



An *ex situ* study on body characteristics and effect of plumage color on body weight of indigenous chicken (*Gallus domesticus*) in Bangladesh

Nipa Rani Sarker¹, Azharul Hoque¹, Shakila Faruque², Nazrul Islam² and Fazlul Haque Bhuiyan^{1*}

¹Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. ²Poultry Production Research Division, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh. *Author for correspondence. E-mail: bhuiyanbau@gmail.com

ABSTRACT. The study was conducted at the Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh with the objectives of comparing the body characteristics and body weight of three Indigenous chicken genotypes namely Common Desi, Hilly and Naked Neck. Of the four hundred and eighty nine birds analyzed the proportion of Common Desi, Naked Neck and Hilly chicken were 49.49, 24.95 and 25.56% respectively. The most predominant plumage color was reddish black (33.13%). Four types of shank colors were most frequently observed, i.e. white (39.87%), yellow (37.22%), black (20.04%) and mixed (2.87%). The earlobes were mainly reddish white (44.79%) followed by white (29.24%) and red (25.97%). The most predominant skin color was white (92.22%). Most birds had a single comb (96.12%). Hilly birds were heavier than the other Indigenous chicken groups ($p < 0.05$). The mature weight between Common Desi and Naked Neck did not differ significantly ($p > 0.05$) but significantly differed from that of Hilly chicken. In terms of shank length and circumference, there were no significant ($p > 0.05$) differences between Common Desi and Naked Neck chicken, but Hilly chicken had significant ($p < 0.05$) differences from both.

Keywords: indigenous chicken, morphological characteristics, body weight.

Investigação *ex situ* sobre as características do corpo e os efeitos da cor das penas no peso corporal de frangos indígenas (*Gallus domesticus*) em Bangladesh

RESUMO. O estudo foi conduzido no Instituto de Pesquisa Animal (BLRI) em Savar, Dhaka, Bangladesh, para comparar as características corporais e o peso corporal de três genótipos de frangos indígenas, Common Desi, Hilly e Naked Neck. A proporção dos genótipos Common Desi, Naked Neck e Hilly foi respectivamente 49,49, 24,95 e 25,56% num total de 489 aves analisadas. A cor predominante das penas foi preto avermelhado com 33,13%. Foram observados os quatro tipos de cores mais frequentes das pernas: branca (39,87%), amarela (37,22%), preta (20,04%) e mista (2,87%). A cor das orelhas era geralmente branca avermelhada (44,79%), seguida por branca (29,24%) e vermelha (25,97%). A cor da pele mais predominante era branca (92,22%). A maioria das aves tinha uma só cresta (96,12%). As aves Hilly eram mais pesadas do que os outros grupos de aves indígenas ($p < 0,05$). Não havia diferença significativa entre o peso maduro entre as aves Common Desi e Naked Neck ($p > 0,05$), mas havia diferença significativa do peso das aves Hilly. Em termos de comprimento de perna e circunferência, não havia diferença significativa ($p > 0,05$) entre Common Desi e Naked Neck, embora as aves Hilly diferissem significativamente ($p < 0,05$) dos outros dois.

Palavras-chave: aves indígenas, características morfológicas, peso corporal.

Introduction

Domestic chickens are believed to have originated in Southeast Asia (HILLEL et al., 2003). The decrease in the genetic diversity of native chicken populations described in recent genetic studies has raised concern because the unique genotypes and traits of native populations are at risk of being lost, with a consequent threat to a well-established food source (NASSIRI et al.,

2007). This situation suggests that the management of native chicken genetic resources should be given greater priority. It can be assumed that local breeds contain the genes and alleles pertinent to their adaptation to particular environments and local breeding goals. Such local breeds are needed to maintain genetic resources permitting adaptation to unforeseen breeding requirements in the future and can serve as a source of research material

