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Comparison Of Some Features Of The Small Intestine Of Nigerian Local And Exotic (Isa Brown) Breeds Of Chicken

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ABSTRACT

The Nigerian local and Isa Brown pullets were used to study the features of the small intestine. The length of the small intestine, the height and depth of the villi and crypts were determined respectively. In most of the age groups studied, the absolute mean lengths of the small intestine of the exotic (Isa brown) breed were significantly greater than that of the local breed ($p<0.05$). The height of the villi and the depth of the crypts of Lieberkuhn were observed to be significantly greater in the Isa brown ($p<0.05$). While the villi were finger shaped in the Isa brown, they were observed to be leaf shaped in the Nigerian Local Breed. These findings tend to suggest that the small intestine of the Isa brown breed has a better-developed surface area modification for absorption. Information obtained may be of great value in selections involving Nigerian Chickens.

KEY WORDS: Features, Small intestine, Chicken.

The small intestine is broadly divided into duodenum, jejunum, and ileum (Banks, 1986). Kirk, (1998) reported that anatomical landmarks to distinguish these areas are lacking. The digestive tract of avian species is relatively shorter than those of mammals (Brown, 1922). He stated that most of the relative decrease is in the intestinal region. The decreased length leads to shorter time for retention of feedstuffs in the gut and less efficiency in recovering the nutrient from feedstuffs (Turk, 1982). The feed requirement of the bird is thus largely determined by the anatomy and capabilities of its digestive tract. The plicae circulares have been reported to be absent in birds (Turk, 1982). While variations in the length of the intestine, the length, shape and size of the villi have been reported across species (Farner, 1972) and even within species depending on diet (Hill, 1977). Stack, (1987) reported that the morphology of the intestinal mucosa has the ability to respond to environment and may be affected by both qualitative and quantitative under-feeding.

Most of the data on the anatomy of avian gastrointestinal tract are from studies on exotic breed reared outside Nigeria. The paucity of literature on the anatomy of avian gastrointestinal tract, and the suspicion that most birds are qualitatively and quantitatively underfed in Nigeria, prompted the investigation on the features of the small intestine of Nigerian Local and Exotic breed of chicken. The data expected from the study may provide some basic information on the anatomy of the small intestine of Nigerian Local birds.

MATERIALS AND METHODS

Nigerian Local pullets and exotic pullets (Isa Brown breed) were used for the study. The apparently healthy Isa Brown pullets were purchased from the neighbourhood. While the fertile eggs from local hens kept at the Veterinary Farm, University of Nigeria Nsukka were collected and hatched using kerosene incubator. They were given feed (Broiler Starter) and water *ad libitum*. The birds were sacrificed periodically until 15 weeks of age. Five birds from each breed were sacrificed at weeks 1,2,3,4,5,7,9,11,13 and 15. The small intestine was dissected out, and measurement of the length taken. Samples of the duodenum, jejenum and ileum were taken. The duodenal sample was taken at the midpoint between the ventriculus and the cystic duct; the jejenum sample was taken midpoint from the cystic duct and yolk stalk, and the ileum sample was taken midpoint between the yolk and caeca. The samples were thereafter prepared for light microscopy

by fixing in Bouins fluid. The samples were post fixed in 70% alcohol, and were later dehydrated in graded alcohol series and embedded in paraffin wax. Sections 5um thickness were cut and stained with Haematoxylin and Eosin (H & E). The height of the villi and the depth of the crypts were measured using Binocular microscope at a magnification of 10 x 10 with the aid of stage and eyepiece micrometers. 20 villi and 20 crypts were randomly selected and measured per section. Thereafter other features of the small intestinal mucosa were examined using Binocular microscope and photographed with photomicroscope.

Quantitative Measurements:

The live body weight was determined for each bird before it was killed. The relative length of the small intestine (cm/g) was determined for each small intestine. The post hatch growth potential of the small intestine was determined for each bird by using the lengths at week 1 to divide the lengths at subsequent ages of each bird.

Statistical Analysis:

Means and standard errors were calculated for each group and student's t-test was used to evaluate the statistical significance between groups.

