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Evaluation of Fertility and Hatchability Traits of Locally-Adapted Turkey Strains in a Tropical Rain-Forest Zone of Nigeria

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Abstract: Data on 270 eggs from Black (90), White (90) and Spotted (90) plumaged strains of laying locally-adapted Turkey hens were used to evaluate their fertility and hatchability traits as well as estimate phenotypic correlations (r_p) among the traits. The fertility and hatchability traits studied were Average Egg Weight (AEWT), Fertility (FER), Hatchability on Fertile Eggs (HFE), Hatchability on Eggs Set (HSE), Dead In Germ (DIG), Dead In Shell (DIS), Normal Poults (NP), Abnormal Poults (AP) and Poult Weight at Hatch (PWT). Apart from AP and PWT, strain had no significant ($p>0.05$) effect on the other hatching traits considered. AP was significantly ($p<0.05$) higher in the White strain (21.21±6.21) and least in the Black plumage strain (10.32±2.86). Black strain had significantly ($p<0.05$) highest PWT (64.56±4.11) compared to the White (53.40±1.76) and Spotted (52.11±1.30) which were statistically similar. The r_p estimates among the hatching traits for the 3 plumage strains followed a similar trend and estimates were moderately or highly significant ($p<0.05$; $p<0.01$) for most of the traits. A positive significant association was obtained among AWET, HFE, HSE, NP and PWT. The r_p values ranged between 0.27-0.61 (Black), 0.38-0.90 (White) and 0.34-0.91 (Spotted). FER, HFE, HSE, NP and PWT were also significant and positively correlated. AP, DIG and DIS had significant positive estimates in all the 3 strains: r_p = 0.58 and 0.29 (Black), 0.37 and 0.33 (White) and 0.35 and 0.68 (Spotted), respectively. DIG, DIS and AP were significantly and negatively correlated with AWET, PWT, fertility and hatchability. The r_p estimate between NP and AP was highly significant ($p<0.01$) and perfect (r_p = -1.00). The result of this study suggests that fertility and hatchability traits are influenced more by non-genetic factors such as management and environment. The r_p estimates also confirmed that fertility and hatchability are interdependent traits that could be improved phenotypically by selecting either of the traits.

Key words: Fertility, hatchability, strain, phenotypic correlation, Turkey

INTRODUCTION

Turkey (*Meleagris gallopavo*) is a well known domestic bird with dwindling commercial operations in the Nigerian market as compared to the chicken. However, in recent times, there seems to be an upsurge of interest among farmers in the rearing of Turkey birds. This implies that the supply of healthy and large numbers of poults is very important for the success of the Turkey production chain as in other poultry species. The foremost objective of the Turkey breeder therefore is to secure the maximum number of quality poults from eggs set for hatching. Supply is however dependent on the fertility and hatching Turkey eggs.

Fertility and hatchability are the major determinants of profitability in hatchery enterprises (Peters *et al*., 2008). These traits have also been considered as major parameters of reproductive performance which are most sensitive to environmental and genetic influences (Stromberg, 1975). Islam *et al*. (2002) reported that fertility and hatchability are interrelated heritable traits that vary among breeds, strains, varieties and individuals within breeds, strains and varieties. Studies investigating the fertility and hatchability performance of Turkeys are highly scant in literature. Etuk (2008) reported paucity of reliable information on the productive performance of the Nigerian local Turkey strains.

Ozcelik *et al*. (2009) observed that low egg fertility and hatchability constitute a major problem in Turkey production. In corroboration, Sapp *et al*. (2004) reported low heritability estimates (0.06-0.13) for fertility and hatchability traits in chicken. This could be more pronounced in local strains as it has been noted that performance are generally higher in exotic breeds when

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compared to local ones. However, the local strains are adaptive to their environment. According to Ibe (1990), productive adaptability is a phenomenon whereby an animal gives acceptable level of production in a stressed environment. Such locally-adapted strains therefore have great potential for supply of cheap meat and eggs which could help to improve the animal protein intake of average Nigerians.

It then follows that genetic and/or phenotypic improvement of the Nigerian local Turkey strain is important. Such improvement is dependent on the knowledge of phenotypic as well as genetic associations among economically important characters (Ubani *et al*., 2010; Kosum *et al*., 2004). This research therefore was designed to compare fertility and hatchability traits among three local Turkey strains and to estimate their phenotypic associations.

