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BODY MASS INDEX AND HETEROSIS OF BODY WEIGHT AND MORPHOMETRIC TRAITS OF PURE AND CROSSBRED TURKEY POULTS

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ABSTRACT

Records of 374 turkey poults belonging to four genotypes were used to determine body mass index (BMI) in pure and crossbred turkeys and F_1heterosis for body weight and morphometric traits in the reciprocal crossbred poults. The body weights of poults were taken weekly, from 0 to 20 weeks. Morphometric traits (Body length, Shank length, Thigh length, Keel length, Breast Girth and Wing length) were measured at 1, 4, 8, 12, 16 and 20 weeks of age.The results indicate a general increase in the BMI of poults with age in the four genotypes. The Nicholas White x Nigerian local (NWxNL) poults had significantly lower ($P<0.05$) BMI compared with purebred Nicholas White x Nicholas White (NWxNW). It was also lower in BMI than the reciprocal crossbred poults at 4, 8, 12, 16 and 20 weeks of age. Negative F_1heterosis value of -1.60 to -32.54 percent and -2.65 to -31.75 percent were obtained for body weight in crossbred NWxNL and NLxNW, respectively.The values for F_1heterosis for morphometric traits were generally low and negative for the investigated morphometric traits. However, a high coefficient of variation was obtained for heterosis for body weight of poults at 4-14 weeks old. It is recommended that crossbreeding programme involving the Nigerian local turkey should be preceded by an initial selection in the local population. This would help the breeder to take advantage of the additive genes for body weight and morphometric traits in the Nigerian local turkey. Direction of cross = (♂x ♀). Data collected were subjected to the General Linear Model of SPSS to obtain the mean value used in estimating the body mass index.

Key words: Coefficient of variability, Crossbreeding, Nicholas White, Nigerian local, Heterosis

INTRODUCTION

Quantitative traits such as morphometric measurements and body mass index are polygenic or multifactorial traits which are produced due to the effects of two or more genes, and the environment (Fayeye, 2014). The genetic component of quantitative traits may be due to additive and non-additive genetic variation (Williams *et al.*, 2002). Crossbreeding has been one of the tools for exploitation of genetic variation and hybrid vigour by combination of different important characteristics of each breed (Hanafi and Iraqi, 2001). Heterosis obtained through crossbreeding is proportional to the degree of heterozygousity of the crosses (Sheridan, 1981) and the magnitude is inversely related to the degree of genetic resemblance between parental populations (Willams and Pollak, 1985). However, gain made in heterosis through crossbreeding does not provide a comprehensive overview of bird's physiological health and overall well-being. For instance, a bird with good body weight but with excess fat will rank low in health status, meat quality and egg production (Shahin and ElAzeem, 2006). Body Mass Index (BMI) measured as a ratio of body weight and height or length (Kg/m^2 or g/cm^2) is used to obtain information about body fat and the health status of different livestock species. Generally, an increase in the BMI is synonymous with increase in fat content (Mendes *et al.*,

2007). Nigeria local turkeys, though well adapted to prevailing local conditions (Nwakpu *et al.,* 1999) are characterised by small body size (Ilori *et al.,* 2010). The exotic strains of turkey have better performance in body weight, but they have been found to have problem of adaptation to Nigerian local environment (Ilori *et al.,* 2009). The exploitation of good adaptive features and heterosis would be more efficient through inter mating of the local turkey with high performance exotic breeds. Nicholas White turkeys were averagely better when compared to other exotic breeds (Roberson *et al.,* 2003). Therefore the aims of this study were to determine body mass index in pure and crossbred (Nigeria Local x Nicholas White) turkeys and F_1heterosis for body weight and morphometric traits in crossbred poults.

