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Physico-Chemical Attributes of Meat, Abdominal Fats and Blood Lipids Indices of Nigerian Indigenous Chickens and their Crossbreds

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Abstract

The effect of genotype on physico-chemical attributes of meat, abdominal fats and blood lipid indices of Nigerian indigenous chickens and their crossbreds was investigated. One hundred and thirty-eight day-old chicks were generated: naked neck (NN) 23 (NN x NN), normal feather (NF) 26 (NF x NF), Kuroiler (KR) 24 (KR x KR), Kuroiler normal feather crossbred 29 (KR x NF) and Kuroiler naked neck crossbred 36 (KR x NN). Progenies produced were maintained under similar environment for 12 weeks, the parameters obtained for physico-chemical attributes of meat were moisture (%), ash (%), total protein (%), crude protein (%) and crude fibre (%), abdominal fats (%), cholesterol (%), triglycerides (%), high density lipoprotein(%) and low density lipoprotein(%) were analysed in a completely randomised design. Results indicated that genotype had significant ($P<0.05$) effect on physico-chemical attributes of chickens and naked neck chickens had highest crude protein content. The Naked neck genotype also displayed the lowest amount of abdominal fat, cholesterol, triglycerides and low density lipoprotein. However, the kuroiler naked neck crossbred chickens had the highest value of high density lipoprotein. It was concluded that Naked neck chicken was better and recommend base on the fact that meat from this naked neck has less risk to cardiovascular health because it presents lower concentrations of lipids and cholesterol, greater amounts of polyunsaturated fatty acids, which are beneficial for human health.

Keywords: Physico-chemical indices, abdominal fat, blood lipid, Nigerian indigenous chickens, kuroiler

Introduction

The rapid growth of the human population in Nigeria has led to a relatively high demand for protein while meat and eggs are among the most important forms of animal protein in economically developed and developing areas of the world. Poultry meat is the cheapest source of protein compared to other animal protein forms and, probably, the most consumed. Medical research also indicates that poultry meat has lower cholesterol content in contrast to red meat (Suchý *et al*., 2002). However, local chickens are insufficient to provide sufficient meat to the people in a highly populated country. So there is a growing demand from the farmers for the exotic hybrids suitable to family production system. Hence, efforts have been diverted to production of dual purpose breeds and hybrids with improved production profiles. Utilization of native chicken breeds for the development of suitable scavenging chicken has resulted in great success in our country (Adedeji *et al*., 2008; Amao, 2017a). These hybrids are readily accepted by the rural farmers owing to their similarity to the typical appearance of the local birds and low operational cost with significant returns under the existing methods of rearing in the rural areas (Amao, 2017b). Hence, the commercial hybrid cross between a native breed and an exotic bird would be a good proposition for the ideal replacement of native scavenging chicken in the backyard poultry keeping. To meet the growing demands of the human population and to

improve the per capita consumption among the rural and tribal people, many organizations developed improved chicken varieties which are suitable for the free range and backyard farming forrural and tribal areas (Devankar *et al*., 2018). Poultry meat is considered as nutrient dense food which is desirable in planning health diets (Kondaiah *et al.,* 2002). It is playing an important role in providing nutritious diet to consumers with high protein and low-fat level and universal acceptability without any taboo. In addition to high content of meat (especially breast muscles) and low content of skin with subcutaneous fat and abdominal fat in carcass, modern consumers are also paying more attention to the quality of meat as a result of the increased incidence of lifestyle-related diseases such as obesity, diabetes, heart attacks and atherosclerotic strokes (Kokoszyński and Bernacki,2008). Apart from good meatiness and low fatness of chicken carcasses, more importance is now given to the chemical composition, fatty acid profile, cholesterol content, microstructure, and physicochemical and sensory properties of meat (Kokoszyński *et al*., 2013). Physico-chemical attributes of poultry meat may be affected by a number of factors such as genotype, diet, stocking density, rearing condition, temperature, exercise, pasture intake, age at slaughter and motor activity of the birds that impact on muscle metabolism as well as on chemical composition (Sokoya *et al*., 2019; Castellini *et al.,* 2008). Meat quality is a function of the interaction of genotype and other environmental factors. Devankar*et al*. (2018) reported that breeds affected chemical composition of chicken meat. Blood lipids (fat and its derivatives) are very important from a sensory aspect since it is a source of many aromatic substances affecting the meat taste. The content and quality of fat are considered to be important quality features of meat (Martino *et al*., 2015).Lipids are essential fats for normal growth and development of all animals. The functions of these fats range from source of energy, transport and absorption of vitamins, protection of organs, physical and thermal insulation, hormone precursors in the organism and they are extremely important in texture, flavor, palatability, color and preservation of food. Meat is an important source of lipids in the human diet and its consumers are increasingly interested in fat composition, since nutritional guidelines recommend reducing total fat intake, especially saturated fat, and increasing polyunsaturated fat (Sierra *et al*., 2008; De Marchi *et al*., 2012).Considering the necessity to develop potential poultry crossbreds, suitable for consumption and as well as commercial farming, the present study is undertaken to evaluate and compare the meat physico-chemical attributes, abdominal fat and blood lipid indices of indigenous chickens and their crossbreds.

