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# Histological and histometric study on the compartment 1 of the one-humped camel (*Camelus dromedarius*) during the prenatal development

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***KEYWORDS***

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***ABSTRACT***

Compartment 1 of camel constitutes the largest part of the stomach and plays an important role in the microbial fermentation of the ingesta. The aim of this study was to investigate the histological and histometric changes in the compartment 1 of the one-humped camel during prenatal development. Camel foetuses were collected and divided into the first (below 130 days), second (131- 260 days) and third (261 - 390 days) trimesters. At early stage of gestation (71 days), the wall of the primitive stomach comprised three layers: Stratified epithelium, pluripotent blastemic, and myoblastic tissues. At 89 days of gestation, the first outline of compartment 1 appeared. It displayed four layers: Epithelium, pluripotent blastemic tissues, tunica muscularis and serosa. At 100 days of gestation, compartment 1 differentiated into two regions, glandular and non-glandular. Later (from 115 to 390 days of gestation), the muscular layer of compartment 1 was made up of smooth muscle cells that arranged in two layers, inner circular and outer longitudinal. At 224 to 390 days of gestation, the mucosa of the glandular region was lined by either simple columnar or non-keratinized stratified squamous epithelium, while the lining of the non-glandular region was non-keratinized stratified squamous epithelium. During the three trimesters, the cells lining the glands in the glandular regions were positive for Periodic acid Schiff stain. The thicknesses of the different layers of compartment 1 significantly ($P \leq 0.001$) increased with the foetal development. In conclusion, the present study revealed that the development of compartment 1 of the dromedary camel differs from that of other ruminants.

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## INTRODUCTION

The one-humped camel, known as dromedary (Camelus dromedarius), is commonly found in arid regions such as the Middle East, northern India and Africa. The most useful attributes of camels are their unique acclimatization to arid environments and they are capable of grazing plants that are rejected or unreachable to other grazing animals (Yagil, 1982). In addition to their economic importance as a source of meat, milk, wool, hair and transport, camels are also used in sports such as camel racing (Gauthier-Pilters and Dagg, 1981). Although camels ruminate but are considered as not true ruminants, because the morphology of their stomach differs from that of other ruminants (Abdel-Magied and Taha, 2003; Abuagla *et al.,* 2014).

The rumen of the camel stomach constitutes the largest part of the stomach (Abdel-Magied and Taha, 2003; Abuagla *et al.*, 2014; Bello *et al.*, 2014), and it plays an important role in the microbial fermentation of ingesta, production, and absorption of volatile fatty acids (Bannink *et al.*, 2008). Previous studies on the adult camels have shown that the morphology and functions of camel rumen differ from that of the other ruminants (Smuts and Bezuidenhout, 1987; Osman *et al.*, 2001) The rumen of the camel stomach is lined by smooth mucous membrane and is raised in small folds (König *et al.*, 2007), while in ruminants, it is covered by large conical papillae lined with keratinized stratified squamous epithelium (Aughey and Frye, 2001). Therefore, several authors have used the term "compartment 1" referring to the camel rumen. Ibrahim and Siddig (2017) and Abuagla *et al.* (2014) reported that the rumen of the camel consists of three regions: The first one is large and it is known as the non-glandular region, which has a smooth surface lined with keratinized stratified squamous epithelium, while the other two regions are named the glandular, which is divided into cranioventral and caudodorsal sacs (Osman *et al.*, 2001; Abuagla *et al.*, 2014; Ibrahim and Siddig, 2017). However, Abdel-Magied and Taha (2003) divided compartment 1 of camels into two regions namely, regions 1 and 2. The mucosa of both cranioventral and caudodorsal sacs contain large interconnected folds lined by either simple columnar or keratinized stratified squamous epithelium (Osman *et al.*, 2001; Abuagla *et al.*, 2014).

Multiple studies have reported the morphology of the rumen in adult camels (Hegazi, 1950; Purohit and Rathor, 1962; Smuts and Bezuidenhout, 1987; Lechner-Doll *et al.*, 1995; Singh *et al.*, 1996; Osman *et al.*, 2001; Abuagla *et al.*, 2014). Nonetheless, there is little attention on the histology and histometry of the compartment 1 of camel during foetal life (Naghani and Akradi, 2012; Bello *et al.*, 2014; Ibrahim and Siddig, 2017). Therefore, the present study was undertaken to provide baseline information on the developmental changes in the histology and histometry of compartment 1 of the One-humped camel (Camelus dromedarius) during prenatal development.

## MATERIALS AND METHODS

A total of 35 foetuses of both sexes of the one-humped camel (Camelus dromedarius) were obtained from Al-Salam (Omdurman, Khartoum State, Sudan) and Tamboul (Tamboul district, Al-Jazirah State, Sudan) abattoirs. In order to estimate the age of the foetuses, the Curved Vertebral Crown-rump Length (CVRL) was applied. Using a tape meter, the CVRL was measured (in centimetres) from the crown of the foetus following the column of the hump and ended at the root of the tail. Foetal age was then calculated using the method given by (Elwishy *et al.*, 1981).

$$\boldsymbol{x}\ (\textbf{unknown fetuse age}) = (\boldsymbol{y} + \mathbf{23.99})/\mathbf{0.366}$$

Where $\boldsymbol{y}$ indicates body dimensions (in cm)

After their ages being estimated, the body weight of each foetus was recorded using a digital balance (sensitivity 10 g – 50 kg). The gestational stages were selected based on a previous study in camel by Bello *et al.* (2012) (Table 1). The University of Khartoum Research Committee approved this study (2013).

