CONCLUSION AND RECOMMENDATION

From this study, it can be inferred that sex of kit has little or no effect on the birth weight and progressive post weaning weekly weights of rabbits. Our results further show that NZxLC produced the best body weight gains across 20 weeks compared to other crossbreds. NZxLC crossbreeding regimes are therefore recommended in the improvement of the local breeds of rabbits by farmers and breeders.

REFERENCES

Abdel-Azeem, A.S., Abdel-Azim, A.M., Darwish, A. A. and Omar, E.M. (2007). Body weight and carcass traits in four pure breeds of rabbits and their crosses under Egyptian environmental conditions. In: The 5th International Congress on Rabbit Production in Hot Climate, Hurghada,, Egypt, pp. 67-80

Assan, N., 2018. Effect of genotype and some non-genetic factors on weaning weight in rabbits. *Agricultural Advances,* 7(1), 444- 454.

Attalah, G.E.Y. (2005). Performance of some economic traits in Bauscat and Baladi Red rabbits. The 4th International Conference on Rabbit Production in Hot Climates, Sharm El-Skeikh, Egypt. 101-110.

Ayorinde, K.L., and Oke, U.K. (1995). The influence of body weight and two feeding regimes during growing phase of growth performance and early lay characteristics of pullets *Nigerian Journal of Animal Production* 22:101-107

Chineke, C.A. (2005). Genetic and non-genetic effects on weaning and post-weaning traits in rabbit breeds and crosses. *Pakistan J. Biol. Sci.,* 8(10), 1402-1410.

Egena, S.S.A., Akpa, G.N,. Alemede, I.C., Aremu, A. (2014). Genotype, gestation length, season, parity and sex effects on growth traits of two rabbit breeds and their crosses *Institute for Animal Husbandry* Biotechnology in Animal Husbandry 30 (4), p 717-729

Marykutty, T. and Nandakumar, P. (2000). Factors influencing litter traits and body weight up to 12 weeks among temperate rabbit breeds in humid tropics *World Rabbit Science* 8:67-70

Morenikeji, O. B., Ogunshola, O. J., Adu , O. A., Aro, S. O. and Chineke, C. A. (2019). Genotype and sex effects on the performance characteristics of *pigs International Journal of Livestock Production* 10(4), pp. 127-134

Ologbose, F. I., Ajayi, F. O. and Agaviezor, B. (2017). Effects of breed, sex and on inter – relationship between body weight and body linear measurements in rabbit. *Journal of Fisheries Livest Production*. 5(3):250.

Pasupathi, K., Sakthivel, M., Gopi, H., Balasubramanyam, D., Babu, M. (2014). Factors influencing pre-weaning growth of rabbits under farm condition. *Int. J. Sci. Eng. Technol. Res.,* 3(9), 2278-7798.

Youssef, Y.M.K., Omara, M.E., Farid, A. (2008). Genetic evaluation of some litter and lactation traits in New Zealand White and Baladi Black rabbits. *Egypt Poult. Sci.,* 28(4), 1203-1216.

PERFORMANCE AND HETEROTIC EFFECT OF THREE STRAINS OF LOCAL TURKEY CROSSBRED IN THE HUMID TROPICS

Ogbuagu, K.P., Ramalan, A.H, Abel-Achimugu, J., Itodo, I.J., [*]Obi, O.C., and [*]Nwachukwu, E.N
Department of Animal Science, Federal University of Lafia, Nigeria
[*]Department of Animal Breeding and Genetics, Michael Okpara University of Agriculture, Umudike, Nigeria

