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Prenatal, Gross Morphometrical and Histometrical Studies on the Small Intestine of the Dromedary Camel *(Camelus dromedarius)*

IBRAHIM, A. ABUAGLA[*1], HASSAN, A. ALI[2] AND TAHANY, M. ELNAGY[3]

1. Department of Anatomy, Faculty of Veterinary Medicine, University of Al-Butana, Tamboul, PO. Box: 200 – Ruffa, Sudan.
2. Department of Biomedical Science, College of Veterinary Medicine, Sudan University of Science and Technology
3. Department of Biomedical Science, College of Veterinary Medicine, Sudan University of Science and Technology

***Corresponding Author:** badi251@gmail.com.*

ABSTRACT

The small intestine was divided into the three parts; duodenum included cranial part (ampulla), descending and ascending duodenum, jejunum and ileum share a common histological pattern with some specific characteristics of their own. This investigation aimed to study the gross morphometry and histometrical measurements of small intestine of camel foetuses included the duodenum, jejunum and ileum in all trimesters. It was conducted on seventeen fresh specimens of small intestine in different trimesters and both sexes. These specimens used to measure the length, weight and volume. Nine foetuses in different trimesters were used for the histometric measurements. The results revealed significant differences between the gross morphometry of length, weight and volume of small intestine of camel foetuses in first, second and third trimesters, the respective lengths of the duodenum, jejunum and ileum in the first trimester were 2.1±0.22 cm, 21±3.71 cm and 1.7±0.60 cm; in the second trimester, they were 5.1±1.56 cm, 87.6±16.72 cm and 4.1±0.74 cm; in the third trimester, the measurements were 7.75±3.11 cm, 139.5±64.51 cm and 8.06±4.55 cm. The mean volume of small intestine was (75.65±79.34 cm^3), whereas the mean weight of small intestine was (86.35±103.40 gm). The general histometric measurements of small intestine included length of villi, thickness of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa in all trimesters included duodenal ampulla, duodenum, jejunum and ileum. In conclusion, the results revealed highly significant differences in gross morphometry and histometry studies at all parts of small intestine during all trimesters.

Keywords: dromedary fetuses, small intestine, gross morphometry, histometr

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INTRODUCTION

Gross Morphometry

The intestinal tract of the domestic animals is divided into small intestine (duodenum, jejunum and ileum) and large intestine (caecum, colon and rectum) (Getty, 1975). Unfortunately, the linear measurements commonly quoted cannot be taken for granted, since formidable difficulties to measurement are present in life and are certainly introduced by relaxation of the gut after death (Dyce, Sack and Wensing, 2002). Although measurements are easier to obtain from the dead animal, but they are comparable only if taken under similar conditions (Nickel *et al*., 1979). The length of the small and large intestines were respectively in camel about 40 and 19.5 meters (Smuts and Bezuidenhout, 1987).

The total length of adult camel duodenum ranged between 1.2 to 3.1 m. The average length of duodenum was ±2.17 m (Althnaian *et al*., 2012); in adult camel the caecum appeared as a smooth cylindrical sac measuring 51.35± 6.40 cm (Mohamed *et al*., 2018).

In the camel fetuses at first trimester, the entire small intestine was found to be 76.00 ± 3.0 cm. Clear differences were showed at second and third trimesters; the duodenum, jejunum and ileum were found to be 66.00 ± 2.00 cm, 139.50 ± 3.00 cm and 75.00 ± 3.00 cm in the third trimester (Bello *et al*., 2012).

Mohamed, (2012) reported in adult she-camel that the length of small intestine ranged between 10.6 and 11.79 meters (the mean length of all parts of small intestine was 10.97±0.66 meters). The range of the diameter of ampulla of the duodenum was between 21 – 23 cm and length ranged from 14 to 17 cm and the diameter of small intestine ranged from 5 to 16 cm (Mohamed,
2012). In a full grown one-humped camel the small intestine measured about 40 m in length (Wilson, 1989; Al-Ani and Qureshi, 2008).

In giraffes the total length of small intestine was about 2782 cm; the duodenum about 100 cm, jejunum about 2630 cm and ileum about 52 cm (Perez *et al*., 2009). In alpacas the small intestine measured about 771 ± 140 cm. The gross whole intestinal length was 610 ± 128 cm (Perez *et al*., 2016).