### *Samples collection and microscopy*

An incision was made into the abdominal cavity to expose the stomach and the compartment 1. Tissue samples (1 cm3 blocks) were collected from the glandular and non-glandular regions of the compartment 1 and were immediately fixed by immersion in either 10% neutral buffered formalin or Bouin's solution. Samples were then processed routinely for light microscopy.

Sections (5 µm thick) were cut and stained with haematoxylin and eosin (H&E) for general histology, Van-Gieson for demonstration of collagen fibers, Masson's trichrome for the differentiation between connective tissue and smooth muscle fibers, Aldehyde fuchsin for illustration of elastic fibers, Gordon and Sweet for staining of reticular fibers, and Periodic acid Schiff (PAS) for neutral mucopolysaccharides.

**Table 1:** The CVRL, age and body weight of the foetuses of the one-humped camel during first, second and third trimesters.

| Parameters | Stage of gestation period | | |
|---|---|---|---|
| | **First trimester (n = 10) (Less than 130 days)** | **Second trimester (n = 13) (131- 260 days)** | **Third trimester (n = 12) (261 - 390 days)** |
| CVRL (cm) | 2 - 24 | 25 - 65 | 66 -120 |
| Age (days) | 71 - 120 | 134 - 246 | 270 - 393 |
| Body weight (kg) | 0.87 ± 0.45 | 2.24 ± 0.40 | 11.60 ± 3.42 |

### *Histometric measurements*

Histometric measurements of thickness (in µm) of the mucosa, submucosa, tunica muscularis, and serosa of glandular and non-glandular regions of compartment 1 were performed at 20x magnification under light microscopy, using H&E-stained sections ($n$ = 5 in each of the 3 gestational stage). Similarly, the length of the simple tubular gland length in the glandular region of compartment 1 was also recorded. All measurements were performed using using an ocular micrometer lens connected to an Olympus microscope (CH20). The thickness of mucosa, submucosa, tunica muscularis, and serosa of glandular and non-glandular regions of compartment 1 were measured on at least five regions, selected randomly.

### *Statistical analysis*

The histometric data of the thickness in different layers from foetuses of the three trimesters were tested for normality and homogeneity of variances and then analyzed by One-Way Analysis of Variance (ANOVA) using Statistical Package for the Social Sciences (SPSS) software (version 23, IBM Crop., Armonk, N.Y., USA). $P \leq 0.05$ was considered statistically significant.

## RESULTS

### *Histogenesis*

*First trimester*

The wall of the primitive stomach comprised three layers: epithelial, pluripotent blastemic tissue and myoblastic (Figure 1a). The epithelial layer was lined with stratified cells containing cytoplasmic vacuoles and their nuclei were located at different levels in the cytoplasm (Figure 1a). Some of these cells displayed different stages of mitotic division. The pluripotent blastemic tissue consisted of undifferentiated mesenchymal cells and angioblasts (Figure 1b). The myoblastic layer was composed of longitudinally oriented myoblastic cells which arranged as either simple (one layer) or stratified (two layers) cell layers (Figure 1a).

In a foetus at 89 days of gestation, the first outlines of compartment 1 appeared. The wall of the compartment consisted of four layers: epithelial layer; pluripotent blastemic tissue; tunica muscularis, tunica serosa (Figure 1c). The epithelial layer was stratified and comprised 5 to 6 cell layers, while the lamina propria-submucosa was made up of loose connective tissue consisting of numerous fibroblasts and mesenchymal cells. The tunica muscularis was composed of 4 – 5 longitudinal smooth muscle cell layers. The tunica serosa was made of fibroblasts and mesenchymal cells, and it was covered with mesothelium (Figure 1c).

In foetuses of 100 – 110 days of gestation, the compartment 1 was divided into two regions, glandular and non-glandular. The walls of these regions comprised four well-developed layers: epithelial; lamina propria-submucosa; tunica muscularis; tunica serosa. The glandular region was lined with invaginated pseudostratified columnar epithelium with cells containing

elongated nuclei and cytoplasmic vacuoles (Figure 1d). The non-glandular region was lined with stratified epithelium, which consisted of two layers, basal with one eosinophilic cell layer and apical consisting of 2 – 3 polyhedral cell layers (Figure 1e). The lamina propria-submucosa of both glandular and non-glandular regions was comprised connective tissue which contained collagenous and reticular fibres, fibroblasts, and mesenchymal cells. In the non-glandular region, however, there were 2 – 3 longitudinal smooth muscle cell layers separating the lamina propria from the submucosa (Figure 1d, e, f, g). The tunica muscularis was consisted of inner circular and outer longitudinal smooth muscle cell layers. The tunica serosa contained loose connective tissue and it was covered with mesothelium.