(ROMANOV; WEIGEND, 2001). Poultry is one of the fastest growing segments of the agricultural sector in Bangladesh (FARUQUE et al., 2007). The economy of Bangladesh is based on agriculture where livestock is an integral part of the rural economy. About five to six million people are dependent directly or indirectly on poultry and poultry-related activities. Poultry especially chicken is the cheapest source of animal protein in the form of meat or eggs throughout the world including Bangladesh (UDDIN, 2001; WINDHORST, 2008). Indigenous chickens produce about 75% of the eggs and 78% of meat consumed domestically (BHUIYAN et al., 2005). Bebes (2009) showed that Indigenous and local chicken breed share 90% of the total population in developing countries. Bangladesh has a wide variety of chicken, mostly of non-descript type, which include 188 million chickens of commercial hybrids and native chickens (GOB, 2006). Indigenous chickens of the tropics are important reservoirs of useful genes and possess a number of adaptive traits (HORST, 1989). To increase the genetic potential of Indigenous chickens in developing countries, utilization of animal breeding programs is necessary (AINI, 1990; TADELLE et al., 2000). Indigenous chicken populations are able to take valuable position in future animal breeding programs in the world. In addition to being valuable gene pools or major source of genes (which directly or indirectly influences the production characteristics under tropical management conditions), Indigenous chickens are able to improve quality of products through heterosis or morphological and physiological changes (TADELLE et al., 2000). There is wide performance variability in these chicken types. Many phenotypic variations exist among the native chicken population; especially plumage colors, e.g. Black, Red, Spotted, Ash and combination of different colors furnished the chicken's appearance. Such variations among individuals or groups of chickens provide room and opportunity for breeding and selection. So, keeping this in view the proposed research work was aimed at the following objectives: (a) to evaluate the body characteristics of Common Desi, Naked Neck and Hilly chicken genotypes based on some phenotypic measurements reared *ex-situ*, (b) to reveal the body weight and growth traits of Indigenous chicken reared *ex-situ*, (c) to recommend a breeding strategy appropriate for *ex-situ* Indigenous chicken development in Bangladesh.

Material and methods

The experiment analyzed body characteristics and body weight of three Indigenous chicken genotypes namely Common Desi, Hilly and Naked Neck (Figure 1) in *ex situ* condition at Poultry Farm, Poultry Production Research Division, Bangladesh Livestock Research Institute, Savar, Dhaka. Four hundred and eighty-nine birds, comprising 93 males and 396 females, were selected to record the qualitative and quantitative traits.



Figure 1. Male and female birds of three indigenous chicken genotypes.

Morphological Characteristics

Different phenotypic variant such as body measurements, plumage color, shank color, earlobe color, skin color, comb color and comb types were observed on Non-descriptive Common Desi (ND), Hilly (H) and Naked Neck (NN), respectively. Observations on Native chickens different plumage colors reported Black (RB),

Blackish Red (BR), Red (R), Black (B), Reddish White (RW), Brown (BR), Black with white spot (BW), Mixed (M) and White with black spot (WB); four types of shank color were most frequently encountered, i.e. white, yellow, black and mixed; the earlobes were mainly reddish white followed by white and red; the most predominant skin color was white. Most birds had single comb, few chickens were cape headed, one was butter comb and one was rose combed.

So that each variety of native of native chickens could be characterized, the morphological variants were identified and documented on birds. Different body measurements such as body weight (live), back length, body circumference, wing length, breast width, keel length, shank length and shank circumference of these varieties were measured. A measuring tape and a weighing balance were used to measure the following body parts.

- Body weights were measured by a digital weighing balance up to the nearest gram(g);
- Back length was measured from the beginning of the neck to the tail;
- Body circumference was the circumference of the body;
- Wing length was measured from the beginning of the wing to the tip of it;
- Breast width was the width of chicken breast;
- Keel length was measured from the beginning of the keel bone to the last;
- Shank length was the length from top of hock joint to the footpad;
- Shank circumference was the circumference of the shank.