ABSTRACT
A total of 215 day-old poults were used to evaluate the performance, heterosis and reciprocal effects of three strains of local turkey crossbred (*Meleagric gallapavo*) in the humid tropics. The experiment was conducted using three phenotypes of indigenous domestic turkeys with the plumage colour: black, white and lavender (spotted). The poults used for the study were hatched from a foundation stock of 86 turkeys comprising 25 Hens and 5 Toms forblack and white phenotypes each, respectively and 21 Hens and 5 Toms for lavender (spotted) phenotype. Randomized complete block design (RCBD) was also used to analyze the data with phenotypic class as a major factor and batch as block. Data obtained were subjected to analysis of variance (ANOVA). Results obtained showed that body weight (BW) and Linear body measurements (body length, wing length, drumstick length, breast width, shank length, keel length and neck length) had a significant increase as age (weeks) increased for the main crossbred (black x lavender (spotted), BxS) and Lavender x Black compared with its purebred (Black x Black, (BxB), White x White (WxW) and lavender x lavender (SxS) counterparts. final body weights for main crossbred (3710.25, 3732.42 and 3738.66g) and reciprocal crossbred (3791.58, 3795.72 and 3797.44g) differed significantly ($P<0.05$) across the weeks. Positive heterosis (hybrid vigour) was observed for BW and all LBMs measured in the main (direct) (BxW, BxS, and WxS) and reciprocal crossbreds (WxB, SxB and SxW) studied, ranging from 0.12 to 34.16%, respectively. Reciprocal effect was not significant for BW and all LBMs with the values ranging from -0.015 to 0.661 for BxW, BxS and WxS crossbreds. Non-significant differences observed in RE suggests that any of the breeds may be used as sire or dam in planned crossbreeding programmes.
Keywords: Heterosis, Reciprocal Effect, Crossbred, Phenotype, Traits

INTRODUCTION

Exploitation of heterosis is a major reason for crossbreeding in farm animals (Ibe *et al*., 2005). Utilization of this phenomenon has led to the development of high quality breeds of livestock in both poultry and other farm animals. Usually characters that suffered reduction in inbred status are often restored or tend to be restored on crossing (Falconer, 1981). Commercial turkey breeders have made major improvements in growth traits of the modern turkey (Havenstein *et al*., 2004). Genetic gains could be due to improvement within the primary breeding lines (additive genetic variation) or exploited through heterosis (non-additive genetic variation) in the crosses used to produce the commercial turkeys. Several studies have showed increase in body weight, breast width and (McCartney *et al.,* 1968; Nestor, 1977; 1984 and Nestor *et al*., 1996) due to genetic selection within lines of several strains. Heterosis has been exploited to genetically improve characters that are subject to little additive gene action, such as those related to fitness (Ndjon and Nwakalor, 1999).

Nwenya *et al*. (2017) reported a positive heterosis of the F1 progenies (main and reciprocal) of Indigenous Chicken Crossbred over their parents in body weight, average feed intake and feed conversion ratio. The reciprocal cross (i.e. frizzle feather rooster x naked neck hen) showed a significant improvement in their performances genetically, explaining that better results are achieved through crossbreeding of indigenous breeds using frizzle feather (F) sire and naked neck (NN) dam. Particularly, initial body weight and body weight gain in the reciprocal cross increased significantly, from 29.50g to 90.31g against the parents whose peak of weight gain was 73.50g at 16 weeks. Crossbreeding, therefore, is one of the sure ways of achieving rapid genetic improvement in non-descript and unselected indigenous stocks within the shortest time (Jagdish, 2007). However, under experimental and field breeding conditions, not every crossbreeding effort produces desirable results. It is therefore important that an animal breeder knows what mating method to employ and what breeding goals to accomplish (Dickerson, 1992). Geoff (1998) had reported that the most desirable form of heterosis is the better parent heterosis, a situation where the resulting progeny outperforms the superior parent. Although attaining this level of improvement is somewhat difficult, it still remains the target of most breeders. Reciprocal effect could also be exploited in crosses. Fayeye and Ayorinde (2000) observed that reciprocal effect was important for a number of litter traits and that this was higher in New Zealand White x Californian than in New Zealand White x Chinchilla and Californian x Chinchilla. Similar results were reported by Lebas *et al.* (1986) and Emsley *et al*. (1980). Reciprocal effects have also been reported for sexual maturity and mature body weight in poultry (Emsley *et al.*, 1980) and for post weaning growth and carcass characteristics in cattle (Johnston *et al.,* 1992). Genetic progress can be accomplished either by selection or crossbreeding. Crossbreeding of the indigenous stock with exotic commercial birds will take advantage of artificial selection for productivity in the exotic birds, and natural selection for hardiness in the native birds. Crossbreeding can be carried out as two-way, three-way or four-way crosses, back crosses or rotational crosses. Khawaja *et al.* (1999) studied growth patterns in chickens of reciprocal crossing between RIR and Fayoumi breeds. The results showed that crossbred chickens of FIRI (Fayoumi male x RIR female) showed better performance in all traits than crossbred chickens of RIFI (RIR male x Fayoumi female). This crossbreeding system also maximizes the expression of heterosis or hybrid vigour in the cross, normally reflected in improved fitness characteristics (Hoffmann, 2005). To retain heterosis in the maternal traits, three way or four-way crossing has to be applied. In three-way crosses the crossbred chicken is mated with a third line.

