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Original Article

Progress in the Performance of Indigenous Chickens Selected for Economic Traits in Bangladesh

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A B S T R A C T

This study was conducted to investigate the progress in productive and reproductive performances of three indigenous chicken genotypes namely Non-descript Deshi (ND), Hilly (HI) and Naked Neck (NN) being selected since 2010 under intensive management system. Eight generations data on body weight (BW) at 8th week and seven generations data on body weight at 40th week of age, age at sexual maturity (ASM), egg production (EP) from 24-40 weeks of age and egg weight (EW) at 40th weeks of age were evaluated. It was observed that HI chicken had significantly ($p<0.001$) heavier body weight than ND and NN birds at both 8th and 40th week of age. Weight gains for ND, HI and NN at 8th and 40th weeks of age were 259.10, 324.08, 250.96g and 290.11, 453.13, 293.32g respectively over the seven generations of selection. Male chicks were significantly ($p<0.001$) heavier in body weight than females at 8th week of age. ASM decreased significantly ($p<0.001$) with the progress of generations of selection. The observed number of EP from 24-40 weeks of age in ND, HI and NN have increased from 58.33, 52.48 and 52.70 eggs in G_0 to 72.40, 60.32 and 68.33 eggs respectively in generation six (G_6). In case of ND, HI and NN chicken the EW has increased from 41.64g, 41.14g and 41.61g in G_0 to 45.01g, 45.09g and 44.88g in G_6 respectively. The results indicate that selective breeding program has made significant progress through increasing the mean of economic traits selected in indigenous chickens of Bangladesh coupled with their concurrent conservation ex-situ.

Introduction

Indigenous chicken is the most important poultry genetic resource in the hands of smallholder farmers in Bangladesh, specifically among rural populations who depend heavily on these chickens for food and income from sales. Indigenous chickens of Bangladesh are categorized as Non-descript Deshi, Naked Neck, Hilly, Aseel and Jungle fowl in respect of the morphological variations as well as production performances (Bhuiyan *et al.,* 2005). Deshi chickens have average hatch weight of 29 g; body weight at 4, 8, 12 weeks and weekly weight gain (0–12 weeks) are 77, 175, 315 and 24 grams respectively; age at first egg of 175 days; weight of pullet of 0.9 kg; mature body weight of 1.3 kg; hatchability of 52%; fertility of 83%; annual egg production of 45 -50 eggs; 9.0% mortality up to 500 days of age (Bhuiyan *et al*., 2005). Because of poor genetic potentiality and low productivity of the indigenous chicken, the rural farmers are now being interested towards industrial or commercial poultry under intensive management condition. However, the indigenous chicken resource of Bangladesh possibly may be disappeared in the near future due to indiscriminate breeding, lack of conservation efforts and continuous pressure of high production potentials commercial chickens. Depending on the phenotype Bhuiyan *et al*. (2009) have predicted that indigenous chickens are genetically diluted in about 60%.

Genetic improvement of indigenous stock by selective breeding as well as changing their productive environment for the improvement of productivity of native chicken is a long desire of the breeders in the country. Recent studies showed that despite their low overall productivity indigenous chicken display wide range of variability in terms of morphological, production and genetic characteristics (Halima, 2007) implying the potential for improvement through selective breeding. Keeping aforesaid aspects in mind, Bangladesh Livestock Research Institute (BLRI) did initiate programs for the conservation and development of

indigenous chicken through poultry development projects since 2010. The present work was undertaken to assess the progress in productive and reproductive performances of three indigenous chicken genotypes in an on-going selective breeding program under intensive management system in Bangladesh.

Materials and Method

The data was collected from the on-going program "Conservation and Improvement of Native Chicken" of BLRI, under Poultry Production Research Division, Savar, Dhaka, Bangladesh. This selection program was started since 2010. The details on the procedure of formation of foundation flock, selection objective, selection criteria, data recording, breeding design and results of the earlier generations have been presented by Faruque *et al*., (2015) and Faruque *et al*., (2017a; 2017b; 2017c). For this study data were retrieved and collected from foundation to generation 7 (for body weight at 8^{th} week of age up to 7^{th} generation while for body weight at 40^{th} week of age, age at sexual maturity, egg production and egg weight up to 6^{th} generation). Data of first generation birds at 40^{th} week of their age were not available due to an outbreak of Avian Influenza surrounding the BLRI Poultry Farm at 35^{th} week of birds' age. Three types of indigenous chickens were selected for the study. These were Non-descript Deshi, Hilly and Naked Neck. Data on two categories of traits were recorded: productive and reproductive. The productive traits included: body weight at 8^{th} and 40^{th} week of age where as egg production up to 40^{th} weeks, egg weight at 40^{th} week of age and age at sexual maturity were as the reproductive traits. SAS version 9.3.1 software was used for analyzing data and least square means were obtained using SAS GLM program. The means of the significant fixed effects were compared using least significant difference tests. Based on the type of traits, the following two general linear models were fitted:

A) Body Weight Traits

$Y_{ijkl} = \mu + B_i + G_j + S_k + e_{ijkl}$

Where, Y_{ijkl} = Effect of the l^{th} observation on k^{th} sex of the j^{th} generation of the i^{th} genotype

μ = Overall population mean for any of the said traits;

B_i = Effect of the i^{th} genotype (where i = ND, HI and NN)

G_j = Effect of the j^{th} generations (where j = G_0, G_1, G_2, G_3, G_4, G_5, G_6 and G_7 generations)

S_k = Effect of the k^{th} sex (where k = male and female)

e_{ijkl} = Random residual error associated with Y_{ijkl} observation.

B) Age at Sexual Maturity, Egg Production and Egg Weight Traits

$Y_{ijk} = \mu + B_i + G_j + e_{ijk}$

Where, Y_{ijk} = Effect of the k^{th} observation on the j^{th} generation of the i^{th} genotype

μ = Overall population mean for any of the said trait;

B_i = Effect of the i^{th} genotype (where i = ND, HI and NN genotypes)

G_j = Effect of the j^{th} generations (where j = G_0, G_1, G_2, G_3, G_4, G_5 and G_6 generations)

e_{ijk} = Random residual error associated with Y_{ijkl} observation.

Results and Discussion

Body weight and body weight gain

The least squares means (±SE) of 8^{th} week body weight (g) of ND, HI and NN as affected by generation and sex are presented in Table 1 and the least squares means (±SE) of 40^{th} week body weight (g) of ND, HI and NN as affected by generation are presented in Table 2.

Table 1. Least squares means (±SE) of 8^{th} week body weight (g) of ND, HI and NN as affected by generation and sex

Factor		ND	HI	NN
	LS	***	***	***
Generation	G_0	349.99^{h}±2.60 (861)	380.07^{g}±4.38 (353)	340.43^{g}±4.56 (260)
	G_1	459.16^{f}±3.18 (577)	500.37^{f}±3.88 (450)	442.08^{f}±4.18 (308)
	G_2	447.12^{g}±2.56 (886)	534.29^{e}±4.29 (366)	457.51^{e}±4.08 (324)
	G_3	511.59^{e}±3.10 (605)	663.79^{b}±4.97 (273)	503.80^{d}±4.35 (285)
	G_4	548.39^{d}±3.55 (461)	585.57^{d}±5.38 (233)	529.83^{c}±4.15 (313)
	G_5	558.81^{c}±3.16 (583)	626.24^{c}±8.67 (90)	552.49^{b}±4.72 (242)
	G_6	573.92^{b}±3.12 (599)	662.69^{b}±3.61 (519)	562.14^{b}±4.26 (297)
	G_7	609.09^{a}±4.19 (331)	704.15^{a}±4.44 (343)	591.39^{a}±4.05 (329)
Sex	LS	***	***	***
	M	556.62^{a}±1.61 (2352)	632.89^{a}±2.54 (1212)	547.41^{a}±2.16 (1162)
	F	457.91^{b}±1.55 (2551)	531.40^{b}±2.34 (1415)	447.51^{b}±2.13 (1196)

LS = Level of Significance, M = Male, F = Female, Figures in the parentheses indicate the number of observations, *** = significant at p<0.001, Means with different superscripts in a column indicate significant difference (p<0.05), – = Missing value

Table 2. Least squares means (±SE) of 40^{th} week body weight (g) of ND, HI and NN as affected by generation

Factor		ND	HI	NN
	LS	***	***	***
Generation	G_0	1240.71^{e}±15.49 (180)	1448.30^{c}±29.41 (100)	1218.34^{c}±19.71 (100)
	G_1	-	-	-
	G_2	1380.26^{d}±16.42 (223)	1714.89^{b}±28.04 (110)	1254.74^{c}±19.24 (105)
	G_3	1450.33^{c}±15.05 (190)	1756.36^{b}±27.07 (118)	1370.88^{b}±19.24 (105)
	G_4	1587.37^{a}±16.33 (212)	1886.29^{a}±28.43 (107)	1419.98^{b}±20.44 (93)
	G_5	1572.84^{ba}±14.67 (178)	1841.79^{a}±25.31 (135)	1513.37^{a}±20.78 (90)
	G_6	1530.82^{b}±15.89 (200)	1901.43^{a}±24.17 (148)	1511.66^{a}±18.46 (114)

LS = Level of Significance, Figures in the parentheses indicate the number of observations, *** = significant at p<0.001, Means with different superscripts in a column indicate significant difference (p<0.05), – = Missing value