Data were subjected to analysis of variance (ANOVA) using with the following general statistical model:

$$Y_{ijkl} = \mu + P_i + A_j + C_k + e_{ijkl}$$

where:

Y_{ijkl} = the dependent variable of the experiment;
 μ is the overall mean;

P_i = the effect of the i^{th} plumage color ($i = 1-9$);

A_j = the effect of the j^{th} age group ($j = 1-2$);

C_k = the effect of the k^{th} chicken type ($k = 1-3$);

e_{ijkl} = the error term specific to each record.

Analysis was performed by analysis of variance method (SNEDECOR; COCHRAN, 1989) using the Generalized Linear Model (GLM) procedure under Statistical Package for the Social Science (SPSS) version 17.0 with the option univariate. In addition, for significant variables, pair-wise comparisons of treatment means were made using Duncan's Multiple Range Test (DMRT).

Results

Morphological characteristics of Indigenous chicken *ex situ*

Of the four hundred and eighty-nine (489) birds analyzed 19.02% were male and 80.98% were female. Also, the proportion of Common Desi, Naked Neck and Hilly chicken were 49.49, 24.95 and 25.56% respectively. The most predominant plumage color of the local chicken population was reddish black (33.13%). However considerable number of chickens had diverse plumage color like red, blackish red, black, white with black spot, mixed color, brown, blackish white and reddish white accounted for 13.7, 13.5, 12.67, 11.04, 5.55, 4.9, 4.9 and 0.61% respectively (Table 1). Naked Neck birds were very colorful – reddish black (33.60%), blackish red (22.13%), black (18.03%), red, blackish white and mixed color feather combinations were found. Hilly birds were covered with plumage of white with black tips (41.6%). Four types of shank color were most frequently encountered, i.e. white (39.87%), yellow (37.22%), black (20.04%) and mixed (2.87%); the earlobes were mainly reddish white (44.79%), followed by white (29.24%) and red (25.97%); the most predominant skin color was white (92.22%); most birds had a single comb (96.12%), some were cape headed (3.84%), one (0.20%) was butter comb and one (0.20%) was rose combed (Table1).

Table 1. Morphological characteristics of Indigenous chicken *ex situ*.

Parameters	Number of birds			Percentage (%)
Plumage Color				
Reddish black	107	41	15	33.13
Blackish red	26	27	13	13.5
Red	54	13	0	13.7
Black	29	22	11	12.67
White with black spot	0	2	52	11.04
Reddish white	1	0	2	0.61
Brown	19	2	3	4.9
Blackish white	3	10	11	4.9
Mixed	3	5	18	5.55
Total	242	122	125	100
Shank color				
Yellow	75	49	58	37.22
White	125	33	37	39.87
Black	38	34	26	20.04
Mixed	4	6	4	2.87
Total	242	122	125	100
Earlobe Color				
Red	32	56	39	25.97
Reddish white	85	56	78	44.79
Total	242	122	125	100
Skin color				
White	231	111	109	92.22
Red	11	11	16	7.78
Comb Type				
Single	237	116	117	96.12
Single (cape headed)	5	4	8	3.84
Rose	0	1	0	0.02
Butter	0	1	0	0.02
Total	242	122	125	100

Effect of plumage colors and chicken types on body weight of Indigenous chicken

Table 2 shows that the average body weight of Common Desi, Naked Neck and Hilly bird was 1312.54, 1293.30 and 1616.93 g, respectively, at the age of 30 weeks. The highest body weight was found in Hilly bird (1616.93 g) and the lowest body weight was found in Naked Neck (1293.30 g).

Table 2. Effect of plumage colors and chicken types on body weight of Indigenous chicken.