MATERIALS AND METHODS

Study location: This study was conducted at the Poultry Unit of Michael Okpara University of Agriculture, Umudike Teaching and Research farm. Umudike is located on latitutde 05°29'N and longitude 07°33'E and at approximately 122 m above sea level. It has minimum and maximum daily temperature ranges of 20-26 and 27-36°C, respectively with relative humidity of 57-91% and annual rainfall of 2177 mm.

Experimental birds and their management: Fourty five adult local Turkey strains comprising of 12 hens and 9 toms each of Black, White and Spotted strain, respectively were used to generate the eggs that were evaluated. The birds were reared on deep litter breeder pens, housing each strain with their respective males and females to allow natural mating. They were fed *ad libitum* on a compounded laying mash of 14% CP and 2850 kcal kg ME^{-1}. Clean drinking water was also provided *ad libitum*. The study lasted for 10 weeks.

Mating design and data collection: The matings were as follows: pure crosses Black x Black (B×B), White x White (W×W) and Spotted x Spotted (S×S) in a ratio of 1 tom: 3 hens, with 3 replicates for each strain. A total of 270 eggs were collected (Table 1) and used for the study.

Table 1: Mating scheme and total numbers of eggs laid by the three Turkey strains

Mating scheme	No. of Turkey hens	No. of toms	Eggs
Black x Black	12	3	90
White x White	12	3	90
Spotted x Spotted	12	3	90
Total	36	9	270

Egg collection was done twice a day within the stipulated period, weighed and marked appropriately according the genetic group. The eggs were stored at approximately 17°C and 75% relative humidity prior to incubation, bulked and sent to a modern incubator in 5 batches. Eggs were candled on the 14th and 25th days of incubation to ascertain fertility and dead in germ, respectively. Hatched poults were collected on the 28th day and weighed. Unhatched eggs and pips were regarded as dead in shell while poorly feathered, lame, blind, open naveled and undersized were termed abnormal. Calculations were made on fertility, hatchability on fertile eggs, hatchability on eggs set, dead in germ, dead in shell, normal poults and poult weight as percentages (%). Average egg weight was calculated as indicated below:

$$\text{Average egg weight} = \frac{\text{Total egg weight}}{\text{Total number of eggs}} \times 100$$

Experimental design and statistical analysis: The experiment was a completely randomized design. Data generated from the 270 eggs were subjected to analysis of variance using SPSS (2004) analytical package. Significant means were detected using Duncan (1955)'s New Multiple Range test. The phenotypic correlations (r_p) among the traits for each of the strain were estimated using Pearson's Correlation Coefficient procedure of SPSS (2004). The model used for data analysis is as specified:

$$Y_{ijk} = S_i + B_j + (SB)_{ij} + e_{ijk}$$

Where:

Y_{ijk} = The trait of interest
μ = Overall mean
S_i = Fixed effect of ith strain (i = 1-3)
B_j = Fixed effect of jth batch (j = 1-5)
$(SB)_{ij}$ = Interaction effect of ith strain and jth batch
E_{ijk} = Random errors normally, independently and identically distributed around zero mean and constant variance (iind $(0, \delta^2)$)

A preliminary analysis showed that both batch and interaction effects were not significant on the parameters measured. It was therefore concluded that batch and strain x batch interaction effects are probably not an important source of variation in this data.

RESULTS

Strain effect on the hatching traits: The effect of strain (Table 2) on the various fertility and hatchability traits

Table 2: Means±standard errors of the various fertility and hatchability traits of the different Turkey strains

	Strain		
Traits	Black	White	Spotted
AWET (g)	88.12±2.720	80.87±0.80	79.45±4.94
FER (%)	83.62±2.950	72.06±8.33	77.34±3.44
HFE (%)	80.59±4.140	78.38±6.53	79.83±4.14
HSE (%)	66.83±4.380	57.97±6.42	62.46±3.38
DIG (%)	6.74±2.910	8.83±4.33	5.64±3.64
DIS (%)	18.16±3.350	21.23±6.28	20.79±4.35
NP (%)	92.14±5.100	78.79±6.21	87.10±4.09
AP (%)	10.32±2.860^{c}	21.21±6.21^{a}	12.82±4.06^{b}
PWT (%)	64.56±4.110^{a}	53.40±1.76^{b}	52.11±1.30^{b}

