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Research Paper

Estimation of heritability and genetic correlation of body weight gain in the indigenous and exotic turkey

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Abstract
This study was conducted to evaluate the genetic parameters of growth traits on the exotic (White Nicholas), Nigerian indigenous black and Nigerian indigenous white genotypes of turkey.The specific objectives were to: estimate the heritability and genetic correlation of growth traits in the three turkey genotypes.This research was conducted at UmuchigboIji Nike, Enugu, Enugu East local government area. A total of 100 random bred and unselected male and female turkeys comprising the exotic (White Nicholas), local black and local white genotypes formed the base population. 27 males and 48 females comprised the acquired stock used for the research. The birds that formed the base population were raised till maturity to generate progenies that were used for the actual research. A total of nine mating groups was used for the research, weighing (body weight) was done 4th weekly from day old till 12weeks. Heritability (h^2) of body weight and genetic correlation (r_G) for body weight between day old and body weights at 4, 8 and 12weeks was done. h^2 was calculated using paternal half sib (Becker, 1992) and genetic correlation was calculated using covariance and variance of weight at day old with body weights at 4, 8 and 12 weeks respectively.The h^2 at day old was mostly low ranging from 0.14 – 0.34 owning to the fact that common environmental effects were remarkable at day old. h^2 was high between 4weeks to12weeks ranging from 0.34 – 0.89 but the highest heritability average when comparing all ages was at 12weeks meaning there will be high response to selection for body weight and genetic progress determination at 12weeks.Average heritability of body weight at day old was 0.23 whereas from 4 – 12 weeks it was 0.61. Genetic correlation(r_G)was generally high and positive for all ages ranging between 0.10 – 0.84 meaning that as the animal gets older, body weight increased. This means that the difference in live weights was mainly due to physiological factor which increases as the birds get older. However, being a genetic tool and a key parameter for determination of response to selection in our indigenous genetic stock when given a chance for selection.

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I. Introduction

Nigeria is a country with very heavy population density which depends wholly or partially depends on agricultural products for her livelihood with little or zero contribution to it. However, as the population rises, the cost of living in the countries equally rises and it becomes intense by the day. Nigeria is grossly underprovided with essential food components like protein which is important for the development of human potentials both mentally and physically (Nextzon, 2017).

Turkey production is seen as a realistic approach to counter the animal protein deficit in the diets of Nigerians which the indigenous breeds can greatly contribute too. The indigenous breeds however are well adapted to the extensive husbandry conditions with very low level of inputs, disease resistance and tolerance to climatic changes (FAO, 2007) are neglected and poorly described or characterized. They are basically non-descript types vary widely in body size, conformation and other phenotypic characteristics with a better survivability and adaptability under different production systems when compared to exotic breeds of turkey. The

local genetic resources are becoming seriously endangered owing to the high rate of genetic erosion because of mainly negligence due to the extensive and random distribution of exotic turkey breeds by both governmental and non-governmental organizations which are believed to dilute the indigenous genetic stock. If this trend continues, their gene pool could be lost in the nearest future before they are properly described, utilized, studied and conserved. Therelevance of turkeyconservation / improvement was a reason to design this study for the estimation of heritability and genetic correlation of body weight gain in indigenous and exotic turkeys.

Justification of the study

Considering turkey based onmeat availability and low cholesterol level when compared to most animal protein sources, feeding on diets as low as 16.5% crude protein at maturity (Nutrient requirement of Poultry, 2009) which is very affordable when compared to otherpoultry families.

On the other hand, the high rate of genetic erosion of indigenous AnGR's calls for sustainable research on our indigenous genetic stock because of their general hardiness and potential source of important genes controlling some economic traits. There is limited information on this subject with regards to turkey species thereby making the formulation of Nigerian Indigenous turkey breeding program difficult mainly because Nigerians have given limited attention to the characterization and classification of indigenous turkey genotypes and research is at its rudimentary stage for the identification, description and evaluation of these genetic resources. The genetic characterization in the present study will provide a baseline data for the breeders in-terms of genetic improvement of our indigenous turkey genotype and for decision and precision making processes towards the total conservation and preservation of Nigerian Indigenous turkey genetic resources.

II. Materials and methods

Location of the study: The experiment was be carried out at UmuchigboIji - Nike, Enugu East, Enugu state and is located on Longitude 6^0 32'N´ and latitude 7^0 32'E´ at an altitude of 430m above sea levels (Wikimedia 2020). Enugu is in a tropical rain forest zone with a derived savannah (SME Draft Final Report, 2016). Average diurnal minimum temperature ranges between 20 – 23.9^{o}c while the average maximum temperature ranges between 32.8 – 36.7^{o}c (Sanni, 2007).