MATERIALS AND METHODS

Management of Experimental Animals

A total of 374 turkey poults belonging to four genotypes: 58 Commercial Nicholas White x Nicholas White (NWxNW); 117 Commercial Nicholas White x Nigerian Local (NWxNL); 72 Nigerian Local x Commercial Nicholas White (NLxNW); and 127 Nigerian Local x Nigerian Local, (NLxNL) were hatched from a locally fabricated kerosene incubator (1000 egg capacity) in 2014. The birds were tagged with wing bands and were raised in deep litter brooders situated in close-window rooms. 200 Watt bulbs were used to supply warmth and to supplement natural daylight to about 23 hours of light daily. The poults were fed on starter mash (28% CP, 3100KcalME/Kg) for six weeks and grower mash (24% CP, 3000 KcalME/Kg) from 7 –20 weeks of age. The study was carried out in Ilorin metropolis. Ilorin is located between the rainforest of the Southwest and Savannah grassland of Northern Nigeria. It bears the co-ordinates of 8° 30' 0" North, 4° 33' 0" East and lies on an altitude of 305m, 1001' above sea level. Its annual rainfall, relative humidity and day temperature are 600-1200 mm, 65-80% and 33-37^0 C, respectively

Data collection

The body weight of poults was taken at day old and at 1, 4, 8, 12, 16 and 20 weeks of age. Body Mass index (BMI) was derived by dividing Bodyweight expressed in gram units by the square of body length expressed in cm units, and expressed in Kg/m^2 units. Morphometric body measurements were taken at 1, 4, 8, 12, 16 and 20 weeks of age using a tape rule. 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 in centimeter (cm). Shank length (SL) was taken as the distance from the hock joint to the tarsometarsus digit joint in cm. Thigh length (TL) taken as the distance between the hock joint and the pelvic joint in cm. Keel length (KL) in cm was measured as the length of the cartilaginous keel bone or metasternum. The Breast Girth (BG) was measured as the region of the largest breast expansion for a bird that was positioned ventrally in cm. Wing length (WL) was measured when the wing was stretched and the measurement taken from the humorus – coracoids junction to the tip of the digit in cm. These morphometric traits were measured as described by Olawunmi *et al.* (2008). Shank thickness (ST) was measured with the aid of vernier calliper (caliberated in mm) as the diameter of the tarso – metarsus junction below the spur.

Statistical analysis

The data obtained were expressed in mean values for BMI using the General Linear Model of SPSS (2011). Significant means were separated using Duncan's New Multiple Range Test of SPSS (2011) at probability level of 5%. F_1Heterosis for each type of cross was estimated as the

average of the mean of the two way crosses minus the average of the means of the pure strains involved in the crosses as follows:

Heterosis H (NL x NW) = [(NL x NW) – {(NL x NL) + (NW x NW)}/2]
Heterosis H (NW xNL) = [(NW x NL) – {(NL xN L) + (NW x NW)}/2]

(NL x NW)= unit average for body weight or morphometric trait in NL x NW crossbred.

(NW x NL)= unit average for body weight or morphometric trait in NW x NL crossbred.

Pure bred mean = {(NL xN L) + (NW x NW)}/2

Coefficient of variation = $\left[\frac{\{(\text{NL xN L})+ (\text{NW x NW})\}}{2} - \frac{2\text{C}}{\{(\text{NL x NL})+ (\text{NW x NW})\}}\right] \times 100$
C = NL x NW or NW x NL

Percentage heterosis was calculated as observed heterosis divided by the average of the pure breeds, multiply by 100.

i. e. Heterosis percentage H% = $\frac{H}{\{(\text{NL xN L}) + (\text{NW x NW})\}/2}$ 100

Body Mass Index (BMI); was be taken as ratio of body weight to the square of body lenght
BMI = $\frac{Body\ weight\ (g)}{[Body\ lenght(cm)]^2}$ (Mendes *et. al*., 2007)
Mean F_1heterosis for each trait was estimated as the average of the means of all crosses minus the average of the means of the two pure strains.

RESULTS

The results of Body Mass Index (BMI) of pure and crossbred turkey are shown in Table 1. The results indicate a general increase in the BMI of poults with age in the four genotypes. The NL x NL poults had significantly lower (P<0.05) BMI compared with purebred NW xNW. It was also lower in BMI than the reciprocal crossbred poults at 4, 8, 12, 16 and 20 weeks of age.

