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Evaluation of Growth Parameters of Main and Reciprocal Crossbred Normal, Naked Necked and Frizzle Chickens in a Humid Tropical Environment

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Abstract: A total of 216 day-old F_1 chicks generated by main and reciprocal crossbreeding of normal local (NL), naked neck (Na) and frizzle (F) chickens with Arbor Acre broiler (E) breeder stock were used in the study. Mean day-old weights of the main crossbreds (ExNL, ExNa and ExF) were 26.80, 26.00 and 26.50 g, respectively and were significantly ($p<0.05$) less than mean day-old weights of 30.10, 30.50 and 30.40 g for reciprocal crossbreds (NLxE, NaxE, and FxE), respectively. These reciprocal crossbreds maintained their superiority in body weight, had higher feed intake and better feed conversion ratios till the end of experiment at 18 weeks. The Linear Body Measurements (LBMs): Body length, wing length, keel length, breast width except shank length were longer in the reciprocal crossbreds than in their main cross counterparts. The final range of body weights achieved in the main crossbreds (866.33 to 941.00 g) and in the reciprocal crossbreds (1350.00 to 2150.00 g) depict the main cross individuals as light birds which could be developed as egg-laying lines and the reciprocal crosses as heavy birds which could be developed as meat-type or dual purpose birds. In general, the performance of these crossbred chickens showed evidence of maternal influence with each group behaving like its dam-of-origin. The FxE individuals outperformed all other genetic groups with respect to body weight and linear body parameter development, thus indicating that the frizzle gene may be advantageous in producing fast growing chickens in the humid tropics.

Key words: Crossbreeding, major genes, growth traits, Local chicken genotypes, broiler breeder stock, maternal effect

INTRODUCTION

The view that the genetic profile of the native fowls can be improved through crossbreeding with exotic stock or through utilization of some advantageous gene complexes or major genes in breed development strategies has been expressed[1,31,2] . The naked neck (Na) and Frizzle (F) genes are among the major genes naturally propagated in the local chicken population in the tropics[3,4]. The associated effects of these thermoregulatory genes on some quantitative traits in poultry especially in hot or artificially hot environments have been reviewed comprehensively by Merat[5]. Opinions are consistent among investigators that birds possessing Na and F genes tolerate thermal stress better than their normal feathered counterparts; with such birds manifesting evidence of productive adaptability[3,6-8]. Productive adaptability itself is a phenomenon whereby an animal gives acceptable level of production in a stressed environment[4]. The tropical environment is generally characterised by such stress factors as excessive heat, poor nutrition, poor housing and disease. Developing poultry stocks that can tolerate such an environment and give acceptable level of production is desirable.

Breed development strategies would require evaluating or characterising the new stocks (breeds or strains) for growth and egg production. This is important because of expected variation in productivity resulting from genotype x environment interactions and adaptability problems. In Nigeria, crossbreeding work has been reported more for egg-type chickens[4,9-11] and a handful of information on broiler-type chickens[12,13]. However, information on crossbred chickens especially those carrying the naked neck and/or the frizzle genes in Nigeria are scanty and more baseline information on their growth characteristics are needed for meaningful future breeding programmes.

This study therefore was, undertaken to evaluate the growth performance of main and reciprocally crossed normal, naked neck and frizzle chickens and to determine whether maternal effect was important for the growth parameters evaluated.

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MATERIALS AND METHODS

Study area: The experiment was conducted in the poultry unit of the Teaching and Research farm of Michael Okpara University of Agriculture, Umudike, Abia state, Nigeria. The climatic data were taken from the meteorological station of the National Root Crop Research Institute, Umudike. The maximum and minimum daily temperatures during the study period ranged between 27.0 to 36.0°C and 20.0 to 26.0°C, respectively while the relative humidity ranged between 57 to 91%. The study period (May-September, 2004) corresponded to the peak of the rainy season in the South-East agro-ecological zone of Nigeria.

Management of parent stock: The base population consisted of mature males and females of Normal Local (NL), naked neck (Na) and Frizzle (F) local chicken genetic resource kept at the poultry unit of the University farm. The exotic Arbor Acre broiler (E) breeder stock was obtained from a reputable poultry breeder farm at Owerri in Imo State. The birds were de-wormed and de-loused using piperazine adipate and diazintol (an acaricide), respectively. All the birds were administered with booster dozes of Newcastle disease vaccine (NDV-Lasota), prophylactic antibiotics and anticoccidial drugs were given to the birds periodically. Feed and water were offered *ad libitum* to the local chicken parent stock while measured quantities of feed (145 g/bird/day) were provided to the broiler parent stock.