Materials and Methods

Experimental Site

The experiment was carried out at the Animal Breeding Unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso is situated in the derived savannah zone of Nigeria on longitude 4^{o} 15' east and latitude 8^{o} 15' north east of the Greenwich meridian. The altitude is between 300m and 600m above the sea level. The mean annual rainfall and temperature are 1247 mm and 27^{o}C respectively (BATC, 2006).

The Experimental Animals and Management

The total number of 56 birds (matured cocks and hens) were used for this study that comprises of normal feather (NF) (3 male, 12 female), Kuroiler (KR)(6 male, 9 female), naked neck (NN) (9 male, 16 female) were obtained from existing chicken population stock at Animal Breeding Unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso. One

hundred and thirty-eight day old chicks were generated: naked neck (NN) 23 (NN x NN), normal feather (NF) 26 (NF x NF), Kuroiler normal feather crossbred 29 (KR x NF) and Kuroiler naked neck crossbred 36 (KR x NN). The experimental birds were managed strictly under intensive system of management. The age of the birds was between 18 weeks to 24 weeks for the hens and 18 weeks for the cocks. The birds were wing tagged individually for identification purpose. Cocks and hens were tagged individually in an open sided poultry house providing a two-tier galvanized battery cage space of 1800 square inches. Each bird was confined in a cell space of 15 by 7.5 inches. Medication and vaccination such as Lasota, Gumboro and Fowl pox was done as required.

Feed and Feeding of Parent Stock

The cocks were fed *ad libitum* with commercial breeders grower mash containing 16%crude protein and 2600 kcal/kg metabolizable energy. Hens were also fed commercial layers mash containing 16% crude proteinand 2800 kcal/kg metabolizable energy. Clean and cool water were also supplied *ad libitum.*

Experimental Mating

Artificial Insemination (AI) method was used in mating the hens. The massage technique was used to collect semen from the cocks; the cocks were trained for two weeks for semen collection by applying pressure at the back towards the tail forty times before sperm production. Feathers around the cock's vent were trimmed at two weeks interval and semen collection from the cock started at 22 weeks of age after the collection of the semen it was immediately inseminated into a doughnut shape in the left vent of the hen. This was done twice in a week in the evening. For each hen, 0.1ml of undiluted fresh semen used for insemination each time with an inseminator.

Mating Design

The mating design is as shown below:
Normal feather (sire) x Normal feather (dam): NF x NF
Naked neck (sire) x Naked neck (dam): NN x NN
Kuroiler (sire) x Kuroiler (dam): KR x KR
Kuroiler (sire) x Normal feather (dam): KR x NF
Kuroiler (sire) x Naked neck (dam): KR x NN

Egg Collection and Incubation

Eggs from artificial inseminated hens were collected along genotypes' lines and allow accruing in a cool room having 25^{o}C for five days before transferred to the hatchery for incubation. Eggs were set in a cabinet-type incubator at a commercial hatchery in Ibadan, Oyo State Nigeria and set along genotypes' lines at a temperature between 27-39^{o}C and a relative humidity of 55 to 56% for18 days, then the temperature and relative humidity increased to 29-40^{o}C and 70-75% respectively from 19th day to hatching time. The eggs were turned automatically through 90^{o}in the incubator. Candling was carried out on the 5thand 18thday of the incubation for the identification of fertile eggs and clear eggs using a candler fixed with a neon florescent tube carried out in a dark room.

