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Genetic variations in local ecotype Turkeys. 2. effect of genotype, sex and hatch batch on growth-related measurements in live birds

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Abstract

Three locally adapted ecotype parental turkey lines comprising of Black (B), Bronze (Br) and White (W) plumage colored genotypes were used as experimental lines with each line comprising of 7 males and 15 females. A total of 228 poults generated from the crossing of the parental genotypic lines were used for this study. The effects of genotype, sex, hatch batch and genotype x sex interaction were tested on bodyweight, breast width, drumstick length, body length, shank length and keel length at 4, 8 and 12 weeks of age. There was no significant ($p<0.05$) hatch batch effect as well as genotype by sex interaction effect on all traits measured. There was significant genotype effect on bodyweight at 8 and 12 weeks with W lines expressing higher bodyweight followed by Br and B lines respectively. Body length and breast width also had significant genotype effect at 8 and 12 weeks with W and Br lines exhibiting higher body length and breast width than B lines. Keel length was significantly higher in W lines at 8 weeks while there was no significant genotype effect at 4 and 12 weeks. However, drumstick length showed significant genotype effect with Br lines having higher drumstick length than W and B lines at 8 and 12 weeks. In addition, shank length was significantly higher in B and Br lines than in W lines. Moreover, there was no significant genotype effect at 4 weeks across all traits. In addition, there was significant sex effect with the males being significantly higher than females in all the traits measured at 4, 8 and 12 weeks of age.

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Introduction

Turkey can be classified by their breeds or plumage colour (Thear 2007). Several plumage colours of turkey exists which include black, bronze, brown, red and white (Schorger, 1964) with black, bronze and white predominantly existing in the tropical environment.

Environment has been shown to influence productivity of farm animals particularly in the tropical environment where the weather affects deleteriously on the productive performance and well-being of all domestic animals (Ilori *et al.,* 2009). Hot ambient temperatures, above the thermo-neutrality for domestic poultry, typify the summer season in the grater poultry producing area especially in tropical regions and these affect performance and overall adaptation to the climatic regions (Ilori *et al.*, 2009). According to Reece and Lott (1983), these conditions reduce feed intake and growth rate and negatively affect feed efficiency in growing birds. Prolonged periods of elevated ambient temperature stress increase the time to reach market weight and increase mortality (Deaton *et al.*, 1978). Productive adaptability itself is a phenomenon whereby an animal gives acceptable level of production in a stressed environment (Ibe, 1990). The tropical environment is generally characterized by such stress factors as excessive heat, poor nutrition, poor housing and disease.

With plumage colour being a possible source of heat stress as typified in black materials that are good heat absorbers and retainer of heat, the influence of the black plumage coloured genotype or white genotype in the performance of turkey in hot humid environment can be either deleterious or helpful due to the extra heat absorption or dispersion (Okoro *et al*, 2012). Although the rearing of turkey extensively especially the rural people's back-yard system is becoming common in Nigeria, there is paucity of reliable information on the production performance of the local turkey strain in terms of lines (Etuk, 2005). Personal observation among rural people's small scale backyard turkey production revealed that white plumage coloured genotype are mostly preferred to other genotypes (Okoro *et al*, 2012). This research is conducted to compare the growth trait of three genotypes of turkey, black plumage coloured (B-line), bronze plumage coloured (Br-line) and white plumage coloured (W-line) genotype turkey strains in south-eastern Nigeria, in relation to their growth and growth related measurements at 4, 8 and 12 weeks of age.

Materials and methods

Study area

This research was carried out in the study area as described earlier in Okoro *et al* (2012). Management of parent stock also is as described earlier in Okoro *et al* (2012).