Parent population: Study population was based on two genetically different turkey genotypes which are the Nigeria Indigenous breeds (both white and black) and the exotic (white Nicholas turkey).

A total of 100 unselected random bred males and females of the indigenous and exotic day-old poults were purchased, and the study population had generated them.

Breeding procedure: Mating was by artificial insemination in the mating ratio of one Sire to two Dams for the three genotypic groups. The table below is the arrangement of mating group pattern**.**

Mating Groups	Breeding groups	Number of breeding Turkeys Male	female	Mating ratio Male	female	Number of Pens
1	Exotic turkey ♂ X Exotic turkey ♀	3	6	1	: 2	3
2	Local white turkey ♂ X Local white turkey ♀	3	6	1	: 2	3
3	Local black turkey ♂ X Local black turkey ♀	3	6	1	: 2	3
4	Exotic turkey ♂ X Local white turkey ♀	3	6	1	: 2	3
5	Exotic turkey ♂ X Local black turkey ♀	3	6	1	: 2	3
6	Local black turkey ♂ X Local white turkey ♀	3	6	1	: 2	3
7	Local white turkey ♂ X Exotic turkey ♀	3	6	1	: 2	3
8	Local white turkey ♂ X local black turkey ♀	3	6	1	: 2	3
9	Local black turkey ♂ X Exotic turkey ♀	3	6	1	: 2	3

Management of experimental animals

Both the parents and F_1population were brooded with Anak broilersto stimulate and enhance them towards proper feeding and movement towards heat source. Brooding procedures, medications and vaccinations were strictly adhered to minimize stress and mortality. Brooding `lasted for 6 weeks. Each genotype wasbrooded and reared in different pens. The parents were allowed to get to full sexual maturity (between 24 – 26 weeks) before the females from each group were inseminated bi-weekly through artificial insemination with a gap of maximum of 3days to generate the experimental population (F_1). The eggs generated from different mating groups were tagged before incubation, which was according to Hawkins, (2021) procedure. Weighting was done fourth weekly beginning from day old till 12weeks. At the poult stage, they were placed on starter ration (24% crude protein) for a period of 2months after which their diet was changed to finisher ration (crude protein between 21 – 22%) which continued till they laid the first egg then layers ration (crude protein between 15 – 18%) was then resumed.

Data collection: Body weight

Body weights were taken from day old and subsequently 4weekly (4, 8 and 12weeks).

Heritability (h^2) and genetic correlation estimation: The $h^2$was done by using the paternal half sib heritability while the later was achieved using the Full-sib correlation estimate.

Experimental design

Fourweekly data collected from growth rate were analysed using one way analysis of variance in a completely randomized design (CRD) according to SPSS., (2017). Mean values with significant differences were separated using Duncan's Multiple Range Tests (Duncan 1955).

Statistical model used

$Y_{ij} = \mu + S_i + e_{ij}$

Where Y_{ij} = observation on the j^{th} progeny of the i^{th} sire, μ = population mean, S_i = i^{th} sire effect on the progeny and e_{ij} = random error associated with the experimentation.

III. Result and discussion

Mean body weight measurements (in grams)

S/N	mating groups	mean body weight measurements (in grams)			
		Dayold	**4weeks**	**8weeks**	**12weeks**
1	E X E	51.25 ± 0.15^{c}	180.61 ± 1.05^{c}	2610.09 ± 44.59^{c}	3942.83 ± 10.34^{b}
2	E x LW	45.93 ± 0.17^{b}	172.15 ± 1.3^{b}	2226.09 ± 8.56^{b}	3050.21 ± 10.48^{b}
3	E X LB	40.27 ± 0.24^{b}	146.53 ± 0.44^{b}	1793.47 ± 1.19^{a}	3141.73 ± 2.90^{a}
4	LB X LB	37.35 ± 0.18^{a}	110.15 ± 1.46	495.78 ± 9.56	1126.71 ± 5.20
5	LB X E	40.37 ± 0.15^{b}	121.37 ± 0.85^{a}	1171.64 ± 1.6^{a}	2016.16 ± 1.27^{ab}
6	LB X LW	39.83 ± 0.29^{b}	117.42 ± 0.38^{a}	674.69 ± 1.05	1212.67 ± 1.22^{ab}
7	LWX LW	43.67 ± 0.17^{b}	112.69 ± 1.31^{a}	814.12 ± 8.56^{a}	1823.03 ± 10.48^{a}
8	LW X E	44.27 ± 0.18^{c}	159.72 ± 0.55^{b}	1391.99 ± 1.29^{ab}	2105.89 ± 9.93^{ab}
9	LW X LB	38.27 ± 0.11^{a}	117.15 ± 0.28	764.41 ± 1.93^{a}	1326.78 ± 7.43^{a}

a, b and cimply means of progenies of each group at significant differences of 5%, E means exotic groups, LB means local black group while LW means local white groups.

