

*Original Research***Prenatal Study of the Developing Omasal Laminae in Goat****Varsha Gupta<sup>\*</sup>, Muneer Mohammad Farooqui, Ajay Prakash, Archana Pathak and Abhinov Verma**

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**Abstract**

The study was conducted on developing omasum from 36 healthy and normal embryos/ foeti of Indian goat. Embryos/foeti were assigned into three groups (0-50, 51-100 and 101-150 days of gestation). Internal surface of the omasum showed leaf like omasal laminae from 38 days of gestation. Primary, secondary, tertiary and quaternary laminae were observed grossly on 38, 51, 55 and 87 days and histologically at 38, 46, 51 and 70 days of gestation, respectively. The free border of the laminae showed serration at 94 days in primary and 100 days of gestation in secondary and tertiary laminae. Quaternary laminae were devoid of serrations. Under light microscope the first sign of omasal laminae formation was evidenced by evagination of basal zone of epithelium laid to formation of undulations towards the omasal lumen. Height of the laminae and interlaminae space between laminae were increased with advancement of gestation. Lateral outpocketing of omasal laminae was first noticed at 51, 60 and 87 days of gestation in primary, secondary and tertiary laminae, respectively referred as corial papillae.

**Key words:** Corial Papillae, Omasum, Omasal Laminae, Prenatal Goat**How to cite:** Gupta, V., Farooqui, M., Sharma, A., Pathak, A., & Verma, A. (2020). Prenatal Study of the Developing Omasal Laminae in Goat. International Journal of Livestock Research, 10(1), 48-62. doi: 10.5455/ijlr.20191011072548**Introduction**

Goat is important in arid, semiarid and mountainous region where crop and dairy farming are not economically feasible. The ruminant has an ability to convert fibrous foods into products of great nutritive value. This ability develops scientific interest on the structure and function of the digestive tract of these animals. Omasum plays an important role in digestion and serves mainly as a dehydration area and acts as a sieve. The omasum has two physiological compartments: omasal canal that transfers food from the reticulum to the omasum, and the inter-laminae recesses between the mucosal laminae which provide the area for absorption (Hofmann, 1989). Dellmann and Brown (1987) mentioned that largest laminae had a thick concave free edge. They further pointed out that the food was present in thin layers in the narrow

spaces between the laminae and reduced to a fine pulp by the numerous rounded horny papillae that stud the surface of mucosa. Literature on development and growth of omasal laminae are very scanty. Therefore, the study was designed to get necessary knowledge of day of appearance of omasal laminae, its differentiation and maturation.

## Materials and Methods

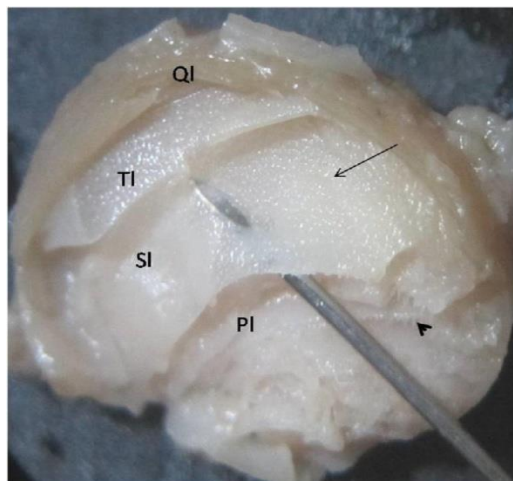
The present study was conducted on the developing omasum collected from 36 healthy and normal embryos/ foeti of either sex of non- descript goat (*Capra hircus*) of Mathura region of India (in 2016). An approval was obtained from institutional animal ethic committee of DUVASU, Mathura (U.P.) India, prior to the commencement of the study. The embryos/ foeti ranged from 32 days to near full term (145 days) of gestation. The age of embryos/foeti was ascertained by using formula for goat foetus,  $W^{1/3} = 0.096(t-30)$ , where  $W$  = body weight of foetus in gram and  $t$  = age of foetus in days (Singh *et al.*, 1979). Embryos/foeti were assigned into three group viz. group I (0-50 days of gestation), group II (51-100 days of gestation) and group III (101-150 days of gestation). The abdominal cavity was opened and developing omasum was harvested. After careful dissection of omasum internal surface of the omasum was observed under stereozoom microscope and structures were recorded with the help of digital Vernier Caliper. Small pieces of tissues were cut in group II and III while in group I whole of the stomach was collected. The tissues were fixed in 10 per cent neutral buffered formalin and were processed by routine paraffin embedding technique (Luna, 1968). Six  $\mu$ m thick sections were taken and stained with hematoxylin and eosin for histo architecture (Luna, 1968), Wilder's reticulin stain for reticular fibres (Luna, 1968), Verhoeff's stain for elastic fibres (Luna, 1968) and Mallory's triple stain (Crossman, 1937) for collagen fibers. Stained slides were observed under light microscope. Micrometric observations were done on hematoxyline eosin stained sections by Leica DM750 computerized image analyser. The data generated by the micrometrical observations were subjected to statistical analysis (Snedecor & Cochran, 1994) with the help of SPSS 20.0 software.