MATERIALS AND METHODS

Location of Study

The study was conducted in the Poultry Unit of Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State. Umudike lies between latitude 05° 29^1 N, longitude 07° 33^1 E and altitude of 122 m above sea level. The town is within the humid rain forest zone of South Eastern Nigeria and has a bimodal rainfall pattern with a total annual rainfall range of 1700 mm to 2100 mm. The minimum and maximum daily temperatures of the area ranges from 18.6^0 to 23^0C and from 26^0 to 36^0C during the rainy and dry seasons, respectively while the humidity range from 57.0% to 91.0% depending on the season of the year. The climatic data were taken from the meteorological station of the National Root Crops Research Institute, Umudike.

Mating Design

The mating design was as follows:

Pure crosses: Black male x Black female, White male x White female, Lavender male x Lavender female

Main Crosses: Black Male x White female, Black male x Lavender female, White male x Lavender female

Reciprocal Crosses: White male x Black female, Lavender male x Black female, Lavender male x White female.

Management of Experimental Birds

A total of 86 adult local turkeys of three phenotypic classes based on colour (Black, White and Lavender) were used as a parent population: 28 Black, 28 White and 30 Lavender phenotypes to generate the 251 F_1 poults for the study. They were brooded differently according to phenotypic group (Black, White and Lavender) from day-old to 6 weeks in a battery cage system after which they were transferred to deep litter pen at 6 weeks of age and reared till week 24. Dry wood shavings were used as litter material. Fresh clean water was given *ad libitum* to the poults during this period. Routine management operations were carried out on daily basis. Prophylactic antibiotics and anticoccidial drugs were administered to the birds every month for six months. The birds were also dewormed. Feeds were provided in adequate quantities to the poults twice daily (morning and evening) and drinking water *ad libitum*. Poults (0-6weeks) were fed starter mash containing 28% crude protein and 2800 kcal ME/kg (as labeled). Growing turkeys (7-20 weeks) were fed growers mash containing 20% crude protein and 3000 kcal ME/kg (as labeled). Laying hens (21-30 weeks) were fed layers mash containing 18% crude protein and 3200kcal ME/kg (as labeled) at 5% egg production. At 16 weeks of age, sexing was done and all the males were transferred to different pens for mating and crossing with other phenotypic groups. Massage method was used for collection of semen from the mature selected males at the farm during the mid-day hours of 12-1pm and inseminated artificially. Eggs produced by the base population turkey hens were collected on a daily basis and identified properly with markers, and incubated for 28 days in four (4) sets and hatched to generate the F1 progenies. The incubator had a relative humidity of 80%, temperature of 55^0C and proper ventilation.