	Number of hens	Body weight (g) (Mean $\pm$ SE)	F- rate
Plumage color		SN	
RB	163	1459.60 ^a $\pm$ 30.33	5.856
BR	66	1388.32 ^c $\pm$ 42.17	
R	67	1211.60 ^a $\pm$ 26.72	
B	62	1285.37 ^b $\pm$ 39.10	
WB	54	1409.72 ^c $\pm$ 47.33	
RW	3	1315.33 ^b $\pm$ 208.18	
B	24	1208.54 ^a $\pm$ 44.21	
BW	24	1522.26 ^c $\pm$ 44.21	
M	26	1602.67 ^c $\pm$ 128.12	
Total	489		
Chicken type		SN	
D	242	1312.54 ^a $\pm$ 19.44	37.78
NN	122	1293.30 ^a $\pm$ 26.73	
H	125	1616.93 ^b $\pm$ 40.42	

^{a,b,c}Superscripts with different letters in the vertical column are significantly different; (p < 0.01); SN = Significant (p < 0.01).

Effect of chicken types back length, body circumference, wing length, breast width, keel length, shank length and shank circumference

The Common Desi, Naked Neck and Hilly chicken had shank lengths of 8.89, 8.76 and 9.04 cm, respectively, at 30 weeks of age; shank circumference for the Common Desi, Naked Neck and Hilly chicken was 4.11, 4.05, and 4.28 cm, respectively. In case of other characteristics, there was no significant (p > 0.05) difference between Common Desi and Naked Neck chicken, but Hilly chicken differed significantly (p < 0.05) from both (Table 3).

Table 3. Effect of chicken types back length, body circumference, wing length, breast width, keel length, shank length and shank circumference.

Parameters	Genotype			F-rate
	D (Mean $\pm$ SE)	NN (Mean $\pm$ SE)	H (Mean $\pm$ SE)	
Back length (cm)	19.94 ^a $\pm$ 0.12	18.22 ^a $\pm$ 0.23	21.22 ^b $\pm$ 0.20	52.46
Body circumference (cm)	29.98 ^a $\pm$ 0.14	28.30 ^b $\pm$ 0.24	30.43 ^a $\pm$ 0.23	26.70
Wing length (cm)	12.60 ^a $\pm$ 0.07	10.67 ^a $\pm$ 0.15	11.96 ^b $\pm$ 0.11	86.19
Breast width (cm)	7.89 ^a $\pm$ 0.05	7.30 ^b $\pm$ 0.05	7.80 ^a $\pm$ 0.06	24.71
Keel length (cm)	9.10 ^a $\pm$ 0.08	9.07 ^a $\pm$ 0.07	10.08 ^b $\pm$ 0.11	32.76
Shank length (cm)	8.88 ^a $\pm$ 0.06	8.76 ^a $\pm$ 0.10	9.61 ^b $\pm$ 0.11	21.75
Shank circumference (cm)	4.12 ^a $\pm$ 0.02	4.05 ^a $\pm$ 0.03	4.28 ^b $\pm$ 0.04	12.64

^{a,b}Superscripts with different letters in the horizontal row are significantly different (p < 0.01).

Table 4. Growth rate (g week⁻¹) of female birds.

Parameters	Number of observation	Genotype			F-rate
		D (Mean $\pm$ SE)	NN (Mean $\pm$ SE)	H (Mean $\pm$ SE)	
8-12 week	100	71.74 ^a $\pm$ 1.37	70.45 ^a $\pm$ 1.03	85.55 ^b $\pm$ 2.90	15.33
13-30 week	46	29.07 ^a $\pm$ 0.76	28.40 ^a $\pm$ 1.03	37.57 ^b $\pm$ 2.07	14.81
8-30 week	49	36.83 ^a $\pm$ 0.73	36.05 ^a $\pm$ 0.85	46.30 ^b $\pm$ 1.73	24.16

^{a,b}Superscripts with different letters in a horizontal row are significantly different; (p < 0.01).

