VARIABILITIES IN GROWTH, CARCASS AND ORGAN TRAITS OF TWO CHICKEN BREEDS NATURALLY INFECTED WITH COCCIDIAL OOCYTES

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ABSTRACT

The overwhelming impacts of coccidial infection on poultry production and profitability have been reported in many studies. Hence, this study was conducted to evaluate the variations in body morphometry of Abor Acre and FUNAAB Alpha chickens naturally infected with coccidial oocytes. Two hundred day-old chicks at 100 equal numbers were raised for eight weeks. Body morphometric data were collected weekly. At about week three, experimental birds came down with coccidiosis as birds were not pre-vaccinated against it. At the end, 40 birds at 20 per breed were randomly selected for the collection of carcass and organ data. Results showed significant differences (p<0.05) between Abor Acre and FUNAAB Alpha chicken breeds for live weight and linear body traits except chest circumference. The Abor Acre breed significantly weighed (p<0.05) heavier (1.54 ± 0.02 kg) than the FUNAAB Alpha (0.65 ± 0.02 kg) breed. Variations in body traits of the chicken' sexes showed that male chickens significantly weighed (p<0.05) heavier and were found longer in most linear traits than their female counterparts. The interaction between breed*sex indicated that live and dress weights were significantly different (p<0.05) especially for breast and thigh tissues which are major economic body parts. Similar trend was observed among carcass and organ variables were breed, sex and their interactions were significantly different (p<0.05) for most parameters. In conclusion, Arbor Acre breed had better growth carcass and organ performance than FUNAAB Alpha chickens when infected with coccidial oocysts. Abor Acre chickens should be recommended to poultry farmers in coccidial endemic locations.

Keywords: Growth performance, Coccidial infection, Breeding programmes, Poultry species, Indigenous chickens

INTRODUCTION

Growth is one of the major characteristics of all living organism that involves dynamic physiological changes which commences when the zygote is formed at the moment of fertilization and continues till maturity of the individual (Oleforuh-Okoleh *et al.,* 2017). Kor *et al.* (2006) noted that growth in all animals apart from relating to increase in body cells and volume is a complex process controlled by both genetic and non-genetic factors. Growth performance is a phenotypic attribute in animals that is largely influenced by the environment but fundamentally the manifestation of genetic constitution of the animal (Oleforuh-Okoleh *et al.,* 2017).

Researchers in the poultry industry have attempted to identify the relationship that exist between body conformation in different breeds of broiler chickens such as shank length, breast width, neck length, back length and thigh length, as these features are associated with the performance of the broiler chickens (Azua *et al.,* 2022). This endeavour intends to create an efficient breeding programme that would generate optimal conformation for highest economic return. It is known that body weight and conformation traits are reliable predictors of the body growth and commercial value of broiler chickens (Yahaya *et al.,* 2012). May *et al.* (2000) reported that breeding programs are generally focused on these profitable traits. Growth performance and body conformation traits are therefore important parameters in assessing the potential of genetic improvement and development of any livestock breed. Such knowledge is essential in planning breeding programmes and in adopting breeding strategies (Oleforuh-Okoleh *et al.,* 2017). They are also essential in poultry production being fundamental attributes for assessing growth and feed efficiency as well as important yardstick in management and economic decision making (Assan, 2015). Body weight is usually used as a measure of growth in farm animals; however numerous studies have shown that other growth traits relating to the body morphometric measurements such as body length, shank length and chest girth can serve as good indicators of growth (Ige, 2013; Yunusa and Adeoti, 2014; Atansuyi *et al*., 2017). Thus, body morphometric measurements have been used to describe body conformation and predict live weight, examine relationship among economic traits, evaluate breed and reproductive performance and to study interactions between heredity and environment (Chineke, 2005; Atansuyi *et al*., 2018a). The use of linear body measurements from farm animals may serve as a basis in poultry and livestock production for selection of chicks for breeding. A number of conformation traits are known to be good indicators of body growth and market value of chickens apart from body weight (Abdel–Lattif, 2019). Body weight and morphometric traits like body length and shank length have been reported to have great influence on growth performances of broiler (Patbandha *et al*., 2017).

