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Gross Morphological and Morphometric Studies on Digestive Tracts of Three Nigerian Indigenous Genotypes of Chicken with Special Reference to Sexual Dimorphism

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ABSTRACT

Gross and morphometric studies were carried out on the Gastrointestinal Tracts (GIT) of three Nigerian indigenous genotypes of chicken with special reference to sexual dimorphism. Eighteen adult chickens of the three genotypes (three male and three female per genotype, all above one year of age) were bought from Mokwa local markets. They were quarantined for two weeks, stabilized for another weeks, live weights taken and then slaughtered using Halal method. After careful evisceration, GIT segments were examined grossly and then weights, lengths, thickness and width of the segments were obtained. The GIT of Normal feathered (No), Naked neck (Na) and Frizzle feathered (F) genotypes like in other breeds of chicken was found to consist of the crop, an expansion of the esophagus, located in the lower neck region, the glandular stomach (proventriculus), the muscular stomach (ventriculus), small intestines (duodenum, jejunum and ileum) and large intestine (ceca and colorectum). The mean weights, lengths, thickness and widths of esophagus, proventriculus, ventriculus, small intestine and large intestine of the three genotypes studied were not significantly different from one another, except the weight of oesophagus and width of ventriculus. Also, no significant difference was found between male and female when the means of these parameters were compared irrespective of genotype involved. In conclusion, all the three genotypes have similar gross and morphometric patterns and in addition their ileum was the longest portion of the intestine in contrast to what was reported in other breeds of chicken in the literature.

Key words: Gross Morphology, Gross Morphometry, Digestive Tract, Genotypes, Chicken, Sexual Dimorphism

INTRODUCTION

The Nigerian indigenous breeds of chicken make up a large percentage (80-84%) of the 120 million poultry found in Nigeria (FDLPCS, 1992; RIM, 1992). They are scavengers, usually self-reliant and hardy, capable of withstanding the abuses of harsh climate, minimal management and inadequate nutrition. Osaiyuwa et al. (2010) reported that the indigenous fowl population is considered as a gene reservoir particularly genes that have adaptive values for the local environment. These values include the mode and pattern of their feeding. They live largely on weeds, seeds, insects and feeds that would otherwise be wastes (Vietmeyer et al., 1991). Horst (1988) and Mathur and Horst (1990) showed that individuals with naked neck and frizzle feathered genes both singly and in combination were superior to those individuals with normal feathering for egg number, egg mass/weight and forty week body weight in tropical environments. Many major gene effects which include those of growth, resistance to infection, fertility, hatchability and semen characteristics have been reported (Wekhe, 1992; Peters et al., 2002, 2005, 2008a, 2008b). However, there are scanty reports on genotype similarities and/or differences that may exist among these breeds in particular the gross and morphometric studies of GIT. Bearing in mind the importance it plays in food digestion as well as in food absorption. It is known that environmental diversification of the birds' habitat and their consecutive ways of nourishment, as well as the sorts of food they feed on, constitute a source of great variety in the structure of their digestive tract (Dziala-Szczepanczyk and Wesolowska, 2008). Alteration and impairment within the digestive system, both in structure and function, has a profound effect on the performance of birds (McLelland, 1979). The objective of this study was therefore to compare grossly and morphometrically the GIT of Normal feathered (No), Naked neck (Na) and Frizzle feathered (F)

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genotypes of Nigerian indigenous chickens and with special reference to their sexual dimorphism.

MATERIAL AND METHODS

The present study was conducted in the Anatomy laboratory, Department of Animal Health and Production Technology, Niger State College of Agriculture, Mokwa, North Central, Nigeria.

Eighteen apparently healthy adult No, Na and F genotypes of Nigerian indigenous chickens (three male and three female of each genotype, all above one year of age) were purchased from local markets in Mokwa. They were quarantined for two weeks and then stabilized for another two weeks in a pen at poultry unit, livestock farm of the College. They were fed commercial grower diet (Animal Care® feed) within these periods and water ad libitum under a good management practice. At the end of these periods, all birds were fasted for 12 hours, live body weights were recorded and then all of them were slaughtered using Halal method (Wilson, 2005) of slaughtering. They were allowed to bleed for two minutes before been de-feathered. Organs were noted in situ and then were eviscerated. The photographs were taken before evisceration and afterwards. The digestive tracts were collected for gross and morphometric studies. The location, shape, size, weight, length, thickness and width of the segments of GIT were considered for the studies. The length of oesophagus was measured from the glottis to where it joins the proventriculus. The length of proventriculus was measured from the caudal end of oesophagus to where it enters into ventriculus at isthmus gastris. The length of ventriculus was measured from the isthmus gastris to the caudal extremity of the saccus caudalis. Additionally, the widths of the proventriculus and ventriculus were measured. The width of the ventriculus was measured as the distance between the centrum tendineum on either side of the ventriculus. The length of duodenum was measured from ventricular outlet to the end of pancreatic loop. The length of jejunum was measured from pancreatic loop end to end of vitelline (formerly Meckel's) diverticulum. The length of ileum was measured from vitelline diverticulum to ileo-ceco-colic junction (Hassan and Moussa, 2012; Giannenas et al., 2010).

The photographs were made using digital camera (Samsung ES95, 16.2 megapixels). The weight (g), length (cm), thickness (cm) and width (cm) were measured using a weighing balance (Shimadzu AW320, Germany), metre rule, Vernier caliper and thread respectively.

Data Analysis

The GIT data obtained were expressed as Mean ± SEM (Standard Error of Mean) and subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) version 17.0. One-Way Analysis Of Variance (ANOVA) at 95% confidence interval (CI) was used to determine the level of significant difference in mean values among the three genotypes as well as their sexual dimorphism. Values of ($P \leq 0.05$) were considered significant. Where there were differences in means, they were separated by Turkey's Honestly Significant Difference (HSD) (Kaps and Lamberson, 2004).

RESULTS AND DISCUSSION

Live weight

Genotype wise: The mean live weights of No, Na and F were 879.33 ± 50.74 g, 847.33 ± 29.06 g and 849.67 ± 74.44 g respectively. There was no statistical significant difference between the three genotypes. The mean live weights for the three genotypes reported in this study were lower than the mean values of 100.50 ± 25.01 g, 898.00± 20.11 g and 908.00 ± 31.41 g earlier reported by Peters et al. (2010) in matured No, Na and F genotypes respectively that had undergone at least one breeding cycle.

