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Research Article

Body conformation, morphometry and meat yield characteristics of different genotypes of chicken

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Abstract

The aim of this study was to evaluate body conformation, morphometry and meat yield characteristics of broiler, Sonali, deshi and Fayomi chicken available in local market. Experiment was carried out at the poultry science laboratory of Jhenidah government veterinary college (JGVC), Jhenidah for a period of one month from February 2022 to March 2022. A total number of 38 chicken (20 females and 18 males) were collected from different local market viz. broiler (10), Sonali (9), deshi (8) and Fayomi (11). The healthy birds were selected based on the availability and market demand. This study revealed that shank length, chest circumferences and digestive tract length were found highest in broiler. On the other hand, body length was recorded highest in Fayoumi and lowest in Sonali chicken. However, body conformation indices of male chicken showed higher value than their female counterparts. The findings indicated that broiler chicken had the highest body mass index (BMI), followed by Fayomi, Sonali, and deshi chicken. Similarly, broiler had the highest and Sonali had the lowest massiveness and compactness indices, whereas reverse feature was found for shape index. Sonali had the highest and broiler had the lowest shape index. Meat yield characteristics of male chicken were found higher than the female chicken among the genotypes. On the other hand, percentage of breast meat weight was found higher in female than male birds of all genotypes. However, both sexes of broiler had the highest and Sonali had the lowest percentage of dressed weight, breast meat and total meat weight. The study revealed that broiler chicken showed better meat yield performance when compared to deshi, Fayomi and Sonali chicken as meat bird available in local market of Bangladesh which provides an important message for consumer, producer and researcher.

Introduction

There has been a strong consumer demand for chicken products in foreign and domestic markets as a result of an accelerated increase in the global population and the consumer perception of the health benefits of chicken meat (Lopez et al., 2011). Bangladesh is on the lower end of global protein consumption (FAO, 2007). The daily protein requirement of an adult human is 0.83 g per kg of body weight (WHO, 2007). Thus, an average adult person in Bangladesh requires approximately 50-70 g of protein everyday (Islam, 2017). But the nutritionists recommend that out of total protein at least 30-35 g (person/day) should come from an animal source. However, in Bangladesh, the availability of animal protein is only 12 g/person/day (Ali et al., 2017). Chicken meat has been promoted as a lean protein source as most of the fat is stored as subcutaneous fat and within the skin membrane making it easy to remove prior to cooking (Decker and Canton, 1992; Wang et al., 2010). The meat itself is an excellent source of protein in the diet as it contains all the essential amino acids which are the building blocks for protein along with assisting in the production of enzymes and many essential processes in the body (Akter et al., 2009; Akter et al., 2022; Ali et al., 2022a; Hossain et al., 2021a, and 2021b; Rahman et al., 2022; Rahman et al., 2023; Pellett and Young, 1990). However, even in the developed world where consumers are accustomed to paying low prices for poultry meat, they are increasingly interested in products that they perceive as naturally produced or environmentally friendly, provide a high level of nutrition with no contaminants, good flavor, provide good welfare for the birds, and provide more information about the products they eat. The organic market has targeted indigenous chickens in many developing countries due to environmental concerns, personal health concerns, highly publicized food scares, and debates over genetically modified food (Chang and Zepeda, 2005).

The poultry industry is one of the faster growing and most promising industries in the agricultural sector of Bangladesh. The annual average growth rate in commercial chicken is satisfactory, though poultry industry has evidence fastest growth in the livestock sector. People needed meat 120gm/day where Bangladesh produces 92.65 lakh metric tons (DLS, 2022). In Bangladesh, a higher portion of poultry meat mainly comes from deshi chicken, broiler, Sonali and duck. The share of the commercial strain of chicken and family poultry was 60:40 in meat production in Bangladesh (Bhuiyan, 2011). Consumers also acknowledge the relatively low price, the typically convenient portions, and the lack of religious restrictions against its consumption (Jaturasitha, 2004).

Poultry production and processing technologies have become rapidly accessible and are being implemented on a worldwide basis, which will allow continued expansion and competitiveness in this meat sector (Aho, 2001). Therefore, the success of poultry meat production has been strongly related to improvements in growth and carcass yield, mainly by increasing breast proportion. Recently, there is a tremendous increase in poultry production in Bangladesh with a consequent increase in poultry meat consumption. However, the success of any food product is determined by consumer acceptability which is largely determined by the perception of quality (Dransfield, 2001). Meat quality is a complex trait that is influenced by genetic and environmental factors, and the variation in meat quality within and between animals can be large (Rehfeldt et al., 2004).