Poult rearing and management

A total of 228 poults hatched in 7 batches were used for this study. The genetic groups contributed varied number of poults, thus resulting in unequal sample sizes. The poults were brooded in deep litter pens according to their genetic groups. All poults identified individually with wing tags as individual records were taken all through the experiment. Commercial feeds were provided for the birds *ad libitum*. Starter mash containing 28% Crude protein (CP), grower mash containing 24% CP and finisher mash containing 20% CP, were fed to the birds from 0-6 weeks, 7-10 weeks and 10-12 weeks of age respectively. Clean, cool water were supplied *ad libitum*. Necessary vaccinations against Newcastle, fowl pox and gumboro diseases as well prophylactic antibiotics and anticoccidial drugs were administered to the birds.

Bodyweights (BW) were taken on all groups at weekly basis up to 12 weeks of age, linear body measurements (LBMS) were also taken at four weeks interval of 4weeks, 8weeks and 12 weeks of age. The LBMs taken include Breast width (BrWt) which is measured as the region of the largest breast expansion while the bird was positioned ventrally, Drum stick length (DSL) which is the distance between the hock joint and the pelvic joint, the

Table 1. Descriptive statistics for growth traits at 4 weeks of age of three lines of turkey.

Genotype	Trait	n	Mean±SE (4 Replicates/treatment)	CV (%)	Minimum	Maximum
B	BW (g)	88	190.09±11.48	56.67	75.00	400.00
	BrWt (cm)	88	4.00±0.15	34.58	2.00	7.80
	DSL (cm)	88	4.09±0.14	33.13	2.30	6.20
	SL (cm)	88	3.30±0.10	29.58	1.50	4.90
	KL (cm)	88	5.84±0.13	21.38	3.00	8.10
	BL (cm)	88	10.60±0.31	27.20	6.50	15.00
Br	BW (g)	60	175.75±11.88	52.34	75.00	375.00
	BrWt (cm)	60	3.81±0.17	34.57	2.00	5.70
	DSL (cm)	60	3.97±0.19	36.19	2.40	6.60
	SL (cm)	60	3.22±0.14	33.36	1.60	4.90
	KL (cm)	60	5.92±0.15	19.27	3.80	9.10
	BL (cm)	60	10.63±0.31	22.38	6.70	14.30
W	BW (g)	66	181.65±11.22	50.20	50.00	350.00
	BrWt (cm)	66	3.80±0.15	32.30	2.00	5.60
	DSL (cm)	66	4.05±0.14	29.01	2.20	5.90
	SL (cm)	66	3.22±0.13	33.35	1.70	7.80
	KL (cm)	66	5.99±0.14	18.46	4.00	8.10
	BL (cm)	66	10.46±0.32	25.16	6.70	14.30

Table 2. Descriptive statistics for growth traits at 8 weeks of age of three lines of turkey.

Genotype	Trait	n	Mean±SE (4 replicates/treatment)	CV (%)	Minimum	Maximum
B	BW (g)	85	692±19.41	25.85	475.00	1300.00
	BrWt (cm)	85	7.31±0.07	8.83	6.00	8.60
	DSL (cm)	85	6.79±0.06	7.74	5.70	7.90
	SL (cm)	85	5.76±0.06	9.13	5.00	6.70
	KL (cm)	85	10.68±0.21	18.38	8.30	13.20
	BL (cm)	85	17.85±0.19	10.05	14.40	20.70
Br	BW (g)	59	807.29±25.97	24.71	550.00	1150.00
	BrWt (cm)	59	9.48±0.20	16.05	7.60	11.80
	DSL (cm)	59	7.04±0.08	8.95	5.80	8.60
	SL (cm)	59	5.78±0.07	9.26	5.10	6.90
	KL (cm)	59	11.27±0.21	14.61	9.00	15.10
	BL (cm)	59	18.77±0.28	11.35	15.90	22.30
W	BW (g)	66	908.33±24.25	21.69	600.00	1200.00
	BrWt (cm)	66	9.54±0.20	16.72	6.60	11.60
	DSL (cm)	66	6.66±0.08	9.97	5.00	7.90
	SL (cm)	66	5.65±0.16	23.04	4.40	15.10
	KL (cm)	66	11.42±0.20	14.05	9.00	14.10
	BL (cm)	66	18.94±0.26	11.22	15.80	22.30

Shank Length (SL) which is the distance from the digit-3 joint tarsometarsus to the hock joint, Keel Length (KL) taken as the length of the cartilaginous keel bone or metasternum while the Body Length (BL) was measured as length of the body from the base of the comb to the base of the tail around the uropigial gland. All LBMs were measured with a flexible tape rule in cm as described by Ibe and Nwachukwu (1988).