In prenatal dwarf goats (*Capra hircus*) the mean length and diameter of the duodenum and jejunum were 8.7 ± 3.1 cm, 0.7 ± 0.3 mm; 96.0 ± 18.3 cm, 0.5 ± 0.2 mm for gestation day (GD)30 – 50 foetuses, 13.8 ± 4.7 cm, 1.2 ± 0.2 mm; 150.3 ± 26.3 cm, 1.1 ± 0.6 mm for GD 51 – 100 foetuses, 20.6 ± 2.5 cm, 1.7 ± 0.1 mm; 305.3 ± 9.5 cm, 1.8 ± 0.2 mm for GD 101 – 146 foetuses, 28.1 ± 4.0 cm, 6.2 ± 0.1 mm; 470.1 ± 177.2 cm, 5.3 ± 0.3 mm for kids respectively (Nwaogu, 2021).

Bello *et al*., (2019) stated that the mean weight value of the duodenum in postnatal goat were found to range between 16.75 to 42.75 and the mean value of length, width, thickness and volume were observed to be within the range of 71.00 to199.50, 1.05, to 2.01, 0.28 to 0.66 and 8.50 to 35.00 from group A to group E respectively.

Histometry

Microscopic examination in camel (Korkmaz and Kum, 2016) revealed that the length of the mucosal folds (villi) decreased

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progressively from the duodenum to the ileum. The deepest crypts were observed in the duodenum (P<0.001) and the longest villi were detected in the jejunum (P<0.001). Villi with the largest crypt diameter were observed in the ileum (P<0.001). The small intestine epithelium consisted of 3 parts; the tip of the intestinal villi, the villus-crypt space and the crypt base.

In camel the mean thickness of the wall in colon was more than that in caecum (487.9±26.6 µm), (366.7±34.1 µm) respectively. The colon epithelium revealed large number of Lieberkuhn crypts and goblet cells reached (31 ± 4), (262 ± 11) respectively, more than that in caecum (27 ± 5), (218 ± 12), respectively. The mean thickness of the tunica submucosa in caecum was more than that in colon (243.2±44.3 µm) and (124.8±16.6 µm) respectively. Tunica muscularis in colon was more than that in caecum (694.7±37.4 µm) and (513.9±46.3 µm) respectively. The tunica serosa or adventitia consisted of loose connective tissues with mean thickness of this tunica in colon was more than that in caecum (212.7±14.1 µm) and (187.9±17.6 µm) respectively (Ahmed *et al.*, 2018).

In camel the morphometric results showed that the mean of the thickness of the mucosa and submucosal layer in the duodenal region was more than the jejunum and ileum. The mean thickness of the muscular layer in both sexes in the intestinal jejunum region is less than the duodenum and ileum (Dehkordi *et al*., 2019).

In foetuses of dwarf goats (*Capra hircus*) the duodenal and jejunal mean villous heights, widths and intervillous crypt depths were 204.2 ±21.6, 66.8± 19.3, 51.0 ± 10.3; 204.8 ± 73.6, 65.9 ± 9.9 and 71.4 ± 18.6 µm for GD 101 – 146 foetuses, 366.5 ± 38.6, 166.9 ± 29.6, 85.0 ± 15.6; 1191.0 ± 262.0, 142.3 ± 9.8 and 158.2 ± 30.6 µm for kids (Nwaogu, 2021).

Elnagy, (2006) reported in postnatal male rabbits, the proximal small intestine at 0- day of age, suckling neonates, the average length of the villi was 116.46 µm. At 6 days of age, an average of the length was 139.60 µm. At 12 days of age, the average of length was 203.61 µm. While in the suckling and feeding neonates, 18 days of age, the average of length was 89.47 µm. At 24 days of age, the average of length was109.52 µm. At 30 days of age, after weaning, the average of length of the villi was 107.21 µm. In distal small intestine at 0-day of age, suckling neonates the average length of the villi was 101.04 µm. At 6 days of age, the average length was 71.73 µm. At 12 days of age, the average length was 104.12 µm. In the suckling and feeding neonates, at 18 days of age, the average length was 121.86 µm. At 24 days of age, the average length was 158.11 µm. At 30 days of age (after weaning), the average length was 92.55 µm.

In the rabbit the mean thickness of tunica muscularis in the ileum was significantly high (Ranjan and Das, 2020).