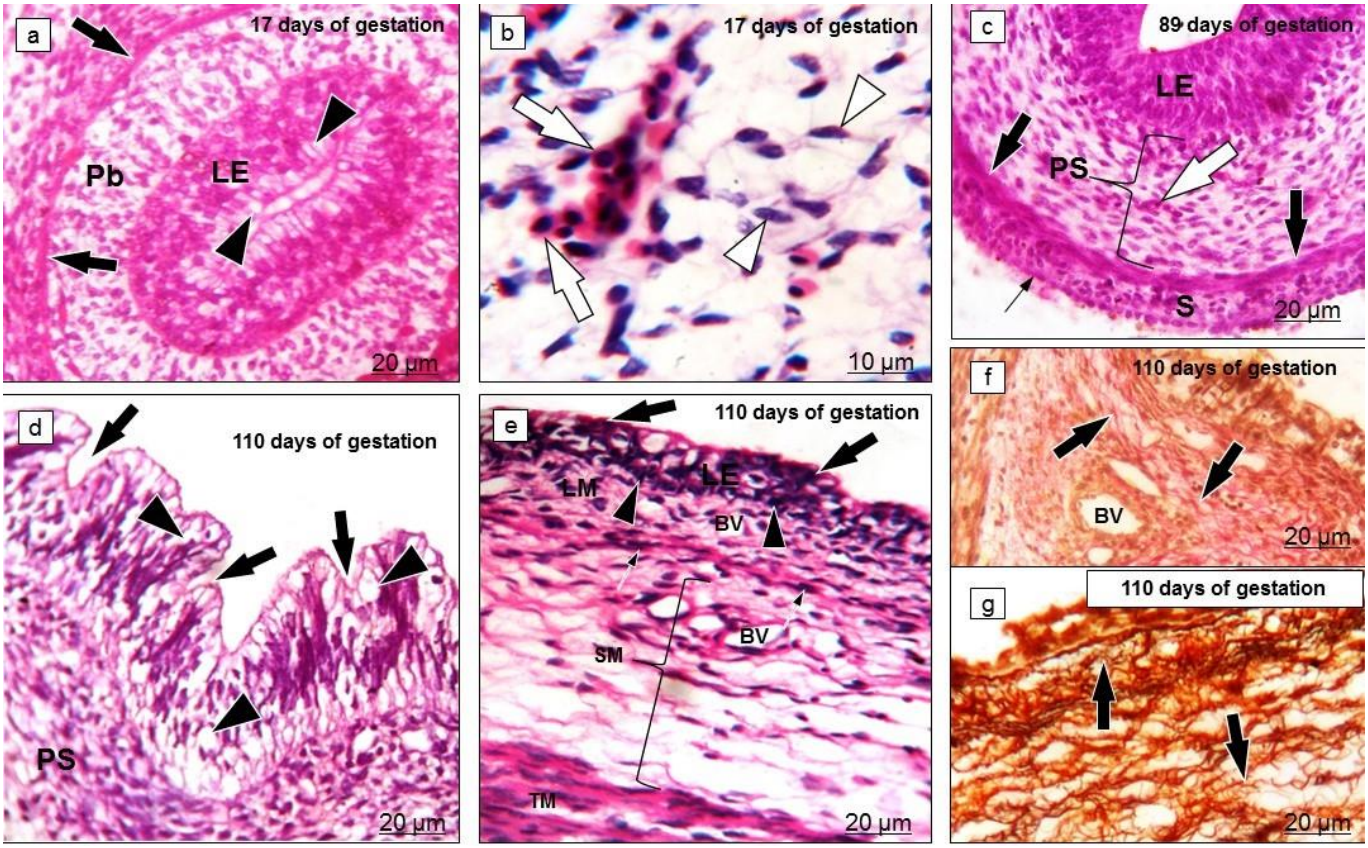


**Figure 1:** Light photomicrographs of compartment 1 of the one-Humped camel during the first trimester – 71 days of gestation period (a and b), 89 days of gestation period (c) and 110 days of gestation period (d–g). a and b: Cytoplasmic vacuoles (black arrowheads) in the luminal epithelium (LE) of the primitive stomach, myoblastic layer (black arrows), angioblasts (white arrows) and undifferentiated mesenchymal cells (white arrowheads) in the pluripotent blastemic tissue layer (Pb); (c) Angioblast (white arrow) in the lamina propria-submucosa (PS), smooth muscle cells layer (black thick arrows) and mesothelium (thin arrow) covering the serosal (S) layer; (d) Arrows indicate invaginations in the LE of the glandular (G) region. Arrowheads depict cytoplasmic vacuoles; (e) Apical flattened (thick arrows) and basal polyhedral (arrowheads) cells in the epithelium of the non-glandular (NG) region. Thin arrows depict the longitudinal smooth muscle cells layer forming the muscularis mucosa (TM). Bracket shows the submucosal layer (SM) in the NG. (f) Arrows indicate collagen fibres in PS of G region. (g) Arrows depict the reticular fibres in the lamina propria (LM), muscularis mucosa, and submucosa (SM) of the NG. **(a–e) Hematoxylin and eosin. (f) Van Gieson stain. (g) Gomori's silver impregnation.**