Sexual dimorphism: The mean live weights of male, female and male and female combined (irrespective of genotype and sex) were 900.67 ± 42.25 g, 816.89 ± 39.53 g and 858.78 ± 29.85 g respectively. There was no statistical significant difference ($p>0.05$) between the mean weights of the male and female across the genotypes. The mean live weight for Males and females across the genotypes reported in this study is lower than values reported by Peters et al. (2010) in Nigerian native chickens, Okpe et al. (2010) in Nigerian local breed of chicken and Mekonnen et al. (2010) for indigenous scavenging chickens in Ethiopia. They were however within the range reported by Gueye (1998) for chickens in Africa and Aini (1999) for family rural chickens in East Asia. The weight of the male chickens found in this study to be numerically higher than that of the female ones was similarly observed also by Ajayi and Agaviezor (2009) in indigenous chickens.

Entire GIT

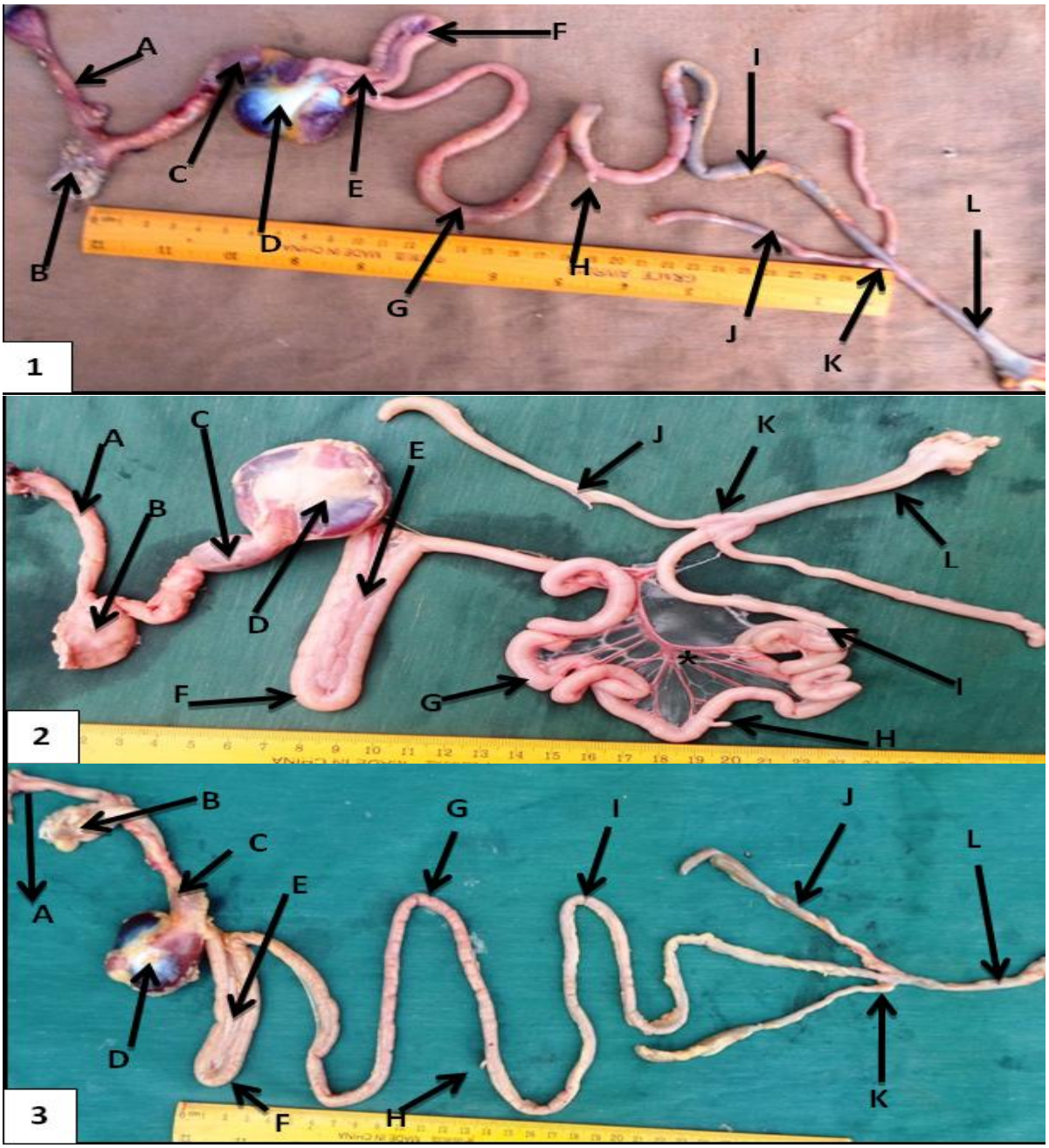
Gross morphology: The GIT of No, Na and F genotypes like in other breeds of chicken was found to consist of the crop, an expansion of the esophagus, located in the lower neck region, the glandular stomach (proventriculus), the muscular stomach (ventriculus), small intestines (duodenum, jejunum and ileum) and large intestine (ceca and colorectum) (Figs. 1, 2 and 3).

Gross morphometry

Genotype wise: The mean weights of GIT in No, Na and F were 78.78 ± 5.91 g, 69.18 ± 4.68 g and 71.12 ± 6.15 g respectively. There was no statistical significant difference among the means of entire GIT weights of these genotypes. The results on mean GIT weight obtained in this study are lower than the values of 144.52±8.9 g, 114.26 ±7.66 g and 126.97±7.99 g earlier reported by Peters et al. (2010) in matured No, Na and F respectively.

Sexual dimorphism: The mean weights of GIT in male, female and male and female combined (irrespective of genotype) were 72.23 ± 4.88 g, 73.82 ± 4.45 g and 73.03 ± 3.21 g respectively. There was no statistical significant difference between the male and

female genotypes or when combined. The results of the mean weight of GIT in the male and the female across genotypes obtained in this study are lower than values of 128.68±5.77 g and 128.61±6.48 g in male and female respectively earlier reported by Peters et al. (2010).