In human fetal the thickness of the mucosa, submucosa and the muscularis externa was observed to be increased in first trimester, decreased in the second trimester and again increased in the third trimester, which could be because of the increase cell turnover and the arrangement of the collagen fibers as to support the mucosa and the muscularis externa (Salva *et al*., 2019).

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MATERIAL AND METHODS

After dissecting the uteruses, the approximate age of the foeti was estimated using the formula used by El-wishy *et al.*, (1981): GA = (CVRL + 23.99) ÷ 0.366, where GA is age in days and CVRL is the Crown Vertebral Rump Length; following the first trimester; 1– 23.5 cm (68 – 130 days), second trimester; 24 – 71 cm (131 – 260 days) and third trimester; 71.5 – 132 cm (261 – 426 days).

Gross morphometry of small intestine

Seventeen fresh specimens of small intestine of first, second and third trimesters and both sexes were used to measured the length by a meter (McCance, 1974; Elnagy, 2006) and to estimated the weight by a sensitive balance. The volume was estimated by the displacement technique (Aherne and Dunnil, 1982).

Histometry of small intestine

Histometric measurements were carried out to study the development of parts of small intestine (duodenal ampulla, duodenum, jejunum and ileum) in first, second and third trimesters. A total of nine foetuses in different trimesters were used for the histometric measurements. The tissues were fixed in and embedding were carried out as for general histology. Sections 5 µm thick were cut in a rotary microtome and stained conventionally with hematoxylin and eosin (Culling, 1974). either 10% formalin. Dehydration, clearing villi in second and third trimesters and thickness of tunica mucosa, thickness of tunica submucosa, thickness of tunica muscularis and thickness of tunica serosa in first, second and third trimesters consisted the all portions of small intestine. The data of the different histometric parameters were statistically analyzed by the Student's t-test, and the difference was considered statistically significant at $p<0.05$.

Measurements were performed on transversally cut duodenal ampulla, duodenum, jejunum and ileum of all trimesters. Histometric measurements were carried out with Olympus microscope (CH20-Japan) with ocular micrometer lens at 4 X magnifications and the following histometric parameters were measured after calibrating the ocular scale of microscope including length of

RESULTS

Gross morphometry of small intestine

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Table 1: Showing the mean of the biometrical data of the small intestine length, weight and volume according to age in days.

No	Age\day	Sex	Length\ cm			Weight\ gm	Volume\ cm³
			Du	Je	I	Small Intestine	Small Intestine
1	322	M	7	171	9	139	140
2	268	M	7	97	4.5	75	80
3	339	M	13.5	217	16	265	250
4	232	M	6.5	80	4	37	35
5	257	F	6.5	121	4.5	74	70
6	358	M	9	195	11	209	225
7	284	M	6.5	102	7	125	125
8	123	M	2	23.5	1.5	6	8
9	150	M	3	72	3	7	7
10	120	M	2	22	2.5	2	5
11	194	F	4	76	4	16	15
12	372	F	10	188	10.5	351	350
13	246	F	6.5	111	5	102	105
14	238	F	5.5	99	4.5	50	50
15	117	F	2	18.5	1.5	1	5
16	83	M	2	16	1	1	4
17	126	F	2.5	25	2	8	10

Du: Duodenum, Je: Jejunum and I: Ileum

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Table 2: Showing the mean linear of the small intestine regions.

No	Region	Mean ± SD
1	Duodenum	5.62±3.27
2	Jejunum	96.12±65.59
3	Ileum	5.38±4.08

$P < 0.05$

Table 3: Showing the means of the biometrical data of the small intestine volume (cm^3) and weight (gm) during all trimesters.

Parameter	Mean ± SD
Volume	75.65±79.34
Weight	86.35±103.40

Table 4: Showing the mean and standard deviation of the length (cm) of the small intestine regions during the first, second and third trimesters.

No	Item	Mean ± SD		
1	Region	Duodenum	jejunum	Ileum
2	First trimester	2.1±0.22	21±3.71	1.7±0.60
3	Second trimester	5.1±1.56	87.6±16.72	4.1±0.74
4	Third trimester	7.75±3.11	139.5±64.51	8.06±4.55

Table 5: Showing the mean weight (gm) and standard deviation of the small intestine covering the three trimesters.

