



## Morphological Changes of the Small Intestine of Red Sokoto Goat (*Capra aegagrus hireus*): Anatomical View

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### Abstract

This study is aimed at investigating the age related changes in postnatal development of small intestine of red Sokoto goat. In this study, a total of ten red Sokoto goat digestive tract samples were used, and they were grouped into five (5) age categories (group A to E). The goat ages were estimated using dentition eruption and wearing. The small intestines were identified and separated from the other part of digestive tract. The gross study revealed that the small intestine in Red Sokoto goat is situated in the right ventral caudal area of abdominal cavity which start from the pylorus and ended at the caecum in ileocaecal junction. It is composed of three segments (duodenum, jejunum and ileum). Generally, the small intestine was examined grossly in which the duodenum takes origin from the pyloric region, it bends and runs as the descending duodenum, the ascending part the return toward the liver passing to the left of the cranial mesentery to enter the fringe of the mesentery between the descending and ascending loops of duodenum. The demarcation between jejunum and ileum is arbitrary although certain progressive structural changes occur, these do not allow the recognition of a sharp boundary. The result revealed that the jejunum in the Red Sokoto goat was long, coiled and most mobile tubular organ. It was observed to be greyish to light brown in colour. The jejunum was observed to begin at the final segment of duodenum. The ileum was short tubular terminal part of small intestine, appeared dark pink to grey in color, it began at the final segment of the jejunum lies on an attached to floor of abdomen and passed to the right in suitable ventrally to the fifth lumbar vertebra then curved caudally to be entered the caecum. Based on these findings, it was concluded that there is no much significant difference in shape, size, position and location of the small intestine of Red Sokoto goat with other species of caprine genus.

**Keywords:** Age Related Changes; Morphology; Study; Small Intestine; Red Sokoto Goat

### Introduction

Goats are among small ruminant having four chambered stomach (Rumen, Reticulum, Omasum and Abomasum) as with another mammals' ruminant. They are characterized as even-toed ungulates [1,2] the only published characterization of the traditional varieties of goat in Nigeria is Ngere., *et al.* [3]. Three main varieties of goat are recognized in Nigeria, the Sahel, Desert or West African long-legged goat, the Sokoto Red and the West African Dwarf [4]. According to the Food and Agriculture organization (FAO), the top producers of goat's milk in 2008 were India (4 million metric tons) Bangladesh (2.16 million metric tons) and the Sudan (1.47 million metric tons) [5].

The intestines are parts of digestive system responsible for chemical digestion and absorption of nutrients and water in the abdominal cavity. There are two anatomical regions, the small intestine and the large intestine [6]. Both of which further divided into anatomical subdivision. The small intestine has three (3) parts; duodenum, jejunum and ileum and the large intestine is subdivided into colon, Caecum and Rectum. The intestine of goats is used to make "Cat gut" which is still use as a material for internal human and animal surgical sutures and strings for musical instruments. The horn of the goat which signifies plenty of wellbeing (the cornucopia) is also used to make spoon [7].

There are a number of researches that carried in many species and breeds of animals more especially on wild animal regarding postnatal developmental changes of small intestine [8] in free living axis deer; [9] on morphological features of the small intestine in the adult indigenous Indian Buffaloes, in Pampas Deer [10] and in the Brown Brocket deer [11], but none was done on red Sokoto goat. Also, there are a number of disease problems that include both infectious, parasitic and Nutritional which affect digestive and absorptive ability of small intestine the frequently encountered in Goat. In Nigeria this has great consequences on production and breeding of goat and goat by-product. Hence this study is designed to have revealed slight variation in general morphology (Gross) and Histology of intestinal segment at different age of development.

To know the changes on postnatal development of small intestine of red Sokoto goat. To study the age related changes in development of small intestine of Red Sokoto Goat. To determine the Biometric data of the small intestine at different age of development. To determine Gross characteristic of small intestine at different age of development. To relate the data to the clinical importance of the various segment of small intestine at different postnatal age of development

## Materials and Methods

### Study area

The study was conducted in Sokoto metropolis, the capital of Sokoto State of Nigeria. Geographically the state is situated on Latitude 12° 15N and 05°E and is 308m above the sea level. Sokoto state occupies an area of short grass savannah vegetation in the south and thorn in the north. It shares boundaries with Zamfara State to the east, Niger Republic to the North and Kebbi State to the west and southwest [12].

