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COMPARATIVE MORPHOLOGICAL STUDIES ON THE SKIN OF SOME NIGERIAN INDIGENOUS GENOTYPES OF CHICKEN

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ABSTRACT

Comparative morphological studies were carried out on the skin of three genotypes of Nigerian indigenous chickens. Thirty adult chickens of the three genotypes (10 birds per genotype), all above one year of age, were used to study the morphology of the skin. In all the genotypes studied, they showed quite similar structural characteristics of white to pinkish thin skin. Among the three genotypes studied, the mean body weight was significantly different for the Normal Feathered Chicken compared to the other two genotypes. Mean weight of the skin as well as the percentage weight of the skin were significantly different for all the three genotypes. Contribution of skin to the total body weight in these genotypes ranged from 12.01±0.79 to 21.77±1.21 per cent. The thickness varied considerably in different regions of the body in all the genotypes. Minimum thickness was noticed in the neck region of the naked neck genotype while maximum micrometric thickness was observed in the same region. As in mammals, skin of the Nigerian indigenous chickens was composed of a superficial epidermis and a deep dermis. The current study has demonstrated the likely reason why the naked neck chickens are relatively doing better than other genotypes. Since, less thickness of the skin on the neck region may be translated to be an edge for them in terms of reduction in tropical heat stress by improving body surface area for body heat convection. This ultimately may result in improved feed intake, feed conversion efficiency and performance.

Keywords: Normal Feathered Chicken, Naked Neck Chicken, Frizzle Feathered Chicken, Skin Morphology.

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INTRODUCTION

The Nigerian native chickens play major roles not only in rural economics but also contribute substantially to the Gross National Product (Momoh *et al*., 2007). They have remained predominantly in villages because of their inherent advantages over the exotic breed. Most of the birds are kept in small flocks under a scavenging system and the feed resources for the birds are household refuse, homestead pickings, crop residues, herbage, seeds, green grasses, earthworms, and small amount of supplemented feeds offered by the flock owner. The factor responsible for low productivity of the local poultry resources is the neglect of the local chickens by animal research scientists in preference for exotic breeds (Ndofor-Foleng *et al*., 2010). They constitute 80% of the 120 million poultry type raised in the rural areas in Nigeria (Ajayi, 2010). They are self-reliant and hardy birds with the capacity to withstand harsh weather condition and adaptation to adverse environment. They are known to possess qualities such as the ability to hatch on their own, brood and scavenge for major parts of their food and possess appreciated immunity from endemic diseases. Their products are preferred by the majority of Nigerian because of the pigmentation, taste, leanness and suitability for special dishes (Horst, 1989). Their outputs (egg and meat) are readily available to villagers and people in urban semi urban areas thus serves as a good source of protein in their diet, in the same vein, they serve as good source of income. The indigenous poultry species represent valuable resources for livestock development because their extensive genetic diversity allows for rearing of poultry under varied environmental conditions, providing a range of products and functions. Thus, great genetic resources embedded in the indigenous poultry await full exploitation that will provide basis for genetic improvement and diversification to produce breeds that are adapted to local conditions for the benefit of farmers in developing countries (Sonaiya *et al*., 1999). In Nigeria, indigenous chickens were characterized along genetic lines of feather and plumage colour (such as normal or frizzled feathered), body structure (such as naked neck, dwarf types and colour variants (such as black, white, brown, mottled etc.). The frequency distribution of the normal feathered chicken was about 91.8% while that of frizzled and naked neck were 5.2 and 3.0% respectively in Bayelsa State of Nigeria (Ajayi and Agaviezor, 2009). Classification has also been on the basis of location. There are various ecotypes of the local chicken in the different agro ecological zones in Nigeria as reported by different authors. Most of the classification by the different agro ecological zones considered mainly the normal feathered indigenous chicken because they are the most prominent whereas the naked neck and frizzled feathered are rare and almost becoming endangered and the gene pool they represent may be lost if not characterized and conserved (Ajayi and Agaviezor, 2009). Certain major genes have been found to be relevant to the indigenous breeds in their tropical production environment which is characterized by stress factor (Mathur and Horst, 1990). The feather distribution gene, naked gene (Na) and the feather structure gene, frizzle (F) are among these major genes. Major genes are economically