The poultry industry is one of the faster growing and most promising industries in the agricultural sector of Bangladesh. Annual average growth rate in the commercial chicken is satisfactory. On the other hand, the growth rate of indigenous chickens is not satisfactory as evident from the supply of egg and meat in the market. Though poultry industry has evidenced faster growth in the livestock sector, still there is a huge gap between supply and demand of poultry meat and eggs. For example, per head annual consumption of eggs in the country is 95 against the minimum requirement of 104 eggs. Morphological characteristics and production performance variations of some Bangladeshi chickens have been reported by Ferdaus et al. (2019) and Islam (2011). However, there is very little information about the comparison on body conformation, morphometry indices and meat yield traits of indigenous, Sonali and Fayoumi chicken under hot-humid climate like Bangladesh. Therefore, the present study was carried out to characterize and compare the morphometric traits, body conformation indices and meat yield traits of different types of meat chicken.

Materials and Methods

Study Area and Experimental Birds

The study was carried out in the Jhenidah government veterinary college Poultry Science lab during the period of February 2022 to March 2022. A total number of 38 birds (20 females and 18 males) were collected from different local market viz. Broiler (10), Sonali (9), Deshi (8) and Fayomi (11). The healthy birds were selected on the basis of availability and market demand (MOFA, 2020). Clinically healthy was defined as normal feeding, movement behavior and alert to environment. No visible changes in wattle or comb and body temperature were normal when purchase the chicken.

Morphometric measurements

Measures of live weight and morphometric traits were taken using a weighing balance and a measuring tape for all experimental chickens. The following metric measures (FAO, 2012) were recorded (cm): body length (distance from the tip of the beak, through the body trunk to the tail), shank length (length of the tarso-metatarsus from the hock joint to the metatarsal pad), chest girth (the circumference of the breast around the deepest region of the breast) trunk length (from the base of the neck to the base of the tail). All measurements were taken by the same person to minimize human error.

Body Conformation Indices

Live weight and body measurement values of chickens were accounted for when calculating the body conformation indices (Kokoszynski et al., 2012) of massiveness (percentage ratio of weight in kg to trunk length, in cm), compactness (percentage ratio of chest circumference to trunk length, in cm). Measurements on body weights and various body dimensions were individually collected from the chicken. The formulae used to calculate the body shape index (shape ratio) and body mass index (BMI) are given below:

$$\text{Shape index}=\frac{\text{Shank length (cm)}}{\sqrt[3]{\text{Body weight (kg)}}} \times 100 \quad \text{(Ferdaus, 2018; Ferdaus et al., 2019)}$$

$$\text{BMI} =\frac{\text{Body weight (g)}}{(\text{Body length (cm)})^2} \quad \text{(Mendes et al., 2007)}$$

Carcass characteristics

A total of 38 birds (20 females and 18 males) were slaughtered. The collected birds were kept fasted for 12h, and then slaughtered, weighed, eviscerated, dressed, dissected, and the meat stripped from carcass. The components of carcass were dissected according to Singh et al. (2003). Carcass volume of each chicken was determined by dipping it in water (at room temperature) as described by Amin et al. (1994) and Ferdaus (2018). According to Ferdaus (2018), carcass density of a bird was measured considering carcass mass (g) of those birds divided by carcass volume (cc). The recorded data of each bird were encompassed live weight, head, heart, gizzard, neck, breast meat, thigh meat, drumstick meat, skin, wing meat and weight of thigh bone, drumstick bone, wing bone, and neck weight. An electronic balance was used to weigh chickens, the carcasses, and the various cuts. Meat yield traits were converted into percentage of individual live weight prior to analyzing the data statistically.

Statistical Analysis

The collected data was compiled in excel sheet of MS office 2013 from the record sheet maintained during the experimental period. The data was then processed through sorting and removing of extreme value. Data were then analyzed using analysis of variance (ANOVA) technique by using SAS statistical package in accordance with the principle of Completely Randomized Design (SAS, 2009).