Effect of generation

The mean BW of ND, HI and NN chickens increased at 8th week of age from 349.99, 380.07, 340.43g in G_0 to 609.09, 704.15 and 591.39g in G_7 respectively and at 40th week from 1240.71, 1448.30, 1218.34g in G_0 to 1530.82, 1901.43 and 1511.66g in G_6 respectively. Weight gains at 8th week of age for ND, HI and NN were 259.10, 324.08 and 250.96g respectively, and at 40th week of age weight gains were 290.11, 453.13 and 293.32g respectively for ND, HI and NN over the seven generations of selection. Hence the effect of generations of selection on body weight was highly significant ($p<0.001$). Sultana (2019) also found that generation of selection increased the body wait both at 8th and 40th week of age. Faruque *et al*. (2017c) found that under intensive management system selection improved the BW of indigenous chickens in second generation and observed that weight gains at 8th week of age for G_2 were 107.34, 175.95, 150.70g respectively for ND, HI and NN genotypes and BW increased by 202.91, 337.36 and 72.82g at 40th week of age for ND, HI and NN genotypes respectively. Wondmeneh *et al*. (2014) also stated that the genetic trend of BW at 16th week of age was positive under selection from generation 4 (G4) and G6; which were in agreement with the present findings.

Effect of sex

This study also shows that male and female birds have significant differences ($p<0.001$) in BW. In case of all the three genotypes male chickens were significantly heavier in BW than the female chickens. This observation is similar to that of Kitso *et al*. (2018) who found that males of the naked neck and normal strains of indigenous Tswana chickens were significantly heavier ($p<0.05$) than their age-matched female counterparts from 14 to 20 weeks of age. The significant effect of sex on BW from this study is also in agreement with Faruque *et al*. (2015) who observed that male chicks were significantly heavier ($p<0.001$) in BW at 8th, 12th and 16th weeks than the females. However Jahan *et al*. (2017) observed that the effects of sex on BW at hatch, BW at sexual maturity, BW at one year of age, BW gain up to sexual maturity and BW gain from sexual maturity to one year of age of indigenous chickens were non-significant ($p>0.05$) and is disagreed with the present findings. Breed or genotype and no. of observation might be one of the reasons for this difference.

Age at sexual maturity

The least squares means (±SE) of ASM of ND, HI and NN as affected by generation are presented in Table 3.

HI chicken started laying eggs at a higher age (166.35 days) compared to NN genotype (160.07 days) and ND genotype (162.22 days) in G_0 generation. In G_6 ND started laying eggs at earlier age (147.92 days) compared to HI (148.68 days) and NN (150.52 days). This study reveals that different genotypes and generation of selection has significant effect ($p<0.001$) on ASM. Generations of selection reduced 14.3, 17.67 and 9.55 days of ASM for ND, HI and NN respectively over the seven generations. The finding from this study is in agreement with Sultana (2019) and also with Weyuma *et al*. (2015) who observed that overall average ASM of indigenous chickens expressed in terms of age at first egg was 5.49 ± 0.8 month. According to Bhuiyan *et al*. (2005) the ASM was found 175 days in ND Chicken and 234 days in NN chicken which was much higher than the present finding. Feeding practices and rearing systems might be reasons behind these differences.

Table 3. Least squares means (±SE) of age at sexual maturity of ND, HI and NN as affected by generation

Factor		ND	HI	NN
	Level of significance	***	***	***
Generation	G_0	162.22^{a}±0.75 (200)	166.35^{a}±1.17 (100)	160.07^{a}±1.04 (100)
	G_1	-	-	-
	G_2	155.56^{b}±0.79 (178)	158.27^{b}±1.11 (110)	154.51^{b}±1.01 (105)
	G_3	154.26^{b}±0.73 (212)	153.57^{c}±1.08 (118)	153.03^{cb}±1.01 (105)
	G_4	151.04^{c}±0.79 (180)	150.57^{d}±0.79 (107)	151.46^{cb}±1.08 (93)
	G_5	147.47^{d}±0.71 (223)	147.53^{d}±1.07 (135)	152.20^{cb}±1.09 (90)
	G_6	147.92^{d}±0.77 (190)	148.68^{d}±0.96 (148)	150.52^{c}±0.97 (114)

Figures in the parentheses indicate the number of observations, *** = significant at $p<0.001$, Means with different superscripts in a column indicate significant difference ($p<0.05$), – = Missing value

Egg production

The least squares means (±SE) of EP from 24-40 weeks of age (number) of ND, HI and NN as affected by generation are presented in Table 4.