The State was ranked second in the nation livestock population with an estimated number of 3 million cattle, 3.85million sheep, 4 million goats, 0.8 million camels, 2 million chickens and 1 million poultry [13]. These animal species are one of the major sources of proteins to the inhabitants of the state and over 75% of them are reared or are raised in traditional free range system living on close association with human settlements [13].

### Experimental design

Goat small intestines were collected from Slaughtered Goats at the Sokoto Metropolitan abattoir and transported to the Anatomy Laboratory, Department of Veterinary Anatomy, Faculty

of Veterinary Medicine, Usmanu Danfodiyo University Sokoto. The goats were sexed using external genitalia. The goat ages were estimated using the dentition eruption and wearing as adopted by Bello, et al. 2015. This is as follows

0 – 6 months - Eruption of all the deciduas teeth.

6 months- 1 year - Wearing of all the deciduate teeth.

1 year- 1 ½ year - Eruption of the permanent I<sub>1</sub>

1 ½ year- 2 year - Eruption of the permanent I<sub>2</sub>

2 year - 3 year - Eruption of the permanent I<sub>3</sub>

Above 3 year - Eruption of the permanent I<sub>4</sub>

Where

I<sub>1</sub> = Central incisor

I<sub>2</sub> = Second Incisor

I<sub>3</sub> = Third Incisor

I<sub>4</sub> = Canine or Corner incisor

Note that the I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub> and I<sub>4</sub> are for the lower jaw.

Based on this the small intestinal sample were categorized into five groups as follows:

1<sup>st</sup> - 0 to 6 months (Group A)

2<sup>nd</sup> - 6monthsto 1 year (Group B)

3<sup>rd</sup> - 1 year to 2 year (Group C)

4<sup>th</sup> - 2 year to 3 year (Group D)

5<sup>th</sup> - Above 3 years (Group E)

### Gross Examination

During the course of the study, each separate segment of the small intestine tract was observed for gross features. These segments include duodenum, jejunum and ileum. These organs were thoroughly observed grossly in terms of shape, size, colour, location or position, both internally and externally.

### Results

The small intestine of Red Sokoto goat was shown to be situated in the right ventral caudal area of abdominal cavity; it begins at the pylorus and ended at the caecum in ileocaecal junction. Observations shown that it consists of three segments that named Duodenum, Jejunum and Ileum (Figure 1 and 3). It connects with the large intestine in the lower most part of the alimentary canal which begins with the caecum and ends with the rectum. The entire organ shown to be a musculomenbranous structure and elastic throughout its course with slight differences between the segments (Figure 1).



**Figure 1:** Photograph of the digestive tract of red Sokoto goat, it shows A: Rumen; B: Omasum; C: Abomasum; D: Colon; E: Rectum; Omentum (black arrow: Duodenum(red arrow); Jejunum(yellow arrow); Ileum (green arrow).



**Figure 2:** Photograph of the small and large intestine of red Sokoto goat, it shows A: Centripetal and centrifugal (A) coiling of colon; Body of the caecum (B); ileum (green arrow); Jejunum; (red arrow): Duodenum (yellow arrow); Rectum (blue arrow).

Anatomically, the finding shown that the small intestine was related dorsally to the abdominal wall and attached to by the dorsal mesentery over its whole length. The mesentery was long for the most part and permits an extraordinary level of mobility to the small intestine permitting the entry of blood vessels and nerves. It fixes the small intestine in position to prevent movement from the Midline of the body (Figure 2).

Generally, the small intestine was examined grossly in which the duodenum takes origin from the pyloric region, it bends and runs as the descending duodenum, the ascending part the return toward the liver passing to the left of the cranial mesentery to enter the fringe of the mesentery between the descending and ascending loops of duodenum. The pancreas lies in which its duct attachment with the caudal part of the ascending loop of duodenum mark the end of duodenum, it continued by the jejunum as shown in figure 3. The duodenum has smaller diameter, relatively firmer than the jejunum and ileum due to the nature of their content, the duodenum is pink to slight red in color and also the duodenum is shorter (Figure 1).

The jejunum forms many short coils within the free margin of the mesentery their general course takes them ventrally, caudally and finally dorsally toward the large bowel (Figure 2). The position of these coil usually must lie within the supra mental recess, but some may spill from this to insinuate themselves behind the rumen. The jejunum is less firm than the duodenum and has a large diameter and relatively grey in appearance as shown in figure 2 and 3.



