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Meat yield characteristics of different upgraded dwarf chicken under intensive management condition

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Abstract

The study was conducted with attempts to determine the effects of autosomal dwarf (*adw*) gene introgression from Indigenous dwarf chicken (IDC) to White Leghorn (WLH) and Fayoumi (Fay) on growth and meat yield characteristics. Experiment was carried out at the Poultry Farm of Bangladesh Agricultural University (BAU), Mymensingh for a period of 28 months from March 2013 to June 2015 under intensive management condition. In this study, the di-allele crossing between WLH, Fay and IDC produced 4 up-graded chickens viz. IDC♂ × WLH♀, WLH♂ × IDC♀, IDC♂ × Fay♀ and Fay♂ × IDC♀. The up-graded F_1 generations were mated intersex to access their productivity. The up-graded F_1 generations were mated intersex to access their productivity. Pre-slaughter live weight of birds significantly ($P<0.001$) varied by genotype, sex and genotype × sex interaction. Percentage of thigh meat, drumstick meat, dark and total meat weights was significantly influenced by genotype. Although meat yield parameters of male birds in relation to live weight were found higher than their female birds, some parameters like breast meat, liver, giblet and total meat yield were found higher in female birds than that of male birds of all genotypes. However, meat yield parameters like percentage of thigh, drumstick and total meat yield were the highest in IDC♂ × Fay♀ and Fay♂ × IDC♀ and the lowest in IDC♂ × WLH♀. From the above findings, Fayoumi mediated dwarf genotypes showed better meat yield characteristics than Leghorn mediated dwarf genotypes.

Introduction

Chicken is the cheapest and important source of animal protein in the form of eggs and meat that can meet up the shortage within least possible time and could play a major role in improving the human nutritional status. Indigenous chicken contributes to rural livelihood, food security, woman empowerment, and still remains main genetic resource of Bangladesh (Gondwe, 2004). A significant proportion of city dwellers and village consumers have strong fascination to indigenous chicken eggs and meat. Because, the increasing rate of drug residues in commercial poultry products resulting from the intensive use of antibiotics, growth promoter and anti-coccidiostats are of growing concern for health-conscious consumers, who definitely prefer drug residue-free poultry products (Mensah et al., 2011). Therefore, they pay more for eggs and meat of indigenous chicken in comparison with that of hybrid layers and broilers (Islam and Nishibori, 2009). Broiler carcass contains higher fat, less protein and higher cholesterol (Mendes et al., 1994). The meat and egg of indigenous chickens are widely preferred by consumers because of their lean meat, more protein content, taste, pigmentation, firmness, flavor and suitability for special dishes (Islam et al., 2002). Upgrading and crossbreeding of native fowl was thought to be the most easy and quickest method of improvement of native germplasm for traits of economic importance (Khan, 1983). Bangladesh does have a great possibility to increase production of meat and eggs by improving genetic potentials of native chicken. Most of the past efforts were concentrated to improve indigenous stock through upgrading (Ahmed and Islam, 1985). But little attention has been given to the adaptability under hot humid environment, poor management and fluctuating supply of feed.

Reduction in body size due to dwarf (*dw*) gene is an important factor in the acclimatization of chicken to the tropics through body heat dissipation through radiation and convection, and endogenous heat production (Horst, 1989). The dwarf chicken possesses additional genetic merits for more water holding in the body which allows them to be more heat resistant (Horst et al., 1996). Relatively smaller body size (Horst and Petersen, 1978) and higher sodium concentrations in their plasma (Singh and Panda, 1992) are associated with better production and survivability of dwarf hens under heat stress. Dwarf birds are heat and disease tolerant, more meat producer, need less maintenance and feed requirement than for the normal sized birds (Sadjadi et al., 1983). Thus, dwarfing inheritance among the chickens is of interest to the scientists for their numerous pleiotropic effects (Guillaume, 1976). Dwarfing genotypes revolutionized broiler industry by decreasing maintenance feed when dam line is dwarf. The ISA maintaining dwarf dams in female parents for higher stocking density and lower feed cost (Willard, 1981). Thus, genetically diverse breeds could provide an indispensable source for research to improve genetic merits (Weigend and Romanov, 2002).Therefore, reducing maintenance feed requirement, increasing feed efficiency as well as adaptability in a hot-humid tropical environment through the introduction of dwarf types, synthesized by using indigenous autosomal dwarf chicken and exotic breeds might fulfill the demand and increase village level meat and egg production of chicken. The above-mentioned circumstances indicate that the increased production of the upgraded indigenous chicken might be supported by the existing level of feed intake in the backyard system. However, the potentiality of *adw* gene was not sufficiently explored for improving economic traits of indigenous chicken of Bangladesh. Therefore, it becomes imperative to search an observation for the presence of dwarfing genotypes and their inheritance. Notably, in Bangladesh, the inheritance and influence tested by Yeasmin and Howlider (2013) using a few individuals. So, production of up-graded types using Indigenous dwarf chicken with exotic breed (White Leghorn and Fayoumi) would improve the productivity of fowl. With those ideas in view, the present study was undertaken to know and compare the meat yield characteristics of different upgraded dwarf chicken.