Parameters Measured

Body weight (BWT), Average daily feed intake (ADFI), Brooding mortality (BM), Body length (BDL), Shank length (SL), Keel length (KL), Wing length (WL), Breast width (BW), Drumstick length (DL) and Neck Length (NL). All parameters except BWT were measured weekly using a tailor's tape calibrated in cm.

Statistical Analysis

Analysis of variance (ANOVA) procedure was used to analyse the data on growth traits and linear body parameters using SPSS (2010) analytical package. Duncan's new multiple range test (Duncan, 1955) was used to compare significant means of the nine (9) phenotypic classes of local turkey.

Direct heterosis: Direct and percentage heterosis for each cross was estimated with the method of linear contrasts as outlined by Dickerson (1992), as follows:

Direct heterosis = Mean of the crossbred – Mean of parental purebreds.

Percentage heterosis = $\dfrac{\text{Direct heterosis}}{\text{Mean of purebreds}} \times \dfrac{100}{1}$

RESULTS AND DISCUSSION

Table 1 below shows the performance of F_1 turkeys (purebred, main crossbred and reciprocal crossbred). There were no significant (P>0.05) differences in all the progenies of the purebred, main crossbred and reciprocal crossbreds at day old (initial body weight). In the final body weight, there were no significant (P>0.05) differences in the reciprocal crossbred and main crossbred, although they were significantly (P<0.05) higher than their purebred counterparts. The result obtained in this study shows improvement in body weights and daily weight gain of purebred and crossbred progenies. It is comparable with the findings of Amao *et al.* (2015) who reported significant (P<0.05) increase in daily weight gain and body weights for main and reciprocal crossbreds than its purebred counterparts. Nwachukwu *et al.* (2005; 2006) also reported a significant (P<0.05) increase in weight gain for main and reciprocal crossbreds than its purebred counterpart. Improved genetic potential for growth was evident in the F_1 progeny (main and reciprocal crossbred) more than its purebred counterpart. This increase in weight observed in the progenies as they approach sexual maturity is in line with the findings of Peters *et al.* (2007) who reported consistent increase in body weight as age increased.

Table 1. Growth performance of F_1 turkeys (purebred, main crossbred and reciprocal crossbred).

	Purebred			**Main crossbred**			**Reciprocal crossbred**		
Parameters	BxB	WxW	SxS	BxS	BxW	WxS	WxB	SxW	SxB
Initial body weight (g)	31.04 (3.18)	31.35 (3.86)	31.53 (3.92)	34.86 (3.41)	34.96 (3.45)	35.06 (3.48)	35.02 (3.47)	35.26 (3.55)	35.68 (3.59)
Final body weight (g)	2813.30^b (26.15)	2826.84^b (27.66)	2829.55^b (27.83)	3710.25^a (33.80)	3732.42^a (34.57)	3738.66^a (35.11)	3791.58^a (32.61)	3795.72^a (32.87)	3797.44^a (33.21)
Average daily weight gain (g/day)	322.33^c (8.03)	323.55^c (8.27)	323.38^c (8.45)	329.61^b (8.13)	330.33^b (8.29)	327.33^b (8.44)	336.67^a (8.41)	338.08^a (8.53)	339.55^a (8.67)

$^{a-c}$ means in the same row with different superscripts are significantly different (P<0.05).*S.E.M in Parenthesis, Purebred= BxB = Black x Black, WxW = White x White and SxS = Lavender x Lavender, Main crossbred= BxS = Black x Lavender, BxW = Black x White and WxS = White x Lavender, Reciprocal crossbred= WxB = White x Black, SxW = Lavender x Lavender, SxB = Lavender x Black.