The poultry industry plays a significant role in providing protein to the global population. However, it faces numerous challenges, including coccidiosis, which is one of the diseases that affects the productive performance of poultry chickens (Mesa-Pineda *et al.,* 2021). The disease is caused by the ingestion of sporulated oocysts, which can lead to various negative effects such as malabsorption, growth reduction and increased mortality (Chapman, 2014). The control of coccidiosis involves the use of several strategies, including farm level management practices, vaccines, as well as traditional and natural anticoccidials (Shivaramaiah *et al.,* 2014).

Exotic chickens are noted for their high productive efficiency in terms of growth rate. Researchers have shown that local chicken genotype possesses great potentials for genetic improvement through selection and breeding programs (Amao, 2017; Adebambo, 2018; Adebambo *et al*., 2018). Crossbreeding of local breeds of poultry with their exotic stocks will take merits of systematic scientific selection for productivity in the exotic birds and hardiness in the local birds. The call for the improvement and development of chicken breeds that are adaptive to tropical climate such as Nigeria led to the development of the FUNAAB Alpha chicken breed (broiler and dual purpose). The breed was developed at the Federal University of Agriculture, Abeokuta, Nigeria, using the Naked and Frizzled feather chicken genotype (broiler type) having over six generations through cross breeding with some exotic lines to maximize growth and their productive performance (Adebambo, 2018; Adebambo *et al*., 2018). Therefore, this study was carried out to evaluate the growth performance of Abor Acre and FUNAAB Alpha chicken breeds exposed to natural coccidial infection which is a common occurrence in many poultry farms.

MATERIALS AND METHODS

Location of the Study: The study was be carried out at the Poultry Unit of the Teaching and Research Farm, The Federal University of Technology, Akure, Ondo State, Nigeria with Latitude 07° 16[1] and 07° 18[1] N and Longitude 05° 09[1] and 05° 11[1] E. There is a unimodal rainfall pattern which starts from April to October with about 1556 mm per annum in the state. The average ambient temperature is about 30 - 32°C and relative humidity of 80% (Daniel, 2015).

Pre-Experimental Management: The brooder's house was cleaned with Lysol disinfectant and partitioned according to the design of the experiment. All necessary materials for brooding were provided before the arrival of chicks. On arrival, the chicks were tagged individually at the wings for ease of identification, weighed and distributed at 10 birds per replicate based on their sexes. All routine and occasional management practices were strictly adhered to during the period of this study.

Ethics: All birds used for the experiment were handled according to the EU Directives 2010/63/EU for laboratory animal experiments (European Union, 2010).

Experimental Layout and Feeding: A total of 200 Abor Acre and FUNAAB Alpha chicken breeds at 100 birds each were used for the experiment that lasted for eight weeks. The FUNAAB Alpha and Abor Acre chicken breeds were obtained respectively from FUNAAB Hatchery and FUNTIS Hatchery, Abeokuta, Ogun State, Nigeria. Having divided the birds into two breeds at 100 birds, each breed was equally halved into two at 50:50 male to female ratio during brooding period. At the 5th week, the two chicken breeds were further divided into 20 replicates at 10 birds for the experimental period. Two commercial diets (Hybrid Feeds, Kaduna) of 21% crude protein and 3000 KJ/kg (starter), and 20% crude protein and 2800 KJ/kg (finisher) were purchased from a reputable source. The birds were fed *ad-libitum* during the period of the experiment. The design of the experiment was a 2 x 2 factorial in completely randomized arrangement. The breeds and sex were regarded as the fixed and random factors respectively.

Monitoring of Birds with Coccidial Oocysts: Poultry birds are natural hosts to *Eimeria*, the birds used for this experiment were not treated against the invasion of this protozoa. Therefore, birds were closely monitored for coccidial symptoms at week three when they naturally came down with coccidial infection and left to recover naturally without intervention. The litters were regularly changed to reduce coccidial load of experimental birds.