Figures 1, 2 and 3: Photographs of GIT of the normal feathered (1), necked neck (2) and frizzle feathered (3) chickens showing: A = Oesophagus, B = Crop, C = Proventriculus, D= Ventriculus, E = Pancreas, F = Duodenum, G = Jejunum, H = Vitelline Diverticulum, I = Ileum, J = Cecum, K = Cecal tonsil, L = Colorectum, * Mesentery.

Oesophagus

Gross morphology: The esophagus in all the three genotypes was found to be a long, narrow and straight tube that extends from the glottis at the posterior end of the pharynx, through the neck and thorax to join with the glandular stomach (Figs. 1, 2 and 3).

Gross morphometry

Genotype wise: The mean weights of esophagus in No, Na and F were 9.91 ± 1.05 g, 6.98 ± 0.57 g and 6.77 ± 0.58 g respectively (Diagram 1). The mean lengths of esophagus in No, Na and F were 16.89 ± 0.68 cm, 16.89 ± 0.39 and 15.67 ± 1.31 cm respectively (Diagram 3). The mean thickness of esophagus in all three was found to be 0.12 ± 0.02 cm. There was significant difference ($P \leq 0.05$) in the mean weights of oesophagus in three genotypes. On further separation, it was found that, those of Na and F did not differ significantly ($P > 0.05$) from each other but they both differed significantly ($P \leq 0.05$) from that of No. The present results on mean weights of oesophagus in the three genotypes are within the ranges reported by Nasrin et al. (2012) in broiler chicken at 28 days of age.

While the mean length of oesophagus at that age was lower than was obtained in this study.

Sexual dimorphism: The mean weights of esophagus in male, female and male and female combined (irrespective of genotype and sex) were 7.98 ± 0.98 g, 7.79 ± 0.54 g and 7.89 ± 0.54 g respectively (Diagram 2). The mean lengths of esophagus in male, female and male and female combined (irrespective of genotype and sex) were 16.89 ± 0.63 cm, 16.07 ± 0.79 and 16.47 ± 0.49 cm respectively (Diagram 4). The mean thickness of esophagus in male, female and male and female combined (irrespective of genotype) were 0.11 ± 0.01 cm, 0.12 ± 0.01 and 0.12 ± 0.00 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights of oesophagus of male and female or when combined.

Stomach

Gross morphology: The No, Na and F stomachs consisted of a cranial glandular compartment or proventriculus and a caudal muscular compartment or ventriculus (Figs. 1, 2 and 3). The gross appearance of the proventriculus and ventriculus was similar in all genotypes examined except that the proventriculus was most pronounced and distinct in Na than the remaining two genotypes (Figs. 1, 2 and 3). This present result on the stomach of the studied chickens to be composed of glandular portion and muscular portion is in line with previous reports on the stomach of fowl by Suganuma et al. (1981), Macari et al. (1994), Bailey et al. (1997), Bacha and Bacha (2000) and Dyce et al. (2002).

Gross morphometry

Genotype wise: The mean weights of the stomach in No, Na and F were 33.43 ± 2.89 g (3.80 % of the total body weight), 28.92 ± 2.48 g (3.40% of the total body weight) and 30.63 ± 2.63 g (3.60% of the total body weight) respectively. There was no statistical significant difference (P≥0.05) in the mean weights of stomach of the three genotypes.

Sexual dimorphism: The mean weights of the stomach in male, female and male and female combined (irrespective of genotype and sex) were 38.80 ± 2.48 g (4.30% of the total body weight), 29.19 ± 1.69 g (3.60 % of the total body weight) and 30.99 ± 1.52 g (3.61% of the total body weight), respectively. There was no statistical significant difference (P>0.05) in the mean weights of stomach of male and female or when combined. The results obtained in this present study are not in agreement with the earlier reports in quails by Ahmed et al. (2011). They observed mean stomach weight to body weight ratio (%) in quails of 45 days of age to be 1.40± 0.3 g.

Proventriculus

Gross morphology: The glandular stomach or proventriculus was relatively small and tubular. It was located caudal to the crop. It was related dorsally to left lung, testis or ovary and cranial part of kidney; ventrally, medially and laterally to the left lobe of liver. Also the spleen was located at its medial wall. The caudal extent of the proventriculus was marked by a constriction, the isthmus gastris. The proventriculus was most prominent and distinct in the Na than the remaining two genotypes. This present result on the location, size and relationship of proventriculus to other organs are similar to the reports of Macari et al. (1994) in chickens.

Gross morphometry

Genotype wise: The mean weights of proventriculus of No, Na and F were 3.47 ± 0.16 g, 3.65 ± 0.52 g and 3.21 ± 0.33 g respectively (Diagram 1). The mean lengths of proventriculus of No, Na and F were 3.18 ± 0.18 cm, 3.22 ± 0.24 cm and 3.27 ± 0.22 cm respectively (Diagram 3). The mean thickness of the proventriculus of the No, Na and F were 0.52 ± 0.05 cm, 0.55 ± 0.4 cm and 0.52 ± 0.03 cm respectively. The mean widths of the proventriculus of the No, Na and F were 2.57 ± 0.13 cm, 2.63 ± 0.19 cm and 2.35 ± 0.00 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights of proventriculus of the three genotypes. The present result on mean weights of proventriculus is lower than what Nasrin et al. (2012) reported in broiler chicken of 28 days of age. While the mean length of proventriculus at that age was close to what was obtained in this study.

Sexual dimorphism: The mean weights of proventriculus of male, female and male and female combined (irrespective of genotype and sex) were 3.66 ± 0.33 g, 3.23 ± 0.25 g and 3.44 ± 0.23 g respectively (Diagram 2). The mean lengths of proventriculus of male, female and male and female combined (irrespective of genotype and sex) were 3.22 ± 0.19 cm, 3.22 ± 0.14 cm and 3.22 ± 0.12 cm respectively (Diagram 4).. The mean thickness of the proventriculus of the male, female and male and female combined (irrespective of genotype and sex) were 0.54 ± 0.04 cm, 0.51 ± 0.08 cm and 0.53 ± 0.02 cm respectively. The mean widths of the proventriculus of the male, female and male and female combined (irrespective of genotype and sex) were 2.56 ± 0.13 cm, 2.45 ± 0.12 cm and 2.52 ± 0.09 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights of proventriculus in the male and female or when combined.

