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Original article

A biometric study of the digestive tract of one-humped camel (*camelus dromedarius*) fetuses

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ABSTRACT

A Biometrical study was conducted on the digestive tract of 35 foetuses of the one-humped camel collected from the Sokoto metropolitan abattoir, over a period of five months at different gestational ages. The approximate age of the foetuses was estimated from the crown vertebral rump length (CVRL) and samples were categorised into first, second and third trimester. The mean body weight of the foetus at first, second third trimester ranged from 1.40 ± 0.06 kg, 6.10 ± 0.05 kg and 17.87 ± 0.6 kg respectively. The mean weights of the entire digestive system at first, second and third trimester were 0.80 ± 0.07 kg, 2.13 ± 0.04 kg and 4.86 ± 0.08 kg respectively. The mean weights of the digestive tract at first, second and third trimester were 0.53 ± 0.07 kg, 1.03 ± 0.05 and 2.43 ± 0.07 kg respectively. The small intestine at first trimester were found not to have any clear demarcation to show duodenum, jejunum and ileum; the entire small intestine was found to be 76.00 ± 3.00 cm at first trimester and showed clear demarcation at second and third trimesters.. The mean volumes of the entire stomach (rumen, reticular and abomasum) ranged from 136.67 ± 8.30 cm^3 at first trimester to 353.33 ± 6.50 cm^3 at third trimester. It was observed that there was increase in body weight, organ weight and individual segment of the digestive tract of the fetuses with advancement in gestation period. A geometrical increase in length and diameter of the various segments of the digestive tract showed a significant difference (P≤ 0.05) with advancement in gestational period.

1. Introduction

Camels are of great economic value in the semi-arid and arid region of the world with about 80% of the world dromedarian camel population (Wilson, 1997).In Nigeria, where only the dromedarian camel is present, with uncertain population record due to intermingling livestock market relationship with the neighbouring countries like Niger, Chad, Cameroon, Benin republic (Anonymous, 1987).

The digestive anatomy and physiology at fetal level is least understood when compared to Llama, Guanaco, Cattle, Sheep, Goat and Pig (Skidmore, 2000a). The description of dromedarian camel is usually made as if it is identical with Llama specie (Skidmore, 2000a; Sukan, 2009).

Research work on the morphology, physiology, pathology, gross and developmental anatomy of various organs and system of dromedarian camel (Bustinza, 1979, Asari et al., 1985, Wilson, et al., 1990, Recce, 1997, Franco, et al., 2004, Sonfada, 2006) has been reported in different countries by many researchers on adult camel. Very little is known about the developmental changes of the digestive tract of one-humped came in Nigeria. Therefore, the present study was planned to establish a base-line data on the normal dimensions of different segments of the digestive tract of dromedarian camel fetus in Nigeria.

2. Materials and methods

Thirty-five (35) fetuses of dromedarian camel at different gestational age were collected from Sokoto metropolitan abattoir and transported to Department of Veterinary Anatomy Laboratory Usmanu Danfodiyo University for the study. On arrival to the laboratory, the fetuses were weighed using electrical weighing balance for the smaller foetuses and compression spring balance (AT-1422), size C-1, sensitivity of 20kg X 50g) in Kilogram for the bigger foetuses. The approximate age of the foetuses was estimated and aged by using their crown vertebral rump length CVRL as adopted by El-Wishy *et al.,* (1981).

The digestive tract of each fetuses were collected by placing the fetus on dorsal recumbency and a mid-ventral skin incision was made via the abdomino-pelvic region down to the thoracic, to the neck up to the inter-mandibular space in order to remove the entire digestive tract. Different segment of the tracts i.e. oesophagus, rumen, reticulum, abomasum, duodenum, jejunum, ileum, caecum, colon and rectum, were measured. The tracts were measured using a metric ruler, thread, divider and hand lens. Morphometrically, the digestive tract was divided into oesophagus, stomach (rumen, reticulum and abomasum) small intestine (duodenum, jejunum, and ileum) large intestine (caecum, colon and rectum).

The length, width and diameter of the various segments of the tract were taken. The length of the oesophagus was taken from the base of the pharynx to the base of the cardiac region of the rumen. The length of the rumen was taken from the craniodorsal grove to the caudoventral grove and the width as the distance from the dorsal grove to the ventral grove. The length of the reticulum was taken from the cranial grove (rumino-reticular junction) to the caudal grove (reticulo-abomasal junction) and the width as the distance from the dorsal smooth border to the ventral coarse border. The length of the abomasums was taken as the greater length from the reticulo-abomasal junction to the pyloric antrum of the abomasum and the width was taken as the circumference of the organ as described by Malie *et al.,* 1987.