$^{a, b}$Means within the same row with different superscripts are significantly different ($p<0.05$). AWET = Average Egg Weight; FER = Fertility; HFE = Hatchability on Fertile Eggs; HSE = Htchability on Eggs Set; DIG = Dead In Germ; DIS = Dead In Shell; NP = Normal Poults, AP = Abnormal Poults and PWT = Poult Weight

Table 3: Phenotypic correlation coefficient of egg hatching traits for the Black plumage strain

	AWET	Percentage							
Traits	(g)	FER	HFE	HSE	DIG	DIS	NP	AP	PWT
AWET	1								
FER	-0.70**	1							
HFE	0.27*	0.70**	1						
HSE	0.59**	0.65**	0.86**	1					
DIG	-0.23*	-0.97**	-0.97**	-0.85**	1				
DIS	-0.79**	-0.84**	-0.70**	-0.74**	0.93**	1			
NP	0.38*	0.51**	0.27*	0.33*	-0.19	-0.27*	1		
AP	-0.70**	-0.44*	-0.46*	0.03^{NS}	0.58**	0.29	-1.00**	1	
PWT	0.61**	0.75**	0.45*	0.67**	-0.47*	-0.56**	0.45*	-0.17^{NS}	1

$^{*}p<0.05$; $^{**}p<0.01$, NS = Not Significant; AWET = Average Egg Weight; FER = Fertility; HFE = Hatchability on Fertile Eggs; HSE = Hatchability on Eggs Set; DIG = Dead In Germ; DIS = Dead In Shell; NP = Normal Poult; AP = Abnormal Poult and PWT = Poult Weight

Table 4: Phenotypic correlation coefficient of egg hatching traits for the White plumage strain

	AWET	Percentage							
Traits	(g)	FER	HFE	HSE	DIG	DIS	NP	AP	PWT
AWET	1								
FER	-0.42*	1							
HFE	0.90**	0.65**	1						
HSE	0.38*	0.85**	0.71**	1					
DIG	-0.54**	-0.83**	-0.82**	-0.98**	1				
DIS	-0.40*	-0.72**	-0.76**	-0.95**	0.94**	1			
NP	0.84**	0.49*	0.28*	0.26*	-0.37*	-0.33*	1		
AP	-0.84**	-0.49*	-0.78**	0.16^{NS}	0.37*	0.33*	-1.00**		
PWT	0.81**	0.37*	0.92**	0.51**	-0.62**	-0.68**	0.77**	-0.20^{NS}	1

$^{*}p<0.05$; $^{**}p<0.01$; NS = Not Significant; AWET = Average Egg Weight; FER = Fertility; HFE = Hatchability on Fertile Eggs; HSE = Hatchability on Eggs Set; DIG = Dead In Germ; DIS = Dead In Shell; NP = Normal Poult; AP = Abnormal Poult and PWT = Poult Weight

Table 5: Phenotypic correlation coefficient of egg hatching traits for the Spotted plumage strain

	AWET	Percentage							
Traits	(g)	FER	HFE	HSE	DIG	DIS	NP	AP	PWT
AWET	1								
FER	-0.66**	1							
HFE	0.91**	0.44*	1						
HSE	0.87**	0.93**	0.75**	1					
DIG	-0.85**	-0.31*	-0.83**	-0.88**	1				
DIS	-0.77**	-0.38*	-0.56**	-0.51**	0.67**	1			
NP	0.54**	0.43*	0.52**	0.42*	-0.32*	-0.67**	1		
AP	-0.54**	-0.23*	-0.53**	-0.18^{NS}	0.35*	0.68**	-1.00**	1	
PWT	0.34*	0.44*	-0.88**	0.45*	-0.48*	-0.17^{NS}	0.71**	-0.002^{NS}	1