Determination of Growth and Body Morphometric Data: Measurements of body weight and linear body traits were done every week. The body weights of the chickens were measured in grammes using electronic sensitive scale (5 kg maximum weight), while the linear body components such as shank length, wing length, trunk length and drum sticks length were taken in centimetre using graduated measuring tape. All measurements were recorded appropriately for data entry and analyses. Data collected were used to evaluate the chickens' breed for growth and linear body characteristics.

Determination of Carcass Characteristics: Ten chickens were randomly selected from each breed at week eight for carcass evaluation. The birds were fasted overnight while weighing and recording was carried out very early the following morning. This is followed by slaughtering and manual defeathering. The dress, carcass such as the head, neck, wing, breast, shank, drumsticks, back etc. and organ such as the heart, lungs, liver, gizzard weights were measured using sensitive scale (5 kg maximum weight). The breed, sex and interactions of the results in the present study were included in the texts as appropriate.

Statistical Analysis: Data collected on body weight, linear body morphometry, carcass and organ weights were subjected to factorial analysis using statistical software package SAS (2018). Duncan Multiple Range Test of the same statistical package was used to separate significant treatment means at probability level of 0.05. Breed and sex differences were analysis using Student's t-test without fixing the probability level.

RESULTS

At about week three, all experimental birds came down with coccidiosis, with obvious associated clinical signs, as indicated by the post mortem analysis conducted on the ceca.

The results of body weight and linear body morphometric traits for the two chicken breeds naturally infected with coccidial oocysts showed that there were significant ($p<0.05$) variations between the body weight and linear body morphometric characteristics except chest circumference which was not significant ($p>0.05$) and where the FUNAAB Alpha and Abor Acre breeds values were 21.80 ± 2.17cm and 27.15 ± 2.17cm respectively (Table 1). The interaction between breed and sex showed a significant ($p<0.05$) variation for the live weight, dress weight, wing and shank length.

Table 2 showed the carcass characteristics of Abor Acre and FUNAAB Alpha chicken breeds naturally infected with coccidial oocysts. In this study the result of the genotypic effect revealed that Abor Acre chickens had a significantly ($p<0.05$) higher morphometric traits than FUNAAB Alpha chickens. Also, the sex effect showed a significant difference ($p<0.05$) in the thigh and breast weights with 102.83 ± 5.23g and 176.83 ± 6.38g for FUNAAB Alpha, and 123.68 ± 5.23g and 213.33 ± 6.38g for Abor Acre respectively. With the economic importance of these parts, they are good pointers for improvement purposes if selected for in future breeding policies and could aid famers' profitability value chain margin. Apart from head, chests and thigh which showed significant differences ($p<0.05$) for the interaction between breed and sex, other carcass parts were not significant ($p>0.05$).

The organ weight of two chicken breeds naturally infected with coccidial oocysts shown in Table 3 indicated that there was significant difference ($p<0.05$) among all the internal organs except the spleen, where Abor Acre exotic chickens had significantly ($p<0.05$) higher values than the FUNAAB Alpha chicken breeds. The interaction between breeds and sex showed no significant difference ($p>0.05$) between the parameters. However, Abor Acre male chickens expressed larger internal organs than their FUNAAB Alpha counterparts.

DISCUSSION

Experimental birds had coccidial infection with notable signs such as ruffled feathers, droopiness, and blood in their droppings as indicated by the postmortem examination of the ceca of the dead birds. The infected birds were left to recover naturally. Pop *et al.* (2019) had reported the natural infection of chicken with *Eimeria* species and the efficacy of the control of coccidiosis using herbal formulations.