The average number of eggs produced was estimated from 168 to 280 days of production of indigenous genotypes studied. The average number of eggs increased from 58.33, 52.48 and 52.70 in G_0 to 72.40, 60.32 and 68.33 in G_6 for ND, HI and NN respectively. Hence the generation of selection increased egg number up to 40th week of age to 14.07, 7.84 and 15.60 for ND, HI and NN respectively over the seven generations which shows that the generation of selection had significant effect on EP ($p<0.001$). The number of eggs produced upto 280 days of this study was highest in ND, intermediate in NN and was lowest in HI. The results obtained from this study were in agreement with Sultana (2019) who found that the average number of eggs were 72.40, 60.32 and 68.33 in G_6 for ND, HI and NN respectively from 24-40 weeks of age. The findings of Weyuma *et al*. (2015) who observed that the average EP of Backyard chicken in selected rural areas of Bishoftu (in Ethiopia) was recorded to be 44.20 ± 9.6 eggs per hen per year, Sarkar and Golam (2009) who recorded 46 eggs/year, Das *et al*. (2008) found 45-50 eggs/year which were much lower than the present findings. Tadelle *et al*. (2003) observed 75 eggs/year for indigenous chicken. Bhuiyan *et al*. (2005); Bett *et al*. (2014) observed that the annual EP as recorded per hen was 50-55 in NN and 45-50 in indigenous chicken under scavenging system which is also much lower than the present results. Rearing system, quality and quantity of supplied feed, population structure (random bred or non-selected) etc. might be the reasons for low performance.

Egg weight

The Least squares means (±SE) of egg weight (g) of ND, HI and NN as affected by generation are presented in Table 5. Generation of selection has increased the egg weight from 41.64, 41.14 and 41.61g in G_0 to 45.01, 45.09 and 44.88g in G_6 for ND, HI and NN respectively which is in agreement with Sultana (2019). Almost similar result was stated by Khatun *et al*. (2005) who observed 43.83g EW in ND genotype.

Table 4. Least squares means (±SE) of egg production from 24-40 weeks of age (number) of ND, HI and NN as affected by generation

Factor		ND	HI	NN
	Level of significance	***	***	***
Generation	G_0	58.33^{e}±0.52 (200)	52.48^{c}±1.11 (100)	52.70^{d}±0.90 (100)
	G_1	-	-	-
	G_2	63.29^{d}±0.55 (178)	54.48^{cb}±1.06 (110)	60.82^{c}±0.88 (105)
	G_3	65.74^{c}±0.51 (212)	56.06^{b}±1.02 (118)	64.50^{b}±0.88 (105)
	G_4	70.73^{b}±0.55 (180)	58.93^{a}±1.07 (107)	68.56^{a}±0.94 (93)
	G_5	72.89^{a}±0.49 (223)	61.02^{a}±0.95 (135)	68.82^{a}±0.95 (90)
	G_6	72.40^{a}±0.53 (190)	60.32^{a}±0.91 (148)	68.33^{a}±0.85 (114)

Figures in the parentheses indicate the number of observations, *** = significant at p<0.001, Means with different superscripts in a column indicate significant difference (p<0.05), – = Missing value

Table 5. Least squares means (±SE) of egg weight (g) of ND, HI and NN as affected by generation

Factor		ND	HI	NN
	Level of significance	***	***	***
Generation	G_0	41.64^{d}±0.19 (200)	41.14^{e}±0.28 (100)	41.61^{c}±0.27 (100)
	G_1	-	-	-
	G_2	41.78^{d}±0.20 (178)	42.61^{d}±0.27 (110)	42.19^{c}±0.26 (105)
	G_3	43.50^{c}±0.19 (212)	43.83^{c}±0.26 (118)	43.94^{b}±0.26 (105)
	G_4	44.79^{b}±0.20 (180)	46.53^{a}±0.27 (107)	44.46^{ba}±0.28 (93)
	G_5	45.58^{a}±0.18 (223)	46.68^{a}±0.24 (135)	44.95^{a}±0.28 (90)
	G_6	45.01^{b}±0.19 (190)	45.09^{b}±0.23 (148)	44.88^{a}±0.25 (114)

Figures in the parentheses indicate the number of observations, *** = significant at p<0.001, Means with different superscripts in a column indicate significant difference (p<0.05), – = Missing value

Conclusions

Selection program for eight generations under intensive management system made remarkable phenotypic progress in weight gains both at 8th and 40th week of age. In case of all the three genotypes male chickens were significantly heavier in body weight than the female chickens. Generations of selection reduced 14.3, 17.67 and 9.55 days of ASM and increased egg number up to 40th week of age to 14.07, 7.84 and 15.60 for the afore-mentioned genotypes respectively and egg weight has also increased in all the three genotypes over the seven generations. So, it can be implied that generations of selection improved both productive and reproductive traits of the three important Indigenous chicken genotypes of Bangladesh.

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