The duodenum, jejunum and ileum segment was taken as; from the pyloric antrum to the beginning of the coiling of the duodenum. The jejunum was taken from the beginning of the coiling to the end of the primary coiling. The ileum was taken as the distance from the end of the primary coiling to the junction of ileo-colic junction. The diameters of these organs were calculated from their respective circumference (Malie *et al.,* 1987.).

The caecum was taken from the apex border to the caeco-colic junction. The length of the colon was taken from the ileo-caeco-colic function to the beginning of the sacculation at colo-rectal junction. The length of the rectum was taken from the beginning of the sacculation at colo-rectal junction to the anorectal junction. The diameter was calculated from their respective circumference. Data obtained were presented in mean $\pm$ standard error of mean and student-t test was employed to analyse the data using SPSS version 17.0 statistical soft ware.

3. Results

Out of the thirty five (35) fetuses at different gestational age used for the study, twelve (34.3%) were females while twenty three (65.7%) were males. 13(37.14%) fetuses belong to first trimester, 11(31.42%) belong to second trimester and 11(31.42%) belong to third trimesters of pregnancy respectively. The mean crown vertebrate-rump length (CVRL) ranged from 20.06 ± 3.0 cm at first trimester to 103.83 ± 6.0 cm at third trimester as shown in Table 1.

Table 1

Mean±SEM of CVRL, weight of fetal body weight, Weight of the Digestive system (D/S), Weight of the Digestive tract (D/T) at various trimesters.

Parameters	First Trimester	Second Trimester	Third Trimester
Number of sample (N)	13	11	11
CVRL)	20.06 ± 3.0	60.27 ± 4.0	103.83 ± 6.0
Fetal weight (Kg)	1.40 ± 0.06^{a}	6.10 ± 0.5^{b}	17.87 ± 0.6^{c}
D/S weight (Kg)	0.80 ± 0.07^{a}	2.13 ± 0.04^{b}	4.86 ± 0.08^{c}
D/T (Kg)	0.53 ± 0.07^{a}	1.03 ± 0.05^{b}	2.43 ± 0.07^{c}
D/S index (%)	57.14	34.91	27.20
D/T index (%)	37.86	16.89	13.60

^{abc}means on the same row with different superscripts are significantly different (P < 0.05).

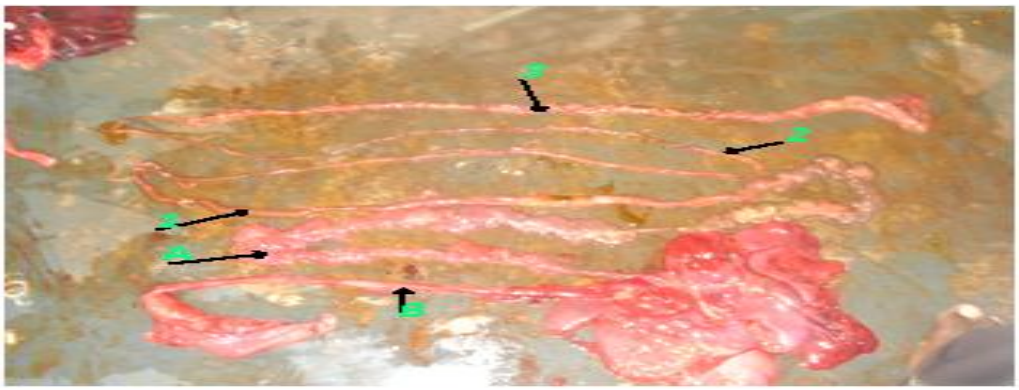

Plate 1. Photograph showing the entire digestive tract of camel fetus at first trimester with no clear demarcation in the small intestine (duodenum, jejunum and ileum) (A),oesophagus (B) caecum (1), colon (2) and rectum (3).