Materials and methods

Collection and multiplication of parent generation

The adult White Leghorn (42♂ + 6♀) and Fayoumi (42♂ + 8♀) chickens were collected from Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka and DLS (Central Govt. Poultry Farm, Mirpur, Dhaka) to develop a foundation stock. The birds were selected on the basis of their phenotypic feature and productive performance.

Production of experimental birds

Di-allele crossing was made involving White Leghorn (WLH), Fayoumi (Fay) and IDC to develop 4 reciprocal crosses (Table 1). Birds were selected from all the 4 genotypes on the basis of body weight, physical feature, feed conversion, survivability, egg production and egg quality. The selection phases to observe response of the different phenotypes to establish superiority of the population using dwarf inheritance.

Table 1. Di-allele crossing of parents to produce different genotypes

Male	Female		
	White Leghorn (42)	Fayoumi (42)	Indigenous Dwarf (42)
White Leghorn (6)	≠	≠	✓
Fayoumi (6)	≠	≠	✓
Indigenous Dwarf (6)	✓	✓	≠

✓ - cross made, ≠ - cross not made, Figure under parentheses indicate number of birds

Di-allele crossing was performed among the up-graded individual of G_1 genotypes which is presented in Table 2. The up-graded of G_1 generation was intercrossed to produce G_2 generation. All sorts of information like G_1 upgraded genotypes were recorded. On the other hand, dwarf genotypes were maintained up to second generation to explore the actual productivity. Based on the recorded data, two upgraded dwarf population was selected and maintained at BAU poultry farm.

Table 2. Intercrossing to produce G_2 generation

Upgraded genotypes G_1 Male	Upgraded genotypes of G_1 Female			
	WLH × IDC (42)	IDC × WLH (42)	Fayoumi × IDC (42)	IDC × Fayoumi (42)
White Leghorn (WLH) × IDC (6)	✓	≠	≠	≠
Indigenous Dwarf (IDC) × WLH (6)	≠	✓	≠	≠
Fayoumi × IDC (6)	≠	≠	✓	≠
IDC × Fayoumi (6)	≠	≠	≠	✓

✓ - cross made, ≠ - cross not made, Figures in the parentheses indicate number of birds

Carcass characteristics

A total of 48 birds from 2nd generation (6 females and 6 males from each genotype) were slaughtered at 24 weeks of age. 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). The recorded data of each bird were encompassed live weight, head, heart, gizzard, neck, breast meat, thigh meat, drumstick meat, skin, abdominal fat, wing meat, trimmed meat, dark meat (thigh meat + drumstick meat+ wing meat+ trimmed meat), total meat (breast meat + dark 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.

Data analysis

Data were subjected to analysis of variance (ANOVA) for a factorial design using the General Linear Models (GLM) Procedure of Statistical Analysis System (SAS, 2009) with sexes and 4 genotypes as fixed effect. Duncan's Multiple Range Test was used to determine the significant differences between means.

Results

Results of the analysis of variance and least squares means for the meat yield characteristics of different upgraded genotypes are presented in Table 3 and Table 4. Pre- slaughter weight of birds varied ($P<0.001$) across the genotypes, sex and genotype × sex interaction. The findings indicated that the percentage of thigh meat ($P<0.05$), drumstick meat ($P<0.01$), dark and total meat ($P<0.05$) weights varied across the genotype. The findings also indicated that the carcass parameters varied across the sexes. However, the weight of the meat yield traits was significantly varied by sex. But, percentage of dressed meat, skin and gizzard were similar across the sexes. Sexual dimorphism too was observed favoring the cockerels. However, some parameters like percentages of the breast meat, liver, giblet and total meat yield favored the pullets irrespective of the genotypes. On the other hand, genotype × sex interaction had similar influence (P>0.05) on all sorts of meat yield traits. The study also revealed that meat yield parameters like percentage of thigh, drumstick meat, dark and total meat yield were the highest in IDC♂ × Fay♀ and Fay♂ × IDC♀, and the lowest in IDC♂ × WLH♀.