Nweke-Okorocha *et al*. (2020) showed that breed significantly affects carcass parameters of chicken; the exotic strain had a higher carcass yield than it improved indigenous strain. This can be further explained with the report of Ojedapo *et al.* (2015) where they opined that genetic makeup of chicken breeds influences carcass parameters such as head, neck, breast, thigh weight, wing, back and shank. Furthermore, Atansuyi *et al.* (2018b) reported that exotic chicken strains performed better than the Nigerian indigenous strains where they recorded highest values for final weight gain (3569.73 g) and total weight gain (3530.00 g), while indigenous normal feather strain had the lowest final weight (1391.11 g). The result of this study where Abor Acre chicken breed significantly ($p<0.05$) had higher values than FUNAAB Alpha breed were in agreement with Ojedapo *et al.* (2015), Atansuyi *et al.* (2018b) and Nweke-Okorocha *et al*. (2020). Although, the result obtained in this study was lower (1650 vs. 650 g) than the report of Atansuyi *et al.* (2017), this may be as a result of the coccidial infection of the experimental birds in this study. Ogunpaimo *et al*. (2020) reported that the interaction between genotype and sex influences the weight and carcass characteristics of chicken.

Table 1: Body weight and linear body morphometric traits of two-chicken genotypes naturally infected with coccidial oocysts

Factor	Breed	Variation	LW (kg)	SL (cm)	DSL (cm)	WL (cm)	NTS (cm)	STL (cm)	CC (cm)	TL (cm)
Breed	AA	AA	1.54±0.02***	8.78±0.16***	11.08±0.23***	19.08±0.17***	18.68±0.14***	19.00±0.18***	27.15±2.17	3.00±0.00***
	FA	FA	0.65± 0.02	7.10±0.16	8.10±0.23	15.13±0.17	16.13±0.14	16.63±0.18	21.80±2.17	2.50±0.00
Sex	AA + FA	Male	1.13 ± 0.02*	8.13±0.16	9.83±0.23	17.50±0.17	17.61±0.14	18.03±0.18	26.30±2.17	2.75±0.00***
		Female	1.06± 0.02	7.75±0.16	9.35±0.23	16.70±0.17	17.20±0.14	17.61±0.18	22.65±2.17	2.75±0.00
Breed*Sex	AA	Male	1.65 ± 0.03^{*a}	9.25±0.219	11.55±0.33	19.75±0.23^{a}	19.00±0.19^{a}	19.25±0.26	27.55±3.06	3.00±0.00^{a}
		Female	1.43±0.03^{*c}	8.30±0.219	10.60±0.33	18.40±0.23^{c}	18.35±0.19^{c}	18.75±0.26	26.75±3.06	3.00±0.00^{c}
	FA	Male	0.62±0.03^{*b}	7.00±0.219	8.10±0.33	15.25±0.23^{b}	16.2±0.19^{b}	16.80±0.26	25.05±3.06	2.50±0.00^{b}
		Female	0.70±0.03^{*d}	7.20±0.219	8.10±0.33	15.00±0.23^{d}	16.05±0.19^{d}	16.46±0.26	18.55±3.06	2.50±0.00^{d}

*LW = Live weight, SL = Shank length, DS = Drumstick, WL = Wing length, NTS = Nose-to-shoulder, STL = Shoulder-to-tail; CC = Chest circumference; AA = Abor Acre, and FA = FUNAAB Alpha, Asterisk (*) = significant mean thus; * = p<0.05, ** = p<0.01 and *** = p<0.001. $^{a-d}$ Means on the same column for breed & sex with different letter superscript are significantly different (p<0.05)*

Table 2: Carcass weights of Abor Acre and FUNAAB Alpha chicken breeds naturally infected with coccidial oocysts