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interesting in modern breeding systems as they act as sex marker genes and disease resistant factors (e.g., avian leucosis). These genes cause a reduction in tropical heat stress by improving the breed's ability for convection, resulting in improved feed conversion and better performance. Horst (1989) further stated that the Na and F gene confer superiority in some production characters in the tropics. Naked-neck and frizzle birds have been found to be thermally stress tolerant compared with their normally feathered counterparts (Nwachukwu *et al*., 2006). The naked-neck and frizzle genes have been found to be associated with heat tolerance, and therefore in areas with high ambient temperature, birds with these genes are superior to their normally feathered counterparts for feed efficiency (Garces *et al*., 2001). According to Fayeye *et al*. (2006), birds with the naked-neck and frizzle genes have better adult body weights than their normally feathered counterparts. Skin is the largest, dynamic, vital and complex organ of the body (Bal, 1977). Skin performs complex functions like protection as it acts as fortified barrier for organisms, organ of secretion, excretion and thermoregulation (Klingman, 1964). The substance and thickness of skin vary on the basis of species, breed, age, sex, body region and season in domestic animals (Bal, 1977). For instance, dorsal surface of body has thickest skin while ventral surface has thinnest (Dellman and Brown, 1987). The skin and its associated structures have inherent regenerative abilities, which are responsible for the reparative properties of the skin (Effimov, 1997). Avian skin consists of two layers, the epidermis and dermis, and skin neither has sweat glands nor sebaceous glands (Lucas and Stettenheim, 1972). The epidermis of chicken according to Banks (1993) is thin, loose and dry. According to Bacha and Bacha (2000), the epidermis of chicken consists of an inner stratum germinativum and outer stratum corneum of superficial flattened cornified cells (keratin layer). The stratum germinativum includes a basal layer of columnar epithelial cells lying on the basal lamina, an intermediate layer (stratum spinosum) of one to several layers of polyhedral cell, and a thin transitional layer (stratum germinativum) of flat vacuolated cells just below the stratum corneum. The stratum germinativum is probably the avian counterpart of the mammalian stratum granulosum (Banks, 1993) but it lacks keratohyalin granules (Eurell and Frappier, 2006). The dermis is subdivided into the stratum superficiale (superficial layer); stratum profundum (deep layer), which includes the stratum compactum (dense layer) and the stratum laxum (loose connective tissue containing fat, large vessels, smooth muscle, and follicles); and lamina elastica (elastic lamina of the dermis) (Eurell and Frappier, 2006). In Nigeria, there is still paucity of information on the morphology of skin local genotypes of chickens. Since the indigenous breeds represent a huge reservoir of chicken genome, it is expected that this study will contribute to conservation of the wide gene pool that they represent, into the future. In this form, they are of the highest value especially in this era of genomics research and enhanced potential for the development of new improved breeds for the future. This genetic diversification could be exploited to improve their productivity. It is a laudable proposition that more attention be given

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to the genetic importance and development of the local chicken, in order to improve on the present acute animal protein shortage in Nigeria (Wines, 2009). Thus, this study is conducted with the aim of studying the morphology of skin in normal-feathered (NF), frizzle-feathered (FF) and naked-neck (NN) chickens of Nigerian.