Ventriculus (Gizzard)

Gross morphology: The muscular stomach was located immediately after the proventriculus. It was placed partly between the lobes and partly behind the left lobe of the liver. It was oval-shaped in all the breeds (Figs. 1, 2 and 3). It consisted of a body with 2 tapering ends, the saccus cranialis and saccus caudalis which are light red in color. The thick muscular walls consisted of the crassus caudodorsalis and crassus cranioventralis muscles which are dark redish brown. A much thinner muscle layer, consisting of the tenuis craniodorsalis and caudoventralis muscles was present in the saccus cranialis and the saccus caudalis respectively. The present result on the ventriculus location and anatomy is similar to what Baily et al. (1997) recorded in chickens.

Gross morphometry:

Genotype wise: The mean weights of ventriculus of No, Na and F were 29.47± 2.86 g, 24.98 ± 2.57 g and 26.11 ± 1.63 g respectively (Diagram 1). The mean lengths of ventricle of No, Na and F were 5.35 ± 0.17 cm, 5.23 ± 0.35 cm and 5.42 ± 0.20 cm respectively (Diagram 3). The mean thickness of ventricle in No , Na and F were 1.82 ± 0.11 cm, 1.72 ± 0.13 cm and 1.87 ± 0.09 cm respectively. The mean widths of ventricle of Na, No and F were 6.23 ± 0.20 cm, 5.12 ± 0.20 and 5.08 ± 0.32 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights and lengths of the ventriculus of the three genotypes. However, there was statistical significant difference (P≤0.05) in the mean widths of the ventriculus. On further separation, the mean widths of ventriculus of Na and F did not differ from each other but they both differed from that of No. The results of the present study on the weight of ventriculus is lower that what Nasrin et al. (2012) obtained in broiler chicken at 28 days of age. While the mean length of ventriculus obtained in this study is around the value of 5.32 they reported.

Sexual dimorphism: The mean weights of ventriculus of male, female and male and female combined (irrespective of genotype and sex) were 27.79 ± 2.45 g, 25.92 ± 1.41 g and 26.86 ± 1.39 g respectively (Diagram 2). The mean lengths of ventriculus of male, female and male and female combined (irrespective of genotype and sex) were 5.50 ± 0.19 cm, 5.20 ± 0.20 cm and 5.33 ± 0.14 cm respectively (Diagram 4). The mean thickness of ventriculus in male, female and male and female combined (irrespective of genotype and sex) were 1.82 ± 0.11 cm, 1.78 ± 0.07 cm and 1.80 ± 0.06 cm respectively. The mean widths of ventriculus of male, female and male and female combined (irrespective of genotype and sex) were 5.62 ± 0.26 cm, 5.33 ± 0.28 and 5.48 ± 0.19 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths, thickness and widths of the ventriculus of the male and female or when combined.

Small intestine

Gross morphology: The gross appearance of the small intestine was similar in all the genotypes examined. The small intestine appeared similar way Nasrin et al. (2012) described it in-situ in the quails. Briefly, it appeared as a thin tube like structure after exposing the abdominal cavity. Duodenum was clearly visible towards the right side of abdominal cavity, whereas jejunum and ileum were partly covered by duodenal loop (Figs. 1, 2 and 3). The duodenum was in the form of a 'U' shaped loop. The loop consisting of a descending and an ascending limb enclosed pancreas. Ventrally, the duodenum appeared as a bulged part of small intestine. It started from the antero-dorsal aspect of the ventriculus and ended at the terminal point of ascending limb towards the anterior aspect of the abdominal cavity. The duodenum on its left side was related to the right side of ventriculus and dorsally it covered jejunum, caecum and ileum whereas, on the right side it was in contact with the right lobe of liver and lateral body wall. The jejunum arranged in the form of coils (jejunal loops) which were suspended by mesentery towards the dorsal part of abdominal cavity. Ventrally, jejunum was in contact with duodenum and ventriculus. Two notable differences in the small intestines of these genotypes are the sizes of the vitelline (Meckel's) diverticulum and cecal tonsil. Both were most pronounced in the Na genotype than the remaining two genotypes (Figs. 1, 2 and 3). The result on location and relationship of small intestines to other organs is also similar to the previous works of Ahmad et al. (2012) on quail small intestine.

Gross morphometry

Genotype wise: The mean weights of small intestine in the No, Na and F were 35.28 ± 2.59g, 25.83 ± 2.74g and 31.50 ± 3.52 g respectively.

Sexual dimorphism: The mean weights of small intestine in the male, female and male and female combined (irrespective of genotype and sex) were 27.63 ± 2.51 g, 34.11± 2.43 g and 30.87 ± 1.87 g respectively.

Duodenum

Gross morphometry:

Genotype wise: The mean weights of duodenum of Na, No and F were 6.92 ± 0.92 g, 6.27 ±0.53 g and 7.62 ± 0.62 g respectively (Diagram 1). The mean lengths of duodenum of No, Na and F were 16.65 ± 1.09 cm, 17.27 ± 1.17 cm and 18.68 ± 1.45 cm respectively (Diagram 3). The mean thickness of duodenum in No, Na and F were 0.15 ± 0.02 cm, 0.43± 0.31 cm and 0.10 ± 0.03 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the duodenum of the three genotypes.

The results on mean weights and lengths of duodenum obtained here are lower than the mean weights and lengths of 13.02 ± 1.361 g and 34.13 ± 1.477 cm respectively reported by Nasrin et al. (2012) in broiler chickens at 28 days of age. The mean weights of duodenum obtained in this study are also lower than mean weights of 12.12 ± 2.01 g and 13.86 ±0.86 g in Anak and Marshal Broiler hybrid birds respectively at 10 weeks of age by Usendi et al. (2013). The mean lengths of duodenum obtained in this study are also lower than mean lengths of 27.30 ±6.80 cm and 34.10 ±0.90 cm in Anak and Marshal Broiler hybrid birds respectively at 10 weeks of age by Usendi et al. (2013).

