MORPHOMETRIC ANALYSIS OF INDIGENOUS, EXOTIC AND CROSSBRED CHICKENS (*GALLUS DOMESTICUS* L.) IN RAJSHAHI, BANGLADESH

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Abstract

Context: The quantification of morphometric variations has been regarded as peripheral to the mechanistic study of development of a species. This is now changing because the rapidly advancing knowledge of development in post-genomic biology is creating a need for more refined measurements of the morphometric changes produced by genetic perturbations or treatments.

Objective: To estimate the age at marketable size and body morphometric parameters of indigenous, exotic and crossbred chicken to use such parameters as discriminate variables and to investigate the relationships among the variables of the chicken breeds under study.

Materials and Methods: Six chicken breeds namely an indigenous (non descriptive, *Deshi*), four exotics as Broiler, Cockerel, Fayoumi and RIR, and a crossbred called *Sonali* (RIR♂× Fayoumi♀), were used for the study.

Results: Age and nine morphometric parameters *viz.*, gross weight (GW), blood weight (BW), feather weight (FW), skin weight (SW), body weight after skinning (BWS), visceral weight (VW), offal weight (OW), net edible weight (NEW) and edible ratio (ER), were determined from a total of 30 adult chickens (6 breeds 5 replicates each). All the parameters except FW showed significant differences among the breeds (P<0.01). RIR showed the highest values for all parameters except ER, which was the highest in Cockerel (1.77±0.23) and the lowest in RIR (1.47±0.01). Association between GW and NEW was statistically significant in Indigenous (P<0.001), Sonali (P<0.01) and all exotics except Broiler (P<0.001).

Conclusion: Present results indicate that Cockerel, Fayoumi, Indigenous and *Sonali* chickens are advantageous genotypes as they had higher ER values compared to Broiler and RIR breeds.

Keywords: *Gallus domesticus*, body morphometric traits, net edible weight, edible ratio.

Introduction

Morphometrics is the quantitative study of morphology, and morphometric data are commonly used to investigate differences among groups of individuals which are genetic or taxonomic in nature (Madsen 1977). Economically important morphometric traits such as body weight, egg production and yield per month are quantitative as well as complex with continuous variability in chickens (Banerjee 1964). Body morphometric parameters are variable on the basis of some factors such as age, sex, climate, nutrition and status of the birds (Banerjee 1992). In the past, studies with chicken body morphometrics by Okada *et al.* (1988) and Kitalyi (1998), and subsequent studies by Dana and Ogle (2002), Rashid *et al.* (2005) and Bell *et al.* (2007) revealed some important results.

Information on the structure of body morphometrics and its various parameters in chickens and other birds are essential for an understanding of migration and dispersal (Warkentin *et al.* 1990), fertility and reproductive performance (Rahman *et al.* 1999, Oke and Ihemeson 2009), breeding biology (Villard *et al.* 2006), growth and development (Bell *et al.* 2007), egg-size and egg-laying performance (Oke *et al.* 2007), type and functions between breeds (Olawumni *et al.* 2008) and selection for phenotypic variability (Rosario *et al.* 2008). Moreover, body weight and body morphometrics in chickens have been used to differentiate native from exotic (Mulyono *et al.* 2009) and commercial (Vitorović *et al.* 2009) breeds, and to establish phenotypic

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correlations among various genetic groups (Yakubu *et al.* 2009). In addition, a recent surge of interest has led to important advances in formal analysis of variations in shape (*i.e.* geometric morphometrics) and phylogenetic significance of such changes (Sensen and Hallgrimsson 2009). Here we analyze age and statistical measures of various body morphometrics of the indigenous, exotic and crossbred chickens and report the advantages of the most suitable breeds that are available in and around Rajshahi.

Materials and Methods

Collection of the chicken breeds: Six adult chicken breeds, one indigenous (non-descriptive, *Deshi*), four exotics *viz.* Broiler, Cockerel, Fayoumi and RIR (Rhode Island Red) and one crossbred called *Sonali* (derived from RIR♂ × Fayoumi♀), were collected at random from six local markets of Rajshahi Metropolitan areas *viz.* Binodpur, Kazla, Talaimari, Shaheb Bazar, New market and Laxmipur.

Morphometric traits: Age (in month) and body morphometric traits (in g) *viz.* gross weight (GW), blood weight (BW), feather weight (FW), skin weight (SW), body weight after skinning (BWS), visceral weight (VW) that included crop, small and large intestines and pancreas, offal weight (OW) including weights of heart, liver, kidneys, processed head and gizzard, and net edible weight (NEW), were recorded from five replicates for each breed. Edible ratios (ER) were determined using the formula: ER=GW/NEW. Correlations between age vs. GW and BW, and those between GW vs. BW, VW and NEW each were calculated.

Statistical analyses: Mean, standard deviation (SD), analysis of variance (ANOVA), least significant differences (LSD) and co-efficient of correlation values (r) were computed using the SPSS (version 11.0 for Windows). Data on age and various body morphometric parameters were subjected to these statistical procedures to detect the significance of the difference between the chicken breeds (Olawunmi *et al.* 2008).