In foetuses at 115 and 130 days of gestation, the epithelium of the glandular region of compartment 1 was divided by deep and branched invaginations. This region was lined with stratified columnar epithelium with cytoplasmic vacuoles, while the lining of the non-glandular region was stratified epithelium that consisted of three cell layers: Apical, middle and Basal (Figure 2a, b). The cells in the apical layer were flat and had elongated nuclei, whereas the middle layer comprised of 2 – 3 polyhedral

cell layers with rounded nuclei. The basal layer contained cells with basophilic staining cytoplasm and rounded nuclei (Figure 2b). The epithelia of the glandular and non-glandular regions were positive for PAS staining (Figure 2 e, f). The lamina propria and submucosa of both regions contained collagenous fibres, reticular fibres, fibroblasts, mesenchymal cells, and blood vessels (Figure 2d). Furthermore, primary lymphatic nodules were observed in the propria-submucosa of the glandular region (Figure 2c). The muscular layer in both regions consisted of inner circular and outer longitudinal layers of smooth muscles. The serosal layer consisted of loose connective tissue that contained collagenous fibres, reticular fibres, blood vessels, and nerve fibres and it was covered with mesothelium.

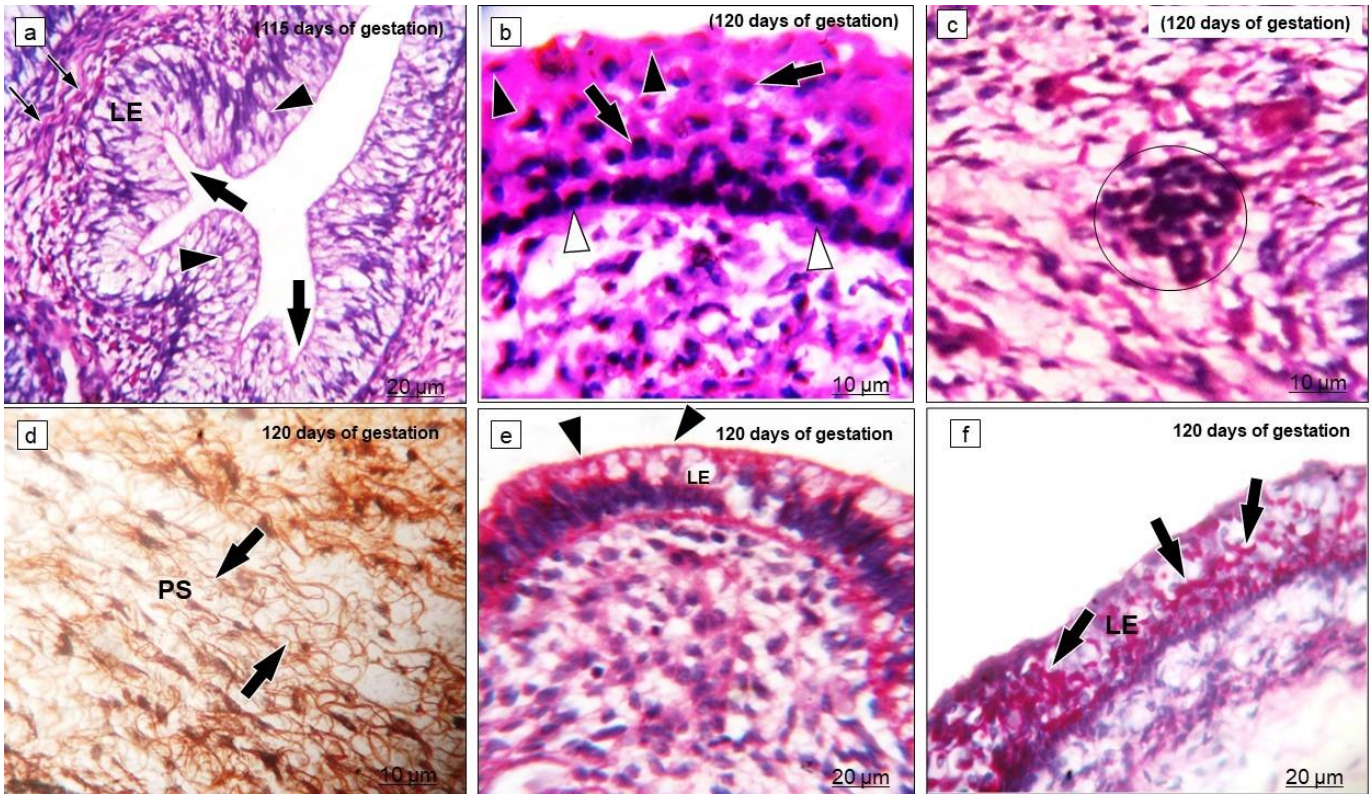


**Figure 2:** Light photomicrographs of compartment 1 of the one-Humped camel during the first trimester – 115 (a) and 120 (b–f) days of gestation period. (a) Cytoplasmic vacuoles (arrowheads) and invaginations (thick arrows) in the luminal epithelium (LE) of glandular (G) region. Thin arrows indicate muscularis mucosa between the G folds; (b) Apical flattened (black arrowheads), middle polyhedral (arrows) and basal (white arrowheads) in the epithelium of the non-glandular (NG) region; (c) Circle depicts a primary lymphatic nodule in the lamina propria-submucosa of G region. (d) Arrows indicate reticular fibres in the lamina propria-submucosa (PS) of the G region.; (e) Positive Periodic acid Schiff (PAS) staining in the apical regions (arrowheads) in the LE of the G region, (f) Arrows indicate PAS- positive staining in the epithelial cells of the NG region. **(a–c) Hematoxylin and eosin. (d) Gomori's silver impregnation. (e and f) Periodic acid Schiff.**

*Second trimester*