RESULTS

The curve of mean length of the small intestine of both breeds (Local and Isa Brown) from week 1-15 post hatch is shown in Fig. 1. The length of the intestine consistently increased over this period. This trend was common to the two breeds. The mean length of the small intestine was significantly higher in the exotic breed at all the age intervals studied ($p<0.05$), except at weeks 1 and 2 where they were similar ($p>0.05$). Measurements of the villus height showed a 3 to 5 fold increase from week 1 to 15, after hatching, the villi of the Isa Brown breed was found to be consistently higher than that of local breed. The mean villi heights of the two breeds were similar at weeks 2 and 3 ($p>0.05$), but the heights of the villi of the Isa brown were significantly higher than those of Local breeds at other intervals studied ($p<0.05$) (Fig.2). The height of the villi was observed to decrease down the length of the intestine – being highest at the duodenum and least at the ileum. The crypts of Lieberkuhn were consistently deeper in the Isa brown breed. Statistically, significant differences were observed at weeks 1,3,4, and 5 ($p<0.05$) (Fig.3).

Table 1: Mean (± SE) And Significance Of Relative Lengths Of Small Intestine (Cm/G Body Weight) Between Isa Brown (Exotic) And Nigerian Local Chicken.

Age	Small Intestine Lengths	
Weeks	Isa Brown	Nigerian Local
1	$0.97^a \pm 0.83$	$1.27^b \pm 0.05$
2	$0.79^a \pm 0.67$	$1.17^b \pm 0.67$
3	$0.56^a \pm 0.69$	$2.03^b \pm 1.55$
4	$0.71^a \pm 0.57$	$0.90^b \pm 0.07$
5	$0.59^a \pm 1.73$	$0.98^b \pm 1.22$
7	$0.47^a \pm 0.15$	$0.90^b \pm 0.44$
9	$0.41^a \pm 0.86$	$0.39^b \pm 0.65$
11	$0.24^a \pm 2.56$	$0.26^a \pm 0.26$
13	$0.21^a \pm 0.56$	$0.25^a \pm 0.33$
15	$0.24^a \pm 1.98$	$0.34^b \pm 1.19$

a, b, = Means in the same row followed by different superscripts are significantly different ($P<0.05$).

Table 2: Comparison Of Post Hatch Growth Potential Between ISA Brown And Nigerian Local Chicken (M.±SE)

Age	Small Intestine Lengths	
Weeks	ISA Brown	Nigerian Local
2	$1.15^{a} \pm 0.23$	1.23^{b} 0.72
3	$1.29^{a} \pm 0.13$	$1.57^{b} \pm 0.54$
4	$1.66^{a} \pm 0.56$	$1.87^{b} \pm 0.48$
5	$1.91^{a} \pm 0.55$	$1.23^{b} \pm 0.37$
7	$1.98^{a} \pm 0.21$	$1.70^{B} \pm 0.72$
9	$1.92^{A} \pm 0.54$	$1.82^{A} \pm 0.39$
11	$1.67^{A} \pm 0.32$	$1.42^{A} \pm 0.54$
13	$1.92^{A} \pm 0.44$	$1.47^{A} \pm 0.28$
15	$2/33^{A} \pm 0.37$	$2.12^{A} \pm 0.70$

a, b, = Means in the same row followed by different superscripts are significantly different ($P<0.05$).

Further examination of the histology of the small intestine showed that the villi were fingerlike in the Isa brown breed, (Fig. 4) but leaf shaped in the local breed of chicken (Fig.5). In both breeds, age-dependent variations in the shape of the villi were not observed along the length of the small intestine. In both breeds, the concentrations of villi were most at the duodenum ,then jejenum but least at the ileum (Figs. 5,6 and 7). Lining the surface of the villi in both breeds were goblet cells interspersed between the enterocytes. An increase in the number of enterocytes per villus, with increase in age, was observed. This trend was common in both breeds. The surfaces of the villi were covered by microvilous projection – the bruch border. These projections were found to be very dense in the villi of the Isa brown breed, but less dense in the Local breed. At the core of the villus in both breeds were numerous blood capilaries lying close to the base of the absorptive cells. In addition, smooth muscle (Fig.8) and protective cells (lymphocytes) (Fig.6) and plasma cells (Fig.9) were observed. Lacteals were not seen in the villi of the two breeds.