## Results and Discussion

### Organogenesis

The internal surface of omasum presented leaf like structures referred as omasal laminae. The laminae were classified as primary, secondary, tertiary and quarterly in decreasing order of their height. One secondary lamina lied between two primary laminae. Tertiary laminae were placed between primary and secondary laminae and quarternary laminae were situated between primary and tertiary and tertiary and secondary laminae. These laminae ran from greater curvature to lesser curvature of omasum and aggregated at the reticular and abomasal junction. The height of the laminae was more at the center and decreased towards junction.

Omasal laminae were first observed in group I from 38 days of gestation. Roy (2009) observed first order laminae at 40 days of gestation in bovine. Three primary and two secondary omasal laminae were noticed at 51 days of gestation under stereozoom microscope. Tertiary and quaternary laminae were first observed at 55 and 87 days of gestation, respectively and were eight and twenty-four in number, respectively. Present observations were in partial agreement with the findings of Nwaogu and Ezeasor, (2008) in West African dwarf goats. These authors observed only first three type laminae at mid gestation while quaternary laminae at full term. Panchmukhi *et al.* (1975) observed primary, secondary and tertiary laminae in buffalo at 2.5, 3.2 and 8.5 cm crown rump length (CRL). The laminae revealed serrations on their free border and small papillae on their surfaces. These serrations were first observed in primary laminae at 94 days and at 100 days of gestation in secondary and tertiary laminae (Fig. 1). In contrast to this Nwaogu and Ezeasor, (2008) noticed that in West African dwarf goats the surface of the laminae were smooth in foetuses and numerous in adult.



**Fig. 1:** Photograph of 116-day old goat foetal omasum showing different type of omasal laminae primary (PI), secondary (SI), tertiary (TI) and quarterly (QI) laminae, arrow head showing serrations on the free border of the laminae, arrow showing corial papillae.

At 150 days of gestation total 89 omasal laminae were counted. Maximum number of primary, secondary, tertiary and quarterly laminae was 12, 11, 22 and 44, respectively in group III. Nickel *et al.* (1979) also described that in adult goat total number of omasal laminae was 80-88. A continuous change in the density of papillae may reflect a mucosal adaptation to the changing environment in the omasal lumen due to the degree of feed particle coarseness and the chemical nature of the contents (Yamamoto *et al.*, 1994).

### Histogenesis

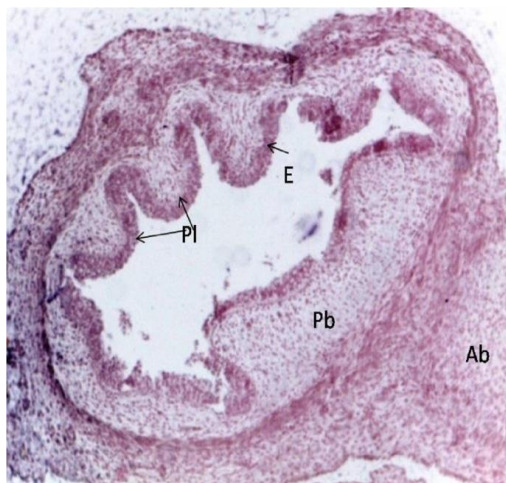
In the present study first sign of omasal laminae formation was evidenced by evagination of basal zone of epithelium laid to formation of undulations towards the omasal lumen at 38 days of gestation. In bovine

omasal laminae were described at 45 and 40 days of gestation (McGeedy *et al.*, 2006 and Rao and Ramayya, 2013, respectively). All laminae were lined by stratified epithelium upto mid gestation period which changed to stratified squamous epithelium in the terminal stage of gestation at about 121 days of gestation. Fifth order laminae could not be observed at any stage of gestation which were contrary to the findings of Wardrop (1961) in sheep at birth, Osman and Berg (1982) and Singh *et al.* (2005) observed fifth order laminae in buffalo foeti at 32 of gestation and between 22.4-28.0 cm CRL, respectively.