Factor	Breed	Variation	DWT (kg)	Head (g)	Neck (g)	Wing (g)	Back (g)
Breed	AA	AA	1.43±0.02***	52.40±1.84***	58.03±3.25***	138.13±3.55***	269.20±9.8***
	FA	FA	0.60±0.02	29.58±1.84	17.00±3.25	51.67±3.55	80.54±9.80
Sex	AA + FA	Male	1.05±0.02*	43.65±1.84*	40.40±3.25	98.00±3.55	179.08±9.80
		Female	0.98±0.02	38.33±1.84	34.63±3.25	91.79±3.55	170.67±9.80
Breed * Sex	AA	Male	1.54±0.03^{a}	58.80±2.74^{a}	62.80±4.84^{a}	146.00±5.29^{a}	282.40±13.15^{a}
		Female	1.33±0.03^{c}	46.00±2.74^{b}	53.25±4.84^{a}	130.25±5.29^{a}	256.00±13.15^{a}
	FA	Male	0.57±0.03^{*b}	28.50±2.74^{c}	18.00±4.84^{b}	50.00±5.29^{b}	75.75±13.15^{b}
		Female	0.63±0.03^{*d}	30.66±2.74^{d}	16.00±4.84^{b}	53.33±5.29^{b}	85.33±13.15^{b}
			Breast (g)		DST (g)	Thigh (g)	Shank (g)
Breed	AA	AA	303.70±6.36***		183.355.02***	169.30±5.23	82.10±2.84***
	FA	FA	86.46±6.36		61.75±5.02	57.21±5.23	31.50±2.84
Sex	AA + FA	Male	213.33±6.38*		128.85±5.02	123.68±5.23*	59.10±2.84
		Female	176.83±6.38		116.25±5.02	102.83±5.23	54.50±2.84
Breed * Sex	AA	Male	344.40±8.50^{a}		197.20±6.69^{a}	189.60±6.98^{a}	87.20±3.78^{a}
		Female	263.00±8.50^{b}		169.50±6.69^{a}	149.00±6.98^{b}	77.00±3.78^{a}
	FA	Male	82.25±8.50^{c}		60.50±6.69^{b}	57.75±6.98^{c}	31.00±3.78^{b}
		Female	90.67±8.50^{d}		63.00±6.69^{b}	56.67±6.98^{d}	32.00±3.78^{b}

*AA = Abor Acre, FA = FUNAAB Alpha, DST = Drumstick and DWT = Dress weight, Asterisk (*) = significant mean thus; * = p<0.05, ** = p<0.01 and *** = p<0.001. $^{a-d}$ Means on the same column for breed & sex with different letter superscript are significantly different (p<0.05)*

Table 3: Organ weights of Abor Acre and FUNAAB Alpha chicken breeds naturally infected with coccidial oocysts

Factor	Breed	Variation	Intestine (g)	Gizzard (g)	PROV (g)	Heart (g)	Spleen (g)	Liver (g)	Lungs (g)
Breed	AA	AA	77.50±3.37***	37.13±1.64***	6.40±0.39***	7.83±0.31***	2.00±0.09***	29.83±1.33***	7.47±0.35***
	FA	FA	37.20±3.37	16.60±1.64	3.53±0.39	3.53±0.31	1.80±0.09	15.13±1.33	3.530.35
Sex	AA + FA	Male	59.20±3.52	28.40±1.71	5.10±0.41	5.70±0.32	1.80±0.09	22.80±1.39	5.50±0.37
		Female	55.50±3.52	25.33±1.71	4.83±0.41	5.67±0.32	2.00±0.09	22.17±1.39	5.50±0.37
Breed * Sex	AA	Male	80.00±4.55[a]	39.60±2.20[a]	6.80±0.53[a]	8.00±0.41[a]	2.00±0.12	30.00±1.79[a]	7.60±0.47[a]
		Female	75.00±4.55[a]	34.67±2.20[a]	6.00±0.53[a]	7.67±0.41[a]	2.00±0.12	29.67±1.79[a]	7.33±0.47[a]
	FA	Male	38.40±4.55[b]	17.20±2.20[b]	3.40±0.53[b]	3.40±0.41[b]	1.60±0.12	15.60±1.79[b]	3.40±0.47[b]
		Female	36.00±4.55[b]	16.00±2.20[b]	3.67±0.53[b]	3.67±0.41[b]	2.00±0.12	14.67±1.79[b]	3.67±0.47[b]

*AA = Abor Acre, FA = FUNAAB Alpha and PROV = Proventriculus, Asterisk (*) = significant mean thus; * = p<0.05, ** = p<0.01 and *** = p<0.001. [a-d] Means on the same column for breed & sex with different letter superscript are significantly different (p<0.05)*

