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Effects of autosomal dwarf gene on growth and shank length of chicken

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Abstract

A partial diallel crossing of Rhode Island Red (RIR), White Leghorn (WLH), Fayoumi (FO), *Desi* normal (DN) and *Desi* dwarf (DD) produced RIR, WLH, FO, DN, DD, RIR x DD, WLH x DD and FO x DD offspring. A total 709 chicks, 75 RIR, 130 WLH, 100 FO, 70 DN, 66 DD, 80 RIR x DD, 80 WLH x DD and 108 FO x DD were reared for studying growth performance up to 18 weeks of age. At 19 weeks, the crossbreds RIR x DD, WLH x DD and FO x DD were separated into normal and dwarf genetic groups on the basis of shank length and thus 11 genetic groups, RIR, WLH, FO, DN, DD, RIR x DD normal, RIR x DD dwarf, WLH x DD normal, WLH x DD dwarf, FO x DD normal and FO x DD dwarf were obtained. Day-old weight differed significantly ($P<0.05$) between genotypes. When crossed with *Desi* dwarf, the day-old weight of RIR, WLH and FO decreased by 7.0, 8.7 and 15.3%. DD chicks had 9.2% lower day-old weight than DN. All DD and DD crossbred chicks had lower feed intake ($P<0.01$) at all stages of growth. There were no significant differences in daily weight gain, feed conversion ratio and mortality between genotypes ($P>0.05$). The shank length differed significantly between genotypes at all ages regardless of sex ($P<0.01$) and differences between genotypes increased at older ages. Shank length of pure breeds and normal crossbreds were similar and much longer than in dwarf crossbreds ($P<0.01$). (*Bangl. vet*. 2013. Vol. 30, No. 1, 25 – 32)

Introduction

The collection, evaluation and conservation of different genotypes are an insurance against future needs (Crawford, 1984). These should help overcome the vulnerability of monotypic population to future challenges from changes in environment, management and food habit. Indigenous stocks are disappearing following development of improved stocks. FAO (1984) therefore suggested a thorough study of different genotypes among indigenous poultry and conservation of those found worthy. The use of dwarf gene is considered an important means of reducing adult body size and shank length (Polkinghorne, 1976; Raut *et al*., 1996). An autosomal recessive dwarf gene (*adw*) has been identified in *desi* chicken of Bangladesh (Yeasmin and Howlider, 1998). The effect of *adw* gene on growth, egg production and egg quality are important traits (Guillaume, 1976). The influence of either *adw* or the sex-linked recessive dwarfism gene *dw* have been reported to vary with the genome in

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which they are introduced (Reddy and Siegel, 1977). In the present study, a partial diallel crossing was made involving-Rhode Island Red (RIR), White Leghorn (WLH), Fayoumi (FO), *Desi* normal (DN) and *Desi* dwarf (DD) to produce eight crossbreds RIR, WLH, FO, DN, DD, RIR x DD, WLH x DD and FO x DD and according to shank length 11 genetic groups: RIR, WLH, FO, DN, DD, RIR x DD normal, RIR x DD dwarf, WLH x DD normal, WLH x DD dwarf, FO x DD normal and FO x DD dwarf progenies to compare effects of *adw* on growth.

Materials and Methods

A total of 709 chicks obtained from a partial diallel cross involving RIR, WLH, FO, DN and DD chicken produced 75 RIR, 130 WLH, 100 FO, 70 DN, 66 DD, 80 RIR x DD, 80 WLH x DD and 108 FO x DD (Table 1). The growth of eight genotypes in two replications were compared up to 18 weeks of age. At the beginning of 19 weeks the crossbred RIR x DD, WLH x DD and FO x DD cockerels and pullets were separated according to shank length (Raut *et al.,* 1996). Among the crossbreds, both normal and dwarf offspring were found and thus 11 genetic groups; RIR, WLH, FO, DN, DD, RIR x DD normal, RIR x DD dwarf, WLH x DD normal, WLH x DD dwarf, FO x DD normal and FO x DD dwarf were obtained.