In foetuses from 145 – 200 days of gestation, the epithelium and other layers of the glandular and non-glandular regions were similar to those of the previous age group.

In foetuses from 220 – 245 days of gestation, the mucosa of the glandular region was lined with simple columnar and non-keratinized stratified squamous epithelium (in the apices of the folds) epithelium, while the lining of the non-glandular region was stratified squamous epithelium non-keratinized (Figure 3a, b, c). In the glandular region, the columnar epithelial cells contained basally located oval nuclei (Figure 3a). In both glandular and non-glandular regions, the non-keratinized stratified squamous epithelium consisted of four strata from the apical to basal including corneum, granulosum, spinosum, and germinativum (Figure 3c). The stratum corneum was located at the apical surface of the epithelium and it was made of 1 – 2 of

flattened cells layers, while the stratum granulosum was consisted of 1 – 2 of polyhedral cell layers with oval nuclei and pale staining cytoplasm. The stratum spinosum located beneath the stratum granulosum and comprised 4 – 5 of polyhedral cell layers with oval nuclei and dark staining cytoplasm. The stratum germinativum was made of simple layer of basophilic staining cells with prominent spherical nuclei (Figure 3c).

Simple tubular glands were also observed in the lamina propria of the glandular region. The luminal epithelium and apical regions in cells lining the glands of the glandular region displayed positive PAS staining (Figure 3e). Positive staining with PAS was also observed in the epithelium of the non-glandular region, in particular the stratum corneum, stratum granulosum and stratum spinosum (Figure 3f). The lamina propria composed of dense irregular connective tissue. The submucosa consisted of loose connective tissue which in turn displayed diffuse lymphatic tissue (Figure 3d)