Table 3. Results of the analysis of variance for the meat yield characteristics of different upgraded genotypes

Trait	Significance level			R^2 of the model
	Genotype (Gno)	Sex (S)	Gno×S	
Body weight	***	***	***	0.989
Dressed weight	NS	NS	NS	0.142
Breast meat weight	NS	***	NS	0.417
Thigh meat weight	*	**	NS	0.365
Thigh bone weight	NS	***	NS	0.388
Drumstick meat weight	**	***	NS	0.734
Drumstick bone weight	NS	***	NS	0.668
Wing meat weight	NS	***	NS	0.478
Wing bone weight	NS	***	NS	0.414
Skin weight	NS	NS	NS	0.074
Head weight	NS	***	NS	0.962
Liver weight	NS	***	NS	0.837
Heart weight	NS	***	NS	0.278
Neck weight	NS	***	NS	0.185
Gizzard weight	NS	NS	NS	0.013
Giblet weight	NS	***	NS	0.570
Dark meat weight	*	***	NS	0.677
Total meat weight	*	*	NS	0.287

*significant at p<0.05, **significant at p<0.01, ***significant at p<0.001, NS non-significant (p>0.05) Gno×S= interaction between genotype and sex

Table 4. Least squares means of meat yield traits of different upgraded genotypes

Trait (% in relation to body weight)	Sex	Genotypes (Mean ± SE)			
		IDC♂ × Fay♀ (n=Fe-6,M-6)	Fay♂ × IDC♀ (n=Fe-6,M-6)	IDC♂ × WLH♀ (n=Fe-6,M-6)	WLH♂ × IDC♀ (n=Fe-6,M-6)
Body weight (g)	F	1042.67^{b}±6.17	1019.67^{c}±8.26	1118.67^{a}±8.62	1111.67^{a}±7.01
	M	1389.0^{b}±6.24	1306.5^{c}±9.52	1430.16^{a}±6.49	1399.83^{b}±4.44
Dressing weight	F	64.85±0.74	64.01±0.94	63.67±0.87	64.02±0.69
	M	65.25±0.49	65.30±0.24	64.35±0.51	65.12±0.48
Breast meat	F	11.06±0.11	11.09±0.12	10.70±0.36	10.72±0.11
	M	9.92±0.15	9.87±0.33	9.48±0.63	9.97±0.17
Thigh meat	F	7.82^{a}±0.14	7.67^{a}±0.24	7.17^{b}±0.07	7.74^{a}±0.11
	M	8.31±0.23	8.31±0.38	7.69±0.20	8.22±0.20
Thigh bone	Fe	1.34±0.06	1.30±0.05	1.30±0.08	1.37±0.02
	M	1.51±0.05	1.54±0.04	1.53±0.06	1.30±0.04
Drumstick meat	Fe	5.39^{a} ±0.09	5.28^{ab} ±0.05	4.89^{b} ±0.22	5.22^{ab} ±0.09
	M	6.35^{a}±0.23	6.33^{ab} ±0.16	5.85^{b} ±0.08	6.38^{a} ±0.16
Drumstick bone	F	1.77±0.02	1.75±0.04	1.76±0.03	1.76±0.06
	M	2.16b±0.07	2.11±0.09	2.21±0.04	2.12±0.09
Wing meat	F	2.81±0.08	2.85±0.06	2.79±0.07	2.77±0.03
	M	3.11±0.04	3.13±0.07	3.0±0.05	3.03±0.09
Wing bone	F	2.53±0.11	2.56±0.06	2.65±0.15	2.57±0.09
	M	2.91±0.06	2.89±0.03	2.91±0.09	2.90±0.04
Skin	Fe	5.71±0.14	5.73±0.05	5.85±0.09	5.75±0.05
	M	5.63±0.08	5.66±0.11	5.64±0.15	5.61±0.14
Head	F	2.75^{b}±0.06	2.76^{b}±0.06	3.12^{a}±0.07	3.03^{a}±0.09
	M	5.24±0.07	5.25±0.06	5.21±0.22	5.23±0.09
Liver	F	2.36±0.03	2.34±0.04	2.39±0.12	2.39±0.04
	M	1.75±0.05	1.75±0.06	1.77±0.05	1.75±0.06
Heart	F	0.42±0.02	0.43±0.02	0.41±0.03	0.41±0.02
	M	0.47±0.03	0.48±0.02	0.48±0.02	0.48±0.02
Neck	F	3.16±0.08	3.13±0.07	3.01±0.08	3.06±0.07
	M	3.29±0.13	3.33±0.16	3.35±0.19	3.32±0.08
Gizzard	F	1.98±0.04	1.92±0.14	1.95±0.14	1.97±0.07
	M	1.92±0.06	1.91±0.05	1.90±0.18	1.91±0.06
Giblet	F	4.75±0.08	4.68±0.16	4.75±0.11	4.48±0.09
	M	4.15±0.08	4.13±0.07	4.16±0.18	4.14±0.09
Dark meat	F	16.56^{a}±0.17	16.27^{a}±0.19	15.61^{b}±0.19	16.19^{a}±0.19
	M	18.37±0.41	18.42±0.56	17.42±0.31	18.20±0.34
Total meat	F	27.63^{a}±0.18	28.29^{a}±0.15	27.36^{b}±0.43	28.29^{ab}±0.29
	M	26.31±0.49	26.91±0.78	26.92±0.71	28.17±0.43