At one day old, all chicks were individually weighed and wing banded, and brooded up to 4 weeks of age. They were housed, separated according to genotype, with a stocking density of 100 cm^2/ bird. In growing phase, between one and 126 days of age, 709 chicks of eight different genotypes; RIR, WLH, FO, DN, DD, RIR x DD, WLH x DD and FO x DD had four replications for comparison between genotypes.

Sawdust was used as litter with a depth of 7.5 cm during the first 4 weeks of age. Chick feeder and chick drinker were provided during the brooding period. The chicks were given a temperature of 35^o C at first week of age, decreasing by 3^oC per week up to 28 days of age.

At day one and fortnightly, body weight, feed intake, and shank length were recorded. Shank lengths recorded are presented for day old, 4, 18 and 46 weeks of age. The shank length was measured as the distance between claw and hock joint. Feed conversion ratio (FCR) was calculated as feed intake per unit live weight gain. Mortality (%) was recorded daily.

All birds were fed *ad libitum* on a starter diet (0-6 weeks) containing CP-20%, ME (Kcal/Kg)-2798, Ca-1.1%, P-0.5%, Lysine-1.1, Methionine + Cystine -0.8%, then a grower diet (7-8 weeks) containing CP 16.7%, ME (Kcal/Kg) 2700, Ca-1.2%, P-0.6%, Lysine-1.0%, Methionine + Cystine-0.7%.

Statistical Analysis

All data were for a completely Randomized Design and analysis of variance was performed to compare results between genotypes (Steel and Torrie, 1980) using MSTAT-C statistical computer package program (Russell, 1994). The significant

variations of means were identified by Duncan's New Multiple Range Test (DMRT).

Results and Discussion

Day-old weight was highest in RIR and WLH, intermediate in RIR x DD and lowest in DN, DD, WLH x DD and FO x DD (P<0.05) (Table 1). For crossing with *Desi* dwarf, the day-old weight of RIR, WLH and FO was decreased by 7.0, 8.7 and 15.3g. DD chicks had 9.2% lower day-old weight than DN. At four and 18 weeks of age, there was little difference in live weight between genotypes. Daily feed intake during 0 - 4 weeks was highest in RIR, intermediate in WLH and FO and lowest in DN, DD, RIR x DD, WLH x DD and FO x DD. Daily feed intake during 5-18 weeks was highest in RIR, WLH, FO and RIR x DD, intermediate in DN, WLH x DD and lowest in FO x DD and DD (P<0.05). There was a tendency of reduced feed intake in genotypes having dwarf inheritance. At 0-4 weeks, RIR, WLH and FO crossbreds had 29.6, 18.2 and 27.2% lower feed intake than their respective pure breeds RIR, WLH and FO, showing the effect of dwarf gene. DD consumed 9.3% less feed than their *Desi* normal counterparts. RIR, WLH and FO dwarf crossbreds ingested 6.6, 9.5 and 16.3% less feed than RIR, WLH and FO pure breeds at 5 to 18 weeks. At 0 - 18 weeks, RIR, WLH and FO dwarf crossbreds ate 8.3, 10.0 and 16.8% less feed than the pure breeds RIR, WLH and FO. DD consumed 16.5% and 16.0% less feed than their *Desi* normal counterparts at 5 - 18 weeks and 0 - 18 weeks. In general, birds having dwarf inheritance ate less than the normal throughout the growing period.

Table 1. Performance of RIR, WLH, FO, DN, DD, RIR x DD, WLH x DD and FO x DD genotypes during brooding and growing periods