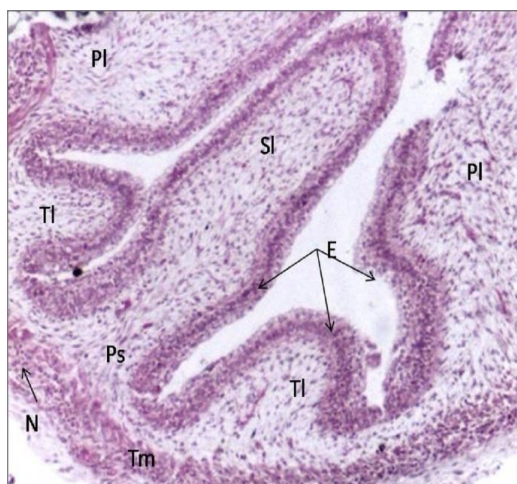
In group I, at 38 days of gestation, the epithelium showed 6-7 undulations of different height which could be referred as the beginning of omasal laminae formation. These laminae were of first order omasal laminae (Fig. 2). The laminae were more developed towards greater curvature of the omasum. At 46 days of gestation interlaminal space between two primary laminae was increased. The epithelium was raised to a certain height lesser than the swelling of primary laminae. This could be spoken as formation of secondary laminae. Secondary laminae were 4-5 in number; the cytological characters of these laminae were identical to those of primary laminae. By 51 days of gestation, different generations of tertiary laminae were observed in between the primary and secondary laminae (Fig. 3). Slight evagination in the basal zone or both sides of the tertiary laminae was noticed at 70 days of gestation i.e. fourth order lamina. Present observations were in close proximity of Gracia *et al.* (2013 and 2014) in goat regarding appearance of first and second order laminae, however, third order laminae observed late (59 days) and fourth order laminae appeared early (64 days) than present study. Fath El Bab *et al.* (1983) reported first, second and third order laminae at 52 days and fourth order laminae at 78 days of gestation in sheep. Whereas, Franco *et al.* (1993) noticed first, second, third and fourth order laminae at 33, 39, 50 and 59 days of gestation in sheep. On the contrary, Nwaogu and Ezeasor (2008) in West African goat foetus observed first three types of laminae at mid gestation and fourth order laminae at full term. In the present study earlier appearance of laminae was probably due to breed and climatic differences.

At 38 days of gestation, the epithelium was undifferentiated stratified type and comprised of three to four layers of cuboidal or narrow columnar shaped cells whose contour was distinct. Spherical or elongated shaped nuclei were located centrally or eccentrically. Infra nuclear zone was either vacuolated or lightly eosinophilic. Several mitotic figures were commonly observed. From 44 days onwards the epithelium layer was divided into superficial and basal zones. Between 44-49 days of gestation the basal zone contains two to three rows of cells at the base and two rows at the tip. Cell were cuboidal shaped with apically placed spherical nuclei upto 46 days and became cuboidal to low columnar shaped at 49 days of gestation. At 46 days of gestation, cytoplasm of few cells became highly eosinophilic in infranuclear zone and their supranuclear zone was pale. In group II (51-100 days of gestation) cells of basal zone were cuboidal type with spherical vesicular nuclei. The cytoplasm was pale or lightly eosinophilic. In group III (101-150 days of gestation) cells of the deepest layer were simple cuboidal type with indistinct cell

boundaries and had spherical nuclei. Cells of the upper layers were cuboidal to high cuboidal or narrow columnar shape with spherical or elongated centrally placed nuclei. The nuclei were darkly stained with uniformly distributed nuclear chromatin. The cytoplasm was pale to lightly eosinophilic. Vacuolated infranuclear zone and acidophilic supranuclear zone were noticed in narrow columnar cells. At full term cell cytoplasm became granular and eosinophilic.



**Fig. 2:** Photomicrograph of section of 38 day old goat foetal omasal wall showing undifferentiated stratified epithelium (E), pleuripotent blastemic tissue (Pb), serosa (S), primary omasal laminae (Pl) and abomasum (Ab) (H & E X 100).



**Fig. 3:** Photomicrograph of section of 51 day old goat foetal omasal wall showing undifferentiated stratified epithelium (E), propria submucosa (Ps), tunica muscularis (Tm) neuronal elements (N), serosa (S), primary (Pl), secondary (Sl) and tertiary omasal laminae (Tl) (H & E X 100).