No	Trimester	weight (Mean ± SD)
1	First trimester	3.6±3.209
2	Second trimester	42.4±37.40
3	Third trimester	155.8±112.90

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Table 6: Showing the mean volume (cm^3) and standard deviation of the small intestine covering the three trimesters.

No	Trimester	weight (Mean ± SD)
1	First trimester	6.4±2.51
2	Second trimester	42.4±38.53
3	Third trimester	156.25±111.44

Histometry of small intestine

The general histometric measurements of small intestine of camel fetuses included length of villi, thickness of tunica mucosa, thickness of tunica submucosa, thickness of tunica muscularis and thickness of tunica serosa.

The length of villi

The histometric analysis of data in the second trimester of camel fetuses revealed that the mean length of villi of duodenal ampulla was (105.4±3.55 µm), duodenum was (268.2±2.65µm), jejunum was (250.8±3.93 µm) and ileum was (242±3.77 µm), whereas in third trimester the mean length of villi of duodenal ampulla was (162.03±24.48 µm), duodenum was (361.5±44.13 µm), jejunum was (393.9±1.63 µm) and ileum was (254.2±26.55 µm). The villi in first trimester formed mucosal folds.

There were significant differences between the different measurements of the length of villi in third and second trimesters.

Small intestine layers

The mucosal thickness of duodenal ampulla in the first trimester was (84.2±30.15 µm), duodenum was (68.6±38.67 µm), jejunum was (105±62.09 µm) and ileum was (94.8±29.93 µm), whereas in the second trimester the duodenal ampulla was (209.8±43.19 µm), duodenum was (298.8±99.01 µm), jejunum was (297.7±33.94 µm) and ileum was (273.1±3.78 µm) and the duodenal ampulla in the third trimester was (252.9±66.44 µm), duodenum was (278.6±44.16 µm), jejunum was (439.5±1.63 µm) and ileum was

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(335.7±26.46 µm). The submucosal thickness in first trimester the duodenal ampulla was (127.6±2.46 µm), duodenum was (63.3±5.08 µm), jejunum was (66.31±6.22 µm) and ileum was (108±1.40 µm) in second trimester the duodenal ampulla was (111.7±2.34 µm), duodenum was (147±5.28 µm), jejunum was (143.1±3.83 µm) and ileum was (112.3±4.00 µm) and third trimester the duodenal ampulla was (137.17±60.49 µm), duodenum was (222.0±35.90 µm), jejunum was (81.3±19.40 µm) and ileum was (102.2±28.79 µm). The muscular thickness in first trimester of the duodenal ampulla was (100.9±7.60 µm), duodenum was (48.5±4.93 µm), jejunum was (37.9±5.50 µm) and ileum was (48.0±2.60 µm), whereas in second trimester the duodenal ampulla was (187.6±5.14 µm), duodenum was (108.1±7.11 µm), jejunum was (66.4±6.55 µm) and ileum was (98.7±5.55 µm) and in third trimester the duodenal ampulla was (221.61±48.3µm), duodenum was (218.3±46.22 µm), jejunum was (161.8±27.92 µm) and ileum was (149.5±15.99 µm). The serosal thickness in first trimester the duodenal ampulla was (16.3±1.50 µm), duodenum was (18.1±5.40 µm), jejunum was (8.5±1.92 µm) and ileum was (10.7±2.90 µm) in second trimester the duodenal ampulla was (62.4±1.20 µm), duodenum was (116.9±2.53 µm), jejunum was (21.5±2.50 µm) and ileum was (49.9±4.41 µm) and in third trimester the duodenal ampulla was (100.07±2.70 µm), duodenum was (69.2±2.60 µm), jejunum was (110.6±3.05 µm) and ileum was (67.3±3.80 µm).

There were highly significant differences between the different parameters of thickness of the tunics in duodenal ampulla, duodenum, jejunum and ileum at first, second and third trimesters.

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Table 7: The mean and standard deviation (Mean±SD) of thickness of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa for duodenal ampulla (A), duodenum (D), jejunum (J) and ileum (I) in first trimester

Prameter	T.mucosa	T. sub	T. m	T. Serosa
A	84.2±30.15	127.6±2.46	100.9±7.60	16.3±1.50
D	68.6±38.67	63.3±5.08	48.5±4.93	18.1±5.40
J	105±62.09	66.3.1±6.22	37.9±5.50	8.5±1.92
I	94.8±29.93	108±1.40	48.0±2.60	10.7±2.90

$P < 0.05$ A: Duodenal ampulla, D: Duodenum, J: Jejunum and I: Ileum

Table 8: The mean and standard deviation (Mean±SD) of villi length, thickness of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa for duodenal ampulla (A), duodenum (D), jejunum (J) and ileum (I) in second trimester.