Table 2 shows body weight (g) of the F_1 Local Turkeys (purebred, main and reciprocal crossbred) at age 4 to 24 weeks. There were no significant (P>0.05) differences in weeks 4 and 6 among the purebred, main crossbred and reciprocal crossbred. However, significant (P<0.05) differences were observed from week 8 to 24 with the reciprocal crossbred and main crossbred having better performance than their purebred counterparts. However, the reciprocal crossbred progeny had significantly (P<0.05) higher body weight than the main crossbred in weeks 8, 12, 14, 18, 20, 22 and 24. The main crossbred were significantly (P<0.05) higher in body weight than the reciprocal crossbred only in week 10. There was no significant difference (P>0.05) between the two in week 16.

The significant increase in the mean body weight of crossbred turkey phenotypes suggests that the crossbreds may have potentials for fast growth. This result is similar to the findings of Amao *et al.* (2015) who reported a significant increase in body weights as age increase in main and reciprocal crossbreds of Nigerian Indigenous turkey breeds and their exotic counterparts. This increase in body weight as age increased was probably due to high genetic potentials for growth in the F_1 progeny as they attain sexual maturity age (Ibe, 1993; Peters *et al.*, 2007).

Table 2. Body weight (g) of the F_1Turkeys (purebred, main and reciprocal crossbred) at age 4 to 24 weeks

	Purebred			Main Crossbred			Reciprocal Crossbred		
Weeks	WxW	BxB	SxS	BxS	BxW	WxS	WxB	SxW	SxB
4	620 (2.71)	623 (2.73)	622 (2.74)	660 (26.98)	662 (27.27)	663 (28.56)	664 (27.55)	667 (27.83)	665 (27.61)
6	880 (37.71)	879 (36.55)	881 (38.46)	885 (39.26)	886 (40.74)	888 (41.51)	884 (40.32)	885 (40.65)	886 (40.69)
8	1080^c (40.22)	1082^c (40.24)	1083^c (40.25)	1206^b (61.33)	1208^b (61.64)	1210^b (62.48)	1215^a (61.88)	1218^a (62.51)	1217^a (61.93)
10	1208^c (61.84)	1211^c (62.33)	1209^c (61.87)	1515^a (51.66)	1518^a (52.71)	1522^a (53.78)	1488^b (68.00)	1490^b (68.26)	1486^b (67.66)
12	1514^c (55.80)	1517^c (57.56)	1516^c (56.34)	1881^b (65.18)	1883^b (66.35)	1886^b (66.73)	1893^a (65.23)	1895^a (65.51)	1897^a (65.66)
14	1720^c (71.00)	1718^c (70.89)	1722^c (71.50)	2159^b (75.03)	2161^b (76.81)	2164^b (77.08)	2204^a (76.05)	2206^a (76.49)	2209^a (76.83)
16	1965^b (69.31)	1966^b (70.47)	1968^b (70.55)	2630^a (79.33)	2632^a (82.71)	2638^a (83.46)	2651^a (78.45)	2653^a (78.63)	2656^a (78.81)
18	2358^c (81.03)	2361^c (82.66)	2355^c (80.73)	2960^a (83.17)	2963^a (85.40)	2966^a (86.67)	2983^b (85.44)	2986^b (85.63)	2990^b (87.12)
20	2493^c (84.45)	2503^c (87.03)	2497^c (84.86)	3260^b (86.05)	3262^b (87.57)	3263^b (87.68)	3312^a (86.78)	3317^a (86.94)	3320^a (88.05)
22	2755^c (85.41)	2753^c (84.87)	2765^c (86.16)	3510^b (89.03)	3512^b (90.57)	3514^b (91.68)	3528^a (89.32)	3531^a (90.52)	3534^a (91.64)
24	3018^c (83.38)	3028^c (84.93)	3016^c (83.15)	3630^b (91.84)	3633^b (92.56)	3637^b (93.65)	3750^a (92.93)	3752^a (94.93)	3754^a (95.93)

$^{a\text{-}c}$ means in the same row with different superscripts are significantly different (P<0.05).*S.E.M in Parenthesis, Purebred= BxB = Black x Black, WxW = White x White and SxS = Lavender x Lavender, Main crossbred= BxS = Black x Lavender, BxW = Black x White and WxS = White x Lavender, Reciprocal crossbred= WxB = White x Black, SxW = Lavender x Lavender, SxB = Lavender x Black.