At 44 days of gestation the superficial zone was lined by single layer of cuboidal cells. Spherical nuclei were located towards the apical region of the cell with evenly distributed nuclear chromatin. Eosinophilic cell boundaries were distinct while cell cytoplasm was pale. Between 46-49 days of gestation cuboidal to polyhedral shaped cells were arranged in two to three layers. The height of the cell reduced towards lumen

in 49 days of gestation. In group II this zone contained four to five layers. The cells were cuboidal to polygonal shaped. The nuclei were situated at one corner and cytoplasm was pale. Nuclear characters were identical to the cells of 49 days of gestation. Cells of the topmost layer were vacuolated. Process of lumen formation was also observed at this stage. In group III cells of superficial zone was 10-12 layered. The cells were regularly arranged and most of them were polygonal in shape. At 102 days of gestation few cells became roughly columnar in shape and had a cytoplasmic process at their apical end, could be referred as future stratum spinosum (Fig. 5). At 121 days of gestation at certain level the cells became flattened and showed characters of keratinization (Fig. 6). At full term at certain level top most layer of this zone had lost their nuclei and contained highly eosinophilic cytoplasm, indicating the keratinization. However, at certain places darkly stained flat nuclei were also encountered.



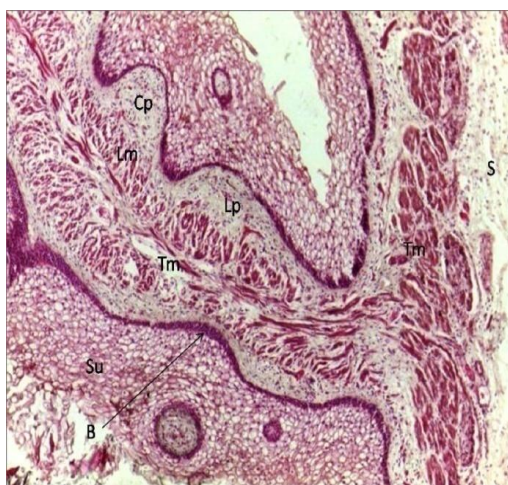
**Fig. 4:** Photomicrograph of section of 60-day old goat foetal omasal wall showing primary (PI), secondary (SI) and tertiary omasal laminae (TI), tunica muscularis (Tm), serosa (S) and corial papillae (Cp) in the wall of primary and secondary laminae (H & E X 100).



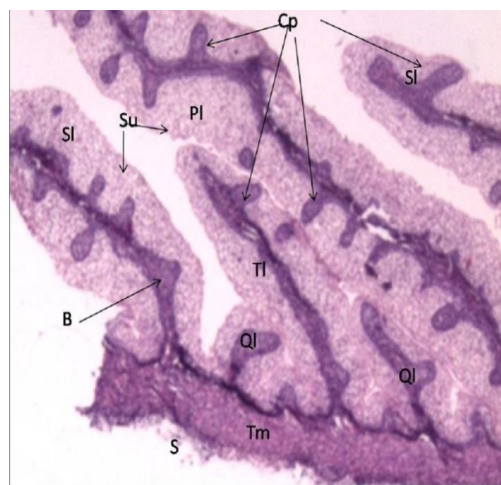
**Fig. 5:** Photomicrograph of section of 102-day old goat foetal omasal wall showing primary (PI), tertiary (TI) and quarterly (QI) omasal laminae, superficial (Su) and basal (B) zones of epithelium and stratum spinosum (Sp) (H & E X 200).

The number of layers of superficial and basal zoon took part in the formation of laminae at origin, middle and tip of the laminae were inconstant. The study indicated that the number of basal and superficial zones layer was more at the base than middle and tip. Involvement of basal zone cells was more at mid gestation than early and late gestation period. The contribution of superficial zone was gradually increased from early prenatal to late prenatal period. In group I the core of omasal laminae was composed of blastemic tissue containing differentiating irregular mesenchymal cells, fibroblasts, scattered RBC'S and sub epithelial capillaries (Fig. 3). Similar observation was also reported earlier in sheep by Franco *et al.* (1993). However, Panchamukhi *et al.* (1995) recorded that the core of the laminae was formed by lamina propria, submucosa and inner circular layer of tunica muscularis at 3.2 cm CRL. The thickness of