Experimental design and statistical analysis Data obtained was first analyzed using the descriptive statistics procedure of SAS (1999). The GLM procedure of SAS (1999) was later used to test for significant means; where significance was established, Duncan multiple range test was used to separate the means (Gomez and Gomez, 1984).

The model used was as specified below:

$Y_{ijk} = \mu + B_i + P_j + (BP)_{ij} + e_{ijk}$

Where,

Y_{ijk} = The parameter of interest

μ = Overall mean for the parameter of interest

B_i = Fixed effect of i^{th} Sex (j = 1-2)

P_j = Fixed effect of j^{th} genotype (1-3)

$(BP)_{ij}$ = Interaction effect of i^{th} sex and j^{th} genotype.

$e_{ijk \sim iid}$ $N(0, \sigma^2)$ = errors normally, independently and identically distributed around zero mean and constant variance.

Table 3. Descriptive statistics for growth traits at 12 weeks of age of three lines of turkey.

Genotype	Trait	n	Mean±SE (4 replicates/treatment)	CV (%)	Minimum	Maximum
B	BW (Kg)	82	1490.00±40.00	22.13	950	2300
	BrWt (cm)	82	13.81±0.24	15.50	10.00	16.60
	DSL (cm)	82	8.83±0.06	6.22	7.70	9.90
	SL (cm)	82	7.83±0.06	7.00	7.00	8.80
	KL (cm)	82	17.83±0.22	11.33	15.00	20.20
	BL (cm)	82	23.73±0.21	8.07	20.40	27.80
Br	BW (Kg)	57	1650.34±32.00	12.22	1200	2000
	BrWt (cm)	57	14.91±0.21	10.41	12.00	16.80
	DSL (cm)	57	9.20±0.09	7.71	7.80	10.80
	SL (cm)	57	7.94±0.07	7.03	7.10	8.90
	KL (cm)	57	17.77±0.23	9.70	13.40	21.00
	BL (cm)	57	27.34±0.28	7.70	24.20	30.30
W	BW (Kg)	64	1700.41±31.00	12.81	1300	2000
	BrWt (cm)	64	14.67±0.20	10.71	12.20	16.60
	DSL (cm)	64	8.75±0.08	7.32	7.00	9.90
	SL (cm)	64	7.58±0.07	7.45	6.40	8.50
	KL (cm)	64	17.41±0.27	12.29	5.90	20.10
	BL (cm)	64	27.22±0.26	7.61	24.00	30.20

Table 4. Least squares means and standard errors for the effects of genotype and sex on bodyweight (g) of three lines of turkey.

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	190.09	175.75	181.65	11.48	196.72^a	167.78^b	8.50
8	692.18^c	807.29^b	908.33^a	24.25	861.33^a	718.12^b	18.50
12	1485.06^b	1645.61^a	1695.78^a	32.00	1720.91^a	1465.96^b	25.00

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

Table 5. Least squares means and standard errors for the effects of genotype and sex on body length (cm).

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	10.60	10.63	10.46	0.31	10.75	10.34	0.25
8	17.85^b	18.77^a	18.94^a	0.24	18.69	18.19	0.19
12	23.73^b	27.34^a	27.22^a	0.23	26.65^a	25.00^b	0.25

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

Table 6. Least squares means and standard errors for the effects of genotype and sex on breastwidth (cm).

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	4.00	3.81	3.80	0.16	3.91	3.86	0.12
8	7.31^b	9.48^a	9.54^a	0.16	8.91^a	8.31^b	0.16
12	13.81^b	14.91^a	14.67^a	0.22	14.81^a	13.95^b	0.18

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

A preliminary analysis showed that hatch batch effect was not significant. In addition, there was no significant interaction effect of sex and genotype on the parameters measured. It was concluded that hatch batch and sex x genotype interaction effects are probably not an important source of variation in this data.