Results

Results of the analysis of variance and least square means for morphometric measurement of different chicken are presented in Table 1 and Table 2. Body length, chest circumferences and digestive tract length ($p<0.001$) and shank length ($p<0.01$) varied across the genotypes. But trunk length was statistically non-significant ($p>0.05$) among the genotypes. Generally, all sorts of morphometric measurement were similar across the sexes. But shank length was significantly ($p<0.05$) varied by sex. Sexual dimorphism too was observed favoring the male chicken. Body length, trunk length and shank length were similar across

(p>0.05) the genotype × sex interaction. However, chest circumferences (p<0.01) and digestive tract length (P<0.05) varied across the genotype × sex interaction. The findings indicated that the shank length, chest circumferences and digestive tract length were found the highest in broiler. On the other hand, body length was recorded the highest in Fayoumi and the lowest in Sonali chicken.

Table 1. Summary of analysis of Morphometric measurement of different chicken

Trait	Significant level			R^2 of the model
	Genotype (Gn)	Sex (S)	Gn × S	
Body length	***	NS	NS	0.812
Trunk length	NS	NS	NS	0.225
Shank length	**	*	NS	0.487
Chest circum.	***	NS	**	0.771
D. tract length	***	NS	*	0.877

*Significant at p<0.05, **significant at p<0.01, ***significant at p<0.001, NS non-significant (p>0.05)

Table 2. Morphometric measurement of different chicken

Trait (cm)	Sex	LS Mean ± SE			
		Broiler (M=5, F=5)	Sonali (M=4, F=5)	Deshi (M=4, F=4)	Fayomi (M=5, F=6)
Body length	M	43.20±2.31	42.20±1.32	45.75±2.78	49.60±0.93
	F	38.20±2.22	35.00±1.83	41.25±2.78	48.33±3.18
Trunk length	M	23.40±1.75	22.60±1.32	23.33±1.15	26.00±1.29
	F	22.40±1.8	19.50±0.65	20.50±4.16	25.25±1.25
Shank length	M	9.20±0.58	7.40±0.19	8.75±0.25	8.90±0.46
	F	8.38±0.24	7.36±0.24	8.20±0.20	7.92±0.20
Chest circum.	M	37.40±1.86	26.40±1.03	34.75±1.25	36.00±0.71
	F	34.30±1.69	22.25±0.85	29.25±1.31	31.50±1.09
D. tract length	M	248.20±8.87	161.50±3.18	135.50±3.30	173.83±11.67
	F	231.40±7.03	136.60±7.63	131.75±3.38	148.20±8.30

M=male bird, F=female bird, values in the parentheses indicate the number of observations, LS=Least square, SE=Standard error

Results of the analysis of variance and least square means for body conformation indices of different chicken are shown in Table 3 and Table 4. Massiveness, compactness, shape index and body mass index were highly significant (p<0.001) among the genotypes. On other hand, all body conformation indices were similar across (p>0.05) the sex and genotype × sex interaction. However, body conformation indices of male chicken showed higher value than their female counterparts. The findings indicated that percentage of massiveness, compactness and body mass indices were higher in broiler whereas shape index was higher in Sonali chicken.

Table 3. Summary of analysis of Body conformation indices of different chicken

Trait	Significant level			R^2 of the model
	Genotype (Gn)	Sex (S)	Gn × S	
Massiveness	***	NS	NS	0.521
Compactness	***	NS	NS	0.777
Shape index	***	NS	NS	0.480
Body mass index	***	NS	NS	0.816

*significant at p<0.05, **significant at p<0.01, ***significant at p<0.001, NS non-significant (p>0.05)

Table 4. Body conformation indices of different chicken

Trait (cm)	Sex	LS Mean ± SE			
		Broiler (M=5, F=5)	Sonali (M=4, F=5)	Deshi (M=4, F=4)	Fayomi (M=5, F=6)
Massiveness	M	9.06±0.12	4.21±0.13	5.38±0.06	8.66±2.63
	F	8.52±0.76	3.18±0.32	4.87±0.15	4.99±0.61
Compactness	M	161.13±4.5	118.35±7.89	122.96±2.16	122.20±3.19
	F	155.31±8.3	112.05±1.03	114.65±2.07	119.86±1.47
Shape index (Shape ratio)	M	716.09±0.32	833.42±0.20	783.56±0.23	735.84±0.42
	F	667.21±0.09	788.80±0.28	783.22±0.26	731.62±0.21
Body mass index	M	1.14±0.04	0.68±0.03	0.32±.01	0.73±0.04
	F	1.29±0.04	0.40±0.01	0.33±0.01	0.63±0.17

