JAPSC
Journal of Animal and Poultry Sciences, 2014 3 (3): 76-85
Available online at http://www.JAPSC.com

Short communication

Morphometric variations among five Bhutanese indigenous chickens (*Gallus domesticus*)

N. Dorji [1*], and S. K. Sunar [1]

[1]*Department of Animal Science, College of Natural Resources, Bhutan, Lobesa, Punakha*

Abstract

Morphometric characterization provides baseline information for initiating population's improvement. Thus, the study aims to investigate variations of morphometric traits in five indigenous chickens of Bhutan. A total of 122 adult female birds belonging; Seim (Red Jungle-fowl type), Yuebjha Narp (Black), Khuilay (Naked neck), Phulom (Frizzle) and Shekheni (Short-legged) were included for live weight and linear body measurements. Descriptive and inferential statistics of SPSS 16 were used to determine the influence of bird type on some quantitative traits. Adult Seim was the heaviest (mean, 1.58; SE, 0.10 kg), followed by Naked neck (mean, 1.46; SE, 0.05 kg) while the lowest was Frizzle (mean, 1.36; SE, 0.04 kg). Mean body was the widest and narrowest for Seim (29.85 cm) and Shekheni (27.67 cm), respectively. In addition, lengths of body were longer and shorter in Seim (40.48 cm) and Shekheni (27.67 cm), respectively. On the contrary, the longest back length was observed in Shekheni (21.23 cm). Frizzle (11.55 cm) and Seim (11.53 cm) was bigger thigh circumference while Shekheni (10.84 cm) was low. Similarly, thigh lengths were the longest in Frizzle and Seim. Strong positive correlations for body weight and linear body measures were examined in all populations Seim and Naked neck had the best coefficient of correlations in studied traits. A cluster analysis could also classify the Bhutanese indigenous chickens into two main clusters; creeper (Shekheni) and non-creepers (Frizzle, Yuebjha Narp, Naked neck and Seim). These information may prove essential with any future research on local chickens of Bhutan.

Key words: Breeding strategy, income, indigenous chicken, sustainable

***Corresponding author: Tel: +9752376249; Fax: +9752376254
E-mail address: nedup@cnr.edu.bt

Introduction

Poultry has been playing crucial roles in sustaining and supplementing a cheap protein to poor and their cultural values in rural communities of Bhutan (Dorji et al., 2012; Dorji and Gyeltshen, 2012). However, the poultry products from our local poultry keepers could not meet the demand within the country. Moreover, the ban on import of poultry products due to experience of diseases in India might have influenced poultry development in Bhutan. However, the part-time and fulltime small and medium scale poultry farms are concentrated in the west and southwest region of the country. Presently, Hyline Brown is supplied by the government as they are better in performance than the local hens. On the other hand, this might lead to dilution of poultry genetic resources in Bhutan.

Currently, the develoiping world is experiencing series of severe threat from climate variability. To adapt the impact of climate change, conservation of the farm animal genetic resources must be prioritized (Hoffman and Sgro, 2011). This local chicken manifests a great deal of variation due to years of unplanned breeding systems. Thus, the rich gene pools guarantees evolution and provide genetic materials for future unpredicted breeding requirements (Dorji, 2012). Moreover, local poultry products taste better and have a good flavour. They are also indicator for cultural evolution. For effective conservation and utilization of available poultry genetic resources, phenotypic characterization should be prioritised (FAO, 2011). Therefore, the objective of the study was to characterize Bhutanese indigenous chicken based on morphometric traits.

Materials and Methods

Study sites

The remote areas are considered to contain the uncontaminated genetic resources. Hence, we sampled birds from Karmaling (Homa and Balabas), Nichula (Hurdung, Solaytar and Garigoan), Sibsooney (Nawtalay, Koilatara and Sibsooney) and Farmgaon (Balaytar, Bichgaon, Jogigoan and Daragoan) of Daga district. All the birds were reared under extensive production system. They have to find their own food, although a handful of grain is provided by their owners. A nigh shelter is usually provided to protect from the predators.

Sample size and data collection

Five strains of Bhutanese indigenous chickens (BICs) namely: Seim (n = 21), Yuebjha Narp (n = 24), Naked neck (n = 25), Frizzle (n = 25) and Shekheni (n = 27) were collected for the present study. The data collections were done in morning. The morphometric data recordings were live body weight, body size (body length, back length, and body width), comb length and width, thigh length and circumference, and shank length (FAO, 2011; Francesch et al., 2011).