Mating scheme: The mating system used to generate the F_1 chicks involved main and reciprocal crossbreeding. Due to obvious differences in body size between the exotic and local parent stocks, artificial insemination technique as described by Lake[14] was used. The main cross chicks (ExNL, ExNa and ExF) were obtained by mating exotic broiler males (E) to NL, Na and F females, respectively. The reciprocal crossbred chicks (NLxE, NaxE and FxE) were obtained from a reverse order mating of the above mating arrangement. Eggs from the six genetic groups were collected daily, identified appropriately with makers and set in the incubator on a weekly basis.

Management of F_1 chicks: A total of 216 day-old chicks hatched in seven batches were utilized in the study. The genetic groups contributed varied numbers of chicks, thus resulting in unequal sample size. The chicks were brooded in deep litter pens according to their genetic groups. Commercial feeds were provided to the birds. Broiler Starter Mash (BSM) containing 23% CP and Pullet Grower Mash (PGM) containing 16% CP were fed to the birds from 0-6 weeks and 7-18 weeks, respectively. Necessary vaccinations against Newcastle and Gumboro diseases as well as prophylactic antibiotics and anticoccidial drugs were administered to the birds. The growing birds were raised on deep litter pens throughout the 18-week study period.

Body weights were taken on all genetic groups at day old, week 6, week 12 and week 18. Feed intakes were recorded while feed conversion ratios were computed for the various crosses at weeks 6, 12 and 18. Brooding and rearing phase mortalities were also recorded for the genetic groups. The Linear Body Measurements (LBMs) were taken at 18 weeks for males and females separate. 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. Wing Length (WL) was measured as the length of the humerus and radius to the third digit (finger) on the left wing of each bird. The Keel Length (KL) was taken as the length of the cartilaginous keel bone or metasternum while the Shank Length (SL) was measured from the hock joint to the tarsometarsus digit-3 joint. The Breast Width (BW) was measured as the region of largest breast expansion while the bird was positioned ventrally. All LBMs were measured with a tailor's cm tape as described by Ibe and Nwachukwu[15].

Experimental design and statistical analyses: The experiment was a Randomised Complete Block (RCB) design with genetic groups as treatment and different hatches as block. The model used was of the type:

$$Yijk = \mu + B_i + T_j + e_{ijk}$$

Where, Yijk = K^{th} individual in the ith block and in the jth genetic group.

μ = overall or population mean
B_i = the effect of the i^{th} hatch (i = 1,..., 7)
T_j = the effect of the j^{th} genetic group (j = 1,..., 6)
e_{ijk} = random error

Means and their associated standard error for measured parameters were computed. Analysis of variance were carried out using statistical package for social sciences[16] while differences in means were detected using Duncan's Multiple Range test[17].

RESULTS AND DISCUSSION

Performance of the main and reciprocal crossbred normal, naked neck and frizzle chickens with respect to body weight, average daily feed intake, feed conversion ratio, brooding and rearing mortalities are presented in Table 1. The body weight of the main cross (ExNL, ExNa and ExE) chicks at day-old were not significantly different ($p>0.05$) from each other and ranged between 26.00 to 26.80 g. However, these genetic groups weighed significantly ($p<0.05$) less than their reciprocal cross (NlxE, NaxE and FxE) counterpart chicks whose body

Table1: Mean Body Weight (BWT), Average Feed Intake (AFI), Feed Conversion Ratio (FCR), Brooding (BM) and Rearing (RM) mortality of main and reciprocal cross normal, naked neck and frizzle chickens