blastemic tissue increased at 46 days and simultaneously reticular fibers made their appearance. At the same age mesenchymal cells with their processes were arranged loosely. At 55 days of gestation few smooth muscle cells delaminated from tunica muscularis and were found projecting towards the primary laminae (Fig. 4). This observation was in close proximity with the earlier reports of Singh *et al.* (2005). Panchamukhi *et al.* (1995) observed these structures at 10.2 cm CRL. Between 60-70 days of gestation the contents of core became mature. Primary laminae contained loosely arranged differentiating mesenchymal cells, smooth muscle cells and fibroblasts which were compactly arranged towards tip. Two to three isolated, parallel arranged smooth muscle cells, future lamina muscularis were present in primary laminae while they were located upto middle and at the base of secondary and tertiary laminae, respectively. At 100 days of gestation lamina muscularis was represented by rows and clusters of smooth muscle cells in primary and secondary laminae, respectively while tertiary and quarterly laminae had isolated smooth muscle cells. At 121 days of gestation muscularis mucosae were arranged in small clusters in two rows parallel to the omasal laminae. Just below this meager amount of submucosal connective tissue rich in blood capillaries was found. In the center of these muscle bundles (muscularis mucosae), at the base, two rows of smooth muscle cells migrating from tunica muscularis projected upto the middle of the laminae, constituting the part of inner tunica muscularis. (Fig. 6 and 7).

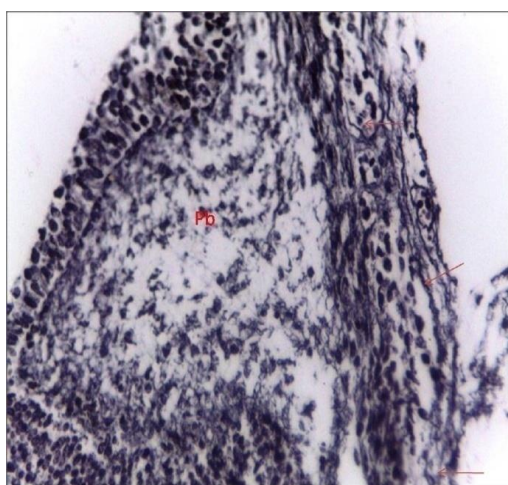


**Fig. 6:** Photomicrograph of section of 121 day old goat foetal omasal wall showing superficial (Su) and basal (B) zones of epithelium, lamina propria (Lp), bundles of lamina muscularis (Lm) in core of primary laminae, corial papillae (Cp), inner circular bundle of tunica muscularis (Tm) projecting in between bundles of lamina muscularis in core of laminae and serosa (S) (H & E X 100).



**Fig. 7:** Photomicrograph of section of 134 day old goat foetal omasal wall showing superficial (Su) and basal (B) zones of epithelium, primary (PI), secondary (SI) and tertiary (TI) and quarterly omasal laminae (QI), corial papillae (Cp), bundles of tunica muscularis (Tm) and serosa (S) (H & E X 100).

Similar pattern of lamina muscularis and inner tunica muscularis layer was also described by Dellman and Brown (1987) in adult ruminants. These authors stated that a thick inner layer of smooth muscle fiber, extending from the inner layer of tunica muscularis to the free end of lamina formed the central part of muscle. Singh *et al.* (2005) in 38.5 cm CRL buffalo foeti and Poonia *et al.* (2012) also opined the similar observation in adult sheep. Ramakrishna and Tiwari (1979) observed muscularis mucosae in omasal laminae of prenatal goat at 14.6 cm CRL stage. In other laminae smooth muscle cells were arranged in rows parallel to each other in sub epithelial connective tissue and confined upto tip, middle and base of secondary, tertiary and quarterly laminae, respectively. On the contrary to this Panchamukhi *et al.* (1995) recorded the presence of inner circular layer of tunica muscularis in the core of secondary laminae at 10.2 cm CRL. Fine, short, isolated reticular fibers were noticed at the base of primary, secondary, tertiary and quarterly laminae at 70, 87, 94 and 102 days of gestation, respectively and their concentration gradually decreased towards the tip (Fig. 9).



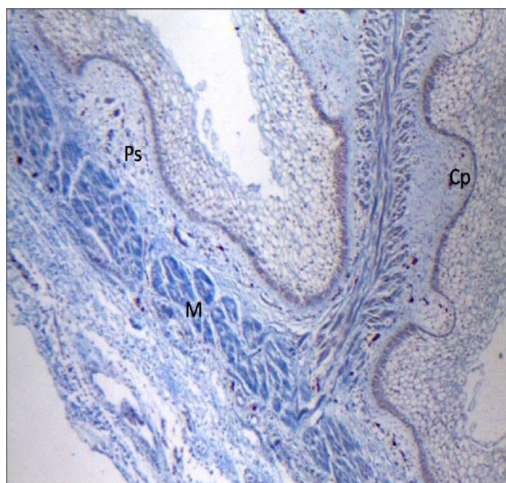
**Fig. 8:** Photomicrograph of section of 46-day old goat foetal omasal wall showing reticular fibers (arrow) in pleuripotent blastemic tissue (Pb). Wilder's reticular stain X 400