M=male bird, F=female bird, values in the parentheses indicate the number of observations, LS=Least square, SE=Standard error

Results of the analysis of variance and least square means for the meat yield characteristics and skeletal difference of different chicken are illustrated in Table 5 and Table 6. Percentage of liver, gizzard and drumstick bone weights were similar (p>0.05) across the genotypes. Except that 3 traits all muscular and skeletal parameters were highly significant (P<0.001) among the genotypes. Percentage of body weight and thigh meat (p<0.05), drumstick meat, skin weight, carcass density and neck length (p<0.01), breast meat, dark meat, head, shank, heart and gizzard (p<0.001) weights varied across the sexes. But percentage of wing meat, dressed weight, total meat, liver weight, neck weight, carcass volume, thigh bone, wing bone and drumstick bone were similar across the sexes (p>0.05). Percentage of body weight, dressed weight, total meat, breast meat, liver, gizzard, carcass volume and density, neck length and wing bone weight were similar across (p>0.05) the genotype × sex interaction but other traits of meat yield were significantly varied by the genotype × sex interaction. On the other hand, percentage of breast meat weight was found higher in female than male birds of all genotypes. However, meat yield characteristics of male chicken were found higher than the female chicken among the genotypes. In general percentage of breast meat, wing meat, thigh meat, drumstick meat and total meat were found the highest in broiler and the lowest in Sonali chicken.

Table 5. Summary of analysis of Meat yield characteristics and skeletal difference of chicken

Trait	Significant level			R^2 of the model
	Genotype (Gn)	Sex (S)	Gn × S	
Muscular Parameter (gm)				
Body weight (g)	***	*	NS	0.572
Dressed weight	***	NS	NS	0.572
Breast meat	***	***	NS	0.844
Wing meat	***	NS	**	0.718
Thigh meat	***	*	**	0.690
Drumstick meat	***	**	***	0.661
Dark meat	***	***	*	0.639
Total meat	***	NS	NS	0.807
Skin	***	**	***	0.753
Shank	***	***	***	0.669
Head	***	***	***	0.952
Liver	NS	NS	NS	0.284
Heart	***	***	***	0.725
Gizzard	NS	***	NS	0.643
C. vol. (cm^3)	***	NS	NS	0.740
Density (g/cm^3)	***	**	NS	0.583
Skeletal Parameter (gm)				
Neck weight	***	NS	***	0.826
Wing bone	*	NS	NS	0.293
Thigh bone	***	NS	*	0.494
Drumstick bone	NS	NS	**	0.339

*significant at p<0.05, **significant at p<0.01, ***significant at p<0.001, NS non-significant (p>0.05)