	Main crosses			Reciprocal crosses		
Parameter	E x NL	E x Na	E x F	NL x E	Na x E	F x E
Day-old						
BWTDO	26.80^{b}(0.86)	26.00^{b} (1.00)	26.50^{b} (0.73)	30.10^{a} (0.49)	30.50^{a} (0.69)	30.40^{a} (0.46)
Week 6						
BWT6	208.40^{e} (23.4)	225.00^{c} (25.01)	347.00^{b} (8.15)	371.05^{a} (11.77)	307.00^{b} (35.19)	367.85^{a}(11.95)
AFI (g/bird)	33.78^{b} (0.78)	30.82^{c} (0.48)	33.94^{b} (0.51)	43.78^{a} (0.29)	43.82^{a} (0.23)	43.94^{a} (0.25)
(FCR)	3.24	3.80	3.36	3.20	2.40	1.68
BM (%)	10.55	25.41	17.50	15.40	34.50	21.6
Week 12						
BWT12	450.00^{e} (63.00)	575.00^{d} (85.01)	690.58^{c} (16.86)	1011.00^{a} (57.34)	945.84^{b} (82.76)	1197.00^{a}(40.75)
A F I (g/b/d)	56.40^{b} (0.30)	57.89^{b} (5.01)	58.64^{b} (3.71)	66.20^{a} (1.20)	67.78^{a} (0.67)	68.80^{a} (0.51)
(FCR)	2.12	2.35	1.78	1.06	2.10	0.96
Week 18						
BWT18	941.00^{d} (92.73)	935.00^{d} (85.01)	866.33^{e}(41.61)	1936.00^{b} (110.84)	1350.00^{c} (32.17)	2150.00^{a}(71.19)
AFI (g/bld)	67.56^{d} (3.60)	65.41^{d} (3.05)	69.36^{c} (5.39)	78.47^{a} (3.50)	76.39^{b} (4.35)	85.56^{a} (2.32)
(FCR)	3.93	3.60	2.87	1.95	2.31	1.65
RM (%)	5.70	15.60	10.60	8.51	21.6	10.55

$^{a-e}$Means in the same row with different superscripts are significantly different ($p<0.05$). Standard error (s.e.m) in parentheses

Table 2: Body weight and some linear body measurements of main and reciprocal crossbred normal, naked neck and frizzle cockerels at 18 weeks of age

	Main crosses			Reciprocal crosses		
Parameter	E x NL	E x Na	E x F	NL x E	Na x E	F x E
Body weight (g)	1210^{d} ±30.35	1125^{de}±75.00	1032^{e}±11.96	2197^{b}±51.0	1462^{c}±89.01	2468^{a}±55.85
Body length (cm)	36.60^{bc}±0.32	35.00^{c}±1.50	34.25^{c}±8.66	38.94^{b}±0.42	39.65^{b}±0.89	41.17^{a}±0.57
Wing length (cm)	18.93^{b}±0.73	19.80^{b}±0.80	19.25^{b}±0.62	19.32^{b}±056	23.15^{a}±084	22.83^{a}±0.34
Keel length (cm)	12.13^{bc}±0.38	11.75^{c}±0.25	13.70^{b}±1.21	15.90^{a}±0.34	11.70^{c}±042	15.08^{a}±0.48
Shank length (cm)	8.60^{b}±0.21	9.25^{a}±0.25	8.42^{b}±0.29	9.23^{a}±0.15	8.75^{b}±0.25	9.38^{a}±0.16
Breast width (cm)	12.67^{bc}±6.67	8.75^{e}±0.25	11.60^{d}±035	14.87^{b}±0.21	11.50^{d}±0.42	17.83^{a}±0.25

$^{a-e}$Means in the same row bearing different superscripts are significantly different ($p<0.05$)

Table 3: Body weight and some linear body measurements of main and reciprocal crossbred normal, naked neck and frizzle pullets at 18 weeks of age

	Main crosses			Reciprocal crosses		
Parameter	E x NL	E x Na	E x F	NL x E	Na x E	F x E
Body weight (g)	682^{e}±73.51	850^{d}±99.00	700^{e}±35.41	1675^{b}±66.21	1250^{c}±45.69	1842^{a}±66.24
Body length (cm)	32.76^{b}±1.31	25.80^{c}±4.30	30.70^{b}±0.67	34.53^{a}±0.67	35.03^{a}±0.69	35.11^{a}±0.89
Wing length (cm)	16.18^{c}±0.43	17.05^{b}±0.25	17.17^{b}±0.23	18.43^{ab}±0.60	21.03^{b}±0.28	19.73^{a}±0.38
Keel length (cm)	10.14^{c}±0.25	10.15^{bc}±0.55	11.76^{b}±0.33	13.04^{a}±0.55	11.02^{b}±0.02	13.65^{a}±0.22
Shave length (cm)	8.16^{a}±0.18	8.35^{a}±0.15	7.12^{b}±0.19	8.82^{a}±9.00	7.66^{b}±0.29	8.68^{a}±0.13
Breast width (cm)	11.28^{bc}±0.64	10.15^{c}±0.35	10.82^{c}±0.24	13.0^{b}±0.13	11.42^{c}±0.31	15.95^{a}±0.35