Table 1: Mean (±SEM) Body mass index (BMI) of pure and crossbred turkey poults at 1, 4, 8, 12, 16 and 20 weeks of age

Age (week)	NLxNL (127)	NWxNL (117)	NLxNW (72)	NWxNW (58)
1	0.97±0.06	0.97±0.07	0.95±0.92	1.07±0.91
4	1.00±0.12^{d}	1.04±0.10^{c}	1.12±0.11^{b}	1.58±0.23^{a}
8	1.39±0.13^{c}	1.59±0.11^{b}	1.61±0.22^{b}	2.88±0.32^{a}
12	1.53±0.11^{c}	1.79±0.11^{b}	1.75±0.12^{b}	2.52±0.31^{a}
16	1.51±0.13^{c}	1.64±0.12^{b}	1.66±0.10^{b}	2.31±0.41^{a}
20	1.64±0.12^{c}	1.76±0.13^{b}	1.72±0.11^{b}	2.03±0.34^{a}

a,b,c,dMmeans in the same row with different superscripts are statistically different (P<0.05)

The results of F_1heterosis for body weight in crossbred poults that were produced from reciprocal crossing of Commercial Nicholas White and an experimental Nigerian Local turkey population is presented in Table 2. Negative F_1heterosis value of -1.60 to -32.54 percent and -

2.65 to -31.75 percent were obtained for body weight in crossbred NWxNL and NLxNW, respectively. A high within breed coefficient of variation (CV) or relative standard deviation was observed in 4-14 weeks old crossbred poults (21.37-28.38 and 17.43-27.55 for NWxNL and NLxNW poults, respectively).

Table 2: Heterosis for body weight in 0-20 weeks old Nicholas White x Nigerian Local reciprocal crossbred turkeys

Trait	Ages	NWxNL			NLxNW			Pooled	
	Weeks	H	H %	c.v	H	H %	c.v	H	c.v
Body	0	-2.01	-4.36	4.36	-2.68	-5.87	5.81	-2.35	5.07
weight	1	-1.40	-1.60	1.60	-2.32	-2.65	2.65	-1.86	2.13
	4	-93.56	-24.01	24.01	-67.90	-23.45	17.43	-80.73	20.72
	8	-537.74	-32.54	28.38	-546.34	-31.75	27.55	-453.04	27.97
	12	-583.72	-23.54	23.54	-589.92	-23.79	23.79	-586.82	23.66
	16	-803.89	-24.41	21.37	-699.48	-21.24	21.24	-701.69	21.31
	20	-390.36	-9.79	9.97	-317.21	-7.96	7.96	-353.79	8.89

H is mean heterosis, c.v is coefficient of variation, H% is percentage heterosis, NW is Nicholas White, NL is Nigeria Local, x cross.

The results of F_1heterosis for morphometric traits in 1, 4 and 8 weeks old Nicholas White x Nigerian Local reciprocal crossbred turkeys is presented in Table 3. The values for F_1heterosis were generally low and negative for the investigated morphometric traits in 1, 4 and 8 weeks old crossbred poults. The CV was generally low except for keel length and breast girth.

The results of F_1heterosis for morphometric traits in 12, 16 and 20 weeks old Nicholas White x Nigerian Local reciprocal crossbred turkeys is presented in Table 4. The values for F_1heterosis were generally low and negative for the investigated morphometric traits in 12, 16 and 20 weeks crossbred poults. Low positive CV (3.53- 8.33) was observed in 12 to 16 weeks old crossbred poults.

DISCUSSION

Generally, an increase in the BMI is synonymous with increase in fat content (Mehmet *et. al.*, 2007). The lower BMI of Nigerian Local (NL) and crossbred poults suggest that they have lower fat contents compared to purebred Nicholas White (NW). It further suggests better health status for the purebred NL and crossbred poults. Excessive fattening is undesirable for both bird health and meat quality (Shahin and El Azeem, 2005; Shahin and El Azeem, 2006). According to Shahin and El Azeem (2006), birds with good body weight but with excess fat will rank low in health status, meat quality and egg production. The higher BMI of purebred NW is expected because they have been produced from long time selection and crossbreeding programme.