$^{*}p<0.05$; $^{**}p<0.01$; NS = Not Significant; AWET = Average Egg Weight; FER = Fertility; HFE = Hatchability on Fertile Eggs; HSE = Hatchability on Eggs Set; DIG = Dead In Germ; DIS = Dead In Shell; NP = Normal Poult; AP = Abnormal Poult; PWT = Poult Weight

measured showed significant differences only for abnormal poult and poult weight. The White strain hatched significantly ($p<0.05$) higher abnormal poults (21.21%) than the Black (10.32%) and the Spotted (12.82%) which was similar to Black. Poult weight as percent of egg weight was significantly ($p<0.05$) highest in Black (64.56%) followed by Spotted (53.40%) and White (52.11%). Although, average egg weight was not significant ($p>0.05$) among the 3 strains, poult weight was higher in the strain (Black) with highest average egg weight and lower in the one (White) with least average egg weight. There was no significant strain effect for the rest of the traits of interest measured.

Phenotypic associations among the various hatching traits: Correlations among the fertility and hatchability traits of the 3 Turkey strains are presented in Table 3-5.

The Black strain: Table 3 showed highly significant ($p<0.01$) positive values between AWET and HSE, AWET and PWT, FER and HFE, FER and HSE, FER and NP, FER and PWT, HFE and HSE, HSE and PWT and DIG and DIS. Significant ($p<0.05$) relationships existed between AWET and HFE, AWET and NP, HFE and NP, HFE and PWT, HSE and NP, DIS and AP and NP and PWT. Significant ($p<0.01$) negative correlations were noted between AWET and FER, AWET and DIS, AWET and AP, FER and DIG, FER and DIS, HFE and DIG, HFE and DIS, HSE and DIS, HSE and DIS and DIS and PWT. Some negative moderate associations ($p<0.05$) were estimated between AWET and DIG, FER and AP, DIG and PWT and DIS and NP. NP and AP had significant ($p<0.01$) perfect and negative correlation estimate.

The White strain: Table 4 showed highly significant ($p<0.01$) positive correlation were found between AWET and HFE, AWET and NP, AWET and PWT, FER and HFE, FER and HSE, HFE and HSE, HFE and PWT, HSE and PWT, DIG and DIS and NP and PWT. Some significant ($p<0.05$) positive but moderate associations were recorded between AWET and HSE, FER and NP, FER and PWT, HFE and NP, HSE and NP, DIG and AP and DIS and AP. Also, highly significant ($p<0.01$) negative correlations between AWET and DIG, AWET and AP, FER and DIG, FER and DIS, HFE and DIG, HFE and DIS, HFE and AP, HSE and DIG, HSE and DIS, HSE and DIS, DIG and PWT and DIS and PWT were noted. Negative but moderate significant ($p<0.05$) correlations were observed between AWET and FER, AWET and DIS, FER and AP, DIG and NP and DIS and NP. NP and AP again had significantly ($p<0.01$) perfect negative correlation.

The Spotted strain: Similarly, some highly significant ($p<0.01$) positive relationships were observed between AWET and HFE, AWET and HSE, AWET and NP, FER and HSE, HFE and HSE, HFE and NP, HFE and PWT, DIG and DIS, DIS and AP and NP and PWT. Positive moderate significant correlations were obtained between AWET and PWT, FER and HFE, FER and NP, FER and AWET, HSE and NP, HSE and PWT and DIG and AP. A significantly high negative correlations were found between AWET and FER, AWET and DIG, AWET and DIS, AWET and AP, HFE and DIS, HFE and AP, HSE and DIG, HSE and DIS and DIS and NP. The associations between FER and DIG, FER and DIS, FER and AP, DIG and NP and DIG and PWT were moderately significant ($p<0.05$) and negative. NP and AP were negatively and perfectly correlated ($p<0.01$) (Table 5).

DISCUSSION

Strain effect: The significant deviation in abnormal poults among strains indicates that genetic profile may have greater influence on poult abnormality rather than management and environment. This present finding contradicts the report of Islam *et al.* (2002) with regard to chick abnormality who stated that it is more a function of management and environment. The result obtained in the study agreed with the findings of Shanawany (1987) who reported that poult weight varied from 60.4-66.4%. With regard to egg weight, the result could suggest that PWT was not only a function of egg weight but was also altered by genetic constitution. Genetic variations in chick weight have been reported earlier by Raju *et al.* (1997) and Islam *et al.* (2002).