Results

Age and body morphometric parameters: Age of the marketable sized chickens differed significantly between breeds ($F_{5,24}$=721.27, P<0.01), where RIR showed the highest and Broiler the lowest (Table 1). This is interpretable because RIR is a dual-purpose breed having both meat production and egg laying qualities and therefore it is reared for longer period of time before selling.

Data on GW and NEW are presented in Fig. 1 which reveals that GW vs. NEW was the highest in RIR and the lowest in Fayoumi, with a significant difference between all breeds ($F_{5,24}$=48.43, P<0.01, and $F_{5,24}$=44.34, P<0.01, respectively for GW and NEW). A similar trend was also recorded for SW, BWS, VW and OW. Similar to GW, BW also showed significant difference between the breeds ($F_{5,24}$=13.34, P<0.01), Broiler showing the highest and Indigenous the lowest values (Table 1). Despite genotypic differences and differential consumptions of protein diets at rearing, FW did not differ significantly between breeds ($F_{5,24}$=2.41, P>0.05). However, RIR exhibited the highest FW and Indigenous the lowest. SW varied significantly between chicken breeds ($F_{5,24}$=11.78, P<0.01) where RIR showed the highest value and Fayoumi the lowest.

Similar to SW, BWS showed significant difference among the breeds ($F_{5,24}$=49.48, P<0.01) where RIR also showed the highest and Fayoumi the lowest. VW showed a similar trend as that for SW and BWS, resulting in a significant difference between the breeds ($F_{5,24}$=30.28, P<0.01). But unlike GW, BW, SW and BWS, VW was higher in Indigenous than those in Cockerel, thus suggesting an adaptive nature of the Indigenous chickens. OW also showed a significant difference among the breeds ($F_{5,24}$=69.52, P<0.01) where RIR exhibited the highest and Fayoumi the lowest. Chicken breeds differed significantly with respect to their ER values ($F_{5,24}$=4.28, P<0.01) where Cockerel, Fayoumi, Indigenous and *Sonali* showed remarkably higher ER compared to that of Broiler and RIR (Fig. 2). This happened due to the higher VW and OW of the latter breeds, even though they had much higher GW values (Fig. 1).

Associations between various body morphometric parameters: Co-efficient of correlation values shown in Table 2 demonstrate that associations between the age at marketable size and GW of the chickens were significant in RIR and *Sonali* (P<0.05), while Broiler and Cockerel each showed negative correlation. Correlation values between the age and BW, on the other hand, were significant for Indigenous and RIR (P<0.05); but Cockerel and *Sonali* exhibited negative association. GW *vs.* BW imparted significant correlations in Cockerel and RIR (P<0.01 and P<0.001, respectively) whereas Broiler showed an insignificant negative value. Only RIR showed a highly significant correlation between GW and VW (P<0.001), but the same correlation showed a negative value in Broiler. Highly significant correlations between GW and NEW (P<0.001) were observed for all breeds except the Broiler, indicating that 'r' values between morphometric traits are important indicators for breed-specific quality of chickens.

Table 1. Age and some body morphometric parameters recorded in an Indigenous, four exotic and a crossbred adult chickens from Rajshahi Metropolitan areas

Breeds	Age	BW	FW	SW	BWS	VW	OW
Indigenous	6.2±1.24[b]	24.2±6.42[c]	43.4±12.20[c]	62.2±25.70[c]	558.4±222.0[d]	76.2±28.8[c]	63.8±24.9[b]
Broiler	1.1±0.07[d]	60.4±6.54[a]	72.0±41.50[a]	119.2±34.60[b]	1064.0±53.2[b]	137.2±41.6[b]	75.0±8.37[b]
Cockerel	1.6±0.19[c]	34.8±7.95[b]	52.6±18.80[b]	73.8±29.10[c]	583.0±295.9[c]	71.8±32.8[c]	62.6±18.5[b]
Fayoumi	1.9±1.19[c]	25.4±6.46[c]	56.4±7.130[b]	53.2±10.80[d]	463.6±99.4[f]	49.6±10.9[d]	49.0±10.0[c]
RIR	18.9±0.61[a]	55.8±9.09[a]	79.4±10.40[a]	147.6±26.90[a]	2250.2±377.0[a]	245.4±40.6[a]	273.2±45.6[a]
Sonali	1.8±1.16[c]	26.8±2.99[c]	49.4±5.98[b]	60.8±13.60[c]	488.8±49.4[e]	56.8±12.8[d]	51.0±9.05[c]

BW= Blood wt.; FW= Feather wt.; SW= Skin wt.; BWS= Body weight after skinning; VW= Visceral wt.; OW= Offal wt.; Values are mean±SD (N=5 for each) with different superscripts for a parameter in the same column differ significantly by LSD (P<0.05)

Table 2. Co-efficient of correlation values (r) estimated between different body morphometric parameters in the Indigenous, exotic and crossbred adult chickens (N= 5 for each breed) from Rajshahi