MATERIALS AND METHODS

The present study was conducted in the Anatomy Laboratory, Department of Animal Health and Production Technology, Niger State College of Agriculture, Mokwa and Department of Agricultural Education, Poultry Unit, Federal College of Education, Kontagora, Niger State, North Central, Nigeria. Mokwa is located on latitude 9°17'38" North and longitude 5°3'16 East While Kontagora is located between latitude $3^0$20 and $7^0$40 East and longitude 8^0 and $11^0$3 North. (Google maps, 2021). Thirty apparently healthy adult local chickens (10 birds per genotype, all above one year of age) obtained from the College incubation unit were used for this study. They were quarantined for two weeks and then stabilized for another two weeks in a pen at the poultry unit, livestock farm of the College. They were fed commercial layer diet (Animal Care® feed) within these periods and water was given *ad libitum* under a good management practice. At the end of these periods, all birds were slaughtered using *Halal* method of slaughtering (Wilson, 2005). They were allowed to bleed for two (2) minutes before been de-feathered and skin samples collected. Weight of the skin was recorded and 1 cm^2 area was marked in eight representative areas of the body *viz*., dorsal neck, alar, dorsal abdomen, ventral abdomen, pelvic, dorsal wing, ventral wing and lateral thigh regions. Then tissue sample were collected from these eight regions and the morphometry was recorded. For histomorphology, skin samples were processed using Earlich's haematoxylin and eosin (H&E) for routine morphology (Singh and Sulochana, 1997). The 10% formalin-fixed skin tissues were dehydrated through a series of graded alcohol (70%, 80%, 90%, 95% and 100%). They were later cleared in xylene and infiltrated with molten paraffin wax. Transverse sections of 5µ thick were cut from the embedded tissues using disposable microtome knives. These sections were mounted on grease free clean glass slides and stained at room temperature using Haematoxylin and Eosin (H and E) stains. Photomicrographs was taken using a Motic camera (Samsung(R) DCM1500, Resolution 10.1 Mega pixels) at a magnification of 40x and 100x when mounted on a light microscope (Olympus(R) CH23, Germany). The micrometrical parameters; thickness of epidermis, *stratum germinativum*, *stratum corneum*, *dermis*, *stratum superficiale*, *stratum compactum*, *stratum laxum*and *lamina elastica* were measured with the help of a measuring software of Tuscen CMOS Camera (IS500, Resolution: 10.0 megapixels). All data were expressed as Mean ± SEM (Standard Error of Mean) and subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) version 26.0. Analysis of Variance (ANOVA) at 95% confidence interval (CI) was used to determine the level of significant difference in mean

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data values of the genotypes measured. Values of ($P \leq 0.05$) were considered significant. Where there are differences in means, they were separated by Tukey's Honestly Significant Difference (HSD).

RESULT AND DISCUSSION

In all the genotypes studied, they showed quite similar structural characteristics of white to pinkish thin skin. Body weight, weight of the skin and percentage contribution of the skin to body weight are shown in tables 1 and 2. Among the three genotypes studied, the mean body weight was significantly different for the NC compared to the other two genotypes. Mean weight of the skin as well as the percentage weight of the skin were significantly different for all the three genotypes. Contribution of skin to the total body weight in these genotypes ranged from 12.01±0.79 to 21.77±1.21 per cent. The thickness varied considerably in different regions of the body in all the genotypes. Minimum thickness was noticed in the neck region of the naked neck genotype. All the genotypes studied showed similar structural characteristics of thin skin as reported by Nickel *et al*. (1977), Banks (1993) in different avian species and Joseph (2018) in ducks. In all the genotypes, the skin was white to pinkish as earlier reported by Stettenheim (2000) in chicken and Joseph (2018) in ducks. The mean live weights for the three genotypes reported in this study were higher than the mean values of 100.50 ±25.01 g, 908.00 ± 31.41 g and 898.00± 20.11 g earlier reported by Peters *et al.* (2010) in matured NF, FF and NN genotypes respectively that had undergone at least. These values are also higher than the values of 879.33 ± 50.74 g, 849.67 ± 74.44 g and 847.33 ± 29.06 g in NF, FF and NN respectively reported by Mahmud *et al.* (2015). This variation may be as a result of Environmental and nutritional factors. The thickness varied considerably in different regions of the body in all the genotypes. Skin was least thick on the Neck region of the Necked neck genotype which is contrary to the reports of Lucas and Stettenheim (2000) who noted that in fowl, the skin is thinner in the less feathered areas than in adjacent feathered areas. This difference might be due genetic and breed variations. As in mammals, skin of the Nigerian indigenous chickens was composed of a superficial epidermis and a deep dermis (Fig. 1). Similar observations were made in ducks by Ahmed *et al.* (1968) and Joseph (2018). Both layers were highly folded and in many regions, secondary folds were also noticed (Fig. 2). Similar results were obtained in ducks by Ahmed *et al.* (1968) and Joseph (2018). Epidermis was very thin and formed of two layers, *viz*., *stratum germinativum* and *stratum corneum* (Fig. 3). According to Hodges (1972) and Stettenheim (2000), the avian epidermis was thin in pteryl areas and thick in apteryl areas and in the present study, only pteryl regions were included. Micrometrical parameters of the epidermis and dermis are given in Table 3. Among the three genotypes studied, naked-neck chickens possessed thickest epidermis (1141.42±19.00 µm) at the dorsal neck, followed by normal feather chickens (1125.27±16.42 µm). Epidermis was thinnest in the frizzle feather (543.64±62.56 µm).