$^{a-e}$Means in the same row bearing different superscripts are significantly different ($p<0.05$)

weights at day-old ranged within 30.10 to 30.50 g. The mean day-old body weights recorded for the main cross progrenies fall within the range reported for indigenous chicks in previous studies[10,18-20]. This observation indicates that the main cross F_1 chicks appeared to be more like their local chicken dams than their exotic broiler breeder sire. The mean day-old weights recorded for both main and reciprocal crossbreds show strong evidence of maternal effects[10,21,22]. The main cross birds maintained their small body size till 18 weeks, finishing with body weight range of 866 to 941.00 g which was even higher than 20 week body weight of 841.67 g for Gold Link (GL) x Local Chicken (LC) reported by Omeje and Nwosu[10]. The advantage of reduction in body size of chicken especially from the point of view of lowered maintenance requirement has been variously reported and this has informed the use of the sex-linked dwarfing gene (dw), which causes 20-30% reduction in body size[23-25] in developing breeds or strains of chicken meant for egg production. Since the body weights of these main cross hybrids did not differ much and tended towards light breeds of chicken, they could be considered as candidates for potential light egg-laying lines. The reciprocal cross individuals on the other hand maintained their superiority in body weight with the NLxE and FxE attaining more than 1.5 kg at 18 weeks of age. These birds could be considered for the development of meat-type or dual purpose chicken in view of t heir improved body weights.

Generally, feed intakes were significantly ($p<0.05$) higher for the reciprocal crossbreds than the main cross individuals at weeks 6, 12 and 18. This observation is a common knowledge; heavier birds consume more feed than lighter ones. Feed conversion ratios were consistently lower in value and therefore more efficient for the reciprocal crossbreds than in their main cross counterparts. This observation is in line with the reports of Cahaner and Leenstra[26] that fast growing birds are more feed efficient than slow growing ones. Among all the genetic groups, the FxE (frizzled) individuals consumed significantly more feed, at weeks 6,12 and 18; they were also more feed efficient and achieved significantly heaviest body weight (2150.00 g). Their outstanding growth performance seems to suggest that this genetic group was better adapted to its humid tropical production environment than other genetic groups. This observation supports the report of Nwachukwu *et al.*[27] who reported that crossbred frizzle broilers achieved greater efficiency of thermoregulation than normal and naked neck individuals due to greater surface area exposed to the atmosphere, which enhances rapid heat loss in the frizzles. The implication of these acquired attributes for the FxE crossbreds is that they could be further screened as possible candidates for tropical broiler breed development since they can consume and convert feed efficiently under high (27-36°C) ambient temperature as reported in this study.

Brooding mortality as seen in Table 1 was generally high, exceeding 10% in all genetic groups and was highest (25.41 and 34.5%) in the ExNa and NaxE), respectively. This abnormal mortality could be partly due to the outbreak of collibaccilosis, which was brought under control. Another factor could be the season of the year (may-June, 2004) corresponding to the peak of rainy season, which was marked by extreme wetness and cold. The naked neck individuals (ExNa and NaxE) who had the highest brooding mortality also recorded the highest (15.6 and 21.6%) rearing phase mortality, respectively. High chick mortality and reduced hatchability for the naked neck genotype has been reported by Horst[3,28]. These workers have shown that birds possessing the naked neck gene manifest reduced liveability at both embryonic and post hatch stages of life. This situation is said to be even severe in birds carrying double doses (homozygous) naked neck genes.