DISCUSSION

The findings of the present study demonstrate that breed differences exist in the length of the small intestine. The Nigerian Local breeds of pullets have a shorter length of small intestine than its Isa Brown counterpart. Quantitative data on the postnatal growth of the small intestine are scarce. It is possible that the short length might be compensated by an increased cross-sectional area of the intestinal tube. This is because Sbarbati (1979) reported that the growth in length and cross section of the intestine show a compensatory effects. Thus the need to study the cross-section of the small intestine of the two breeds. The relative decrease in the length of the intestine if not compensated by wider cross sectional area, suggest that the local breed has less surface area for digestion and absorption. The lengths of the small intestine of the two breeds were observed to be similar at weeks 1, and 2. This suggests an adaptation phenomenon. Similar observations were made in the intestine of mammals by Stack (1997). Most of the villi of the small intestine of the Nigerian Local breed were leaf shaped while those of the Isa Brown were finger shaped. This suggests that the number of the mature enterocytes were more in the Isa Brown when compared to the local breed. This is in agreement with the observation of Trier (1967), who reported that the shape of the villi seems a simple matter of economics. He explained that when abundant cells are available, fingers are formed, but when few cells are available, leaf and ridges are formed. The diminution of adult

cells in the local chicken may have resulted from a failure of output from the crypts or an excess loss from the surface. This may reflect an underlying basic biochemical or immunological defects. Similar intestinal mucosae have been reported in Indians, Siamese, and Africans (Sakula & Shine, 1957).

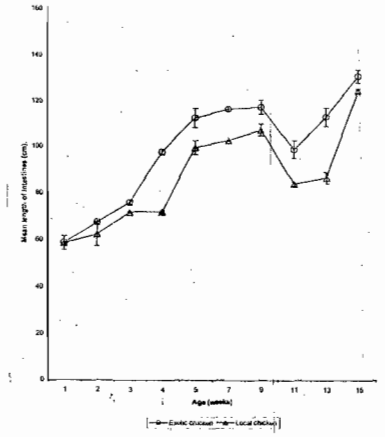

Fig. 1 Comparison of mean length of small Intestine of exotic and local chickens

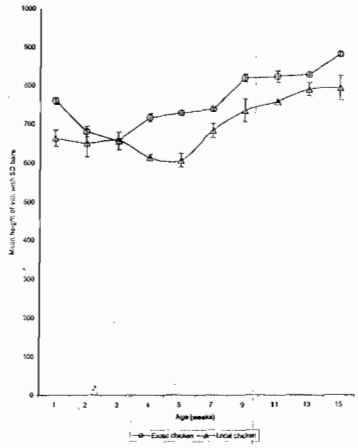

Fig. 2 Comparison of mean height of the villi in the small intestine of exotic and local chickens

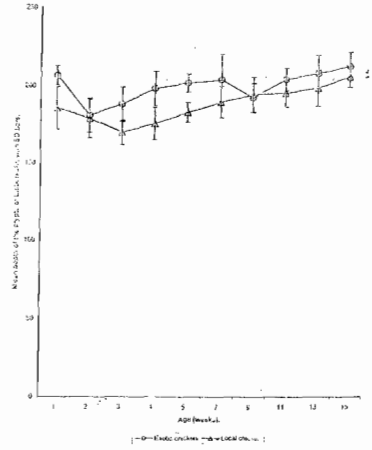

Fig. 3 Comparison of the mean depth of the crypts Of Liberkuhn in the small intestine of exotic and Local chickens.

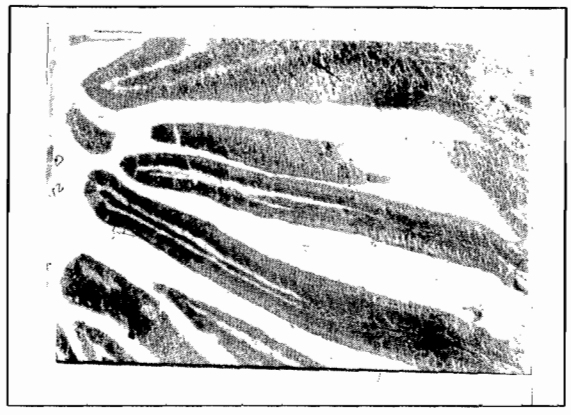

Fig. 4 Finger shaped villi from the duodenum of ISA Brown chicken (X 100).