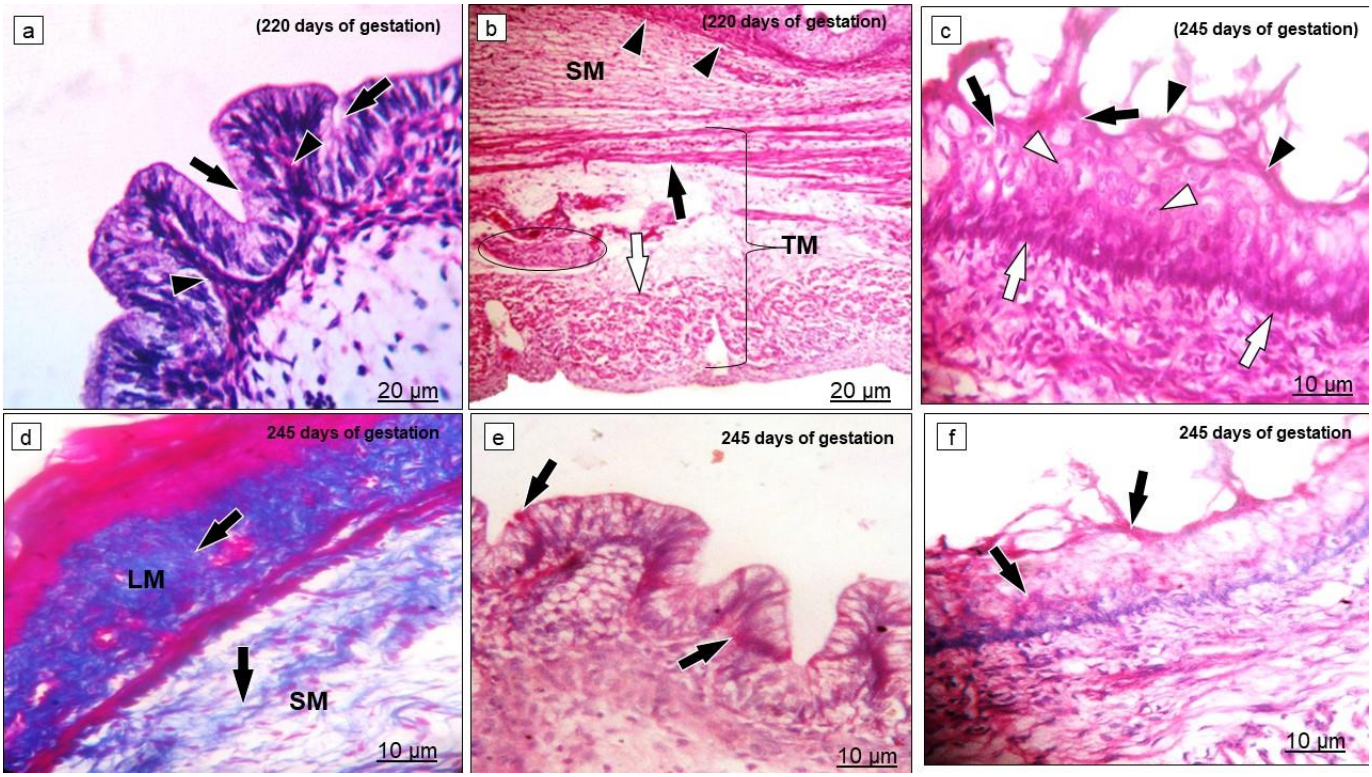


**Figure 3:** Light photomicrographs of compartment 1 of the one-Humped camel during the second trimester – 220 (a & b) and 245 (c–f) days of gestation period. (a) Simple tubular glands (arrows) and smooth muscle cells layer (arrowheads) in the glandular (G) region; (b) Arrows indicate the smooth muscle cells layer forming the muscularis mucosa of the non-glandular (NG) region. Bracket depicts Inner circular (black arrow) and outer longitudinal (white arrow) of smooth muscle cell layers forming the *tunica muscularis* (TM). Oval circle indicate myenteric plexus; (c) The non-keratinized stratified squamous epithelium in the NG region comprised four strata: Corneum (black arrowheads), granulosum (black arrows), spinosum (white arrowheads) and germinativum (white arrows). (d) Arrows indicate collagen fibres in the lamina propria (LM) and submucosa (SM) of the NG region. (e & f) Arrows show PAS positive staining in the cells lining tubular gland of the G (in e) and in the epithelial cells of the NG (in f) regions. **(a–c) Hematoxylin and eosin**. **(d) Masson's Trichrome. (e and f) Periodic acid Schiff.**

*Third trimester*

In foetuses of 270 and 393 days of gestation, the lamina propria of the glandular region showed simple branched tubular glands. They were lined by simple columnar epithelium with nuclei located at the base of the cells (Figure 4a). The mucosa of the non-glandular region of compartment 1 displayed finger-shaped folds (Figure 4b). The PAS-positive reaction was localized in the luminal epithelium and apical regions in cells lining the glands of the glandular region. In non-glandular region, PAS-positive staining was only observed in stratum corneum (Figure 4d, e). The other layers of these regions were similar to those in the previous age.