Statistical analysis

Data normality was tested by either box plot or Shapiro-Wilk test (Ghasemi and Zahediasl, 2012) using SPSS 16. The data deviated from Gaussian distribution (Figure 1) hence all data were transformed to log10 anchored at 1 (Osborne, 2010). All the statistical analyses were involved with the log transformed data (Manikandan, 2010). Bonferroni method of Analysis of variance was used to compare the means at $P < 0.05$. Moreover, Pearson's correlation coefficient (r) was used to determine the relationships between the traits. Then, log10 were transformed back to original data on completion of analysis. A dendrogram was constructed based on squared Euclidean distance (Krishnaswamy et al., 2009).

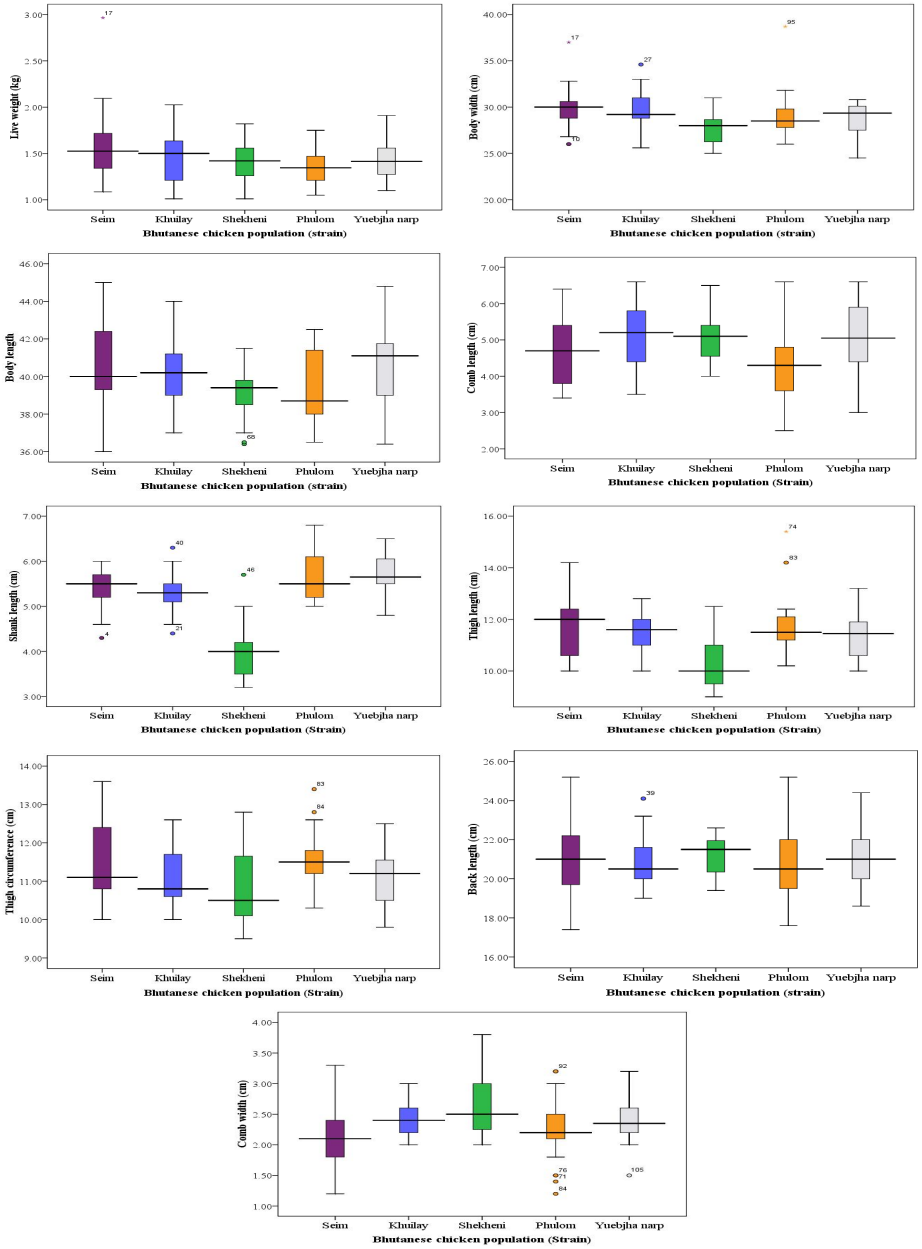

Figure 1. Data distribution in some morphometric traits

Results and Discussion

Live body weight

Adult hen body weight in Seim was the heaviest (mean, M = 1.58; standard error, SE = 0.10) followed by Naked neck (M = 1.46, SE = 0.05) as shown in Table 1. Shekheni 'native dwarf / creeper / short-legged' were heavier than the Frizzle which could be because of its role. For instance, Frizzle is kept mainly for cultural rituals by specific ethnic group which might have indirectly involved with selection. Non significance differences existed among the population with respect to body weight ($P > 0.05$). A similar observation was made among the native hens of South Africa (Alabi et al., 2012) and Nigeria (Olawunimi et al., 2008). However, significance differences were observed for body weight among Bangladeshis native hens (Faruque et al., 2011).

At traditional scavenging management, local hen of Dekina (1.05 kg in Daikwo et al., 2011), Nasarawa (1.19 kg in Yakubu et al., 2009), Kashmir (1.25 kg in Iqbal et al., 2009) and Baladi (Yakout et al., 2009) are lighter than the average BIC hen of 1.44 kg. Furthermore, Sentual (1.85 kg), Kampong (1.38 kg), Wareng-Tangerang (0.84 kg) of Indonesia female birds (Mulyono et al., 2009 reviewed from Iskandar et al., 2004) were higher, closer or lower than the Bhutanese hen's body weight. Moreover, Dinesh et al. (2009) measured 1.32 to 1.49 kg in Cambodia local hens which is close to BIC hen's live weight.