The villi in the duodenum in both breeds of birds were found to be taller than those of the jejenum and ileum. Similar observations have been reported in mammals (Kirck 1998). He opined that it was due to the protective influence of the Brumer's gland secretions, which decreases down the length of the small intestine. In birds, though the Brumer's glands are absent, the copious mucus secretion of the goblet cells may have provided such protection. This is based on the report of Turk (1987), that mucus is particularly thick along the anterior duodenum where it protects the villi from the excessive acidity of the digesta leaving the gizzard. But Sunter (1978) opined that the differences in the height of the villi could be due to inconsistency in the proliferative behaviour from one side to another along the length of the intestine.

The mean depth of the crypts of Lieberkuhn was found to be greater in the Isa brown than the local breed. This suggests that the Isa brown birds have a greater number of undifferentiated cells lining the crypts. This is based on earlier findings by Sbarbati (1979), who reported that the depth of the crypt is directly related to the number of undifferentiated cells. Lacteals were not observed in the present study. This further confirms earlier observations that lacteal is

absent in the avian species (Creamer 1967,Klob anc Stack 1992).

From the findings of the present study, it appears that the Isa Brown breed of chicken is superior to the local chicken in the surface area modifications of the small intestine. This suggests that the Isa Brown has a higher potential for absorption of nutrient, which may be attributable to the observed greater body weight.

The data presented here therefore represents initial attempt to accumulate some basic relevant breeding data, aimed at subsequent improvement of the local breed of chicken.

Fig. 5 Leaf–like villi from the duodenum of local Chicken (X 100).

Fig. 6 Low concentration of villi at the ileum of local Chicken and lymphocytes (Arrow head) (X 200).

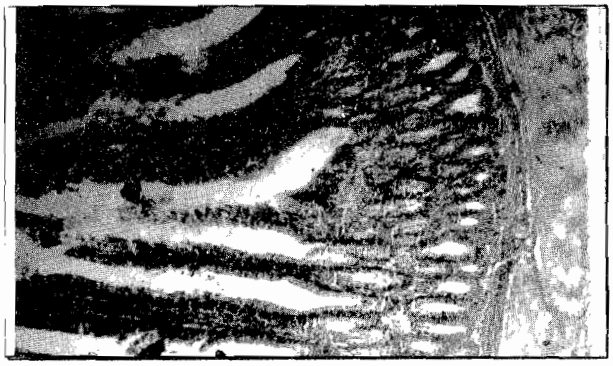

Fig. 7 Low concentration of villi at the ileum Of an ISA Brown chicken (X 200)

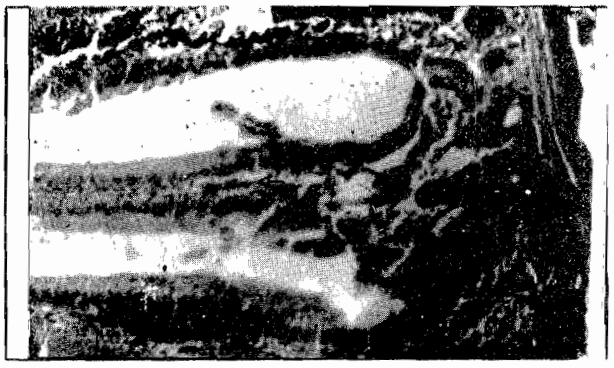

Fig. 8 Muscle fibre at the core of the villus (Arrow head) (X 400).

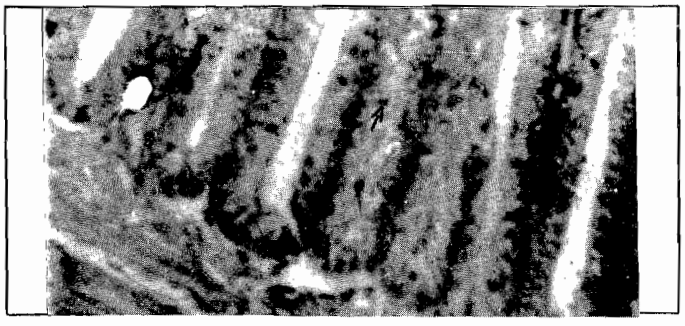

Fig. 9 Plasma cell at the core of the villus (arrow head) (X 400).

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