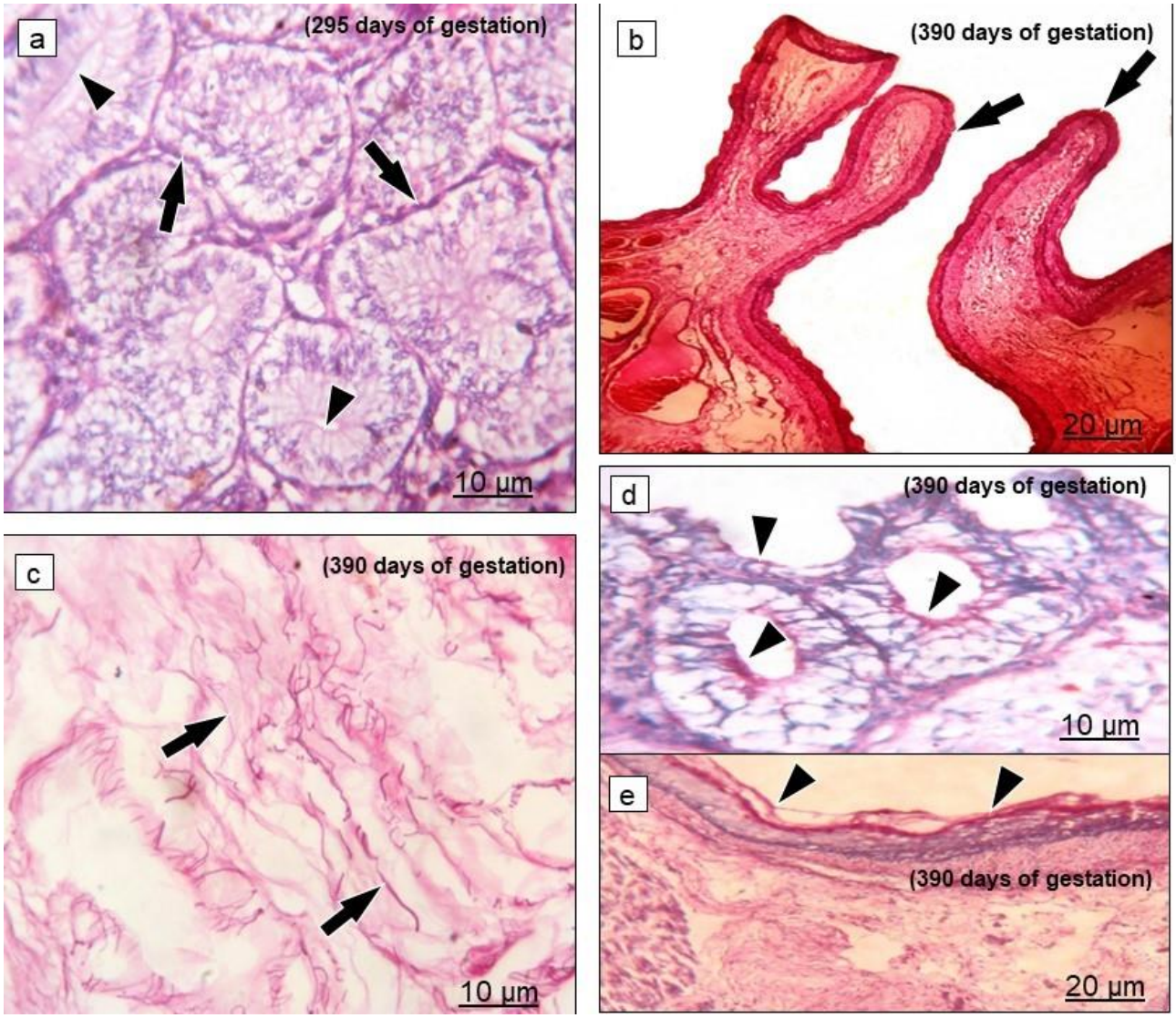


**Figure 4:** Light photomicrographs of compartment 1 of the one-Humped camel during the third trimester – 295 (a) and 390 (b–d) days of gestation period. (a) Arrowheads indicate simple columnar cells in the luminal epithelia of the branched tubular glands of the glandular (G) region. Arrows show smooth muscle cells layer forming the muscularis mucosa; (b) Arrows depict the finger-shaped like folds in the mucosa of the non-glandular (NG) region. (c) Arrows show elastic fibres in the lamina propria and submucosa. (d) Arrows indicate PAS-positive staining in the apical regions of cells lining the epithelium and the glands and the G region; (e) Arrows depict PAS positive staining in the stratum corneum of the NG region. **(a and b) Hematoxylin and eosin**. **(c) Aldehyde fuchsin. (d and e) Periodic acid Schiff.**

***Histometry***

The histometric measurements of the wall layers including mucosa, propria-submucosa, tunica muscularis and serosa in the glandular and non-glandular regions thicknesses of compartment 1 during the three trimesters were shown in Tables 2 and 3.

The thickness of the mucosal layer of the glandular region was gradually increased with foetal development from the first and second trimesters, while it significantly ($P < 0.05$) increased in the third trimester. Significant ($P < 0.001$) increase in the thickness of the submucosal layer of the glandular region was also observed during the second and third trimesters as compared to the first trimester. The thicknesses of the tunica muscularis and serosa of the glandular region were significantly different ($P \leq 0.001$) with foetus development. The length of the glands was significantly ($P < 0.001$) decreased in the third trimester compared to the second trimester.

The thickness of the mucosa of the non-glandular region was significantly ($P \leq 0.001$) increased in the second and third trimesters compared to the first trimester. The thicknesses of the submucosa and tunica muscularis of the non-glandular region were increased significantly ($P \leq 0.001$) in the second and third trimesters compared to the first trimester. The thickness of the serosa of the non-glandular region was significantly ($P \leq 0.001$) increased in the third trimester when compared with the first and second trimesters.

**Table 2:** The mean thickness of the mucosa, submucosa, tunica muscularis and serosa in the glandular region of the compartment 1 of the one-humped camel during the three trimesters (Mean ± SE).

| Parameters | Stage of gestation period | | | P value |
|---|---|---|---|---|
| | First Trimester | Second Trimester | Third Trimester | |
| Mucosa (µm) | 51.6 ± 1.8 [b] | 56.1 ± 5.5 [b] | 122.9 ± 1.4 [a] | <0.01 |
| Submucosa (µm) | 78.1 ±0.2 [b] | 271.0 ± 40.6 [a] | 324.6 ± 51.9 [a] | <0.01 |
| Tunica muscularis (µm) | 75.9± 36.9 [c] | 298.7 ±4.4 [b] | 543.7 ± 6.1 [a] | <0.05 |
| Serosa (µm) | 45.71± 1.5 [c] | 49.5 ± 0.5 [b] | 85.1 ± .7 [a] | <0.05 |
| Gland length (µm) | - | 82.2 ± 0.5 [a] | 77.1 ± 0.2 [b] | <0.05 |

[abc] Different superscripts within the same row denote significant difference

**Table 3:** The mean thickness of the mucosa, submucosa, tunica muscularis and serosa in the non-glandular region of the compartment 1 of the One-humped camel during the three trimesters (Mean ± Standard error).