Sexual dimorphism: The mean weights of duodenum of male, female and male and female combined (irrespective of genotype and sex) were 6.12 ± 0.48 g, 7.74 ±0.56 g and 6.93 ± 0.41 g respectively (Diagram 2) . The mean lengths of duodenum of male, female and male and female combined (irrespective of genotype and sex) were 16.47 ± 0.90 cm, 18.60 ± 1.01 cm and 17.53 ± 0.71 cm respectively (Diagram 4). The mean thickness of duodenum in male, female and male and female combined (irrespective of genotype) were 0.11 ± 0.02 cm, 0.34± 0.20 cm and 0.22 ± 0.11 cm respectively. There was no statistical significant

difference (P>0.05) in the mean weights, lengths and thickness of the duodenum in the male and female or when combined.

Jejunum

Gross morphometry

Genotype wise: The mean weights of jejunum of No, Na and F were 10.80 ± 1.30 g, 7.75± 1.06 g and 9.67 ± 1.16 g respectively (Diagram 1). The mean lengths of jejunum of No, Na and F were 37.67 ± 1.02 cm, 37.42 ± 1.53 cm and 35.37 ± 2.93 cm respectively (Diagram 3). The mean thickness of jejunum in No, Na and F were 0.10 ± 0.01 cm, 0.10 ± 0.00cm and 0.12 ± 0.02 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the jejunum in the three genotypes. The mean weights and lengths of jejunum obtained in this study are lower than mean weights and lengths obtained in Anak and Marshal Broiler hybrid birds at 10 weeks of age by Usendi et al. (2013) and Nasrin et al. (2012) in broiler chicken at 28 days of age.

Sexual dimorphism: The mean weights of jejunum of male, female and male and female combined (irrespective of genotype and sex) were 8.18 ± 0.84 g, 10.63± 1.03 g and 9.41 ± 0.71 g respectively (Diagram 2). The mean lengths of jejunum of male, female and male and female combined (irrespective of genotype and sex) were 36.94 ± 1.33 cm, 36.69 ± 1.86 cm and 36.81 ± 1.11 cm respectively (Diagram 4). The mean thickness of jejunum in male, female and male and female combined (irrespective of genotype and sex) were 0.10 ± 0.01 cm, 0.11 ± 0.01cm and 0.11 ± 0.01 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the jejunum in the male and female or when combined.

Ileum

Gross morphometry

Genotype wise: The mean weights of ileum of No, Na and F were 8.78 ± 0.72 g, 6.50 ± 1.20 g and 7.58 ± 0.92 g respectively (Diagram 1). The mean lengths of ileum in No, Na and F were 38.25 ± 3.57 cm, 39.67 ± 1.64 cm and 37.13 ± 3.19 cm respectively (Diagram 2). The mean thickness of ileum in No, Na and F were 0.10 ± 0.01 cm, 0.12 ± 0.02 cm and 0.10 ±0.00 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the ileum in the three genotypes. The mean weights of ileum obtained in this study are lower than mean weights of ileum obtained in Anak and Marshal Broiler hybrid birds of 10 weeks of age by Usendi et al. (2013) and Nasrin et al. (2012) in broiler chicken at 28 days of age. However, the means lengths of ileum obtained in this study is higher than what were reported in the two studies.

Sexual dimorphism: The mean weights of ileum of male, female and male and female combined (irrespective of genotype and sex) were 6.70 ± 0.75 g, 8.54 ± 0.78 g and 7.62 ± 0.57 g respectively (Diagram 2). The mean lengths of ileum in male, female and male and female combined (irrespective of genotype and sex) were 37.49 ± 2.36 cm, 39.21 ± 2.27 cm and 38.35 ± 1.60 cm respectively(Diagram 4). The mean thickness of ileum in male, female and male and female combined (irrespective of genotype) were 0.11 ± 0.01 cm, 0.10 ± 0.00 cm and 0.10 ±0.00 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the ileum in the male or female or when combined. The results of the present study when the average lengths across genotypes and sexual dimorphism of duodenum (17.53 ± 0.71 cm), jejunum (36.81 ± 1.11cm) and ileum (38.35 ± 1.60 cm) were relatively compared numerically, it was observed that ileum was the longest part of the three portions. This finding is contrary to the reports of Hassouna (2011) in chicken, Ahmad et al. (2012) in quails, Kalita et al. (2012) in Kadaknath Fowl at 112 days of age, Nasrin et al. (2012) in broiler chicken and Usendi et al. (2013) in Anak and Marshal hybrid broiler birds. They all reported that jejunum was the longest part of small intestine.

Large intestine

Ceca

Gross morphology: The two ceca were blind pouches and extend along the line of the small intestine towards the liver having proximal and distal part, and were closely attached to the small intestine along their length by the mesentery. Each cecum had three main parts with the cecal tonsils at the initial portion (Figs. 1, 2 and 3). The results of present study on cecum relationship to some organs and its division into three main parts were similar to earlier reports of Hassouna (2001) and Nasrin et al. (2012) in chickens. The avian cecum is a multi-purpose organ, with the potential to act in many different ways-and depending on the species involved, its cecal morphology, and ecological conditions, cecal functioning can be efficient and vitally important to a bird's physiology, especially during periods of stress. Many familiar avian species, such as chickens and ducks, have very large ceca, which aid in the digestion of vegetation and in water balance (Clench and Mathias, 1995; Kehoe and Ankney, 1985).

Gross morphometry

Genotype wise: The mean weights of ceca (paired) in No, Na and F were 4.47 ± 0.40 g, 3.60 ± 0.46 g and 3.62 ± 0.39 g respectively (Diagram 1). The mean lengths of cecum of No, Na and F were 12.72 ± 0.56 cm, 10.25 ± 0.57 cm and 11.75 ± 0.91 cm respectively (Diagram 2). The mean thickness of the cecum of No, Na and F were 0.13 ± 0.02 cm, 0.12 ± 0.02 cm and 0.12 ± 0.02 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the cecum of three genotypes. The combined cecal lengths of present study are higher than the range of 2.22 to 10.83cm earlier reported by Mobini, (2011) in broiler chickens.

Sexual dimorphism: The mean weights of ceca (paired) in male, female and male and female combined (irrespective of genotype and sex) were 3.34 ± 0.23 g,

4.44 ± 0.34 g and 3.89 ± 0.25 g respectively (Diagram 2). The mean lengths of cecum of male, female and male and female combined (irrespective of genotype and sex) were 12.40 ± 0.54 cm, 10.74 ± 0.60 cm and 11.57 ± 0.45 cm respectively (Diagram 4). The mean thickness of the cecum in the male, female and male and female combined (irrespective of genotype and sex) were 0.13 ± 0.01 cm, 0.11 ± 0.01 cm and 0.12 ± 0.09 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the cecum of male and female or when combined. The mean weights and lengths of cecum obtained in this study are lower than mean weight and lengths earlier reported by Nasrin et al. (2012) in broiler chicken at 28 days of age.