Management of the Chicks

All chicks resulting from each genotype'slines were properly identified at day old by wing tagged with industrial aluminum galvanized tag at two weeks for proper identification. All chicks were raised under the same intensive management system. Vaccination and medication programs were duly observed from day old. The day old chicks were transferred to a separate and previously disinfected brooders pen. Every batch was brooded for six weeks period.

Feed and feeding of the chicks

The chicks were fed *ad libitum* on a commercial chick mash from day old to six weeks of age containing 22 %crude protein and 2900 kcal/kg metabolizable energy. Thereafter, they were fed on a commercial grower mash till 12 weeks.

Data Collection

Proximate composition of meat

The proximate composition such as moisture, crude protein, ether extract and total ash content of the chicken meat from the breast muscle was made according to the procedure of AOAC (2005). Moisture content was determined by drying 20 g of minced meat placed in aluminum moisture cups and dried in a hot air oven for 18 h at 100 ± 5^0C. Crude protein content was measured by the Kjeldahl method. The amount of nitrogen obtained was multiplied by 6.25 to calculate the crude protein content. The ether extract or crude fat content was measured by the Soxhlet extraction system. Total ash content was measured by burning 2 g of sample overnight in a muffle furnace at 600°C.

Lipid profile studies

Fat was performed in triplicate and analyzed according to the procedure 991.36 recommended by AOAC (2005). The total cholesterol was determined according to the methodology described by Bohac *et al.* (1988), adapted by Bragagnolo and Rodriguez-Amaya (1992), in which 10 g of ground raw sample was submitted to the extraction of lipids with chloroform and methanol (2:1). Thereafter, a 10 mL aliquot of the chloroform extract was evaporated with gaseous nitrogen and submitted to saponification with KOH 12% alcoholic solution. The unsaponifiable fraction (cholesterol) was extracted with n-hexane, purified and submitted to color reaction with acetic acid and sulfuric acid, using ferrous sulfate as catalyst. Absorbance was read on a spectrophotometer at 490 nm. Fatty acids were isolated from samples according to the method proposed by Bligh and Dyer (1959), which extracts the lipid phase from the sample. The fatty acid esterification was carried out according to the method proposed by Maia and Rodriguez-Amaya (1993) using a gas chromatograph (Shimadzu 14B, Shimadzu Corporation, Kyoto, Japan) equipped with a flame ionization detector and a fused silica capillary column (Omegawax 250); $H_2$was used as the carrier gas. The identification of peaks was made by comparison with the retention times of standards with known composition.

Statistical Analysis

Data obtained were subjected to analyze of two-way analysis of variance applying the General Linear Model procedure of SAS software (SAS, 2009) while the means were separated using Duncan procedure of the same software. The model employed is as shown below:

$Y_{ijk}= \mu + G_i+ S_j+ (G\times S)_{ij} + \varepsilon_{ijk}$

Where,

Y_{ijk}= Observation of dependent variable recorded on i^{th}genotype of j^{th}sex

μ = Population mean
G_i = Effect of i^{th}genotype (i =1, 2, 3, 4)
S_j= Effect of j^{th}sex (j=1, 2)
$G_i \times S_j$= Interaction between genotype and sex
ε_{ijk}= Residual error of k^{th}observation recorded on i^{th} genotype and j^{th}sex NID ~ 0, σ^2