The above result showed significant differences in body weight measurements of progenies groups for crosses between the pure exotic X local white, local black X exotic, pure exotic, exotic X local black, local white X exotic and pure local white crosses all were significant ($p < 0.05$) at all ages. Local black X local white was significant only at day old and 4-week, pure local black crosses was significant only at day old which shows the variation in weight as their age increased was because of its genetic makeup and finally local white X local black was significant at all ages except at 4^{th} week. This consistent significance difference in body weights at day old is mainly attributed to the fact that body weight at day old is affected by maternal effect. However, weight at day old might positively affect weights at different ages under proper management. The pure exotic and pure local white crosses exhibited significant differences ($p < 0.05$) at all ages showing the exotic genotype are possibly a product of genetic improvement from the indigenous local white as local black would have resulted to varying shades. This simply shows that under intense selection for growth trait that the two local genotypes can be used successfully for improvement or upgrading programs especially for the local white genotype as seen to have better response to selection effect. Body weights of the pure exotic turkeys was significant ($P < 0.05$) higher than that of the crosses at all ages. The body weights increased with increase in age of the birds in all the genotypes. The exotic turkeys were observed to have consistently higher mean values in body weights than its counterparts and the crosses between the exotic sires outperformed the others followed by the crosses of the local white sires. The differences and superiority exhibited by the exotic turkeys confirmed it has a better growth potential than the local genotypes. This is due to the exotic breeds had gone through intense selection for higher growth rate. The implication of these acquired attributes for the cross bred is that they could be further screened as possible genotypes for tropical turkey breeding development /improvement program / upgrading program. On the other hand, there is need to pursue more vigorous crossbreeding, selection and improvement of the local turkey genotypes to improve in the growth potentials of our indigenous breeds. This huge variation in body weight of the exotic genotypes when compared to the indigenous genotypes is attributed to the genetic metamorphosis that must have happened in the exotic turkey breeds. Knowing that our indigenous genotypes have a great diversity as in its adaptation to harsh environmental conditions in-addition to disease resistance ability, this diversity can serve as a base for the creation of foundation stock for the Indigenous turkey genotypes. A concomitant improvement in husbandry and management conditions will result to a net improvement in the Indigenous stock and at the end make it a source of cheap meat and quality protein.

Heritability (h^2) estimate of body weight from day old to 12weeks for all the mating groups

s/n	mating groups	day old	4weeks	8weeks	12weeks
1	E X E	0.18 ± 1.28	0.74± 6.63	0.89 ± 1.13	0.66 ± 5.70
2	E X LW	0.28 ± 1.61	0.57 ± 6.82	0.54 ± 3.46	0.65 ± 5.32
3	E X LB	0.34 ± 1.80	0.42 ± 6.70	0.50 ± 5.12	0.84 ± 1.57
4	LB X LB	0.14 ±1.33	0.58 ± 3.76	0.65 ± 1.50	0.59 ± 1.91
5	LB X E	0.20 ± 0.75	0.52 ± 4.42	0.51 ± 2.09	0.67 ± 3.05
6	LB X LW	0.28 ± 4.84	0.40 ± 5.87	0.76 ± 6.42	0.58 ± 4.7
7	LW X LW	0.12 ± 3.22	0.40± 1.16	0.69 ± 4.86	0.70 ± 4.70
8	LW X E	0.19 ± 2.03	0.51 ± 1.78	0.58 ± 2.98	0.85 ± 5.80
9	LW X LB	0.32 ± 3.10	0.34 ± 1.75	0.55 ± 1.59	0.74 ± 5.79
Mean h^2		0.23± 2.01	0.50 ± 4.3	0.63 ± 3.24	0.70 ± 4.29

Above result shows the heritability of body weight from day old to 12 weeks for all the genotypes ranged between 0.12 to 0.89 which was in line with Okoro *et al.*,(2017) whose heritability ranged between 0.01 - 0.20 for day old poults. Also, according to Arthur and Abplanalp (2014) whose heritability range was averagely 0.41. Also, similar result was reported by Buss (1999), who observed heritability in the range of 0.23 to 0.71 for body weight traits at different ages of turkeys.