Table 2 and 3 show body weight and some linear body measurement (LBMs) taken on cockerels and pullets separate at 18weeks of age. As was observed for body weight in Table 1; the reciprocal crossbred (males and females) weighed significantly ($p<0.05$) heavier than their main cross counterparts. Their observed superiority for instance NLxE versus ExNL, NaxE versus ExNa, FxE versus ExF were 45, 23 and 58%, respectively for cockerels and 59, 32 and 62%, respectively for pullets. They reciprocal crossbreds also had longer body, wing, keel and broader breast but not longer shanks than their main cross counter-parts. The importance of short shanks in developing meat type chicken with good body conformation.

In Table 2 and 3, there was evidence of sexual dimorphism for body weight and the LBMs within genetic groups and this is line with common knowledge. This phenomenon in poultry and ducks has been attributed to differences in hormonal profile, aggressiveness and dominance of males over females especially when both sexes are reared together[2,29,30]. It is noteworthy to mention that the FxE group (males and females) showed superiority in all measured growth parameters. This genetic group seems to hold a promise for breed development and depicts the frizzle gene as a favourable productive adaptability gene in the humid tropical environment. In general, there was strong maternal influence in the expression of the growth traits in the main and reciprocal crossbreds with each group tending towards the dam-of-origin. The reciprocal crossbreds outperformed their main cross counterparts in most of the parameters evaluated. Among the reciprocal crosses, the FxE individuals (cockerels and pullets) showed marked improvement in body weight and linear body parameter development. This seems to indicate that the frizzling gene in the reciprocal crossbred may be advantageous in producing fast growing meat-type chickens in the humid tropical environment.

REFERENCES

1. Horst, P., 1988. Native fowls as reservoir for genome and major genes with direct and indirect effects on the productive. adaptability Proc. XVIII Worlds Poultry Congress, Nagoya, Japan, pp: 99-105.
2. Ibe, S.N. and U.F. Nwohu, 1999. Influence of naked neck and frizzle genes on early growth of chickens Proc. 26th Annual NSAP Conference, Ilorin, Nigeria, pp: 292-295.
3. Horst, P., 1989. Native fowl as reservoir for genomes and major genes with direct and indirect effect on adaptability and their potential for tropical oriented breeding plans. Arch. Geflugella, 5313: 63-69.
4. Ibe, S.N., 1990. Utilizing local poultry resource in Nigeria. Proc. 4th World Congress on Genetics Applied to Livestock Production. Edinburgh XVI, pp: 51-53.
5. Merat, P., 1990. Pleiotropic and Associated Effects of Major Genes. In: Poultry Breeding and Genetics, R.D Crawford, Ed. Elsevier Science publishers, The Netherlands, pp: 429-468.
6. Mathur, P.K. and P. Horst, 1990. Single and combined effects of tropically relevant major genes on performance of layers. Proc. 4th World Congress on Genetics Applied to Livestock Production. Edinburgh, XVI: 68.
7. Van Harren-Kiso, A., P. Horst and A.V. Zarate, 1992. Genetic and economic relevance of the autosomal, incompletely dominant frizzle gene F_1. In: Proc. 19th World's Poultry Congress, Amsterdam, The Netherlands, pp: 66.