Growth rate (g week⁻¹) of female birds

The average growth rates at 8-12 weeks of Common Desi, Naked Neck and Hilly birds were 71.74, 70.45 and 85.55 g week⁻¹, whereas in 13-30 weeks they were 29.07, 28.40 and 37.57 g week⁻¹ and in 8-30 weeks they were 36.83, 36.05 and 46.30 g per week, respectively (Table 4).

Discussion

There is a clear need to base genetic improvement programs for village poultry producers on indigenous chicken genetic resources. This is emphasized by the fact that the adaptive traits in general, and the superior merits of indigenous chickens to high yielding exotic breeds in particular, were rated of the highest significance by local farmers. As has been already established that Indigenous chicken has got its excellence for the various outstanding characteristics, it is essential to improve this genetic resource. The highest body weight was found in Hilly bird (1616.93 g) and the lowest body weight in Naked Neck (1293.30 g). Chicken types and plumage colors had highly significant (p < 0.05) effects on age pooled body weight. The present results were in agreement with the findings by Duguma (2006) who reported that the average individual body weight of Ethiopian ecotypes, classified according to plumage color, at the age of puberty (20 weeks), varied in Horro (876 g), Tepi (822 g) and Jarso (663 g), respectively. Shahjahan (2011) observed that six plumage colors had no significant (p > 0.05) effect on age pooled body weight. The same results agreed with the findings of Abebe (1992) who observed that different Indigenous chicken ecotypes Kei, Tikur, Kokima, Wossara, and Gebsuma attained body weight 1003, 775, 1013 and 986 g, respectively in Alemaya, which were classified according to plumage color and region.

Hilly birds were heavier than the other Indigenous chicken groups ($p < 0.05$), while the other Indigenous hens were relatively similar in body size. Moreover, the mature weight of Common Desi (D) and Naked Neck (NN) didn't differ significantly ($p > 0.05$), but significantly differed from that of Hilly chicken (Table 2). Khatun et al. (2005) reported that the body weight at 38 weeks of age was significantly ($p < 0.01$) highest in Hilly (1429.06 g) compared to D (1358.37 g) and NN (1252.26 g). Faruque et al. (2007) reported that the heavier body weight at sexual maturity was in Hilly (1461.2 ± 251.0 g) and the lowest weight in Naked neck (1310.5 ± 136 g). The matured body weights of Common Desi and NN chicken were almost similar and varied between 1.0 and 1.3 kg. However, Aseel bird was heavier than other Indigenous chickens (BHUIYAN et al., 2005). In the case of other characteristics, there was no significant ($p > 0.05$) difference between Common Desi and Naked Neck chicken, although Hilly chicken differed significantly ($p < 0.05$) from both. It was also reported that the growth rate was lower between 12 and 30 weeks than between 8 and 12 weeks. It may be stated in the interim that the indigenous chickens are multi-colored, shank color was most predominant, earlobe was mainly reddish white and majority of the birds had single comb. From this study, it was revealed that variations of plumage color, age and other characteristics had a great impact on the body weight of Indigenous chicken.

Conclusion

From the above discussion, it may be concluded that the local chicken could attain appreciable body characteristics and that Hilly bird is superior to Common Desi and Naked Neck bird in terms of body weight. It may so be concluded that Indigenous chicken with specific type will increase the performance where definite plumage color may also accelerate the motion of improvement of *ex situ* chicken productivity. Improving the performance of Indigenous chicken through selection and breeding requires a long term breeding program. The results of this work may serve as an important positive base for future research for the selection, conservation and development of chicken in Bangladesh exploiting available Indigenous genotypes.

Acknowledgements

The authors would like to thank the Department of Animal Breeding and Genetics for providing all

the necessary supports for the successful completion of current research work.