**Figure 3:** Photograph of small intestine of red Sokoto goat without mesenteries, it shows A: Duodenum; B: Jejunum; C: Ileum; (green arrow): Pancreas; (green arrow): Duodeno-jejunal junction; (red arrow); Jeuno-ileal junction (black arrow).

The demarcation between jejunum and ileum is arbitrary although certain progressive structural changes occur, these do not allow the recognition of a sharp boundary (Figure 3). But ileum is short relatively more muscular (hence firmer) final portion with direct peritoneal connection with the caecum. But the extent of the short ileum is defined by the ileocaecal fold as shown in figure 1 and 2.

### Duodenum

This study showed that the duodenum was formed the first loop of the small intestine, showing incomplete U-shape, pink



to slight red in color, arise immediately after pyloric area of the abomasum and extend caudally right to the stomach then extend somewhat cranially for short distance that aid to hold the pancreas between its descending and ascending U-shaped limbs as shown in (Figure 3). It began firstly with the cranial part (broadened bit), that run parallel with a descending portion of the large intestine, then advanced caudo-medially to the caudate lobe of the liver; and dorsally to the portal of the liver to look after by the cranial duodenal flexure and the descend segment of the duodenum that extended at the caudal flexure (Figure 3). A point of demarcation between duodenal and jejunal segments of the small intestine was observed at the duodenal-jejunal junction (Figure 3).

Observation show that the mesoduodenum suspended duodenal parts which comprised the body and apex of the pancreas. The short mesoduodenum holding the duodenum is colourless in appearance. The cranial part of the duodenum was connected with the liver by the hepatopancreatic and hepatoduodenal ligament. Within the hepatoduodenal ligament passes the common bile duct (ductus choledochus) from the liver to the duodenum figure 3. In another aspect the ascending duodenum was settled by the duodenoscopic fold to the descending colon.

### Jejunum

The result revealed that the jejunum in the Red Sokoto goat was long, coiled and most mobile tubular organ as shown in figure 1. It was observed to be greyish to light brown in colour. The jejunum was observed to begin at the final segment of duodenum figure 3. Then the jejunum was advanced and framed many loops in the left mid-abdominal area and dorsal to the caecum to end at ileum. The jejunal coils situated mainly closer to the ascending colon behind the rumen against the left flank. It runs as many loops caudoventrally to reach the ileum without an unmistakable limit between them, the variance between the jejunum and ileum was remarked by the ileocaecal fold attached. A mesojejunum was upheld the jejunum to the abdominal roof which contained the jejunal vessels and jejuna arches between its mesentery sheets. The right surface of the mesojejunum was partly attached to the ascending colon especially the centrifugal part.

### Ileum

The Ileum was short tubular terminal part of small intestine, appeared dark pink to grey in color, it began at the final segment of the jejunum lies on an attached to floor of abdomen and passed to the right in suitable ventrally to the fifth lumbar vertebra then

curved caudally to be entered the caecum. The ileum observed as a straight segment of the small intestine near the caecum an attached to it by the ileocaecal fold, eventually, it opens the other hand, this anatomical study revealed that there were no demarcation lines that separate anatomically between jejunum and ileum instead of the border of ileocecal fold.

The mesojejunum was continuous with mesocolon and had the form of a large fan hanging from the abdominal roof with the convoluted jejunum and ileum that situated in its free distal.

### Pancreas

The pancreas is situated transversely dorsal to the wall of the Abdomen, it is a long elongated glandular mass, flattered dorsoventrally, it extends transversely from the duodenum to the spleen lying in the transit partially dorsal caudal end of the



**Figure 4:** Photograph of small intestinal junction of red Sokoto goat, it shows D: Duodenum; J: Jejunum; L: Ileum; (yellow arrow): Duodenum jejunal junction; (black arrow): Jejuno-ileal junction; (blue arrow): Ileo-caecal junction.

### Discussion

This research work showed that the small intestine of Red Sokoto Goat was situated in the right ventral caudal area of abdominal cavity. It begins at the pylorus and ended at the caecum in ileocaecal junction. This is in line with the finding of Luay and Najlaa [9] on mountain sheep and on morphological features of the small intestine in the adult indigenous Indian Buffaloes [8] in free living axis deer who mentioned that the greater part of the whole intestine was situated within the suprarenal recess at the right

side and extend caudally to the left side of abdominal cavity in Indian Buffaloes.