**Fig. 9:** Photomicrograph of section of 134-day old goat foetal omasal wall showing fine to coarse reticular fibers (arrow) in propria- submucosa (Ps), core of lamina (C) and coarse reticular fiber (arrow) in between muscle bundles (M), around blood vessel (Bv) and serosa (S). Wilder's reticular stain X 200

However, their concentration was less in secondary, tertiary and quarterly laminae. These fibers became coarser with advancement of age. Singh *et al.* (2005) observed reticular fiber at 14.7 cm CRL in buffalo foeti. Branching of reticular fibers was noticed from 118 days of gestation in lamina propria and lamina muscularis of primary laminae while in secondary and tertiary laminae fibers were found to be long and isolated. These reticular fibers also surrounded the smooth muscle cells of lamina muscularis. Thin collagen fibrils were noticed at the base of primary and secondary laminae at 76 days of gestation which

became coarser and longer at 82 days of gestation and reached to the distal third of primary laminae at 112 days of gestation. At 134 days of gestation, collagen fibers extended upto middle part of primary, secondary and tertiary laminae while these fibers were confined to base in quarterly laminae (Fig. 10). The core of the laminae contained elastic fibers also. On the contrary Singh *et al.* (2005) could not observed elastic fibers during entire gestation.



**Fig.10:** Photomicrograph of section of 121-day old goat foetal omasal wall showing collagen fibers in propria- sub mucosa (Ps), in between muscle bundles (M), around blood vessel (B) and serosa (S). Masson's trichrome method X 100

Lateral out pocketing of omasal laminae was first noticed at 51, 60 and 87 days of gestation in primary, secondary and tertiary laminae, respectively referred as corial papillae (Fig. 4). Redondo *et al.* (2005) in red deer foetal omasum found corial papillae and referred them as corneum papillae. These authors observed the corial papillae at mid gestation, 142 days and 205 days of gestation onwards in first, second, third and fourth order laminae, respectively. These papillae became fully developed at 87 days of gestation. The core of the corial papillae contained differentiating mesenchymal cells, fibroblasts and subepithelial capillary. The connective elements became denser in group III. Franco *et al.* (1993) reported that the corial papillae were formed due to lateral evagination of stratum basale towards epithelial surface at 113 days of gestation in sheep. Smooth muscle cells were not encountered in corial papillae in the present study. This observation was in close proximity with the earlier reports of Panchamuki *et al.* (1995). According to these authors core of the corial papillae was composed of only lamina propria. In contrary to this Franco *et al.* (1993c) reported presence of smooth muscle cells in the core of corial papillae. Corial papillae of primary laminae contained few fine isolated reticular fibers. However, Redondo *et al.* (2005) reported that the interior of the papillae contained reticular as well as collagen fibers and smooth muscle fibers. The average height of the primary, secondary, tertiary and quarternary laminae, and their width at the base, middle and tip were depicted in Table 1.

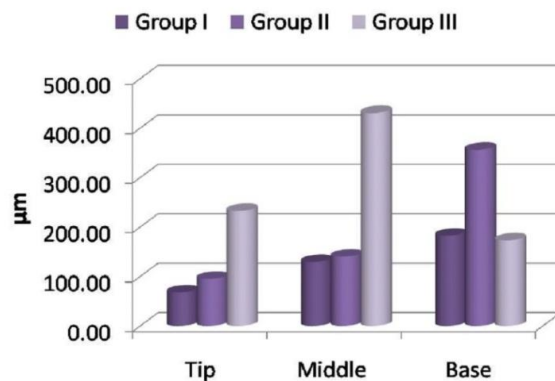
**Table 1:** Micrometrical parameters (Mean ± SE) of omasal laminae in prenatal goat in various stages of gestation