According to Griffin (1996) and Zerehdaran *et al.* (2005), the longtime intensive selection and crossbreeding of broiler chickens for increased growth rate was accompanied by a number of negative consequences, including an increase in fat deposition. Crossbreeding of NW with Nigerian local turkey to produce poults with decreased fat content and BMI is therefore desirable.

Body mass index and heterosis of body weight and orphometric traits

Table 3: F1 Heterosis for morphometric traits in 1, 4 and 8 weeks old Nicholas White x Nigerian Local reciprocal crossbred turkeys

Traits	Ages	NWxNL			NLxNW			Pooled	
	Weeks	H	H %	c.v	H	H %	c.v	H %	c.v
Body length	1	0.14	1.51	- 1.53	0.18	1.94	- 1.94	0.18	- 1.94
	4	0.24	1.44	- 1.44	0.27	1.62	- 1.62	0.26	- 1.56
	8	- 0.27	- 1.00	0.99	- 0.26	0.95	0.95	-0.27	0.96
Shank	1	- 0.10	- 2.70	2.70	- 0.13	- 3.50	3.50	- 0.12	2.97
length	4	0.17	2.65	-2.65	0.17	2.65	- 2.65	0.17	-2.65
	8	- 0.70	-6.60	3.68	- 0.39	- 3.68	3.68	-0.54	5.05
Thigh length	1	0.34	7.01	- 7.10	0.35	7.22	-7.22	0.35	- 7.22
	4	- 0.32	- 3.37	3.37	- 0.32	- 3.48	3.48	- 0.32	3.37
	8	- 0.52	- 3.99	3.99	- 0.61	- 4.68	4.68	- 0.57	4.30
Breast girth	1	- 0.08	- 0.78	0.78	- 0.01	- 0.10	0.10	- 0.07	0.68
	4	- 0.64	- 3.50	3.50	- 0.61	-3.37	3.37	- 0.63	3.45
	8	-2.42	- 8.38	8.38	- 2.35	-8.16	8.16	- 2.39	8.26
Keel lenth	1	- 0.52	-14.77	14.77	- 0.50	- 14.21	14.21	- 0.51	14.49
	4	- 0.51	- 7.86	7.86	- 0.46	- 7.09	7.09	- 0.49	7.40
	8	- 0.45	- 4.96	4.96	- 0.48	- 5.29	5.29	- 0.47	5.08
Wing span	1	0.07	0.72	-0.72	0.06	0.62	- 0.62	0.07	-0.73
	4	- 0.68	- 3.13	3.13	- 0.69	- 3.17	3.17	- 0.69	3.17
	8	- 0.57	- 1.69	1.69	- 0.77	- 2.28	2.28	- 0.67	1.98
Wing length	1	- 0.10	- 2.12	2.12	- 0.11	- 2.33	2.33	- 0.10	2.12
	4	- 0.19	- 2.07	2.07	- 0.18	- 1.96	1.96	- 0.18	1.96
	8	- 0.25	- 1.74	1.74	- 0.33	- 2.30	2.30	- 0.29	2.02
Shank	1	- 0.01	-2.17	2.17	- 0.01	- 2.17	2.17	- 0.01	2.17
thickness	4	- 0.02	-5.00	5.00	- 0.02	- 5.00	5.00	- 0.02	5.00
	8	- 0.06	-0.35	10.35	- 0.02	- 3.45	3.45	- 0.04	6.90

H is mean heterosis, c.v is coefficient of variation, H% is percentage heterosis, NW is Nicholas White, NL is Nigeria Local, x cross.

Table 4: Heterosis for morphometric traits in 12, 16 and 20 weeks old Nicholas White x Nigerian Local reciprocal crossbred turkeys