As observed in this research it is in line with the other species the small intestine consist of three segments named Duodenum, Jejunum and Ileum, and made up of musculomembranous structure throughout its course with slight differences in diameter between the segments [9].

The duodenum was shown to formed the first loop of the small intestine within complete U-shape, pink to slight red in color, that arise immediately after pyloric area of the abomasum and extend caudally right to the stomach than extend somewhat cranially for short distance that aid to hold the pancreas between, its descending and ascending U-shape limbs this is in line with the finding of [9] but was parallel to the observations of [10] in pampas deer [14], in bovines and [8] in free living axis deer, who mentioned that duodenum was connected ventro-caudally with the pylorus and recorded that the duodenum take difference position from the ventral end of the 9<sup>th</sup> to that of 12<sup>th</sup> thoracic vertebrae a descended segment of the duodenum accompanied with the right lobe of the pancreas. Grossly a point of demarcation between duodenal and jejunal segments of the small intestine was observed at the duodenum –jejunal junction. This is line with the findings of Borone [15]; Smith [16]; Klaus-Dieter and Robert [14], in bovines, ovines and caprine respectively and in accordance with the observation in Pampas Deer [10]. In the Brown Brocket deer [12] and in free living Axis Deer [8] whom mentioned that the point of demarcation between duodenum and jejunum was differentiated at the duodenal –jejunal flexure.

It was observed show that the mesoduodenum suspended duodenal parts which comprises the body and apex of the pancreas. The short mesoduodenum holding the duodenum is colorless in appearance. The cranial part of the duodenum was connected with the liver by the hepatopancreatic and hepatoduodenal ligament. The same observation was seen in bovines [14].

The present result shows that the jejunum in Red Sokoto goat was the longest coiled and mobile tubular organ and greyish in color, that began at the final segments of duodenum in which was advanced and framed many loops in the left mid –abdominal area and dorsal to the caecum to end at ileum without an unmistakable limit between them. These finding agreed with Barnwal., *et al.* [17] in Adult Indigenous Indian Buffaloes, [11] in Brown Brocket deer and [14]. In bovines, that mentioned the jejunum in above animals were run in parallel with the coiled ascending colon like a wreath, it runs through many loops caudoventrally to the ileum without a clear boundary between them.

Ileum was short tubular part of small intestine appeared dark pink to grey in color, it began at the final segment of the jejunum lies on attached to floor of abdomen and passed to the right in suitable ventrally to the fifth lumbar vertebra than curved caudally to be entered the caecum. The ileum observed as a straight segment of the small intestine near the caecum an attached to it by the ileocaecal fold. Similar to that recorded by [14,15] in bovines and caprine [18], in giraffe and [19] in New Zealand Rabbit.

## Conclusion

From the result obtained, it shown that the small intestine in Red Sokoto goat is situated in the right ventral caudal area of abdominal cavity which start from the pylorus and ended at the caecum in ileocaecal junction. It is composed of three segments (duodenum, jejunum and ileum). Generally, the small intestine was examined grossly in which the duodenum takes origin from the pyloric region, it bends and runs as the descending duodenum, the ascending part the return toward the liver passing to the left of the cranial mesentery to enter the fringe of the mesentery between the descending and ascending loops of duodenum. The demarcation between jejunum and ileum is arbitrary although certain progressive structural changes occur, these do not allow the recognition of a sharp boundary. The result revealed that the jejunum in the Red Sokoto goat was long, coiled and most mobile tubular organ. It was observed to be greyish to light brown in colour. The jejunum was observed to begin at the final segment of duodenum. The Ileum was short tubular terminal part of small intestine, appeared dark pink to grey in color, it began at the final segment of the jejunum lies on an attached to floor of abdomen and passed to the right in suitable ventrally to the fifth lumbar vertebra then curved caudally to be entered the caecum. Based on these findings, it was concluded that there is no much significant difference in shape, size, position and location of the small intestine of Red Sokoto goat with other species of caprine genus.

## Recommendation

Based on the above results it was recommended that further studies should be conducted in different domestic species and breeds, in Nigeria for the purpose of teaching and research all over the world.

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