The effect of sex on weight and carcass yield was significant ($p<0.05$) in this study, male chickens recorded higher than their female counterparts (1.13 vs. 1.06). This finding was in agreement with the finding of Fadare *et al.* (2020) who reported that male chickens weighed more than female chickens in their study. Their result also showed that major economic parts including thigh, drumstick and breast were significantly heavier in male than female chickens. The findings of this study with regards to the economic parts of male and female chickens e.g. the thigh (123.68 vs. 102.83 g) and breast (213.33 vs. 176.83 g) collaborated with the findings of Fadare *et al.* (2020).

The effect of breed on morphometric traits in this study showed significant difference for all the parameters. These findings were in agreement with the findings of Udeh and Ogbu (2011) that reported significant differences among the body conformation traits. Breed affected body weight, morphometric parameters and organ weights in this study. However, the wing length, nose-to-shoulder length, drumstick length and shoulder-to-tail length showed no significant interaction between breed and sex effect. Other morphometry parameters including shank length, drumstick length, and wings were in the same range with the report of Azua *et al.* (2022). Nweke-Okorocha *et al.* (2020) reported that organ weights of male chickens were higher than that of their female chickens, although gizzard weight, proventiculus and heart weight of male chicken recorded in their study weighed more than the result of this study. Furthermore, higher weights were recorded for spleen and liver in male chickens in this study when compared to the result of Nweke-Okorocha *et al.* (2020). Kwiecień *et al.* (2018) also reported sex effect on organ weight; their report showed that female chickens had higher liver weight which was in contrast with the result of this study where all organs of the male chickens had higher weight than that of the female chickens except for spleen which had higher weight in female. Yousif *et al.* (2014) and Ojedapo *et al.* (2015) showed that growth performance has influence on carcass characteristics, organ weight and body morphometry of chickens for both indigenous and exotic strains. Nwogwugwu *et al.* (2018) had earlier opine that low genetic potential of local chicken can be improved substantially through crossbreeding programs with the exotic chicken which was evident from this study that FUNAAB Alpha chickens possessed great potential for genetic improvement through systematic breeding plans and policies. The same report indicated that interaction between genotype and sex was not significantly different which was in contrast to the result of this study. Also, in this study, all internal organs showed no significant difference between the genotype and sex.

It was observed in this study that growth performance of the two chicken breeds affected the morphometric parameters, carcass characteristics and some of the organ weights. Although, the result of growth performance was significantly lower ($p>0.05$) than the report of Ojedapo *et al*. (2015), Kwiecień *et al.* (2018) and many other literatures, this may be as a result of coccidial infection in the chicken genotypes used in this study. Taylor *et al.* (2022) reported that infection with *Eimeria* causes reduction in performance, in terms of growth and welfare. Although, both strains had significantly lower performance compared to research done by Atansuyi *et al*. (2017; 2018a,b), Soutter *et al.* (2021) reported that indigenous breed have better resistance to *Eimeria* compared to exotic strains which disagreed with the result obtained in this study.

Conclusions: In this study, breed and sex had a significant effect on growth performance, morphometric traits and carcass yield in terms of the major economic parts such as the thigh, drum stick and chest. It can be concluded from this study that Arbor Acre chickens were more superior in body weight at 8 weeks and possessed appreciable innate immunity compared to FUNAAB Alpha chicken genotype. The genetic variations that existed in the growth performance of FUNAAB alpha and Arbor Acre breeds in terms of the expression of body morphometric traits is very important as an effective selection means for coccidial infection resistance and meat yield. Arbor Acre genotype had better innate resistance to coccidial infection and growth performance than FUNAAB alpha broiler chickens. Based on superiority of body weight and resistance to coccidial infection recorded in this study, Arbor Acre chicken breed is recommended to poultry farmers in high coccidial prevalence locations in Nigeria. However, the FUNAAB Alpha being an improved indigenous breed, can be further improved upon for a better resistant to *Eimeria* species.

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