Bhutanese Frizzle and creepers were much heavier than the Banerjee (2012) reports for Frizzle (West Bengal, 1.08 kg; Sikkim, 1.04 kg) and creepers (West Bengal, 1.04 kg; Sikkim, 1.04 kg). Comparing against Naked neck hen of Bangladesh (0.97 kg in Uddin et al., 2011), Sikkim (1.05 kg in Banerjee, 2012) and West Bengal (1.09 kg in Banerjee, 2012), Bhutanese Naked neck seems to be superior in body weight. But, Faruque et al. (2011) recorded weight of Naked neck hen of Bangladesh reared under good husbandry close to the present study. Daikwo et al. (2011) suggested that the local bird containing genes from exotic birds will be larger in size. However, sources for the morphometric characterization in our study were from remote parts of the country and gene admix is less likely to occur. Moreover, Dorji et al. (2012) indicated that the BICs were not genetically close to commercial birds. To supplement further, Naked neck hen kept under improved management in South African (1.61 kg in Alabi et al., 2012) and Nigerian (0.91 kg in Adekoya et al., 2013) is heavier and lighter than the BICs, respectively. Hence, different management and local climatic conditions might have attributed to the difference in our findings as explained by Daikwo et al. (2011).

Comb length and width

Comb shape and size assist breeders to distinguish male from female birds (Mulyono et al., 2009). Larger and longer comb were observed in Shekheni and Naked neck, respectively (Table 1). On the other hand, narrower and shorter comb were recorded for Seim and Frizzle, respectively. Average comb of Bhutanese hens were shorter than the hen of Bangladesh (Faruque et al., 2011) and Nigeria (Olawunimi et al., 2008). This indicates that the comb size is probably associated with climatic condition. For example, comb and wattles serve as an important source for heat dissipation in birds.

Table 1. Morphometric traits measurement in Bhutanese hen populations (Mean ± SE)