Pr	Length of villi	T.mucosa	T. sub	T. m	T. Serosa
A	105.4±3.55	209.8±43.19	111.7±2.34	187.6±5.14	62.4±1.20
D	268.2±2.65	298.8±99.01	147±5.28	108.1±7.11	116.9±2.53
J	250.8±3.93	297.7±33.94	143.1±3.83	66.4±6.55	21.5±2.50
I	242±3.77	273.1±3.78	112.3±4.00	98.7±5.55	49.9±4.41

$P < 0.05$

Table 9: The mean and standard deviation (Mean±SD) of length of villi, thickness of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa of duodenal ampulla (A), duodenum (D), jejunum (J) and ileum (I) in third trimester.

Pr	Length of villi	T.mucosa	T. sub	T. m	T. Serosa
A	162.03±24.48	252.9±66.44	137.17±60.49	221.61±48.3	100.07±2.70
D	361.5±44.13	278.6±44.16	222.0±35.90	218.3±46.22	69.2±2.60
J	439.5±1.63	439.5±1.63	81.3±19.40	161.8±27.92	110.6±3.05
I	335.7±26.46	335.7±26.46	102.2±28.79	149.5±15.99	67.3±3.80

$P < 0.05$

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DISCUSSION

Gross Morphometry

In this study, the respective lengths of the duodenum, jejunum and ileum in the first trimester were 2.1±0.22 cm, 21±3.71cm and 1.7±0.60 cm; in the second trimester, they were 5.1±1.56 cm, 87.6±16.72 cm and 4.1±0.74 cm; in the third trimester, the measurements were 7.75±3.11 cm, 139.5±64.51 cm and 8.06±4.55 cm. According to Bello *et al.,* (2012), the entire length of dromedary camel small intestine was 76.00 ± 3.00 cm without any distinct demarcation between duodenum, jejunum and ileum at the first trimester. The authors reported clear demarcations at the second and third trimesters showing that the respective lengths of duodenum, jejunum and ileum were 44.83 ± 2.67 cm, 111.67 ± 3.33 cm and 59.33 ± 2.67 cm in the second trimester, and 66.00 ± 2.00 cm, 139.50 ± 3.00 cm and 75.00 ± 3.00 cm in the third trimester. The total length of adult camel duodenum ranged between 1.2 to 3.1 m and the average length of duodenum was ±2.17 m (Althnaian *et al.,* 2012) whereas the adult camel caecum appeared as a smooth cylindrical sac measuring 51.35± 6.40 cm (Mohamed *et al.,* 2018). Mohamed (2012) reported that the adult she-camel length of small intestine ranged between 10.6 and 11.79 meters (the mean length of all parts of small intestine was 10.97±0.66 meters). The length of the small and large intestines in the different domestic animals; camel about 40 and 19.5 meters (Smuts and Bezuidenhout, 1987); horse about 22 and 8 meters; sheep and goat about 25 and 8 meters; dog about 4 and 0.6 – 0.75 meter (Getty, 1975). In giraffes the total length of small intestine was about 2782 cm; the duodenum about 100 cm, jejunum about 2630 cm and ileum about 52 cm (Perez *et al.,* 2009). In alpacas the small intestine measured about 771 ± 140 cm, the gross intestine length was 610 ± 128 cm (Perez *et al.,* 2016). However in prenatal goats the mean length and diameter of the duodenum and jejunum were varied depend on the gestation days (Nwaogu, 2021).

The mean volume of small intestine in the present study was (75.65±79.34 cm^3), whereas the mean weight of small intestine was (86.35±103.40 g). Bello *et al.,* (2012) reported that there was an increase in the body weight, organ weight and individual segments of the small intestine in the fetuses with advancement in gestation period.

Histometry of small intestine

Little work has been done on histometric measurements of the small intestine in camelidae.

In this work, the general histometric measurements of small intestine of camel fetuses were performed including length of villi, thickness of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa.