| Parameters | Stage of gestation period | | | P value |
|---|---|---|---|---|
| | First Trimester | Second Trimester | Third Trimester | |
| Mucosa (µm) | 49.2 ± 5.0 [b] | 137.1 ± 6.2 [a] | 131.5 ±13.3 [a] | <0.01 |
| Submucosa (µm) | 63.5 ±45.5 [c] | 224.8 ± 28.9 [b] | 455.6 ± 42.3 [a] | <0.05 |
| Tunica muscularis (µm) | 63.2 ±26.2 [c] | 202.3 ± 28.0 [b] | 1200.7 ± 53.2 [a] | <0.05 |
| Serosa (µm) | 47.9 ± 1.1 [b] | 60.8 ± 2.5 [b] | 153.8 ± 7.5 [a] | <0.05 |

[abc] Different superscripts within the same row denote significant difference

## DISCUSSION

Reports on the development of wall layers of the stomach in embryos of ruminants have shown species-specific characteristics. For example, in sheep and red deer, the wall of the primitive stomach comprises two layers: epithelium and pluripotent blastemic tissue at 23 to 33 and 30 to 60 days of gestation, respectively (Franco *et al.*, 2004; Franco *et al.*, 2011; Redondo *et al.*, 2011). Conversely, in cattle from 23 to 42 days of gestation, the wall of the gastric tube is composed of three layers including epithelium, pluripotent blastemic tissue, and serosa (Vivo *et al.*, 1990). In the present study, at the age of 71 days of gestat ion, the wall of the primitive stomach made up of three layers. In the current study, cytoplasmic vacuoles were also observed in the epithelia of the primitive stomach of the camel. Takaya (1973) suggested that the formation of vacuoles in the cells that originate from the endoderm might be due to their heavy yolk content.

In the current study, in a foetus of 89 days of gestation, the wall of the rumen consisted of four well-developed layers:

Epithelium, pluripotent blastemic tissue, tunica muscularis, and serosa. Similar findings were observed in camel foetus of 50 to 140 days of gestation (Naghani and Akradi, 2012), as well as 30 to 57 days of gestation of bovine foetus (Vivo *et al.*, 1990). In contrast, the wall of the rumen in sheep and red deer (30 and 60 days of gestation) comprises well-defined three layers, an inner epithelium, middle pluripotent blastemic tissue as well as the outer myoblastic layer (Franco *et al.*, 2011).

In the present study, in foetuses of 100 to 110 days of gestation, compartment 1 was divided into glandular and non-glandular regions. The glandular region lined by pseudostratified columnar epithelium, while the lining of the non-glandular region was stratified epithelium. Results from the previous study have shown that the differentiation of compartment 1 into glandular and non-glandular regions occurs at the age of 140 to 160 days of gestation of the One-humped camel (Naghani and Akradi, 2012). These differences in the age of differentiation of compartment 1 could be due to the breed type.

Earlier studies on camel foetus revealed that the primary lymphatic nodules were located in the lamina propria of compartment 1 (Naghani *et al.*, 2010; Naghani and Akradi, 2012). Similarly, these lymphatic nodules were mainly detected in the lamina propria of a glandular region of compartment 1 in the adult dromedaries (Osman, 1999).

In the present investigation, from the age of 100 to 131 days of gestation, the epithelium of the glandular region showed invaginations, which became branched with the advancement of age. At 220 to 245 days of gestation, these invaginations extended to the lamina propria of the glandular region and differentiated to the tubular gland. Additionally, in foetuses of 271 and 366 days of gestation simple branched tubular glands were observed in the lamina propria of the glandular region. These glands were positive to PAS staining. The development of the invagination to the glands has been observed in the proventriculus of the chicken embryo (Thomson, 1969). Furthermore, simple tubular branched glands have also been observed in the glandular region of compartment 1 in the adult one-humped camel (Osman *et al.*, 2001; Abdel-Magied and Taha, 2003; Abuagla *et al.*, 2014). Abdel-Magied and Taha (2003) named these glands as pseudo-cardiac glands.

In agreement with the finding on the adult camel (Osman *et al.*, 2001; Abuagla *et al.*, 2014). The glandular region in foetuses of 220 to 393 days of gestation, lined with two types of epithelia, non-keratinized stratified squamous and simple columnar, while the lining of the non-glandular region was stratified squamous epithelium non-keratinized. On the contrary, Naghani, Akradi (2012) reported that camel foetuses of 250 to 390 days of gestation exhibited mucosa of the glandular region of the rumen which lined only by simple columnar epithelium, while the lining of the non-glandular region is the stratified epithelium.

In general, the current study showed that the thicknesses of different layers in both regions of compartment 1 increased with the advancement of foetal life. Similar observation have been reported in the abomasum of a foetus of the camel (Naghani *et al.*, 2010), rumen of the red deer (Franco *et al.*, 2004). These findings are contrary to observations made of the thickness of the wall of the third compartment in the foetus of the one-humped camel, in which the wall thickness was gradually decreased with advancing age (Naghani, 2011).

## CONCLUSION

The current study indicated that there were developmental stage-related histological, and histometric changes in all regions of compartment 1 of dromedary camel as they developed from first trimester (below 130 days) to second trimester (131 - 260 days) to third trimester (261 - 390 days). The present study has shown that the prenatal development of compartment 1 of the stomach of dromedary camels differs from that of other ruminants.

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## CONFLICT OF INTEREST

The authors of this article declare that there is no conflict of interest.

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