References

- ABEBE, H. **Terminal report on the comparative evaluation of Indigenous chicken in the Hararge administrative region and their crosses with the single comb White leghorn**. Dire Dawa: Alemaya University of Agriculture, 1992. (Mimeographed report).
- AINI, I. Indigenous chicken production in South-east Asia. **World's Poultry Science Journal**, v. 46, n. 1, p. 51-57, 1990.
- BEBES, B. Genotype evaluation and breeding of poultry for performance under sub-optimal village conditions. **World's Poultry Science Journal**, v. 65, n. 2, p. 260-271, 2009.
- BHUIYAN, A. K. F. H.; BHUIYAN, M. S. A.; DEB, G. K. Indigenous chicken genetic resources in Bangladesh: Current status and future outlook. **Animal Genetic Resources Information**, v. 36, p. 73-84, 2005.
- DUGUMA, R. Phenotypic characterization of some Indigenous chicken ecotypes of Ethiopia. **Livestock Research for Rural Development**, v. 18, 2006. Available from: <<http://www.lrrd.org/lrrd18/9/dugu18131.htm>>. Access on: Mar. 13, 2013.
- FARUQUE, S.; SARKER, N. R.; ISLAM, M. N.; SARKER, M. S. K. Performance of native chicken under intensive system. **Journal of the Bangladesh Agricultural University**, v. 5, n. 2, p. 283-288, 2007.
- GOB-Government of Bangladesh. **Year book of agricultural statistics of Bangladesh**. Bangladesh: Bangladesh Bureau of Statistics, 2006.
- HILLEL, J.; MARTIEN, A. M.; GROENEN, A. M.; BOICHARD, M. T.; ABRAHAM, B.; KOROL, A. B.; DAVID, L.; KIRZHNER, V. M.; BURKE, T.; BARRE-DIRIEF, A. Biodiversity of 52 chicken populations assessed by microsatellite typing of DNA pools. **Genetics Selection Evolution**, v. 35, p. 533-557, 2003.
- HORST, P. Native fowls as reservoir for genomes and major genes with direct and indirect effect on the adaptability and their potential for tropically oriented breeding plans. **Archiv fur Geflugelkunde**, v. 53, n. 3, p. 93-101, 1989.
- KHATUN, R.; ISLAM, M. S.; FARUQUE, S.; AZMAL, S. A.; UDDIN, M. S. Study on the productive and reproductive performance of 3 native genotypes of chicken under intensive management. **Journal of Bangladesh Agricultural University**, v. 3, n. 1, p. 99-104, 2005.
- NASSIRI, M. T. B.; HAMID, Z.; TAVAKOLI, S. The investigation of genetic variation at microsatellite loci in Mazandran native chickens. **International Journal of Poultry Science**, v. 6, n. 9, p. 675-678, 2007.
- ROMANOV, M. N.; WEIGEND, S. Analysis of genetic relationship between various populations of domestic and jungle fowl using microsatellite markers. **Poultry Science**, v. 80, n. 8, p. 1057-1063, 2001.

SHAHJAHAN, M.; AMIN, M. R.; BHUIYAN, A. K. F. H. **Diversity in performance of the Indigenous chicken *in-situ* in some selected areas of Bangladesh.** Dhaka: WPSA-BB, 2011.

SNEDECOR, G. W.; COCHRAN, W. G. **Statistical Methods.** 8. ed. Ames: Iowa State University Press, 1989.

TADELLE, D.; ALEMU, Y.; PERES, K. J. Indigenous chicken in Ethiopia: genetic potential and attempts at improvement. **World's Poultry Science Journal**, v. 56, n. 1, p. 45-54, 2000.

UDDIN, M. M. **Review of livestock subsector and 10 years (2001-2010) production projection of livestock products.** Dhaka: Bangladesh Agricultural Research Council, 2001.

WINDHORST, H. W. Asia's changing role in the global egg industry-an analysis of past, present and foreseeable future dynamics. **World's Poultry Science Journal**, v. 64, n. 4, p. 533-552, 2008.

Received on March 12, 2013.

Accepted on September 12, 2013.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.