Traits	Ages	NWxNL			NLxNW			Pooled	
	Weeks	H	H %	c.v	H	H %	c.v	H %	c.v
Body	12	- 0.83	- 2.48	2.48	- 0.45	- 1.35	1.35	- 0.64	1.92
length	16	0.77	1.98	- 1.98	0.57	1.47	- 1.47	0.67	- 1.72
	20	0.43	0.96	- 0.96	0.15	0.34	- 0.34	0.29	- 0.65
Shank	12	- 0.47	- 3.82	3.86	- 0.60	-4.93	4.93	-0.54	4.35
length	16	0.24	1.59	- 1.59	0.04	0.27	0.27	0.14	- 0.93
	20	- 0.37	- 2.19	2.19	- 0.39	-2.31	2.31	- 0.38	2.25
Thigh	12	- 0.52	- 3.25	3.25	- 0.48	-3.00	3.00	- 0.50	3.13
length	16	0.30	1.62	- 1.62	0.25	1.36	- 1.36	0.28	- 1.52
	20	0.67	3.25	-3.25	0.75	3.64	- 3.64	0.71	- 3.45
Breast	12	- 1.26	- 3.57	3.57	- 1.23	- 3.50	3.50	- 1.25	3.53
girth	16	- 2.68	- 6.29	6.29	- 2.12	-2.12	4.97	- 2.40	5.63
	20	- 2.54	- 5.27	5.27	- 2.57	-5.21	5.21	- 2.53	5.25
Keel	12	- 0.66	- 5.57	5.57	- 0.60	- 5.06	5.06	- 0.63	5.32
lenth	16	- 0.80	- 5.52	5.52	- 0.79	- 5.46	5.46	- 0.80	5.49
	20	- 0.03	- 0.19	0.19	0.06	0.38	-0.38	- 0.02	0.09
Wing	12	- 1.31	- 3.29	3.29	- 1.39	- 3.49	3.49	- 1.35	3.39
span	16	- 0.31	- 0.69	0.69	- 0.59	- 1.32	1.32	- 0.45	1.01
	20	- 1.73	- 3.30	3.30	- 1.80	- 3.44	3.44	- 1.77	3.37
Wing	12	- 0.53	- 2.98	2.98	-0.67	- 3.77	3.77	-0.60	3.37
length	16	- 0.03	- 0.15	0.15	- 0.36	-1.80	1.80	- 0.20	0.95
	20	0.09	0.37	-0.37	- 0.44	-1.83	1.83	- 0.18	0.75
Shank	12	- 0.06	- 7.69	7.69	- 0.05	- 6.41	6.41	- 0.05	6.41
thickness	16	- 0.07	- 7.29	7.29	- 0.09	-9.38	9.38	- 0.08	8.33
	20	- 0.07	- 6.14	6.14	- 0.07	-6.14	6.14	- 0.07	6.14

H is mean heterosis, c.v is coefficient of variation, H% is percentage heterosis, NW is Nicholas White, NL is Nigeria Local, x cross.

The present results is in contrast with the report of Emmerson *et al.* (1991) thatheterosis from a crossbreeding trial of a commercial sire line of turkey and an experimental population selected solely for increased 16-wk BWshowed that both F_1 and F_2poult crosses demonstrated improved growth performance as indicated by heterosis for 16 and 20weeks bodyweight. The difference between the present report and that of Emmerson *et al.* (1991) may be due to the differences in the birds used. For instance, the experimental population in this study have not been previously selected for body weight like the one used by Emmerson *et al.* (1991). Never-the-less, negative heterosis is not peculiar with this study. For instance, Emmerson *et al.* (1991) observed negative heterosis for body weight at maturity in their crossbreeding trial of a commercial sire line of turkey and an experimental population. The direction and magnitude of the F_1heterosis suggest that crossbreeding was unfavorable in improving the body weight of Nigerian local turkey. The high CV for body weight poults from 4-14 weeks old crossbred NWxNL and NLxNW suggest that initial selection of the parent population for improved body weight would achieve better result.

CONCLUSION

It is concluded from this study that crossbreedingcould help to improve the body mass index and the health status of commercial Nicholas White turkey. However, the direction and magnitude of F_1heterosis suggest that crossbreeding was unfavorable in improving the body

weight and morphometric traits of Nigerian local turkey. Based on the high coefficient of variability for body weight of poults from 4-14 weeks old, it is recommended that crossbreeding programme involving the Nigerian local turkey should be preceded by an initial selection in the local population. This would help the breeder to take advantage of the additive genes for body weight and morphometric traits in the Nigerian local turkey.

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