Table 3 shows estimates of direct and percentage heterosis for body weight (BW) at 8-20 weeks for main (Direct) and reciprocal crossbred of domestic turkey. In week 8, there was positive heterosis (hybrid vigour) for the main (direct) and reciprocal crossbred with the values ranging from 0.12 to 0.14 for direct heterosis and 11.35% to 12.47%, respectively. In week 12, similar trend was observed where the main crossbred had a positive heterosis ranging from 0.36 to 0.37 for direct heterosis and 23.99% to 24.32% for percentage heterosis for BxS, BxW and WxS crossbreds, respectively The reciprocal crossbred also had a positive heterosis for BW with a range of 0.38 to 0.39 direct heterosis and 24.79% to 25.05% for percentage heterosis. In weeks 16 and 20, there were positive heterosis observed for main crossbred and reciprocal crossbred with the range of 0.66 to 0.69 and 0.76 – 0.83 for direct heterosis respectively. The percentage heterosis were also at the range of 33.64% to 34.96% and 30.24% -33.64% for both main (direct) and reciprocal crossbreds.

The positive direct heterosis reported for both main (direct) and reciprocal crossbreds implies that there was an increase in BW as a result of the crossbreeding in favour of the crossbreds. This indicates that non-additive effects of genes could be exploited through crossbreeding to bring about genetic improvement for body weight. This result is also comparable to the findings of Nestor *et al*. (2001 and 2005) who reported improved positive heterosis for body weight in weeks 8, 16 and 20 in crosses of A and F Turkey lines. Ibe *et al*. (2005) also reported positive heterosis for body weight in crossbred rabbits. Similarly; Nwenya *et al*. (2017); Nwachukwu *et al*. (2006); Chineke *et al*. (2000), and Afifi *et al.* (1987) reported positive heterosis for body weight and linear body measurements at different ages in poultry crossbreds. Lalev *et al*. (2014) suggested that heterosis was important for body weights of chicken (crosses of White Plymouth Rocklines of chicken) at different ages reported a percentage heterosis ranging from 3.76 – 22.33%. Okoro *et al.* (2012) stated that improvement of body weight and linear traits can be done by crossbreeding and exploitation of the existing heterosis.

Table 3 Estimates of direct and percentage heterosis for body weight in 8 to 20 weeks

Age		**Main crossbred**		**Reciprocal Crossbred**		
(Weeks)	**BxW**	**BxS**	**WxS**	**WxB**	**SxB**	**SxW**
8	0.12 (11.35)	0.13 11.54)	0.13 (11.73)	0.13 (12.19)	0.14 (12.47)	0.13 (12.37)
12	0.36 (23.99)	0.37 (24.13)	0.37 (24.32)	0.38 (24.79	0.38 (24.92)	0.39 (25.05)
16	0.66 33.64)	0.66 (33.74)	0.67 (34.04)	0.68 (34.70)	0.69 (34.81)	0.69 (34.96)
20	0.76 (30.24)	0.77 (30.32)	0.78 (30.36)	0.81 (32.32)	0.82 (32.52)	0.83 (32.64)

BW= body weight, SL = shank length, NL = neck length, BRW = Breast width, BL = body length, KL = keel length, WL = wing length and DS = drumstick length, Main crossbred = Black x White, Black x Lavender and White x Lavender, Reciprocal crossbred = White x Black, Lavender x Black and Lavender x White. Percentage Heterosis in parentheses.