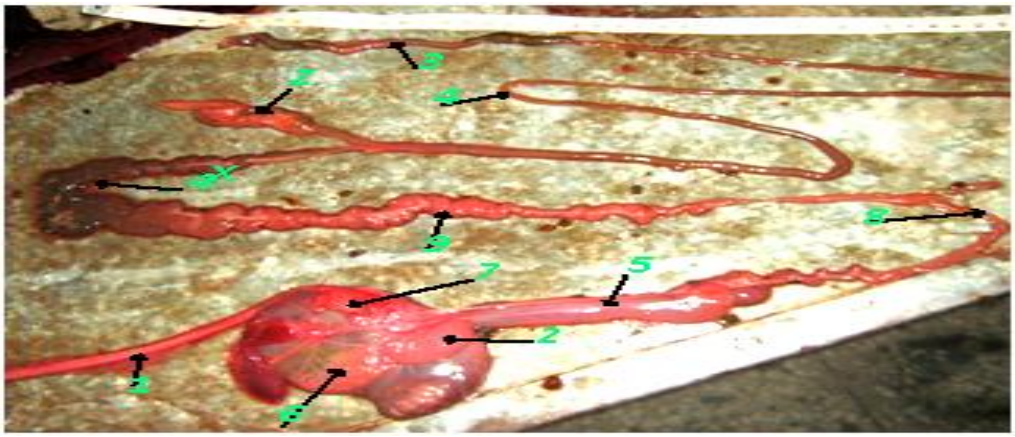

Plate 2. Photograph showing the entire digestive tract of camel fetus at second trimester with clear demarcation in the stomach and small intestine, oesophagus (1), reticulum (2), rectum (3), colon (4), abomasum (5), coarse part of the rumen (6) ,smooth part of the rumen (7), duodenum (8), jejunum (9), ileum(X), caecum (Z).

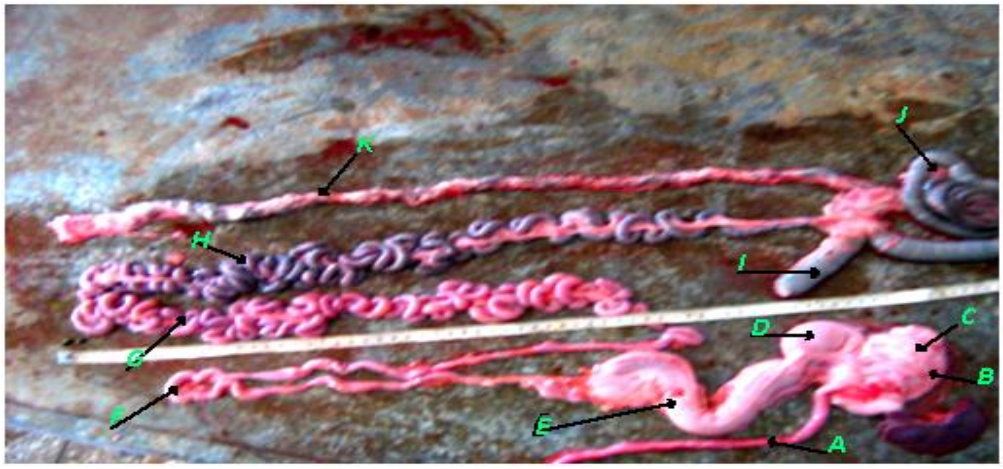

Plate 3. Photograph showing the entire digestive tract of camel fetus at third trimester showing oesophagus(A), smooth part of the rumen (B), coarse part of the rumen (C), reticulum (D), abomasum ((E), duodenum (F), jejunum (G), ileum (H), caecum (I), colon (J) and rectum (K).

The digestive tract index ranged from 37.86 at the first trimester to 13.60 at third trimester, while the digestive system index ranged from 57.14 at the first trimester to 27.20 in third trimester fetus as shown in Table I. The weight of the camel fetus at all three phases of gestation (first, second and third trimesters) were observed to increase as the fetus advanced in age (Table 1).

The mean length and diameter of the oesophagus, rumen, reticulum and abomasum were found to be increasing with advancement in gestation (Table 2 and 3). The small intestine at first trimester did not show any clear demarcation between duodenum, jejunum and ileum (plate 1). At first trimester, the entire small intestine was found to be 76.00 ± 3.00 cm.Clear demarcations were showed at second and third trimesters; the duodenum, jejunum and ileum found to be 66.00 ± 2.00 cm, 139.50 ± 3.00 cm and 75.00 ± 3.00 cm in the third trimester respectively (Table 2).

There was a clear demarcation between the components of the large intestine (caecum, colon and rectum) at all the phrases of gestation (Plate 1, 2 and 3). The mean length and diameter of the caecum, colon and rectum were found to be increasing with advancement in gestation (Table 2 and 3).

4. Discussion

The current study attempted to increase the information about the normal development of the camel digestive tract. From the results obtained in the study, it was observed in general that there was increase in body weight, organ weight and individual segment of the digestive tract in the fetuses with advancement in gestation period. This is in agreement with the observations of Jamdar and Ema, 1982 and Sonfada, 2008, who observed obvious body weight increase with advancement of gestation period in different species of animals. DeNardi and Riddell, 1991 concluded that nutritional status and health condition of the dam played a vital role in the development of the fetus hence increase in weight of the fetus.