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Among the eight regions under study, maximum dermal thickness was noticed in the dorsal neck region of the naked-neck chicken. In emu, both layers of epidermis were thicker in male birds (Weir and Lunam, 2004), whereas no difference between gender was noticed in greater rhea (Picasso *et al.*, 2016). Picasso *et al.* (2016) found significant differences between the thickness of epidermal layers between age groups and regions in greater rhea. Ahmed *et al.* (1968) reported that *stratum lucidum* layer of the epidermis was well developed in chicken whereas, it was almost absent in the epidermis of duck except in the head region. Josheph (2018) reported no *stratum lucidum* could be distinguished in all the eight regions studied in duck.

Table 1: Body weight and weight of the skin in the three genotypes

Parameters	Normal feathered	Frizzle feathered	Naked neck
Body weight (kg)	1.10 ±0.12^{a}	0.98 ±0.06^{b}	0.95 ±0.11^{b}
Weight of skin (g)	326.67 ±23.62^{a}	238.33±09.80^{b}	200.00 ±09.31^{c}
% weight of skin	21.77 ±1.21^{a}	18.17 ±00.53^{b}	12.01±00.79^{c}

$^{a, b, c}$Means within the same row with different superscripts, are significantly different at ($P<0.05$).

Table 2: Thickness of skin (mm) in different body regions in the three genotypes

Body regions	Normal feathered	Frizzle feathered	Naked neck
Neck	1.50 ±0.14^{c}	1.20 ±0.62^{b}	0.90 ±0.03^{a}
Dorsum	1.40 ±0.42	1.35 ±0.82	1.33 ±0.21
Ventrum	1.50 ±0.02^{b}	1.00 ±0.53^{a}	1.40 ±0.12^{b}
Wing	1.32 ±0.0^{b}	1.00 ±0.12^{a}	1.30 ±0.00^{b}
Thigh	1.40 ±0.62^{a}	1.44 ±0.82^{b}	1.50 ±0.66^{b}

$^{a, b, c}$Means within the same row with different superscripts, are significantly different at ($P<0.05$).

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Table 3: Micrometrical parameters (µm) of epidermis and dermis in different body regions in Nigerian local chickens

Parameters	Groups	dorsal neck	alar	dorsal abdomen	ventral abdomen	pelvic	dorsal wing	ventral wing	lateral thigh
Epidermis	Normal-feather	873.25±30.00[a]	895.16±27.19[a]	1052.73±16.97[a]	1088.58±16.71	1002.78±18.03	694.82±17.65[a]	637.81±17.41[b]	1125.27±16.42[c]
	Frizzled-feather	899.04±12.31[a]	904.2±07.54[a]	928.52±85.76[b]	1082.70±07.28	1074.04±36.95	807.19±10.15[b]	543.64±62.56[a]	1061.2±17.25[b]
	Naked -neck	1141.42±19.00[b]	1038.39±23.14[c]	976.10±21.14[c]	999.95±10.69	992.83±44.05	977.05±7.65[c]	924.46±10.21[c]	982.05±55.69[a]
Dermis	Normal - feather	983.85±21.00	956.36±77.29	942.43±62.07	1007.78±45.71	992.78±19.03[b]	884.82±27.86[a]	797.81±31.41[b]	1005.28±42.42
	Frizzled - feather	999.06±32.21	947.2±67.44	925.42±81.76	982.60±16.98	1005.05±35.95[b]	907.49±40.25[a]	673.84±67.82[a]	1002.2±19.00
	Naked-neck	1041.46±29.10	978.39±23.14	953.10±71.14	909.93±16.69	902.83±84.05[a]	996.05±08.65[b]	983.76±18.92[c]	998.09±89.00