According to Muhammad *et al.* (2011b), body weight traits at day 40, 60, 80 and 120 were found to be highly heritable; with heritability estimates (h^2) of 0.32, 0.39, 0.42, and 0.40 respectively and at day 1 and 17 days were found to have low heritability with estimates of 0.0 and 0.12 respectively. This implies that the average heritability in their study for body weight traits was 0.38, except for early weights that were strongly affected by maternal effects. Also, Kranis*et al.* (2006) and Nestor*et al.* (2000) also found high heritability for body weight at various ages, ranging from 0.28 to 0.48 respectively which was also within the ranges in my study. Nestor *et al.* (2000) equally reported that the un-weighted averages of published narrowed sense heritability estimates of body weight in selected population of turkey birds were 0.40, 0.42, 0.43 and 0.36 for birds in the age groups 0 to 8, 9 to 16, 17 to 24 and over 24 weeks respectively. From the heritability table 11 above, highest heritability estimate for all ages was at 12 weeks which means there will be high response to selection for body weight at 12weeks and to determine genetic progress for the three turkey genotypes.

According to Liu *et al.* (2003), body weight (BW) traits were found to be influenced by not only genetic effects but also common environmental or sometimes maternal effects too. Strong positive genetic correlations were found between the 16-wk BW and BW at other ages (8, 20, and 24 wks. of age). The average heritability estimate for body weight traits was 0.38, except for early weights that were strongly affected by maternal effects. This study showed that body weight traits and upper asymptote (a growth curve trait) had high heritability.

Estimates of genetic correlation (r_g) of body weights at different ages for the mating groups (day old to 12weeks)

Mating groups		Day old	4weeks	8weeks	12weeks
E X E	Day old	1.00	0.75	0.52	0.64
	4weeks	0.24	1.00	0.53	0.61
	8 weeks	0.20	0.53	1.00	0.66
	12 weeks	0.19	0.61	0.63	1.00
E X LW	Day old	1.00	0.61	0.53	0.49
	4weeks	0.21	1.00	0.86	0.81
	8 weeks	0.15	0.52	1.00	0.71
	12 weeks	0.11	0.81	0.71	1.00
E X LB	Day old	1.00	0.49	0.68	0.54
	4weeks	0.14	1.00	0.62	0.64
	8 weeks	0.20	0.64	1.00	0.52
	12 weeks	0.21	0.46	0.59	1.00
LW X LW	Day old	1.00	0.74	0.60	0.69
	4weeks	0.13	1.00	0.70	0.61
	8 weeks	0.19	0.70	1.00	0.74
	12 weeks	0.14	0.61	0.74	1.00
LW X LB	Day old	1.00	0.78	0.63	0.52
	4weeks	0.19	1.00	0.66	0.64
	8 weeks	0.20	0.66	1.00	0.95
	12 weeks	0.12	0.64	0.95	1.00
LW X E	Day old	1.00	0.60	0.51	0.59
	4 weeks	0.15	1.00	0.84	0.88
	8 weeks	0.13	0.62	1.00	0.84
	12 weeks	0.11	0.88	0.84	1.00
LB X LB	Day old	1.00	0.73	0.66	0.84
	4 weeks	0.14	1.00	0.50	0.59
	8 weeks	0.20	0.50	1.00	0.61

	12 weeks	0.19	0.54	0.59	1.00
LB X LW	Day old	1.00	0.63	0.72	0.88
	4 weeks	0.14	1.00	0.88	0.73
	8 weeks	0.12	0.55	1.00	0.69
	12 weeks	0.12	0.72	0.59	1.00
LB X E	Day old	1.00	0.84	0.81	0.52
	4 weeks	0.14	1.00	0.83	0.93
	8 weeks	0.20	0.83	1.00	0.94
	12 weeks	0.10	0.93	0.91	1.00

Table above shows the genetic correlation in the study was high and positive in all body weight except at day old for all the mating groups ranging between 0.11– 0.98 which concurs with the report of Okoro *et al.,* (2017) and Singh *et al.,* (2003) which states that genetic correlations (r_G) among body weights were positive and Muhammad *et al.,* (2011b) also reported a strong positive correlation existed between body weights at different ages. They found high positive genetic between body weights at different ages.

Recommendation

i. New era of turkey production which should be completely dependent on the Indigenous stock be established in our country through selective, purposeful and scientific crossbreeding work by geneticist to enhance vigour of the Indigenous turkeys

ii. Proper conservation of Indigenous stock is recommended for upgrading with exotic breeds having in mind their good potentials.

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