CONCLUSION

Body weight and linear body measurements (LBM) showed significant improvement on the main (Direct) and reciprocal crossbreds from week 2 to week 24, indicating the importance of crossbreeding in domestic turkey. Thus, the linear body traits (body length, wing length, drumstick length, neck length, breast width, shank length and keel length) showed an increase as age increased with the main and reciprocal F1 crossbreds having best performance compared to their purebred counter parts. Interactions between batch and phenotype effects were not significant in all ages for both main (direct) and reciprocal F1 crossbreds. There was positive heterosis (hybrid vigour) for body weight (BW) and all the linear body measurements (LBMs) in both main (direct) (BxW, BxS and WxS) and reciprocal F1 crossbreds (WxB, SxB and SxW) studied. This indicates that non additive effects of genes could be exploited through crossbreeding of BxS, BxW and WxS phenotypes to bring about genetic improvement for BW and LBMs. Reciprocal effect was not significant for BW and all LBMs. This suggests that any of the breeds may be used as sire or dam in planned crossbreeding programmes.

REFERENCES

Afifi, E.A., Emara, M.E. and Kadry, A.E.H. (1987). Birth weight in purebred and crossbred rabbits. *Journal of Applied and Rabbit Resource*. 10: 133-136.

Amao, O. J., Ayorinde, K. L. and Fayeye, T. R. (2015). Body mass index and heterosis of body weight and morphometric traits of pure and crossbred turkey poults. *Journal of Animal Producion Resources.* (27):1-8.
Chineke, C.A., Agaviezor, B., Ikeobi, C.O. and Ologun, A.G. (2000). Some factors affecting body weight and measurements of rabbits at pre-and post weaning ages. In: *Proceeding 27th Annual Conference of Nigeria Society for Animal Production*. Pp. 1-4.
Dickerson, G.E. (1992). Manual for evaluating breeds and crosses of domestic animals. Publication DIV, FAO, Rome, Italy.
Duncan, D.B. (1955). Multiple Range and Multiple F-tests Biometrics 11:1-42.
Emsley, A., Dickerson, G.E. and Gowe, R.S. (1980). Inbreeding effects on layer performance at two levels of protein intake. *Poultry Science.* 59: 1155-1166.
Falconer, F.N. (1981). Estimation of crossbreeding effect and Variance component due to direct and maternal effects for growth traits of 3 turkey strains. In: *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production,* 17: 229-232.
Fayeye, T.R. and Ayorinde, K.L. (2000). Heterosis and reciprocal effect for litter characteristics in rabbit crosses. *Proc. 25th Annual Conference of Nigeria Society for Animal Production, Umudike*. Pp. 248-251.
Geoff, D.N. (1998). Breed and heterotic effect on post weaning traits in Altex and New Zealand White straight and crossbred rabbits. *Journal of Animal Science* 1(2): 9-15.
Havenstein G.B., Ferket, P.R., Grimes, J.L., Qureshi, M.A and Nestor, K.E. (2004a). Performance of 1996 vs 2003 turkeys when fed representative 1996 and 2003 turkey diets. In: *Proceedings of the World's Poultry Congress, Istanbul*.
Hoffmann, I. (2005). Research and investment in poultry genetic resources for maternal effects on chick weight and the direct genetic effects on egg composition traits in white leghorn. *Journal of Poultry Science 82:1-8*
Ibe, S.N. (1993). Growth performance of normal, frizzled and naked-neck chicken in tropical environment. *Nigerian Journal of Animal Production 20: 25-31*.
Ibe, S.N., Obasi, V.N., Ojewola, G.S. and Nwachukwu, E.N. (2005). Heterosis and reciprocal effects for growth traits in crosses of New Zealand White, Dutch and Chinchilla breeds of rabbit. *Nigerian Journal of Animal Production* 32(2)
Jagdish, J.J (2007). Effect of crossbreeding on the muscle quality (chemical composition) in Un-Ling black Saudi chicken. *Poultry. Science*. 19, 491- 507.
Johnston, D.J., Thompson, J.M. and Hammond, K. (1992). Additive and non-additive differences in post weaning growth and carcass characteristics of Devon, Hereford and Reciprocal cross steers. *Nigerian Journal of Animal Production.* 70: 2688-2694.
Khawaja, H.A., Marsden, A.P. and Asmundson, V.S. (1999). Inherited differences in weight conformation of bronze turkeys. Poult. Sci. 33: 411-416.
Lalev, M., Mincheva, N., Oblakova, M., Hristakieva, P. and Ivanova, I. (2014). Estimation of heterosis, direct and maternal additive effects from crossbreeding experiment involving two White Plymouth Rocks Lines of Chicken. Biotechnology in Animal Husbandry, 30(1): 103-114.
Lebas, F., Coudert, P., Ravier, R. and De Rochambeau, H. (1986). The rabbit husbandry health and production. *FAO Anim. Prod. and Health Series*. 21: 6-107.
McCartney, M. G., K. E. Nestor, and W. R. Harvey, (1968). Genetics of growth and reproduction in the turkey. 2. Selection for increased body weight and egg production. Poultry Science. 47:717–721.
Ndjon, M.N. and Nwakalor, L.N. (1999). Heterosis in maternal traits from crossing of exotic and local breeds of rabbits. *Tropical Journal of Animal Science* 1 (2): 9-15.
Nestor, K. E., (1977). Genetics of growth and reproduction in the turkey. 5. Selection for increased body weight alone and in combination with increased egg production. *Poultry Science.* 56:337–347.
Nestor, K. E., (1984). Genetics of growth and reproduction in the turkey. 9. Long-term selection for increased 16-week body weight. *Poultry Science.* 63:2114–2122.
Nestor, K. E., D. O. Noble, J. Zhu, and Y. Moritsu (1996). Direct and correlated responses to long-term selection for increased body weight and egg production in turkeys. *Poultry Science* 75:1180–1191.