Table 6. Meat yield characteristics and skeletal difference of chicken

Parameter (% of body weight)	Sex	LS Mean ± SE			
		Broiler (M=5, F=5)	Sonali (M=4, F=5)	Deshi (M=4, F=4)	Fayomi (M=5, F=6)
Muscular Parameter (gm)					
Body weight (g)	M	1868.6±150.1	822.50±52.2	1400.75±77.9	1777.6±58.2
	F	1591.6±191.7	702.0±28.4	1233.8±95.6	1300.3±142.9
Dressed weight	M	70.29±1.63	56.81±1.52	63.8±3.6	59.04±1.4
	F	66.7±2.4	56.07±3.26	62.94±3.55	59.1±1.01
Breast meat	M	21.53±2.19	8.02±0.14	12.44±0.78	10.48±0.4
	F	22.3±1.3	12.20±0.45	14.9±1.0	12.61±0.7
Wing meat	M	4.14±0.13	4.38±0.17	4.12±0.27	4.04±0.1
	F	4.37±0.12	4.23±0.21	3.93±0.08	3.95±0.11
Thigh meat	M	10.79±0.26	9.35±0.42	9.57±0.26	9.03±0.1
	F	10.70±1.05	9.25±0.19	8.46±0.25	8.15±0.23
Drumstick meat	M	6.98±0.36	6.38±0.29	7.89±0.16	7.33±0.03
	F	6.65±0.25	6.21±0.25	6.55±0.08	6.90±0.32
Dark meat	M	22.74±0.54	21.20±0.91	22.27±0.52	21.41±0.24
	F	22.44±1.09	20.49±0.68	20.84±0.61	20.10±0.26
Total meat	M	44.12±2.58	29.23±0.93	34.71±1.28	31.89±0.54
	F	44.94±1.41	32.69±1.11	35.59±1.02	32.70±0.90
Skin	M	5.01±0.25	5.98±0.27	6.28±0.57	7.65±0.1
	F	5.38±0.17	7.15±0.23	4.34±0.27	6.02±0.36
Shank	M	3.75±0.30	3.48±0.08	3.20±0.07	3.78±0.17
	F	3.55±0.15	3.19±0.05	2.45±0.26	2.76±0.04
Head	M	1.70±0.15	3.88±0.20	4.07±0.09	6.23±0.1
	F	1.85±0.15	3.88±0.23	3.02±0.04	3.24±0.17
Liver	M	2.51±0.27	2.73±0.12	2.00±0.04	2.63±0.3
	F	2.55±0.24	2.48±0.07	2.23±0.09	2.61±0.08
Heart	M	0.45±0.03	0.65±0.05	0.45±0.04	0.76±0.03
	F	0.45±0.03	0.51±0.03	0.53±0.03	0.51±0.02
Gizzard	M	1.48±0.12	1.61±0.03	1.56±0.05	1.28±0.1
	F	2.07±0.04	2.19±0.18	2.30±0.16	2.31±0.22
C. vol. (cm^3)	M	1419.7±119.0	481.2±53.6	892.5±68.6	1100.0±45.72
	F	1393.3±304.2	420.0±26.27	885.0±108.7	805.0±83.38
Density (g/cm^3)	M	0.986±0.008	0.966±0.006	0.977±0.003	0.969±0.003
	F	0.976±.0.002	0.953±0.006	0.967±0.004	0.952±0.004
Skeletal Parameter (gm)					
Neck weight	M	2.36±0.11	3.78±0.29	2.78±0.08	3.68±0.04
	F	2.26±0.07	3.04±0.16	2.35±0.08	2.76±0.03
Wing bone	M	2.07±0.16	2.13±0.18	2.26±0.06	2.57±0.06
	F	2.09±0.19	2.26±0.22	2.63±0.14	2.54±0.21
Thigh bone	M	1.83±0.07	1.86±0.02	2.22±0.06	2.10±0.05
	F	1.62±0.08	2.29±0.14	2.41±0.32	1.88±0.16
Drumstick bone	M	2.18±0.25	1.95±0.04	2.06±0.09	2.49±0.15
	F	2.21±0.07	2.50±0.14	2.25±0.10	2.21±0.12

M=male bird, F=female bird, values in the parentheses indicate the number of observations, LS=Least square, SE=Standard error

Discussion

The findings from Table 2 indicate that body length was found the highest in Fayoymi followed by deshi, broiler and Sonali chicken. These findings are in accordance with those of Ferdaus et al. (2019). They found that body length of indigenous cock and hen was 48.21 and 42.17 cm respectively and shank length was 9.5 and 8.7 cm respectively. Besides that, Kokoszynski et al. (2017) recorded shank length of different commercial broiler line was from 10.0 to 10.4 cm which is very close to the present findings. However, the studies by Yakubu et al. (2009); Udeh and Ogbu (2011) observed that body length of commercial Arbor Acre broiler was 36.74 cm and Ross broiler was 37.12 cm at 8 weeks of age respectively, the values were slightly lower than the present study. This variation of morphometric parameters might be due to age, weight, and different types of commercial strain.

Ferdaus et al. (2019) showed that chest circumferences of indigenous cock and hen were 36.55 and 30.27 cm respectively which is consistent with the present investigation. On the other hand, Kokoszynski et al. (2017) reported that chest circumference of different commercial broiler line was recorded from 28.4 to 29.7cm, the values being lower than those obtained in this study. But, the value of chest circumference (32.15 cm) of commercial Arbor Acre broiler as reported by Yakubu et al. (2009) is close to the present investigation. Kokoszynski et al. (2017) also noted that digestive tract length of Ross 308, Hubbard flex and Hubbard F15 commercial broiler was 251.4, 234.8 and 249.4 cm which coincide with the result of the present study.