IDC- Indigenous dwarf chicken, Fay- Fayoumi, WLH- White Leghorn, Fe- Female, M- Male, values in the parentheses indicate the number of observations, SE-standard error; ^{a,b,c} means with different superscripts in the same row differ significantly * P<0.05; **, P<0.01; ***, P<0.001 and without superscripts in the same row represent non-significant difference among the traits.

Discussion

In the present study, genotypes influenced ($P< 0.05$) the weight of the thigh meat. Percentage of thigh meat of IDC♂ × Fay♀, Fay♂ × IDC♀, IDC♂ × WLH♀ and WLH♂ × IDC♀ genotypes were found to be 7.82, 7.67, 7.17 and 7.74 respectively in female birds and 8.31, 8.31, 7.69 and 8.22 respectively in the male birds. These findings are in accordance with those of Rashid et al. (2005). They found that thigh meat percentage of WLH*adw* was 7.30 in female birds. But Howlider and Afrin (2013) found the thigh meat percentage of Rbdw and Na*dw* were 6.51 and 6.09 respectively in female and 6.35 and 6.19 respectively in male which is lower than the present findings. The percentage of drumstick meat varied ($P<0.01$) across genotypes. The highest (5.39) drumstick meat percentage was recorded among the IDC♂ × Fay♀, while the lowest (4.89) was IDC♂ × WLH♀ in the female birds. The study further indicated that as well as the highest (6.38) drumstick meat percentage was observed in WLH♂ × IDC♀ and lowest (5.85) in IDC♂ × WLH♀ in male birds. The results from a study by Rashid et al. (2005) indicated that the percentage of drumstick meat was 4.68 among the crossbred White Leghorn dwarf which is consistent with the present study. However, the studies by Howlider and Afrin (2013) indicated that the percentages of drumstick meat was 4.64 and 4.94 in male and female Na*dw* (sex-linked) chicken respectively at 8 weeks of age, the values being lower than those obtained in this study. Studies by Howlider and Afrin (2013) reported that the dark meat percentage of male and female Na*dw* birds were 13.17 and 13.50 respectively while that of the total meat percentage were 19.0 and 20.04 respectively at 8 weeks of age. The value of dark meat and total meat as reported by Howlider and Afrin (2013) is lower than the present findings. In the present study, the highest and lowest value of dark meat percentage was reported among the female birds and the value was 16.56 and 15.61 respectively and that of the total meat were 28.29 and 27.36 respectively. The variation of meat yield parameters might be the associated with age and genotypes.

Conclusion

The meat yield characteristics of upgraded dwarf chicken of Bangladesh has established through this study. Although meat yield parameters of male birds in relation to live weight were found higher than their female birds, some parameters like breast meat, liver, giblet and total meat yield were found higher in female birds than that of male birds of all genotypes. However, percentage of thigh, drumstick dark and total meat yield were highest in IDC♂ × Fay♀ and Fay♂ × IDC♀ chicken. Therefore, it can be concluded that among the upgraded genotypes, Fayoumi mediated dwarf genotypes showed better meat yield performance when compared to their Leghorn mediated dwarf genotypes. These findings could be utilized to develop a suitable meat bird like Sonali for intensive and semi-scavenging system of Bangladesh.

Conflicts of Interest

The authors declare that there are no potential conflicts of interests.

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