Groups	Group I	Group II	Group III
Parameters (in µm)	(0-50 days)	(51-100 days)	(101 days- till term)
Height of primary laminae	166.29±38.61 (117.88-242.60)	2196.32±623.40 (1129.03-3983.00)	3851.79±1329.77 (1751.50-6314.90)
Width of primary laminae at the tip	67.60±9.21 (58.39-76.80)	95.28±20.62 (59.39-142.00)	232.57±90.83 (63.02-373.80)
Width of primary laminae at the middle	129.37±1.28 (128.10-130.65)	139.85±22.52 (107.52-204.90)	430.45±254.80 (101.97-932.10)
Width of primary laminae at the base	182.45±11.76 (162.60-203.30)	356.31±245.80 (40.88-1089.82)	172.90±59.75 (103.60-291.86)
Distance between primary laminae	301.45±143.20 (158.26-444.65)	1108.33±50.27 (1058.06-1158.60)	1010.80±0.00 (1010.80-1010.80)
Height of secondary laminae	118.38±77.43 (40.95-195.8)	1325.41±442.06 (696.58-2634.76)	1519.62±534.18 (869.91-2578.94)
Width of secondary laminae at the tip	79.05±1.15 (77.9-80.2)	90.46±7.39 (81.34-105.1)	131.97±36.56 (69.42-196.04)
Width of secondary laminae at the middle	192.42±95.92 (96.5-288.34)	133.13±12.12 (100.35-156.81)	194.60±78.29 (61.09-332.2)
Width of secondary laminae at the base	106.50±0.00 (106.5-106.5)	120.06±29.94 (46.26-188.36)	171.89±87.83 (66.61-346.3)
Distance between secondary laminae	-	810.14±68.24 (725.63-945.22)	926.31±0.00 (926.31-926.31)
Height of tertiary laminae	-	472.99±124.83 (195.29-857.94)	646.11±216.31 (419.24-1078.56)
Width of tertiary laminae at the tip	-	69.88±10.64 (47.1-105.88)	100.34±33.05 (50.3-162.75)
Width of tertiary laminae at the middle	-	127.50±21.58 (61.00-164.25)	130.28±49.35 (53.18-222.2)
Width of tertiary laminae at the base	-	148.46±11.81 (104.55-170.17)	145.03±34.44 (85.17-204.48)
Distance between tertiary laminae	-	582.95±137.44 (351.95-962)	1248.39±314.34 (934.05-1562.73)
Height of quarterly laminae	-	101.08±39.31 (61.77-140.39)	137.13±4.26 (131.46-145.47)
Width of quarterly laminae at the tip	-	34.35±0.00 (34.35-34.35)	73.43±20.66 (34.99-105.79)
Width of quarterly laminae at the middle	-	90.25±0.00 (90.25-90.25)	103.93±19.53 (68.71-136.18)
Width of quarterly laminae at the base	-	126.62±0.00 (126.62-126.62)	116.80±16.14 (86.83-142.18)
Distance between quarterly laminae	-	409.56±0.00 (409.56-409.56)	632.35±163.62 (468.73-795.96)

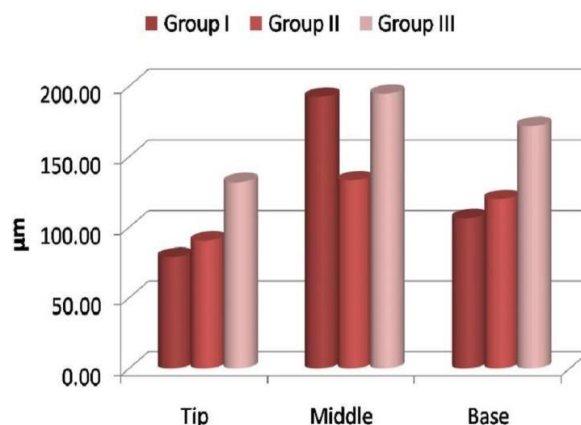
n= 12, Figures in parenthesis indicate range,(-) could not be recorded

Interlaminar distance between two primary laminae was 301.45 ± 143.20, 1108.33 ± 50.27 and 1010.8 ± 0.01 µm in group I, II and III, respectively. In group II and III, the interlaminar distance between two secondary laminae was 664.33 ± 68.24 and 926.31 ± 0.01 µm, respectively, two tertiary laminae was

582.95 ± 133.44 and 1248.39 ± 314.34 μm, respectively and two quarterly laminae was 409.56 ± 0.09 and 632.35 ± 163.62 μm, respectively. There was gradual increase in the height of all type of laminae from group I to group III. The width of primary laminae was more at the base in group II and at the middle and tip in group III. The width of primary laminae was slightly increase at the tip from group I to group II and abruptly increased from group II to group III. The width of primary laminae at the middle was nearly equal in group I and II and twice from group II to group III. The base of the primary laminae was nearly twice in group II than group I and group III (Bar diagram 1). The width of secondary laminae was highest at the middle and lowest at the tip (Bar diagram -2). There was gradual increase in the width of the laminae at the base and tip from group I to group III, while, middle part of the laminae was narrow in group II (Bar diagram- 2).