Colorectum

Gross morphology: It was the terminal part of the intestine, passing between the ileo-cecal junction and the cloaca. It was comparatively short and straight (Figs. 1, 2 and 3).

Gross morphometry

Genotype wise: The mean weights of colorectum of No, Na and F were 2.67 ± 0.34 g, 1.65 ± 0.22 g and 2.75 ± 0.41 g respectively (Diagram 1). The mean lengths of colorectum of No, Na and F were 8.75 ± 0.54 cm, 6.85 ± 0.34 cm and 7.13 ± 0.67 cm respectively (Diagram 3). The mean thickness of colorectum in No, Na and F were 0.13 ± 0.22 cm, 0.12 ± 0.02 cm and 0.15 ± 0.02 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the cecum of the three genotypes. The results of present study on lengths of colorectum are similar to the results obtained by Nasrin et al. (2012) in broiler chickens at 28 days of age. However, their results on the weight of colorectum are relatively higher than what was obtained in this study.

Sexual dimorphism: The mean weights of colorectum of the male, female and male and female combined (irrespective of genotype and sex) were 2.57 ± 0.34 g, 2.14 ± 0.26 g and 2.36 ± 0.22 g respectively (Diagram 2). The mean lengths of colorectum of the male, female and male and female combined (irrespective of genotype and sex) were 8.07 ± 0.57 cm, 7.09 ± 0.39 cm and 7.58 ± 0.35 cm respectively (Diagram 4). The mean thickness of colorectum in the male, female and male and female combined (irrespective of genotype) were 0.14 ± 0.01 cm, 0.12 ± 0.01 cm and 0.13 ± 0.01 cm respectively. There was no statistical significant difference (P>0.05) in the mean weights, lengths and thickness of the cecum of the male and female or when combined. The results on the mean lengths of colorectum obtained in this study are lower than the range of 14.64 to 39.84 cm reported by Mobini, (2011) in broiler chickens. Mobini (2011) however gave an explanation on likely cause of what we obtained here that, larger birds have relatively longer and heavier intestines than smaller birds.

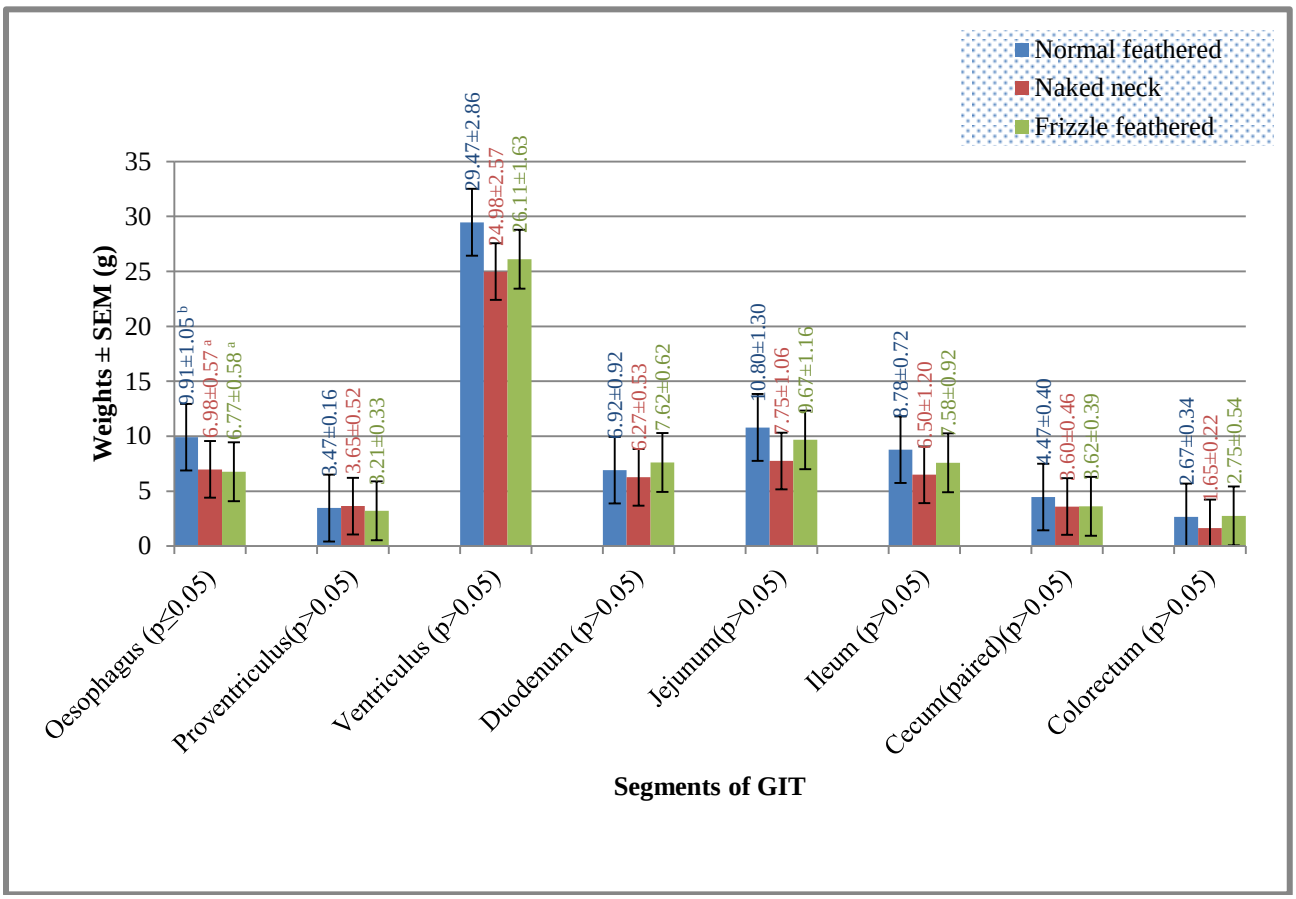


Diagram 1. Comparison of the weights (g) of oesophagus, proventriculus, ventriculus, duodenum, jejunum, ileum, cecum and colorectum in the normal feathered, naked neck and frizzle feathered genotypes of Nigerian indigenous chickens.