Parameters	Age (Weeks)	Genotypes								Significance+
		RIR	WLH	FO	DN	DD	RIR x DD	WLH x DD	FO x DD	
Day-old weight (g/bird)		36.1^{a}	34.5^{a}	34.0^{a}	30.3^{c}	27.5^{c}	33.7^{b}	31.5^{c}	28.8^{c}	*
Daily weight gain (g/bird)	0-4	1.9	1.8	1.9	2.5	1.5	2.0	2.3	1.8	NS
	5-18	11.0	9.9	9.7	8.7	6.8	10.7	9.0	7.8	NS
	0-18	8.8	8.1	8.0	7.3	5.6	8.8	7.5	6.5	NS
Daily feed intake (g/bird)	0-4	11.5^{a}	10.5^{b}	10.7^{ab}	8.7^{c}	7.7^{c}	8.1^{c}	8.6^{c}	7.8^{c}	*
	5-18	39.2^{a}	30.3^{a}	37.9^{a}	34.0^{b}	28.4^{d}	36.6^{a}	34.7^{b}	31.7^{c}	**
	0-18	33.1^{a}	32.1^{a}	31.8^{a}	28.3^{c}	23.8^{e}	30.3^{b}	28.9^{c}	26.5^{d}	**
Feed conversion ratio	0-4	6.4	6.0	5.7	3.6	5.5	4.1	3.8	4.3	NS
	5-18	3.6	3.9	3.9	4.0	4.2	3.5	3.9	4.1	NS
	0-18	3.8	4.0	4.0	3.9	4.4	3.5	3.9	4.1	NS
Mortality (%)	0-4	0.0	6.5	18.0	5.0	11.7	9.0	14.1	5.0	NS
	5-18	25.0	15.4	7.9	12.2	4.2	4.6	0.0	17.3	NS
	0-18	25.0	20.8	25.9	16.7	15.2	13.6	14.1	21.8	NS

+ NS, P>0.05; *, P<0.05; **, P<0.05

There were no significant differences (P>0.05) in daily weight gain, feed conversion ratio and mortality that could be explained by the variation of genotype. RIR x DD and WLH x DD chicks had lowest mortality, but the differences were not significant.

Table 2. Number of chicks of different genetic groups with normal (N) and dwarf (D) ratio in male (M) and females (F) at 19 weeks of age+

Genetic groups	Sex		Ratio of N : D	
	Male	Female	Male	Female
RIR	30	26		
WLH	50	53		
FO	39	36		
DN	26	32		
DD	27	29		
RIR × DDN	19	22	1.6:1	1.4:1
RIR × DDD	12	16		
WLH × DDN	19	20	1.9:1	1.4:1
WLH × DDD	10	14		
FO × DDN	30	28	2.2:1	1.9:1
FO × DDD	44	15		

+ DN, *Desi* normal; DD, *Desi* dwarf

The results in Table 2 indicate that crossing of dwarf *Desi* chicken with different breeds gave normal or dwarf progenies in different ratios for different breeds.

The shank length (Table 3 and 4) differed significantly between genetic groups at all ages regardless of sex (P<0.01). However, the differences of shank length between genetic groups increased at older ages. There was less difference between pure breeds and normal crossbreds, but length in both purebreds and normal crossbreds was much higher than in dwarf crossbreds in both sexes: DN always had higher shank length than DD and differences increased at older ages (P<0.01). There were little difference between males and females.

The differences in day-old weight (Table 1) between genotypes may be mainly attributed to differences in weight of the foundation stocks. When chick weight was expressed as per cent of egg weight (Table 2), the differences between genotypes almost disappeared, indicating chick weight may be largely a function of egg weight. The results coincide with the findings of Strong and Jaap (1977); Delpech (1968); Hutt (1949; 1953; 1959). Arscott and Bernier (1968) reported higher chick weight in *dw* breeders than in normal.

The data between four and 18 weeks of age in Table 1 indicates lack of significant differences between genotypes. Differences appeared later when the crossbreds were

separated into normal and dwarf genetic groups. Live weight depression at older ages for *adw* gene is supported by Marks (1981). He observed that the depression by the *dw* gene on body weight was less at eight weeks of age than at later ages. The higher growth suppression obtained in this study and by Marks (1981) for *dw* gene at older ages is supported by Peterson *et al.* (1977). They found growth suppression of 25.3% and 33.9% at 5 and 20 weeks of age, respectively, after incorporation of *dw* gene in WLH chicken. Brody *et al.* (1984) showed that the reduction of live weight due to *dw* gene in high and low body weight groups of chicken were 16.8% and 43.7%, respectively at 46 days of age, indicating higher growth depletion of *dw* gene in smaller than in heavier breeds. Hoshino *et al.* (1982) observed that dwarf females had lower growth hormone levels at 10 and 20 weeks of age than normal size females. Cole (1969) introducing *adw* gene into Cornell line reported a 40% reduction in body weight at 18 weeks of age.

