.34
BL	0.39	-0.35
SL	0.44	-0.39
BW	0.39	-0.35

*CW, Comb Width; CH, Comb Height; WS, Wing span; BL, body length; SL, shank length; BW, Body Weight

Table 6 Classification result

District	Horro	Jarso	Total
Horro	119 (86.23%)	19 (13.77%)	138 (100%)
Jarso	30 (19.61%)	123 (80.39%)	153 (100%)
Total	149 (51.20%)	142 (48.80%)	291 (100%)
Priors	0.4742	0.5258	

The Mahalanobis distance between Horro and Jarso chicken was 1.7641 and it was highly significant (P-value: <0.0001). The performance of a discriminant function analysis in classification is evaluated by estimating the probabilities of misclassification. Table 6 lists the misclassified observations based on the posterior probability estimates computed by the quadratic discriminant function via cross-validation. Nineteen cases that belong to the Horro district were classified into the Jarso district while thirty cases that belong to the Jarso district were classified into the Horro district.

Conclusion

In this study significant morphological variations between the two chicken ecotypes were detected. The high diversity in indigenous chicken phenotypes is major evidence for the existence of high genetic variability in indigenous chickens of Ethiopia. However, there is an urgent need to preserve this genetic variability of the indigenous chickens of Ethiopia because of continuous pressure of their adulteration. Therefore, further work on indigenous chicken of Ethiopia need to be carried out to assess and to prevent such adulteration through promoting their utilization and undergoing advanced characterization at molecular level to assert their advantage of maintaining genetic diversity and adaptability.

Literature Cited

Alemu, Y., and Tadelle, D. (1997). Proc 5th ESAP, 15-17 may, Addis Ababa, Ethiopia.

Benitez, F. (2002). Proc. 7th WCGALP, August 19-23 Montpellier, France.

Bogale, K. (2008). Msc Thesis Haramaya University; Ethiopia.

Deeve, S. G., Tor Noah, E.T., and Thomas, I.W. (2013). J. IOSR-JAVS, volume 3:60-64.

Duguma, R. (2010). Retrieved November 24, 2010, from http://www.lrrd.org/lrrd18/9/dugu18131.htm.

Food and Agriculture Organization of the United Nations (FAO) (2011). Chicken descriptors 63-66.

Halima, H.M. (2007). Ph.D Thesis, South Africa: University of Free State.

Horst, P. (1989). Archiv für Geflügelkunde, volume 53(3), 93-101.

Nesheim, C.M., Austic, E.R. and Card, E.L. (1979) Poultry production. Philadelphia. 12th edition. Lea and Febiger.

Tadelle, D. (2003). Ph.D. Thesis, Germany: umboldt University.

Tadelle, D. (1996). M.Sc Thesis, Swedish University of Agricultural sciences.