Parameters	Population				
	Seim	Naked neck	Frizzle	Yuebjha Narp	Shekheni
Live weight (kg)	1.58±0.10^{a}	1.46±0.05^{a}	1.36±0.04^{a}	1.43±0.05^{a}	1.40±0.04^{a}
Body length (cm)	40.48±0.52^{a}	40.24±0.38^{a}	39.15±0.37^{a}	40.43±0.41^{a}	39.06±0.26^{a}
Body width (cm)	29.85±0.55^{a}	29.78±0.43^{a}	29.04±0.52^{ab}	28.86±0.33^{ab}	27.67±0.30^{b}
Back length (cm)	21.04±0.44^{a}	20.84±0.28^{a}	20.72±0.37^{a}	20.93±0.28^{a}	21.23±0.19^{a}
Comb length (cm)	4.68±0.21^{ab}	5.11±0.17^{ab}	4.34±0.19^{a}	5.09±0.19^{ab}	5.05±0.12^{ab}
Comb width (cm)	2.19±0.13^{a}	2.38±0.06^{ab}	2.24±0.10^{a}	2.41±0.08^{ab}	2.66±0.09^{b}
Thigh length (cm)	11.63±0.29^{a}	11.52±0.16^{a}	11.79±0.22^{a}	11.33±0.16^{a}	10.33±0.19^{b}
Thigh circumference (cm)	11.53±0.26^{ab}	11.21±0.16^{ab}	11.55±0.14^{a}	11.15±0.81^{ab}	10.84±0.18^{ab}
Shank length (cm)	5.34±0.11^{a}	5.34±0.08^{a}	5.65±0.11^{a}	5.72±0.45^{a}	4.03±0.11^{b}

a-b Means within a row with different superscripts are different ($P < 0.05$)

Body length

Olawunimi et al. (2008) explains the evolutionary advantage of a smaller body size to reduce feed requirements in the tropics. However, there were no differences for body length among BIC populations ($P > 0.05$) and this was also observed among native female birds of Bangladesh (Faruque et al., 2011) and Philippines (Lopez Jr et al., 2013). Mean body length of BIC was longer than the Nigerian birds (Olawunimi et al., 2008; Yakubu et al., 2009; Daikwo et al., 2011), but as long as hens of South African (Alabi et al., 2012) and Philippines (Lopez Jr et al., 2013).

Among BIC hen, Seim, Naked neck and Yuebjha Narp have longer body than the Shekheni and Frizzle (Table 1). The longer body length of these populations indicates that the overall body mass will be more and hence appear bigger in body size. Moreover, the longer length of body informs that they are probably better for egg laying (Olawunimi et al., 2008).

Body width

Similarly, Seim and Naked neck had wider body width and were significantly different from Shekheni only ($P < 0.05$). This results further supports that breast width is associated with meatiness in birds as reported by Olawunimi et al. (2008). Comparable results were observed for scavenging Nigerian hen (Daikwo et al., 2011) while Fulani ecotype (Olawunimi et al., 2008) and Savannah (Yakubu et al., 2009) hen seems to have body with slightly lesser muscle than the BIC hens. In addition, Bhutanese hen's breast girth was narrower than South African hens (Alabi et al., 2012) reared under improved husbandry conditions.

Back length

No significance of differences was observed among the studied populations ($P > 0.05$). By contrast, the differences were observed for five Nigerian birds reared under improved management system at $P < 0.05$ (Adekoya et al., 2013). Back length of BIC Naked neck and Frizzle was close to Nigerian Naked neck and Frizzle hen's back length, respectively (Adekoya et al., 2013).

Shank length

The lightest body weight of Frizzle has also the second tallest shank length. The average shank length of Naked neck was shorter than the Frizzle as recorded by Banerjee (2012) in West Bengal and Sikkim. Dinesh et al. (2009) also observed that the bird's live weight and shank length is correlated. The shank length of Shekheni was the shortest among Bhutanese hen population ($P < 0.01$). Moreover, shank length of BIC hen (except for Shekheni) was not affected by the population ($P > 0.05$) and is in support to Lopez Jr et al. (2013) findings for Philippines local female fowl.

Bhutanese hen's shank length was shorter than the native hens of Indonesia (Mulyono et al., 2009), Cambodia (Dinesh et al., 2009) and Philippines (Lopez Jr et al., 2013). Moreover, Bhutanese Naked neck, Frizzle and Shekheni shank were shorter than the West Bengali and Sikkimese counterparts (Banerjee, 2012) and Bangladesh (Faruque et al., 2011). On the contrary, Daikwo et al. (2011) observed shorter shank in Nigerian female fowl under traditional scavenging system. In creepers, leg bone shortens due to creeper (Cp) gene (Landauer, 1932).This short-legged hens are not to be used for hatching and producing more chickens because high mortality was observed (Landauer,1932).