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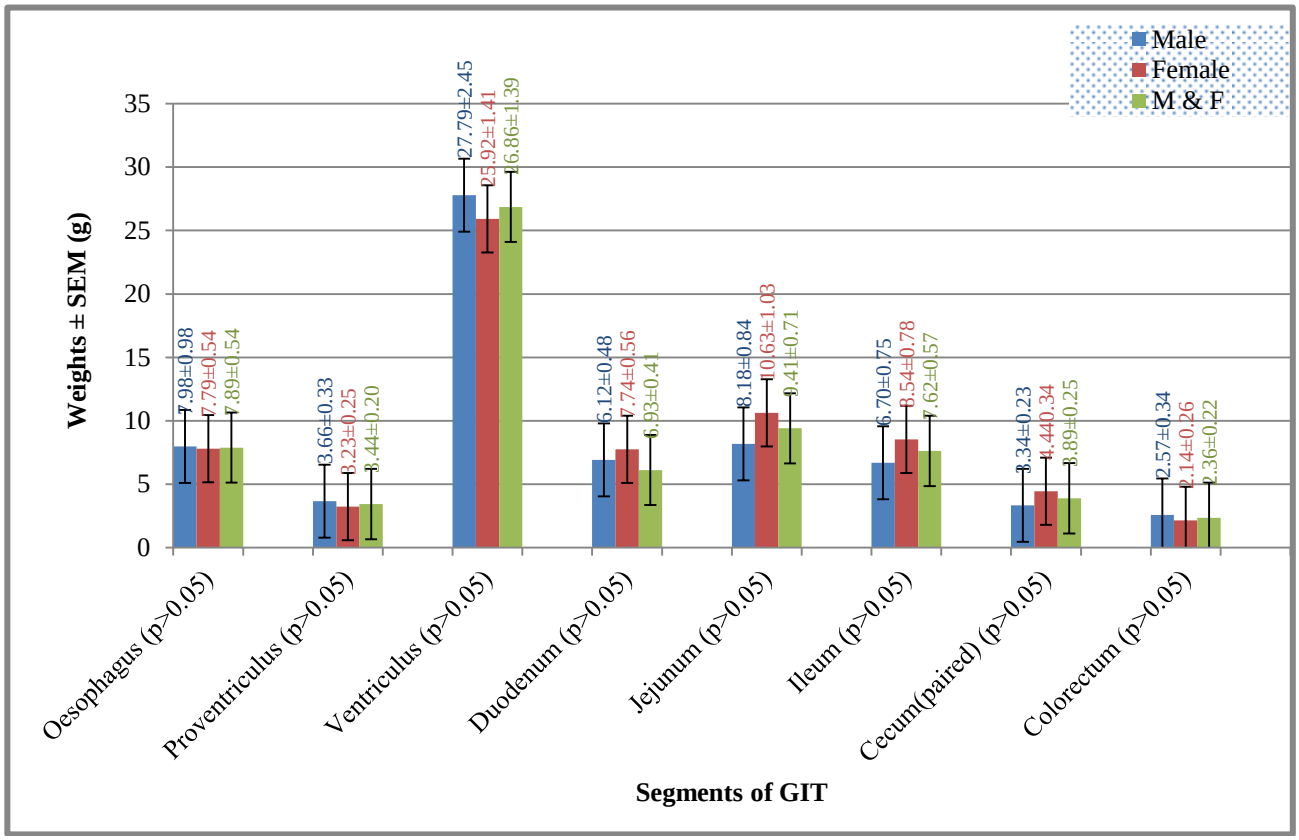

Diagram 2. Comparison of the weights (g) of oesophagus, proventriculus, ventriculus, duodenum, jejunum, ileum, cecum and colorectum in the male, female and male and female combined (M &F; irrespective of genotype and sex) of Nigerian indigenous genotypes of chickens.