Results

The least square means of meat proximate analysis of Nigerian indigenous chickens and their crossbredsis presented in Table 1. There are significant (P<0.05) effect on the genotype and the parameters measured. The moisture content was highest in KR x NF birds (52.19 %) followed by KR x NN (50.98 %) with least moisture content (percent on DM basis) was amounted for NF x NF (43.40 %). The Ash content (percent on DM basis) of breast muscles of KR x KR chickens better (2.59 %) than other genotypes. The total protein of the breast muscles was more for KR x NN chickens of value 37.06 % and the crude protein content (percent on DM basis) of breast muscles of NN × NN birds was highest with value11.67 %. Similarly, crude fat content (percent on DM basis) of breast muscle of pure chickens and crossbreds was highest in KR x NF (3.51 %) crossbred than other genotypes. Table 2 revealed the least square means of abdominal fats and blood lipids indices of Nigerian indigenous chickens and their crossbreds. Significant (P<0.05) variation was obtained among the parameters considered and the genotype of the chickens. The abdominal fat content was highest in N x NF chicken (4.25 %) while NN x NN had the least abdominal fat (0.33 %). The KR x KR chickens had more cholesterol of value 131.52 % than other genetic stocks involved. The triglycerides and high density lipoprotein was highest for KR x NF birds of values 166.67 % and 28.16 % respectively while the least values for both parameters were obtained for NN x NN. The low density lipoprotein was more in KR x KR chickens (85.10 %) and lowest in NN x NN birds (32.55 %). However, the NN x NN birds had the lowest abdominal fat, cholesterol, triglycerides, high density lipoprotein and low density lipoprotein.The male of the birds had more abdominal fat, cholesterol and low density lipoprotein while the female birds had higher triglycerides and high density lipoprotein.

Discussion

The nutritional value of meat can be accessed on the basis of parameters such as protein and fat contents. Devankar *et al.* (2018) claimed that proteins are the most important components of meat from nutritional and technological aspects. Proteins are the major components of dry matter of meat. The protein content in muscles is variable and depends on the function of a particular tissue (Ingr, 1996). Thepattern currently displayed by different genotype on meat proximate analysis were in agreement with the reports of Atansuyi *et al.* (2022); Sokoya*et al.* (2019); Oyewale and Sonaiya, (2017); Adeyanju *et al.* (2016) and Isidahomen *et al.* (2012).The authors from their different studies claimed that meat quality is a function of the interaction of genotype and other environmental factors while breeds affected chemical composition of chicken meat.Atansuyi *et al.* (2022) reported that proximate compositions were varied among local chickens strain of Normal feather, naked neck, Fulani ecotype and frizzled feather in South Western region of Nigeria. Sokoya *et al*. (2019) found variations in physico-chemical properties in FUNAAB indigenous and broiler chickens under intensive system in Nigeria. Oyewale and Sonaiya, (2017) study claimed significant difference existed in Normal feather, naked neck, Fulani ecotype and frizzled feather under intensive farming in Nigeria. The finding of Adeyanju *et al.* (2016) also agreed with current study for reporting significant variation in physico-

chemical and sensory attributes of meat of frizzled feather, naked neck and Dominant black chicken cocks. Isidahomen *et al.* (2012) found differences in meat composition of normal feather, naked neck and frizzled matured chickens genotypes and this similar to the current study. Fat is very important from a sensory aspect since it is a source of many aromatic substances affecting the meat taste. The content and quality of fat are considered to be important quality features of meat (Küçükyilmaz *et al*., 2012). The current study that revealed Naked neck (NN x NN) chickens had lowest amount of abdominal fat, cholesterol, triglycerides, high density lipoprotein and low density lipoprotein and this result was in accordance with the findings of Atansuyi *et al.* (2022); Sokoya *et al.* (2019); Oyewale and Sonaiya, (2017); Imasuen and Otoikhian (2012) and Isidahomen *et al.* (2012).The authors from their different studies claimed that fat contents are a function of the interaction of genotype and other environmental factors. Atansuyi *et al.* (2022) claims on growth performance and profitability analysis of five-chicken strains in south-western Nigeriawere in line with this present study. The study of Sokoya *et al.* (2019) on chemical and colour characterization of breast meat from FUNAAB indigenous and marshal broiler chickens corroborated with this current trend of lipid composition of various chicken meats. Oyewale and Sonaiya, (2017)found variation in the lipid meat quality traits of the Normal feather, naked neck, Fulani ecotype and frizzled feather on their study of evaluation of polyunsaturated to saturated fatty acid ratio in the fat of different chicken types. Imasuen and Otoikhian (2012) findings corroborated the current study on abdominal fat, cholesterol, triglycerides, high density lipoprotein and low density lipoproteinfor evaluating the lipid assessment, cholesterol and fatty acid profile of meat from frizzle bird, naked neck, normal feather and dominant black breeds of layer. Isidahomen *et al.* (2012) reported varied fat percentage and abdominal fat in normal feather, naked neck and frizzled matured chickens genotypes.