Thigh length and circumference

Frizzle and Seim seems to have bigger and longer thigh which could support the heavy body weight of the bird. Total averaged BIC hen thigh length were 11.29 cm long that ranged from 10.33 cm (Shekheni) to 11.79 cm (Frizzle). Significantly ($P < 0.01$) the shortest thigh length was recorded in Shekheni. Nigerian bird's thigh length in Olawunimi et al. (2008) investigation was longer than the present study. A significant difference was not observed between normal plumage hens (Seim and Yuebjha Narp) and non normal plumage hens (Frizzle and Naked neck) at $P > 0.05$ with respect to thigh circumference. This is in consistent with Yakubu et al. (2009) findings among Nigerian fowls.

Correlation among the traits

The greatest correlations in the populations were between comb length and comb width (Seim, $r = 0.93$; Naked neck, $r = 0.88$; Yuebjha Narp, $r = 0.83$), body length and comb length (Shekheni, $r = 0.66$) and live weight and thigh circumference (Frizzle, $r = 0.89$).

A moderate to strong positive correlation between live weight and linear body length were observed in all Bhutanese chickens except for Yuebjha Narp (Table 2). The positive and significant coefficient of correlation between body weight and body ($P < 0.01$) is agreeing with Yakubu et al. (2009), Daikwo et al. (2011) and Alabi et al. (2012) study.

A strong positive correlation between live weight and comb length and width were observed in Seim, Naked neck and Frizzle fowl ($P < 0.01$). We could not determine a significant relationship for Yuebjha Narp and Shekheni though positive and weak moderate association were observed (Table 2). Nevertheless, it may suggest that the comb is associated with live body weight.

A strong positive correlation between live weight and thigh length and circumference were observed for Seim, Naked neck, Frizzle and Yuebjha Narp. On the contrary, positive weak correlation coefficients were

estimated for Shekheni birds. Similarly, a strong positive association were observed between body weight and shank length, except for Shekheni. This is in line to Faruque et al. (2011) report for Bangladeshis local fowls.

Comparing BIC population-wise, Shekheni presented positive and lowly to moderately association between the studied traits while Frizzle's have positive and weakly to strongly correlated ($P < 0.05$ and $P < 0.01$). In Seim and Naked neck population, coefficients of correlation were positive and moderate to strong. It implies that the improvement made in any presently studied traits would improve the others in Seim and Naked neck faster than the Frizzle, Yuebjha Narp and the least for Shekheni chickens.

Table 2a. Correlations between morphometric traits in Seim chickens

	Live weight	Body length	Body width	Comb length	Comb width	Thigh length	Thigh circum.	Shank length
Live weight	1.00							
Body length	0.76**	1.00						
Body width	0.83**	0.87**	1.00					
Comb length	0.69**	0.68**	0.69**	1.00				
Comb width	0.74**	0.75**	0.71**	0.93**	1.00			
Thigh length	0.66**	0.77*	0.70**	0.64**	0.74**	1.00		
Thigh circum.	0.85**	0.80**	0.72**	0.71**	0.76**	0.79**	1.00	
Shank length	0.66**	0.81**	0.76**	0.69**	0.77**	0.81**	0.73**	1.00

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed).

Table 2b. Correlations between morphometric traits in Naked neck birds

	Live weight	Body length	Body width	Comb length	Comb width	Thigh length	Thigh circum.	Shank length
Live weight	1.00							
Body length	0.66**	1.00						
Body width	0.77**	0.61**	1.00					
Comb length	0.70**	0.67**	0.56**	1.00				
Comb width	0.67**	0.66**	0.50**	0.88**	1.00			
Thigh length	0.55**	0.44*	0.50**	0.68**	0.58**	1.00		
Thigh circum.	0.69**	0.67**	0.56**	0.79**	0.80**	0.52**	1.00	
Shank length	0.70**	0.63**	0.66**	0.72**	0.62**	0.79**	0.67**	1.00

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed).

Table 2c. Correlations between morphometric traits in Shekheni

	Live weight	Body length	Body width	Comb length	Comb width	Thigh length	Thigh circum.	Shank length
Live weight	1.00							
Body length	0.41*	1.00						
Body width	0.55**	0.40*	1.00					
Comb length	0.34	0.66**	0.30	1.00				
Comb width	0.47**	0.56**	0.46*	0.65**	1.00			
Thigh length	0.27	0.48**	0.59**	0.35	0.42*	1.00		
Thigh circum.	0.22	0.20	0.37*	0.28	0.03	0.41*	1.00	
Shank length	0.32	0.38*	0.53**	0.26	0.15	0.74**	0.36*	1.00

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed).