Breeds	Age *vs.* GW	Age *vs.* BW	GW *vs.* BW	GW *vs.* VW	GW *vs.* NEW
Indigenous	0.780ns	0.903*	0.740ns	0.796ns	0.995***
Broiler	-0.823ns	0.749ns	-0.859ns	-0.580ns	0.757ns
Cockerel	-0.772ns	-0.641ns	0.966**	0.727ns	0.995***
Fayoumi	0.853ns	0.716ns	0.420ns	0.747ns	0.996***
RIR	0.984**	0.990**	0.999***	0.997***	1.000***
Sonali	0.914*	-0.268ns	0.013ns	0.571ns	0.975**

vs. = versus; GW = Gross wt.; BW = Blood wt.; VW = Visceral wt; NEW = Net edible weight; ns = not significant; *
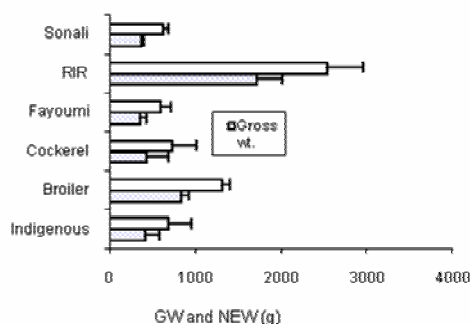= P<0.05; ** = P<0.01 and *** = P<0.001.

Fig. 1. Comparative GW (gross wt.) and NEW (net edible wt.) in various chicken breeds in Rajshahi
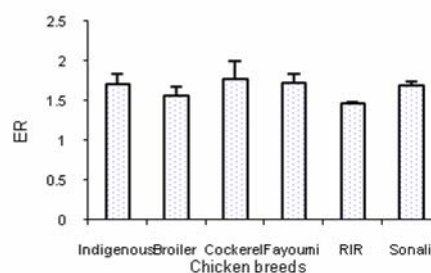
Fig. 2. Estimated ER (edible ratio) in different chicken breeds in Rajshahi

Discussion

The above results on chicken body morphometrics suggest that breeds like Cockerel, Fayoumi, Indigenous and *Sonali* would be suitable for consumers, particularly as they attain significantly higher ER values. However, for having some desirable characteristics such as meat flavour, tolerance and resistance to certain

tropical diseases, being well adjusted to environment and needing less management facilities for rearing, Indigenous would be the most suitable breed (Okada *et al.* 1988, Rashid *et al.* 2005, Oke *et al.* 2007). Similar to the present results, Yakubu *et al.* (2009) observed correlations between body weight and morphometric traits which were positive and highly significant in three genetic group of chickens *viz.* normal, frizzle and naked-neck.

The present results conform to those reported by Madsen (1977) who analyzed various morphometric data in 25 strains of chickens. In recent studies body weight and eviscerated carcass, breast and leg yields have been used for discriminating phenotypic variability between Broiler chicken grandparent lines (Rosario *et al.* 2008) and body size variables were used to distinguish between three breeds of indigenous Indonesian chickens (Mulyono *et al.* 2009). Vitorović *et al.* (2009) employed morphometric and mechanical parameters to differentiate three Siberian naked-neck chickens from commercial hybrids, while Yakubu *et al.* (2009) used body weight and eight body morphometric parameters to differentiate normal, frizzle and naked-neck chickens. In agreement with these findings, ER and VW/OW ratio of the present study can be utilized to discriminate morphometric characters between six chicken breeds under study. Study of the chickens having higher ER and NEW values is important for proper understanding of how to boost production under the prevailing conditions of rearing and their possible inputs for the development of commercial chicken breeds in the country.

Dissimilarities of age at marketable size and morphometric differences observed between breeds of the present study suggest differences in selection goals for chickens. The diversity on these phenotypic characteristics could be considered as distinguishable variables for selection and crosses for improvement of the hybrid line like *Sonali* (Rashid *et al.* 2005). Campbell and Lock (1985), Mulyono *et al.* (2009) and Vitorović *et al.* (2009) emphasized that the origin, domestication process, selection and crossing success may influence phenotypic variation in body morphometry of the chicken breeds. With special reference to applications in morphometric studies, important results for statistical validity of multivariate analyses now are being made available (Sensen and Hallgrimsson 2009, Yakubu *et al.* 2009). The rapidly advancing knowledge of development in post-genomic biology is creating a need for more refined measurements of the morphmetric changes produced by genetic perturbations or treatments. This need, in turn, is driving the development of new methods that allow rapid and meaningful integration of molecular, cellular and morphometric data to analyze commercial breeds.

Conclusion

Nine distinguishing morphometric variables shown in the present study can be used to discriminate commercial chicken breeds in our country. Significantly higher ER values in Cockerel, Fayoumi, Indigenous and *Sonali* compared to those in Broiler and RIR indicate that the former genotypes would be economically and/or nutritionally potential than the later ones, and therefore, can be recommended as better varieties of chicken suitable for rearing and marketing in Rajshahi. For improving these varieties, however, systematic breed evaluation and artificial insemination, accompanied by effective feeding, management and disease control programmes at farm levels should be emphasized.

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