Table 3. Shank length (cm) of male of normal and dwarf genetic groups at different ages

Genetic groups	Age (weeks)			
	Day old	4	18	46
RIR	2.3[b]	3.8[c]	10.0[d]	10.1[c]
WLH	2.2[b]	3.8[c]	9.2[c]	9.5[c]
FO	2.2[b]	3.4[c]	9.3[c]	9.5[c]
DN	1.7[a]	3.4[c]	8.5[b]	8.6[b]
DD	1.2[a]	2.0[a]	4.2[a]	4.2[a]
RIR × DD normal	1.6[a]	3.0[b]	9.0[c]	9.2[b]
RIR × DD dwarf	1.2[a]	2.6[a]	4.4[a]	4.7[a]
WLH × DD normal	1.6[a]	3.5[c]	8.8[b]	9.0[b]
WLH × DD dwarf	1.7[a]	2.7[b]	4.8[a]	5.0[a]
FO × DD normal	2.0[b]	3.4[c]	8.0[b]	8.3[b]
FO × DD dwarf	1.5[a]	2.4[a]	4.9[a]	5.0[a]
Significance[+]	**	**	**	**

+ **, $P<0.01$

Reduced feed intake (7.8 - 39.2%) in pure breed × DD crossbreds compared with pure breeds (Table 1) coincides with Penionzhkevich *et al.* (1976). They reported that dwarf chickens ate 11.2 - 30.7% less than normal Starbro-4 between 9 and 65 weeks of age.

Feed conversion in dwarf crossbreds was higher than in normal crossbreds (Table 1). Marks (1987) noted higher feed utilization in *dw* from 0-8 days than in normal counterparts. Decuypere *et al.* (1991) reported that the feed efficiency of dwarf chicks during the growth period was poorer than in non-dwarf, specially in medium-sized or heavy stocks. Guillaume (1969; 1972; 1973) and Touchburn *et al.* (1975) found that

medium or heavy type chicken's feed to gain ratio was higher in dwarf birds than in normal siblings at all ages. Vlagova and Zlochevskaya (1986) got higher feed conversion efficiency for dwarf than normal broilers.

Table 4. Shank length (cm) of female of normal and dwarf genetic groups at different ages

Genetic group	Age (weeks)			
	Day old	4	18	46
RIR	2.2[b]	3.6[c]	8.2[b]	8.5[c]
WLH	2.1[b]	3.2[b]	8.0b	8.3[c]
FO	2.1[b]	3.3[b]	8.2[c]	8.5[c]
DN	2.0[b]	2.8[b]	7.6[b]	7.9c
DD	1.3[a]	2.1[a]	4.5[a]	4.6[a]
RIR × DD normal	2.0[b]	3.4[bc]	7.6[b]	7.9[c]
RIR × DD dwarf	1.5[a]	2.4[a]	5.0[a]	5.3[b]
WLH × DD normal	1.8[b]	3.3[b]	7.6[b]	7.8[c]
WLH × DD dwarf	1.5[a]	2.3[a]	5.1[a]	5.2[a]
FO × DD normal	1.9[b]	2.8[b]	7.4[b]	7.8[c]
FO × DD dwarf	1.6[a]	2.6[a]	4.7[a]	5.0[a]
Significance+	**	**	**	**

+ **, P<0.01

The reduced mortality in RIR x DD and WLH x DD (Table 1) is supported by Leenstra and Pit (1984). They reported that *adw* dwarfs with lower growth rate had better survival.

Shorter shank length of dwarfs is in agreement with the findings of Willard (1981). In different dwarf crossbred males and females at 18 weeks of age, shank length ranged from 4.4 - 4.9 and 4.7 - 5.1 cm, respectively. It almost coincides with the results of Raut *et al*. (1996). They observed that shank length in male and female dwarfs at 20 weeks were 6.0 ± 0.1 and 5.1 ± 0.0 cm. Increased differences in shank length between dwarfs and normal with increasing age noted in the present study are supported by Petersen *et al.* (1977). They found that shanks in dwarfs were shorter by 9.6 and 20.9% respectively, than in normal at 5 and 20 weeks. For both genotypes, shank length increased almost linearly up to 18 weeks and remained similar up to 46 weeks. Rashid (2000) has reported similar trend of shank length in normal and dwarf crossbreds of RIR, WLH and FO as found in this study.

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