Table 7. Least squares means and standard errors for the effects of genotype and sex on drumstick length (cm).

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	4.09	3.97	4.03	0.16	4.10	3.98	0.13
8	6.79^{b}	7.04^{a}	6.66^{b}	0.07	6.93^{a}	6.70^{b}	0.06
12	8.83^{b}	9.20^{a}	8.75^{b}	0.08	9.13^{a}	8.68^{b}	0.06

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

Table 8. Least squares means and standard errors for the effects of genotype and sex on Keel length (cm).

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	5.84	5.92	5.99	0.14	6.03	5.77	0.11
8	10.68^{b}	11.27^{ab}	11.42^{a}	0.21	11.14	11.02	0.17
12	17.83	17.77	17.41	0.23	17.93	17.41	0.19

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

Table 9. Least squares means and standard errors for the effects of genotype and sex on Shank length (cm).

AGE IN WEEKS	GENOTYPE				SEX		
	B	Br	W	SEM	Male	Female	SEM
4	3.30	3.22	3.22	0.13	3.32	3.18	0.09
8	5.76	5.78	5.65	0.10	5.81	5.66	0.07
12	7.83^{a}	7.94^{a}	7.58^{b}	0.06	7.93^{a}	7.63^{b}	0.05

$^{a, b, c}$ Means in the same row within variable group with different superscripts are significantly different (P<0.05).

Table 10. Least square means and SE of the effect of genotype on mortality rate.

Genotype	Number	Least Significant Means (%) ±SE
B	9	7.92±0.11
Br	7	4.2±0.02
W	5	3.3±0.01

Results and discussion

The performance of the black (B), bronze (Br) and white (W) lines of turkeys with respect to bodyweight, linear body measurements and mortalities are presented in tables 1-10. The descriptive statistics of the data generated in terms of genotypic performance at 4, 8 and 12 weeks of age are shown in tables 1-3. The mean, standard error, number of observation, coefficient of variation and range are presented for all the traits measured. At 4 weeks (table 1), the bodyweight values ranged from 75g to 400g with a mean and SE of 190.09 and 11.48 respectively for line B, 75g to 375g with a mean and SE of175.75 and 11.88 respectively for line Br, and 50g to 350g with mean and SE of 181.65 and 11.22 respectively for line W. At week 8 (table 2), the bodyweight values ranged from 475g to 1300g with a mean and SE of 692 and 19.41 respectively for line B, 550g to 1150g with mean and SE of 807.29 and 25.97 respectively for Br and 600g to 1200g with mean and SE of 908 and 24.25 respectively for line W. At week 12 (table 3) the bodyweight values ranged from 950g to 2300g with a mean and SE of 1490 and 40.00 respectively for line B, 1200g to 2000g with mean and SE of 1650.34 and 32.00 respectively for Br and 1300g to 2000g with mean and SE of1700 and 31.00 respectively for line W. The coefficient of variation for most traits was high at all ages except at week 12 (table 3) where DSL recorded 6.22% in line B being the least. Most of the high CV values indicated a high variability in the lines for all the traits measured, particularly in week 4.