Conclusion

The study demonstrated that genotype had significant effect on physico-chemical attributes of chickens while naked neck chickens had highest crude protein and the Naked neck genotype also displayed the lowest amount of abdominal fat, cholesterol, triglycerides and low density lipoprotein. However, the kuroiler naked neck crossbred chickens had the highest value of high density lipoprotein. The male of the birds had more abdominal fat, cholesterol and low density lipoprotein while the female birds had higher triglycerides and high density lipoprotein.

Table 1: Least square means of meat proximate analysis of Nigerian indigenous chickens and their crossbreds

Genotype	Obs	Moisture (%)	Ash (%)	TP (%)	CP (%)	CF (%)
NF x NF	29	43.40 ± 2.89^{bc}	2.24 ± 0.21^{ab}	25.93 ± 0.55^{c}	0.90 ± 0.36^{bc}	0.66 ± 0.28^{c}
NN x NN	25	39.83 ± 2.94^{c}	1.27 ± 0.03^{c}	35.78 ± 2.89^{ab}	11.67 ± 0.57^{a}	2.16 ± 0.08^{b}
KR x KR	24	44.78 ± 5.53^{b}	2.59 ± 0.02^{a}	27.57 ± 0.16^{bc}	0.38 ± 0.15^{d}	0.56 ± 0.02^{c}
KR x NF	29	52.19 ± 0.83^{a}	1.74 ± 0.01^{b}	33.95 ± 0.91^{b}	1.87 ± 0.11^{b}	3.51 ± 0.79^{a}
KR x NN	36	50.98 ± 0.88^{ab}	1.77 ± 0.02^{b}	37.06 ± 0.58^{a}	0.51 ± 0.20^{c}	3.07 ± 0.61^{ab}

^{abc}: Means along the same column with different superscripts are significantly ($P<0.05$) different
NF x NF = Normal feather, NN x NN = Naked neck, KR x KR = Kuroiler, KR x NF = Kuroiler Normal feather crossbred, KR x NN = Kuroiler Naked neck crossbred, TP = Total protein, CF = Crude protein, CF = Crude fibre

Table 2: Least square means of abdominal fats and blood lipids indices of Nigerian indigenous chickens and their crossbreds

Genotype	Obs	AF (%)	CHO (%)	TRI (%)	HDL (%)	LDL (%)
NF x NF	29	4.25±0.56^{a}	89.26±12.55^{c}	85.71±2.90^{c}	26.28±2.09^{ab}	45.88±1.23^{b}
NN x NN	25	0.33±0.01^{c}	61.44±2.09^{d}	61.23±3.78^{d}	16.84±1.55^{c}	32.55±2.78^{c}
KR x KR	24	3.00±0.03^{b}	131.52±2.90^{a}	117.06±14.23^{b}	23.02±1.22^{b}	85.10±2.34^{a}
KR x NF	30	3.00±0.51^{b}	100.60±5.45^{b}	166.67±22.01^{a}	28.16±1.34^{a}	39.11±2.88^{bc}
KR x NN	36	3.00±0.67^{b}	120.21±4.66^{ab}	95.83±4.90^{c}	26.98±3.11^{ab}	74.19±4.71^{ab}
Sex						
Male	72	104.22±8.34^{a}	107.62±10.34^{a}	24.16±1.66^{b}	24.16±2.77^{b}	58.55±4.12^{a}
Female	72	96.99±3.99^{b}	102.98±10.56^{b}	24.93±1.31^{a}	24.23±1.09^{a}	52.11±5.34^{b}

^{abcd}: Means along the same column at each subclass with different superscripts are significantly ($P<0.05$) different

NF x NF = Normal feather, NN x NN = Naked neck, KR x KR = Kuroiler, KR x NF = Kuroiler Normal feather crossbred, KR x NN = Kuroiler Naked neck crossbred, AF = Abdominal fat, CHO = Cholesterol, TRI = Triglycerides, HDL = High density lipoprotein, LDL = low density lipoprotein

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