The non-significant observations on most of the traits could be due to management practices and environment and negligible genetic influences. This result is in line with other reports noting little breed effects on the fertility and hatchability traits of other poultry species such as chicken (Ali *et al.*, 1993; Islam *et al.*, 2002) and guinea fowl (Obike *et al.*, 2012).

Despite the non-significant strain variation for most of the traits, it was apparent that relative performance with regard to the traits varied between strains. Based on the numerical values recorded, the Black strain seemed to be endowed with more favourable adaptive genes followed by the Spotted and then the White. It then follows that the Black local Turkey strain expressed better fertility and hatchability performance. According to Okoro *et al.* (2012), the White plumage coloured genotype is mostly preferred to the other genotypes by farmers in the zone. This preference could probably be attributed to the aesthetic value rather than performance.

Phenotypic correlation of traits: The result of the correlation study clearly showed that the eggs of these local Turkey strains compared favourably in their hatching traits. It was evident (Table 3-5) that AWET had positive correlation estimates with PWT, HFE, HSE and NP, implying that heavier eggs had higher hatchability which leads to more number of normal poults with heavier body weight. Salahuddin *et al.* (1995) reported heavier chicks from larger eggs for deshi chicken. Islam *et al.* (2002) found positive correlation of egg weight with chick weight in all the four breeds of chicken considered. Also, Raju *et al.* (1997) stated that day old chick weight increased significantly with increase in egg weight.

Significant positive correlations were obtained between FER, HFE and HSE in all the strains. The r_p values were 0.76 and 0.65 (Black), 0.90 and 0.85 (White) and 0.91 and 0.44 (Spotted) indicating that fertile eggs have higher hatchability. There was also significant positive association between HFE and HSE-Black (r_p = 0.86), White (r_p = 0.71) and Spotted (r_p= 0.75). This confirms that more eggs hatch with the setting of higher numbers of fertile eggs. The significant positive association between DIG and DIS regardless of strain is well understood as higher DIG increases DIS and vice versa (Islam *et al.*, 2002).

Some negative associations ($p<0.05$; $p<0.01$) were observed for Black, White and Spotted strains, respectively between AWET and FER (r_p = -0.70, -0.42 and -0.66), AWET and DIG (r_p = -0.23, -0.54 and -0.58), AWET and DIS (r_p = -0.79, -0.40 and -0.77) and AWET and AP (r_p = -0.70, -0.84 and -0.54). This clearly shows that small sized eggs tend to be less fertile due to higher DIG as well as higher DIS which leads to a significant production of abnormal poults and vice versa. Both DIG and DIS were negatively correlated with NP, suggesting that lower DIG and DIS will result to more number of normal poults. FER, HFE, HSE and PWT were all negatively associated ($p<0.05$; $p<0.01$) with DIG and DIS, showing that lower numbers of DIG and/or DIS in any set of eggs would amount to increase in both fertility and hatchability of eggs and weight of poults. NP showed a significantly ($p<0.01$) negative perfect association (r_p = 1.00) with AP, suggesting that high incidence of AP reduces the hatching of normal poults and vice versa. The findings obtained in this study are in agreement with the reports of Salahuddin *et al.* (1995) and Islam *et al.* (2002) who investigated similar traits with chicken eggs.

CONCLUSION

It is evident from the result of this study that strain had minimal effect on the hatchability traits of the locally adapted Turkey strains. The non-significant effect of strain on most of the traits suggests that these traits were influenced more by non-genetic factors such as management and environment. Poult weight was significantly higher in Black compared to White and Spotted strains while poult abnormality was significantly higher in White and least in Black Turkey strains. This result implies that the Black plumage coloured strain is better endowed with more favourable adaptive genes for meatiness and survivability within the zone. Little wonder its numerousity in the rainforest agro-ecological zone. The result of the phenotypic correlations confirmed that fertility and hatchability are interdependent traits which could be improved genetically by selecting either of the traits. The result also indicated that selection for lower DIG and/or DIS would improve egg fertility and hatchability as well as the weight of poults. The correlation between normal and abnormal poults showed that higher numbers of normal would lower the incidence of abnormal poults and vice versa.

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