The results of the mean separation (Tables 4-9) showed significant differences in bodyweight and LBMs. Bodyweight and LBMs increased with increase in age of the birds in all the genotypes. Bodyweight in W lines was significantly (P<0.05) higher than that of B and Br lines in all the weeks except at week 4 where no significant difference (P>0.05) between the three lines. The mean bodyweight ranged from 190.09g, 175.75g and 181.65g in week 4 for B, Br and W lines to 1485.06g, 1645.61g and 1695.78g at 12 weeks of age respectively. Body length was also significantly ($p<0.05$) affected by genotype with increase in age of birds except at week 4. Body length was significantly higher ($p<0.05$) in W and Br lines than B lines at 8 and 12 weeks, while at 4weeks there was no significant ($p>0.05$) difference between the 3 lines. Breast width was significantly ($p<0.05$) affected by genotype as well as increase in age of birds. The W and Br lines were significantly ($p<0.05$) higher in breast width than B genotypes while there was no significance ($p>0.05$) at 4weeks between the 3 lines. Keel length also manifested significant effect on genotype at 8weeks, where W lines were significantly higher than Br and B lines respectively. However there was no significant ($p>0.05$) effect at 4 and 2 weeks of age. Meanwhile, drumstick length showed significant effect at 8 and 12 weeks of age with Br lines being significantly higher ($p<0.05$) than W and B lines, while no significance ($p>0.05$) was recorded at 4weeks. Shank length showed significant difference ($p<0.05$) only at 12 weeks, with B and Br lines being higher than white lines.

Analysis of the results also showed significant sex differences ($p<0.05$) in bodyweight, body length, shank length, breast width and drumstick length; whereas no significant sex effect ($p>0.05$) was found in keel length. Body weight showed significant male effect ($p<0.05$) at 4, 8 and 12 weeks, body length only at 12weeks, breast width and drumstick length at 8 and 12 weeks while shank length at 12 weeks only. In all, males were significantly ($p<0.05$) higher than females. Also, the analysis of the results showed no significant mortality ($p>0.05$) effect on the 3 genotypes, although the B lines recorded the highest mortality, followed by Br lines while the W lines showed least mortality.

Discussions

The differences and superiority exhibited by the W line and sometimes the Br lines suggests that they had a better growth potential as well as better adaptability than the B lines. This could be due to the inherent plumage colour which exposes them to less heat stress than the B lines. This could be due to the findings of Ibe (1990) that productive adaptability itself is a phenomenon whereby and animal gives acceptable level of production in a stressed environment. This is also buttressed by the mortality level recorded by the B lines, though not significant, but numerically higher than the other lines. This suggests that turkey production particularly the backyard small scale production could favour the use of W lines in terms of growth traits. The implication of these attributes for the W and Br lines is that they could be further screened as possible candidates for tropical turkey broiler breed development. Hence, more vigorous crossbreeding, selection and improvement of the local turkey would need to be pursued to improve on growth potential in these strains.

The result from this research on sex effect revealed that male turkeys of all the lines (B, Br and W genotypes) showed remarkable and better growth performance than their female counterparts for all traits and ages except for bodyweight at week 4. These results revealed that males generally had

Higher values in weight and in other body parameters which are in accordance with the report of Garcia *et al* (1991) and Ikeobi *et al* (1995), that sexual dimorphism was in favour of males in the performance of strains of birds studied. The male turkeys used for this study exhibited sexual dimorphism right from day old. Fayeye *et al.*, (2006) attributed this difference to genetic effect of sex which arises from the male physiological activities. It has also been reported that sex differences were usually due to differences in hormonal profile, aggressiveness and dominance especially when both sexes are reared together (Ibe and Nwosu, 1999).

Mortality, was below 10% in all genetic groups and was higher among B lines (7.92±0.11), followed by the Br lines (4.2±0.02) and finally that of the W lines (3.3±0.01). The low rate of mortality which is below 10% mark is due to the adaptability of the lines to the tropical environment since they had been majorly selected based on their ability to survive in the ecotype, yet amongst the 3 lines, some exhibited more mortality than others though not significant. The high level of mortality incurred was in accordance with the report of Joe and Raymond (2005) that heat stress could result in significant losses to producers with all types of poultry, the most obvious loss of which was due to mortality.

Conclusion

Variations in the genetic make-up of the turkey as influenced by the plumage colour accounts for the observed differences in growth and body measurements in the 3 lines B, Br and W lines studied. The highest value of body weight and other LBMs were observed in the W lines, followed by the Br lines and then the B lines. Hence, W lines performed relatively better in terms of growth and growth related measurements on the live birds.

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