Table 2d. Correlations between morphometric traits in Frizzle birds

	Live weight	Body length	Body width	Comb length	Comb width	Thigh length	Thigh circum.	Shank length
Live weight	1.00							
Body length	0.83**	1.00						
Body width	0.74**	0.77**	1.00					
Comb length	0.72**	0.83**	0.55**	1.00				
Comb width	0.68**	0.78**	0.57**	0.81**	1.00			
Thigh length	0.44	0.41*	0.22	0.51**	0.62**	1.00		
Thigh circum.	0.89**	0.78**	0.70**	0.73**	0.69**	0.47**	1.00	
Shank length	0.69**	0.66**	0.43*	0.56**	0.62**	0.38*	0.60**	1.00

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed).

Table 2e. Correlations between morphometric traits in black birds

	Live weight	Body length	Body width	Comb length	Comb width	Thigh length	Thigh circum.	Shank length
Live weight	1.00							
Body length	0.45*	1.00						
Body width	0.69**	0.52**	1.00					
Comb length	0.32	0.12	-0.26	1.00				
Comb width	0.31	0.04	-0.11	0.83**	1.00			
Thigh length	0.67**	0.50**	0.54**	0.10	0.08	1.00		
Thigh circum.	0.64**	0.40*	0.54	0.07	0.01	0.60**	1.00	
Shank length	0.50**	0.26	0.15	0.24	0.20	0.16	0.16	1.00

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed).

Clustering

The cluster analysis could classify the BICs into two main groups namely; first non-creepers group consisting of Yuebjha Narp, Frizzle, Naked neck and Seim and the other by Shekheni (Figure 2). Shekheni seems to be far from the rest chicken populations which are expected with the difference in some morphometric traits. Moreover, non creeper birds could also be classified into three subgroups as; first subclass constituting of Yuebjha Narp and Frizzle; second subclass representing by Naked neck, third subgroup by Seim (Figure 2).

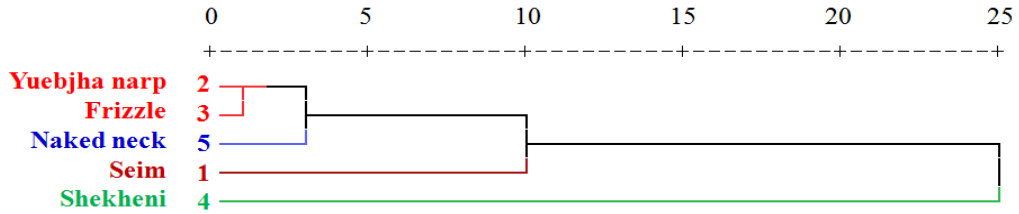

Figure 2. A dendrogram based on Squared Euclidean distance

Conclusion

There were strong positive correlations between body weight and the body measures for all populations. Seim and Naked neck seems to have the best coefficient of correlations hence, quicker improvement could be made. The results further indicated that there is still large variation in the morphometric traits in the

populations. Dendrogram also present that the five Bhutanese indigenous chickens could be classified into two; creeper and non-creepers.

Acknowledgments

We owe the most sincere gratitude and appreciation to the AURG, Royal University of Bhutan for funding the study. Without the support form AURG, the study would not have been possible. The authors thank Director General of College of Natural Resources for his foresight and tireless support to this research study. Moreover, we would like extend deep appreciation to those poultry farmers who were interested and willing to participate in this important research. Finally, Dr. Om Katel, College of Natural Resources deserved for his essential support in statistics logistics.

References

Adekoya, K. O., B. O. Oboh, M. A. Adefenwa, and L. A. Ogunkanmi. 2013. Morphological characterization of five Nigerian indigenous chicken types. *J. Sci. Res. Dev.*, 14: 55-66.

Alabi, O. J., J. W. Ng'ambi, D. Norris, and S. S. A. Egena. 2012. Comparative study of three indigenous chicken breeds of South Africa: body weight and linear body measurements. *Agricultural Journal*, 7(3): 220-225.

Banerjee, S. 2012. Morphological characterization of indigenous chickens of Sikkim and West Bengal, India. *Animal Genetic Resources*, 51: 57-71.