Nestor, K.E. Anderson, J.W. and Velleman, S.G. (2001). Genetic variation in pure lines and crosses of large-bodied turkey lines. 1. Body Weight, Walking Ability and Body Measurements of Live Birds. *Poultry Science* 80: 1087-1092.

Nestor, K.E. Anderson, J.W. and Velleman, S.G. (2005). Genetic variation in pure lines and crosses of large-bodied turkey lines. 3. Growth-related measurements on live birds. *Poultry Science* 84:1341-1346.

Nwachukwu, E.N., Ibe, S.N. and Onyeocha, K.C. (2005). Growth performance of F_1 crosses of normal local, naked neck and frizzle chicken x Arbor Acre broilers breeder stock in a humid tropical environment. Proc. 30th Ann. Con. Genet. Soc. of Nigeria.

Nwachukwu, E.N., Ibe, S.N. and Ejekwu, K (2006). Short term egg production and egg quality characteristics of main and reciprocal crossbred normal local naked and frizzled x exotic broiler stock in humid tropical environment. *Journal Animal and Veterinary Advantage.* 5(7): 547-551.

Nwenya, J.M.I., Nwakpu E.P., Nwose, R.N. and Ogbuagu, K.P. (2017). Performance and Heterosis of Indigenous Chicken Crossbreed (Naked Neck x Frizzled Feather) in the Humid Tropics. *Journal of Poultry Research* 14(2): 7-11.

Okoro, V.M.O., Ogundu, U.E. Kadurumba, O., Iloeje, M.U., Okoro, C.L., Nosike, R.J. and Ibe, S.N. (2012). Genetic variations in locally adapted turkeys. 1. Additive and non- additive genetic effects on growth traits. *Genomics and Quantitative Genetics* 4: 1-7.

Peters, S.O., Ikeobi, C.O.N., Ozoje, M.O., Famakinwa, O.A., Oshodi, Y.S. and Adebambo, O.A. (2007). Egg quality of Nigeria Local Chicken as Influenced by some major genes. *Nigeria Journal of Animal Production* 34(1): 25-35.

SPSS (2010). Statistical Package for Social Sciences. SPSS Inc. 13.0 for Windows.