[a, b, c] Means within the same column with different superscripts, are significantly different at ($P<0.05$)

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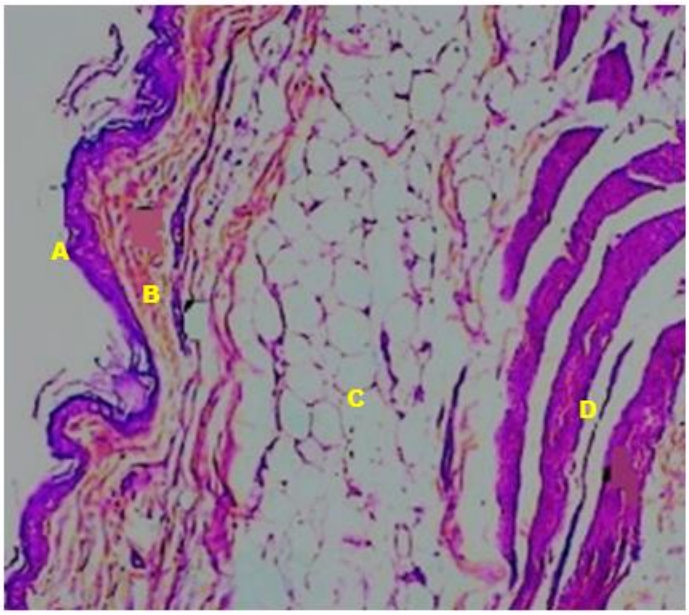

Figure 1: showing a photomicrograph of skin of the dorsal neck region of the naked-neck chicken; A=Epidermis, B= Dermis, C= Dermis, *stratum laxum*, D= Arectoresplumorum muscle (H&E, 100x)

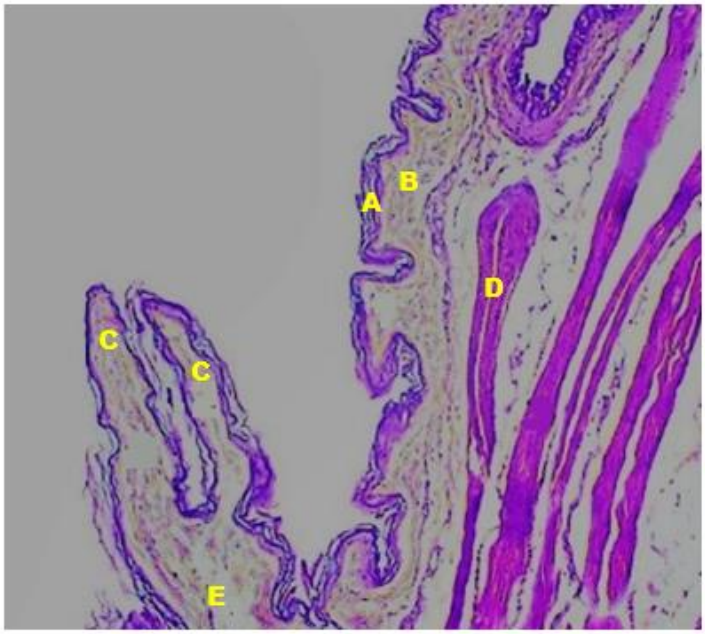

Figure 2: showing a photomicrograph of skin of the alar region of the normal feather chicken; A=Epidermis, B= Dermis, C= Secondary folds, D= Arectoresplumorum muscle, E=Primary fold (H&E, 100x).

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CONCLUSION

The current study has demonstrated the likely reason why the naked neck chickens are relatively doing better than other genotypes. Since less thickness of the skin on the neck region may be translated to be an edge for them in terms of reduction in tropical heat stress by improving body surface area for body heat convection. This ultimately may result in improved feed intake, feed conversion efficiency and performance.

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