The results from a study by Kokoszynski et al. (2017) indicated that the massiveness and compactness indices of different commercial Broiler chickens varied from 10.7 to 11.3% and 142 to 158% respectively. The massiveness index of this investigation is slightly higher than present study but compactness index is very close to the present findings. Although, Massiveness index of deshi chicken in the present study is partially supported by Ferdaus et al. (2019) but compactness index is not consistent with this study. In commercial broiler, the value of body mass index as reported by Oludoyi and Toye (2012) is more or less similar to the present findings. While, Ferdaus et al. (2019) found the body mass index of indigenous chicken at different ages varied from 0.780-0.970 which is much higher than the present investigation. However, the result of shape index of indigenous chicken as reported by Ferdaus et al. (2019) is almost similar to the present findings. These variations of body conformation indices might be due to age, weight, and different types of chicken.

Live weight of both male and female chickens belonging to four genotypes showed that males were heavier than females (Table 6). Live weight of the chicken varied significantly due to different genotypes. The highest dressing and breast meat percentage were recorded in broiler followed by deshi, Fayoumi and Sonali respectively. Dressing percentage of male and female broiler chicken in the present findings was 70.29 and 66.7 which agrees with the findings of Thamizhannal (2022) and Cagus (2017). But higher dressing percentage was found by Das et al. (2014) and lower dressing percentage was recorded by Ali et al. (2022b) and Islam et al. (2022) than the current investigation. However, dressing percentage of deshi chicken in the present study is very close to the findings of Sarker et al. (2022) but lower than the findings of Jahan et al. (2015). Breast meat percentage of broiler was 21.61 as reported by Thamizhannal (2022) which supports the present findings. Similarly, 13.9% and 14.05% dressing yield was recorded by Sarker et al. (2022) and Jahan et al. (2015) respectively which also consistence with this study. Although, Ali et al. (2022b) found lower percentage of breast muscle for both broiler and deshi chickens than present findings while Islam et al. (2022) reported that percentage of breast muscle were 27.76 which is much higher than the current study.

Ferdaus et al. (2015) reported that dark meat in male and female indigenous chicken was 20.70% and 18.14% which is very close to the present findings. Besides, Jahan et al. (2015) showed slightly higher dark meat yield than present investigation. Percentage of thigh, drumstick and wing meat in the current study is more or less similar to the results of Ferdaus et al. (2015). Whereas, Jahan et al. (2015) and Sarker et al. (2022) found slightly higher value of thigh meat than current study. However, percentage of drumstick meat in the present findings is very close to the findings of Jahan et al. (2015) and Ali et al. (2022b). Ali et al. (2022b) also showed slightly lower value of wing meat than present study.

Carcass volume and density of male birds were found higher values than female birds in the present study coincides with the findings of Ferdaus (2018). He reported that carcass volume of indigenous cock and hen was 1312.5 and 887.5 cm^3 and carcass density was 0.937 and 0.944 g/cm^3 respectively. It is notable to mention that scanty information is available to compare the present results with previous studies. However, Allen et al. (2009) reported that the estimated body density of domestic chicken was 0.953 g/cm^3 while Hamershock et al. (1993) found that carcasses of whole feathered chicken was 0.918 g/cm^3. The above findings are in close accordance with the present investigation.

Conclusions

The study revealed that Broiler chicken showed better meat yield performance when compared to other three genotypes. Carcass features were determined by genotype and gender. Broiler chicken had the highest BMI, followed by Fayomi, Sonali, and Deshi chicken. Similarly, Broiler had the highest and Sonali had the lowest massiveness and compactness indices, whereas reverse feature was found for shape index. Sonali had the highest and broiler had the lowest shape index. However, both sexes of Broiler had the highest and Sonali had the lowest percentage of dressed weight, breast meat, and total meat. Drumstick meat percentages were observed highest in deshi male and Fayomi female chickens among the 4 genotypes. Form this study, it would be concluded that broiler chicken gives higher meat yield followed by deshi, Fayomi and Sonali chicken as meat bird available in local market of Bangladesh which provides an important message for consumer, producer, and researcher.

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