Daikwo, I. S., A. A. Okpe, and J. O. Ocheja. 2011. Phenotypic characterization of local chickens in Dekina. *International Journal of Poultry Science*, 10(6): 444-447.

Dinesh, M. T., E. Geerlings, J. Sölkner, S. Thea, O. Thieme, and M. Wurzinger. 2009. Characterization of indigenous chicken production systems in Cambodia. *AHBL - Promoting Strategies for Prevention and Control of HPAI, FAO, Rome.*

Dorji, N., M. Daungjinda, and Y. Phasuk, Y. 2012. Genetic characterization of Bhutanese native chickens based on an analysis of Red Junglefowl (Gallus gallus gallus and Gallus gallus spadecieus), domestic Southeast Asian and commercial chicken lines (Gallus gallus domesticus). *Genetics and Molecular Biology*, 35: 1415-4757.

Dorji, N, and T. Gyeltshen, T. 2012. Characterisation of family poultry production in Haa and Mongar districts of Bhutan. *Livestock Research for Rural Development*, 24 (155).

Faruque, S., N. U. Siddiquee, M. A. Afroz, and M. S. Islam. 2010. Phenotypic characterization of native chicken reared under intensive Management system. *Journal Bangladesh Agricultural University*, 5: 79-82.

Food and Agriculture Organization. 2011. Draft guidelines on phenotypic characterization of animal genetic resources. *FAO, Rome.*

Francesch, A., I. Villalba, and M. Cartañà. 2011. Methodology for morphological characterization of chicken and its application to compare Penedesenca and Empordanesa breeds. *Animal Genetic Resources*, 48: 79-84.

Ghasemi, A, and S. Zahediasl. 2012. Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. *International Journal of Endocrinology Metabolism*, 10(2): 486-489.

Hoffmann, A. A, and C. M. Sgro. 2011. Climate change and evolutionary adaptation. *Nature*, 470: 479-485.

Iqbal, S., Z. A. Pampori, and D. Hasin. 2009. Carcass and egg characteristics of indigenous chicken of Kashmir (Kashmir favorella). *Indian Journal of Animal Research*, 43(3): 194-196.

Krishnaswamy, K. N., A. I. Sivakumar, and M. Mathirajan. 2009. Management Research Methodology: Integration of Principles, Methods and Techniques. *Dorling Kindersley Pvt. Ltd., Delhi.* 465*p*

Lopez Jr, R.V., A. L. Lambio, R. S. A. Vega, and A. P. O. De Guia. 2013. Phenotypic characterization of native chicken in Palawan, Philippines. *Philippine Journal of Veterinary and Animal Sciences*, 39 (2): 147-156.

Manikandan, S. 2010. Data transformation. Journal of Pharmacology Pharmacother, 1(2): 126-127.

Mulyono, R. H., T. Sartika, and R.D. Nugraha. 2009. A study of morphometric-phenotipic characteristic of Indonesian chicken: Kampong, Sentul and Wareng-Tangerang, based on discriminant analysis, Wald-Anderson criteria and Mahalanobis minimum distance. *The 1st International Seminar on Animal Industry*: 278-288.

Ogah, D.M. 2013. Canonical discriminant analysis of morphometric traits in indigenous chicken genotypes. *Trakia Journal of Science*, (2): 170-174.

Olawunmi, O. O., A. E. Salako, and A. A. Afuwape. 2008. Morphometric differentiation and assessment of function of the Fulani and Yoruba ecotype indigenous chickens of Nigeria. *International Journal of Morphology*, 26(4): 975-980.

Osborne, J.W. 2010. Improving your data transformations: Applying the Box-Cox transformation. *Practical Assessment, Research & Evaluation*, 15(12): 1-9.

Uddin, M. H., A. Ali, Y. Akter, and M. A. Khatun. 2011. Geographical distribution, classification, characterization and conservation of different native chicken varieties of Bangladesh. *Bangladesh Research Publication Journal*, 5(3): 227-233.

Yakout, H. M., M. Kosba, and O. Thieme. 2009. Characterisation of domestic chicken and duck production systems in Egypt. AHBL - promoting strategies for prevention and control of HPAI. *Food and Agriculture Organization, Rome*.

Yakubu, A., D. Kuje, and M. Okpeku. 2009. Principal components as measures of size and shape in Nigerian indigenous chickens. *Thai Journal of Agricultural Science*, 42(3): 167-176.