The observed increase in weight, length and diameter of various segments of the digestive tract in the study is in line with the findings in bovine, porcine and caprine specie by Franco *et al.,* 1993a; Bal and Ghoshal (1972) and Georgieva and Gerov, (1975) respectively. The digestive tract indices observed in the study showed significant difference in relation to the age (P≤ 0.05) and the indices were decreasing with advancement in gestation (body development) and similar developments were seen in the study of Georgieva and Gerov, 1975; Bal and Ghoshal 1972 in pocine specie.

The progressive increase in length and diameter of the oesophagus based on gestation period is in line with the observations of Belknap, 1994 and Franco *et. al.,*1993c on the oesophagus of Llama and showed to have significant difference in relation to the age (P≤ 0.05) The observed increase in lengths and widths of the rumen, reticulum and abomasum in this study showed to have significant difference in relation to the age (P≤ 0.05) and is

in line with the observations of Franco *et. al.,* 1993a, Franco *et al.,* 1993b and Franco *et. al.,* 1993c; who study the developmental anatomy of red deer stomach based on gestational period.

Table 2
Mean±SEM of length of the oesophagus, stomach, small intestine and large intestine; and volume of the stomach (rumen, reticulum and abomasum) at various trimesters.

Parameters	First Trimester	Second Trimester	Third Trimester
Oesophagus (cm)	13.83 ± 2.33[a]	31.83 ± 2.00[b]	52.13 ± 2.67[c]
Stomach (cm)			
Rumen	7.47 ± 1.67[a]	13.83 ± 1.67[b]	20.75 ± 1.33[c]
Reticulum	1.97 ± 0.43[a]	3.47 ± 0.47[b]	6.93 ± 0.27[c]
Abomasum	12.67 ± 2.33[a]	18.33 ± 0.40[b]	25.75 ± 0.37[c]
Volume (cm^3)	136.67± 8.30[a]	283.33± 6.50[b]	353.33± 7.65[c]
Small intestine (cm)			
Duodenum	76.00 ± 3.00	44.83 ± 2.67[b]	66.00 ± 2.00[c]
Jejunum		111.67 ± 3.33[b]	139.50 ± 3.00[c]
Ileum		59.33 ± 2.67[b]	75.00 ± 3.00[c]
Large intestine (cm)			
Caecum	9.33 ± 0.30[a]	28.00 ± 3.00[b]	40.75 ± 3.33[c]
Colon	65.00 ± 3.00[a]	110.33 ± 3.00[b]	164.75 ± 3.00[c]
Rectum	8.33 ± 0.30[a]	18.00 ± 2.00[b]	30.00 ± 2.33[c]

[abc]means on the same row with different superscripts are significantly different (P < 0.05).

Table 3
Mean±SEM diameters/widths of the oesophagus, stomach, small intestine and large intestine at various trimesters.

Parameters	First Trimester	Second Trimester	Third Trimester
Oesophagus(cm)	0.30± 0.04[a]	0.70± 0.20[b]	1.30± 0.80[c]
Stomach (cm)			
Rumen	1.93 ± 0.17[a]	6.43 ± 0.43[b]	11.50 ± 1.00[c]
Reticulum	1.00 ± 0.40[a]	2.63 ± 0.30[b]	4.05 ± 0.20[c]
Abomasum	1.33 ± 0.20[a]	3.00 ± 0.23[b]	4.25 ± 0.30[c]
Small intestine (cm)			
Duodenum	0.30 ± 0.01	0.8 ± 0.05[b]	1.18 ± 0.03[c]
Jejunum		0.83 ± 0.02[b]	1.20 ± 0.03[c]
Ileum		0.80 ± 0.03[b]	1.23 ± 0.03[c]
Large intestine (cm)			
Caecum	0.33 ± 0.03[a]	1.13 ± 0.03[b]	2.55 ± 0.03[c]
Colon	0.33 ± 0.01[a]	0.77 ± 0.02[b]	1.60 ± 0.03[c]
Rectum	0.40 ± 0.04[a]	1.00 ± 0.03[b]	3.28 ± 0.03[c]

[abc]means on the same row with different superscripts are significantly different (P < 0.05).

A geometrical increase in length and diameter of the various segments of small intestine and large intestine as observed in this study showed to have significant difference (P≤ 0.05) with advancement in gestation and was in line with the findings in porcine (Vivo and Robina, 1991), bovine (Franco *et. al.,* 1993c and Knospe, 1996), buffalo (Asari *et. al.,* 1985) and Llama (Belknap, 1994).

5. Conclusion

The development of the camels' digestive tract based on embryonic stage was morphologically in succession. From the study, the small intestine at first trimester was not divided in to duodenum, jejunum and ileum morphologically. The morphometrical parameters of GIT were established. The information obtained in this study will serve as a base-line data for the camel specie in this environment**.**

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