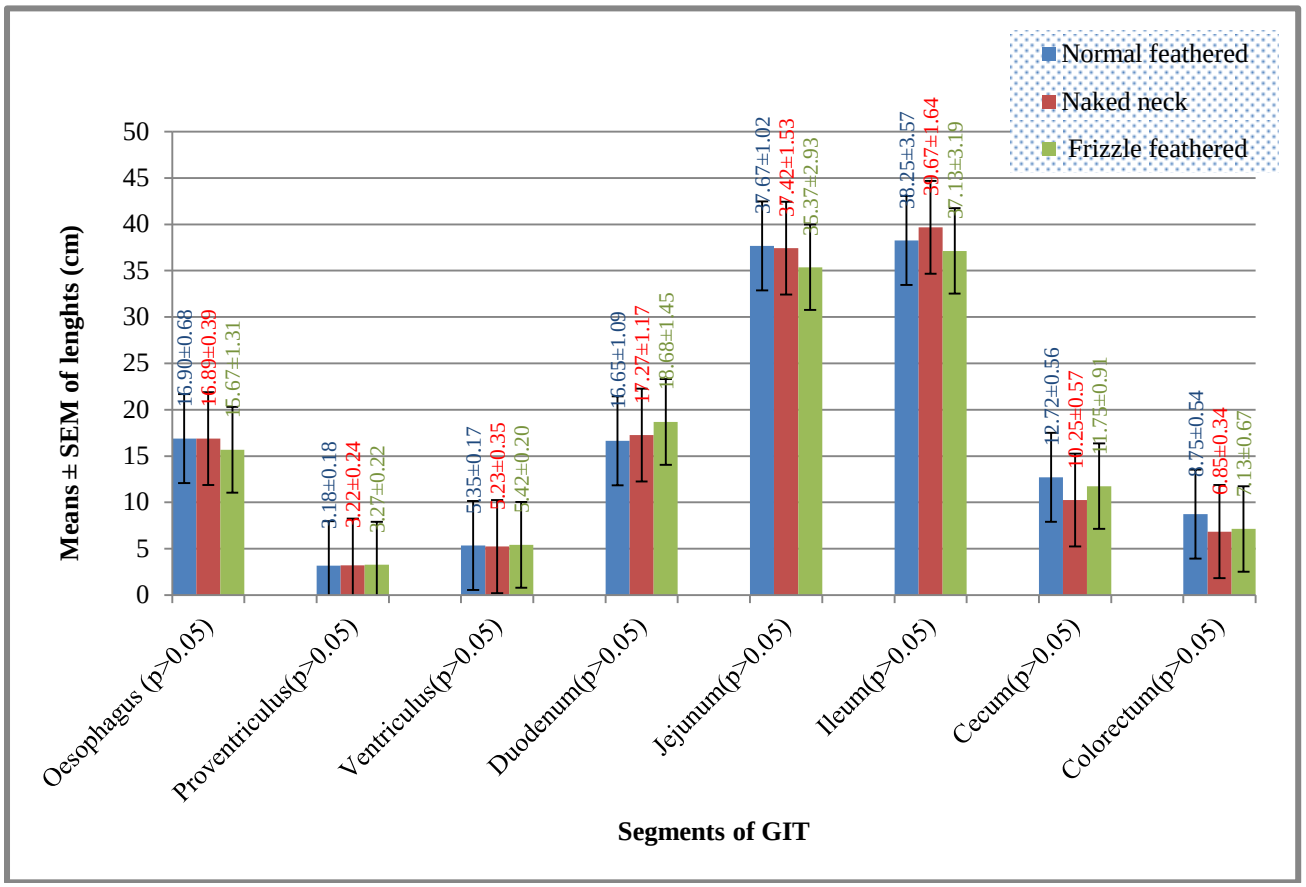

Diagram 3. Comparison of the length (cm) of oesophagus, proventriculus, ventriculus, duodenum, jejunum, ileum, cecum and colorectum in the normal feathered, naked neck and frizzle feathered genotypes of Nigerian indigenous chickens

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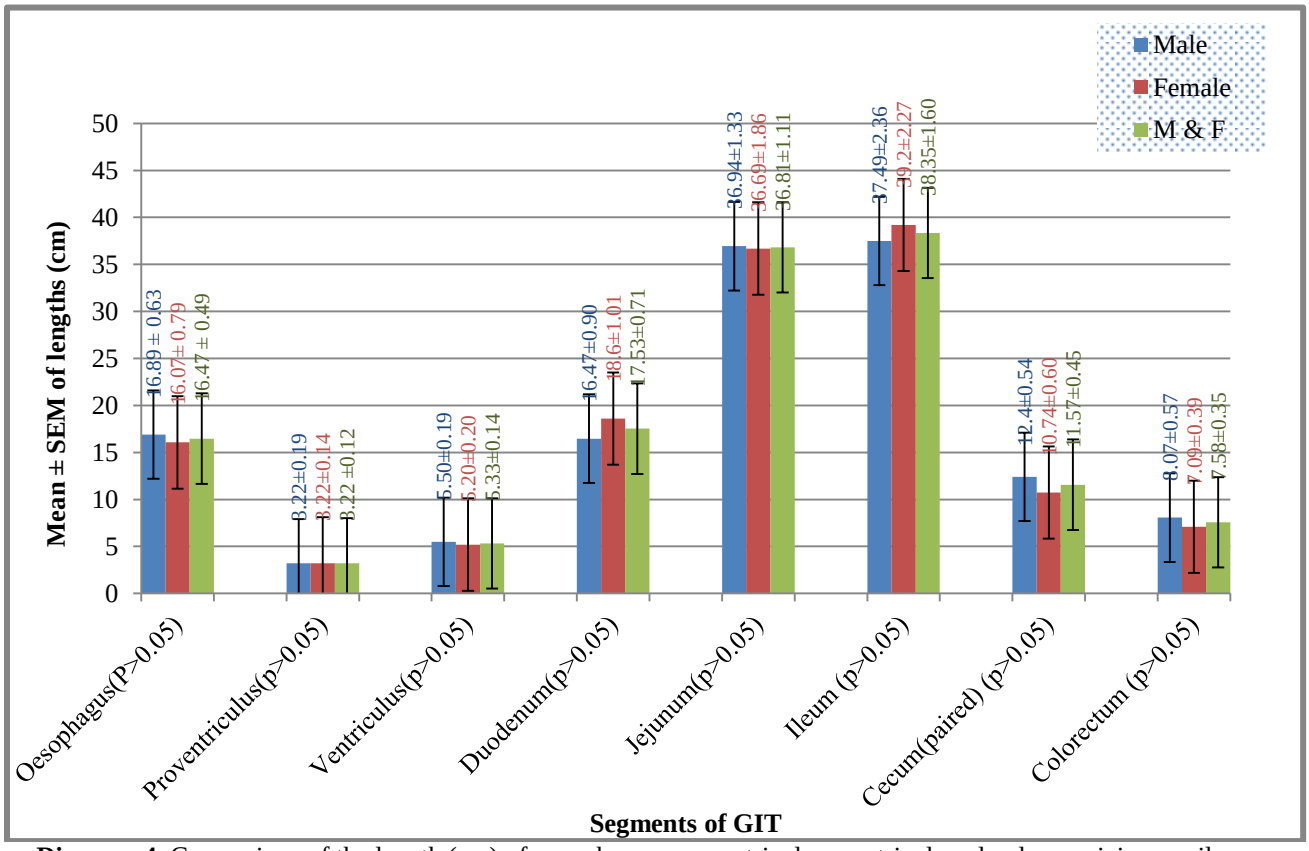

Diagram 4. Comparison of the length (cm) of oesophagus, proventriculus, ventriculus, duodenum, jejunum, ileum, cecum and colorectum in the male, female and male and combined (M&F; irrespective of genotype and sex) of Nigerian indigenous genotypes of chickens.

CONCLUSION

The mean weights, lengths, thickness and widths of esophagus, proventriculus, ventriculus, small intestine and large intestine of three genotypes studied were not significantly different ($p>0.05$) from one another, except the weight of oesophagus and width of ventriculus ($p\leq0.05$). Also, no significant difference ($p>0.05$) was found between the male and the female when the means of these parameters were compared irrespective of genotype involved. All the three genotypes have similar gross and morphometric patterns and in addition their ileum was the longest portion of the intestine in contrast to what was reported in other breeds of chicken in the literature. This study in addition to its contribution to the knowledge of comparative avian anatomy up to genotype level, has also established a comparative baseline data for further digestive studies in these genotypes of Nigerian indigenous chickens.

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