8. Ibe, S.N., 1992. Incorporating adaptability genes in poultry breeding programmes in Nigeria. Proc. XIX, Worlds Poultry Congress, Amsterdam, The Netherlands.
9. Buvanendran, V., 1979. Development of National Poultry Foundation Stocks. In: Olomu, J.M. *et al*; (Eds.) Poultry production in Nigeria, pp: 144-162.
10. Omeje, S.S.I. and C.C. Nwosu, 1984. Heterosis and superiority in body weight and feed efficiency evaluation of exotic parent stock by local chicken. Nigerian J. Gene., 5: 11-26.
11. Oni, O.O., B.V. Abubakar, I.A Adeyinka, B.I. Nwagu, A.A. Sekoni, S.O. Ogundipe and F. Abeke, 1998. Comparison of the Performance of NAPRI-Bred Commercial Layer Strain Under Different Ecological Zones of Nigeria. In Oduguwa *et al*; (Eds). Proc. of Silver Jubilee Annual Conf. of NSAP and Inaugural Conf. of WASAP, Nigeria, pp: 21-26.
12. Nwagu, B.I. and C.C. Nwosu, 1993. Effect of crossbreeding on some conformational characteristics of the local chickens of Nigeria. Ind. J. Anim. Sci., 63: 662-664.
13. Nwugu, B.I. and C.C. Nwosu, 1994. Growth performance of F_1 crosses between Arbor Acre broilers and local chicken of Nigeria. Ind. J. Anim. Sci., 64: 651-653.
14. Lake, P.E., O. Ravier and D. Naddington, 1985. Some effects of the composition of ineminated semen and the site of its deposition and fertility in Gallus domesticus. Anim. Reprod. Sci., 9: 273-284.
15. Ibe, S.N. and E.N. Nwachukwu, 1988. Effect of feed restriction on broiler performance: conformation traits and isometry of growth. Nig. J. Anim. Prod., 15: 177-184.
16. SPSS, 2001. Statistical Package for Social Science and facilities for release. McGraw-Hill Book Co. New York.
17. Gomez, A.K. and A.A. Gomez, 1984. Statistical Procedure to Agriculture Research. 2nd Edition John Wiley and sons Inc. New York USA.
18. Oluyemi, J.A., 1979. Selection of the Nigeria indigenous fowl for 12 week body weight. Nigerian J. Anim. Prod., 6: 15-20.
19. Nwosu, C.C. and B.O. Asuguo, 1985. Body weight improvement in the local chicken. Proc. 10th Annual Conference Nigeria Soc. Anim. Prod., Ile-Ife, Nigeria.
20. Ibe, S.N., 1993. Growth performance of normal, frizzle and naked neck chickens in a tropical environment. Nig. J. Anim. Prod., 20: 25-30.
21. Fairfull, R.W., 1990. Heterosis. In Poultry Breeding and Genetics (Ed. R.W. Crawford). New York: Elsevier Sci., pp: 913-933.
22. Tuiskula-Haavisto, M., D.J. De Koning, M. Honkatukia, N.F. Schulman, A. Maki-tanila and J. Vilkki, 2004. Quantitative trait loci with parent-of-origin effects in chicken. Genet. Res. Camb., 84: 57-66.
23. Guilaume, J., 1976. The dwarfing gene dw: its effects on anatomy, physiology, nutrition management: Its application in poultry industry. Worlds Poult. Sci. J., 32: 285-304.
24. Ducuypere, E.L.M., E.R. Huybrechts, M. Kuhn, Tixier-Biochard and P. Merat, 1991. Physiological alterations associated with the chicken sex-linked dwarfing gene. Critical Rev. Poult. Bio., 3: 191-221.
25. Yeasmin, T., M.A.R. Howlider and M.U. Ahamad, 2003. Effect of introgressing dwarf gene from Bagladeshi indigenous to exotic breeds on egg production. Intl. J. Poultry Sci., 2: 264-366.
26. Cahanaer, A. and F. Leenstra, 1992. Effect of high temperature on growth and efficiency of male and female broilers from lines selected for high weight gain, favourable feed conversion and high or low fat content. Poultry Sci., 71: 1237-1250.
27. Nwachukwu, E.N., S.N. Ibe and K.C. Onyeocha, 2005. Growth performance of F_1 crosses of normal local, naked neck and frizzle chicken x Arbor Acre broiler breeder stock in a humid tropical environment. Proc. 30th Ann. Conference of Genetics Society of Nigeria. Nsukka Nigeria, pp: 85-87.
28. Peters, S.O., E.A. Omidiji, C.O.N. Ikeobi, M.O. Ozoje and O.A. Adebambo, 2004. Effects of naked neck and frizzle genes on egg traits, fertility and hatchability in local chicken. Proc. 9th Ann. Conf. Anim. Sci. Assn. of Nig. (ASAN). Abakiliki, Nigeria.
29. Kalita, N., D. Sarma, J.K. Taluder, N. Barus and N. Ahmed, 2004. Comparative performances of Khaki Campbell ducks, Desi and their reciprocal for certain economic traits in rural conditions. World Poult. Sci. J., pp: 349-355.
30. Ogah, D.N., S.I. Daikwo and N.G. Ehiobu, 2005. Sexual dimorphism in some phenotypic traits of three breeds of duck. Proc. 30th Annual conference of Genetics society of Nigeria Nsukka. Nigeria, pp: 141-143.
31. Cahaner, A., 1944. Poultry improvement: Integration of present and new genetic approaches for broilers. In; Proc. 5th world congress on genetics applied to livestock production, Guelph on, Canada, pp: 25-32.