In this study the villi at the first trimester only formed mucosal folds and the histometric length of villi in the second trimester of camel fetus was (105.4±3.55 µm), (268.2±2.65 µm), (250.8±3.93 µm) and (242±3.77 µm) in the duodenal ampulla, duodenum, jejunum and ileum, respectively; the length of villi at the third trimester was (162.03±24.48 µm), (361.5±44.13 µm), (393.9±1.63 µm) and (254.2±26.55 µm) in the duodenal ampulla, duodenum, jejunum

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and ileum, respectively. These data shows significant differences between the different measurements of the length of villi in third and second trimesters. In adult camels, a microscopic examination by Korkmaz and Kum (2016) revealed that the length of the mucosal folds (villi) decreased progressively from the duodenum to the ileum. The deepest crypts were observed in the duodenum ($P<0.001$) and the longest villi were detected in the jejunum ($P<0.001$). They added that the villi with the largest crypt diameter were observed in the ileum ($P<0.001$). In foetuses of dwarf goats (*Capra hircus*) Nwaogu, (2021) reported that the duodenal and jejunal mean villous heights, widths and intervillous crypt depths were 204.2 ±21.6, 66.8± 19.3, 51.0 ± 10.3; 204.8 ± 73.6, 65.9 ± 9.9 and 71.4 ± 18.6 µm for GD 101 – 146 foetuses, 366.5 ± 38.6, 166.9 ± 29.6, 85.0 ± 15.6; 1191.0 ± 262.0, 142.3 ± 9.8 and 158.2 ± 30.6 µm for kids. On the other hand, Elnagy, (2006) reported in postnatal male rabbits, the proximal and distal small intestine at 0- day of age, suckling neonates, the average lengths were varied with highly significance differences. The current study is disagreements with all authors and findings above. The present study revealed different measurements. These measurements showed highly significant differences between the different parameters of thickness of the tunics in duodenal ampulla, duodenum, jejunum and ileum at first, second and third trimesters. These findings are first reports of the histometric study of camel fetuses in first trimester, second trimester and third trimester. However, Ahmed *et al.*, (2018) reported in camel, the mean thickness of the wall in colon was more than that in caecum (487.9±26.6 µm), (366.7±34.1 µm) respectively. The colon epithelium revealed large number of Lieberkuhn crypts and goblet cells reached (31 ± 4), (262 ± 11) respectively, more than that in caecum (27 ± 5), (218 ± 12), respectively. The mean thickness of this tunica in caecum was more than that in colon (243.2±44.3 µm) and (124.8±16.6 µm) respectively. The mean thickness of tunica muscularis in colon was more than that in caecum (694.7±37.4 µm) and (513.9±46.3 µm) respectively. The mean thickness of the tunica serosa or adventitia in colon was more than that in caecum (212.7±14.1 µm) and (187.9±17.6 µm) respectively. Moreover, Dehkordi *et al.*, (2019) stated in camel that the mean of the thickness of the mucosa and submucosal layer in the duodenal region was more than the jejunum and ileum. The mean thickness of the muscular layer in both sexes in the intestinal jejunum region is less than the duodenum and ileum. In the Rabbit (Ranjan and Das, 2020) reported that the mean thickness of tunica muscularis in the ileum was significantly high. Agreements with Salva *et al.*, (2019) that the thickness of the mucosa, submucosa and the muscularis externa was observed to be increased in first trimester, decreased in the second trimester and again increased in the third trimester, which could be because of the increase cell turnover and the arrangement of the collagen fibers as to support the mucosa and the muscularis externa in human fetal.

Conclusion

In this study, the respective lengths of the duodenum, jejunum and ileum in the first trimester were 2.1±0.22 cm, 21±3.71cm and 1.7±0.60 cm; in the second trimester, they

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were 5.1±1.56 cm, 87.6±16.72 cm and 4.1±0.74 cm; in the third trimester, the measurements were 7.75±3.11 cm, 139.5±64.51 cm and 8.06±4.55 cm. The mean volume of small intestine in the present study was (75.65 ± 79.34 cm³), whereas the mean weight of small intestine was (86.35 ± 103.40 gm). The mean volume of small intestine in the present study was (75.65±79.34 cm³), whereas the mean weight of small intestine was (86.35±103.40 g). The general histometric measurements showed significant differences between the different measurements of the length of villi in third and second trimesters and these measurements showed highly significant differences between the different parameters of thickness of the tunics in duodenal ampulla, duodenum, jejunum and ileum at first, second and third trimesters.

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