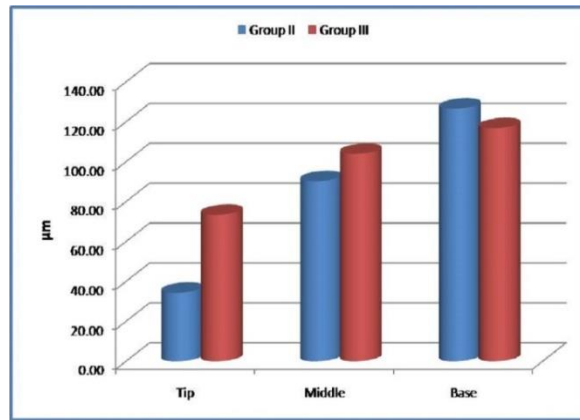
**Bar diagram 1:** Bar diagram showing the width of primary laminae of omasum at different stages of gestation in prenatal goat



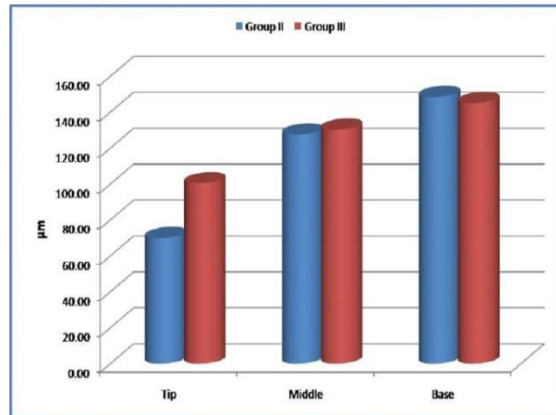
**Bar diagram 2:** Bar diagram showing the width of secondary laminae of omasum at different stages of gestation in prenatal goat

In group II and III the width of tertiary and quarterly laminae was highest at the middle and lowest at the tip. In tertiary laminae the width was more at the tip in group III and at the base in group II. The middle

part was equal in both group II and III, maximum width was observed in tip and middle of quarterly laminae in group III and base in group II (Bar diagrams 3 and 4).



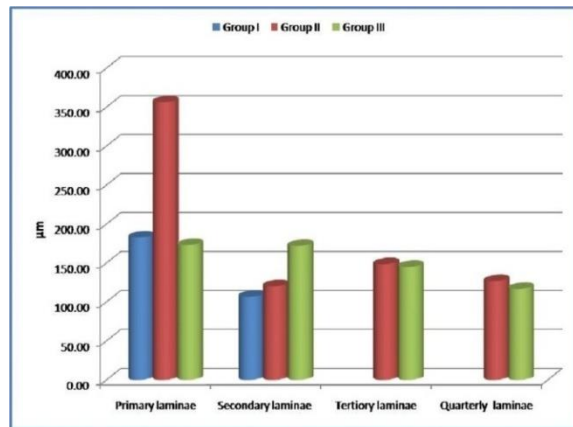
**Bar diagram 3:** Bar diagram showing the width of tertiary laminae of omasum at different stages of gestation in prenatal goat



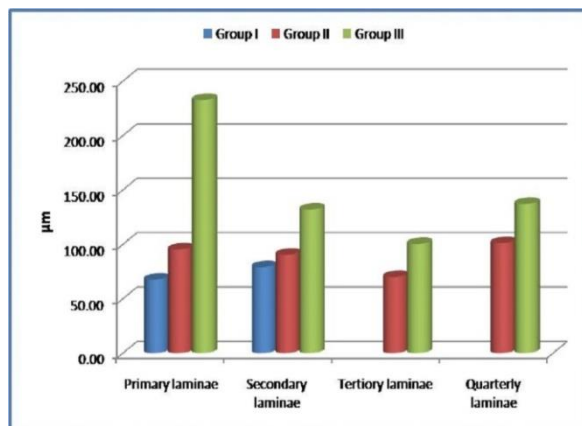
**Bar diagram 4:** Bar diagram showing the width of quaterly laminae of omasum at different stages of gestation in prenatal goat

The width of the laminae was more at the tip in all the laminae of group III than group I and II (Bar diagram 5). In group I, width was more at the tip of secondary lamina than primary laminae. In group II, width was more at the tip of quarterly lamina followed by primary, secondary and tertiary laminae. In group III, width was more at the tip in primary laminae than other laminae (Bar diagram 5). Width of the laminae was more at the middle in primary and quarterly laminae in group III, while in secondary laminae width was more and nearly equal in group I and III. The width was equal at the middle in tertiary laminae of group II and III. In group I, the middle part of secondary laminae was wider than primary laminae. In group II and III, the width at the middle of the laminae was decreased in ascending order of primary to (Bar diagram-6). The width of laminae was maximum at the origin in primary, tertiary and quarterly laminae of group II and secondary laminae of group III. In group I, the base was wider in primary than secondary laminae. In group II, the width of laminae was more at the origin in primary followed by tertiary

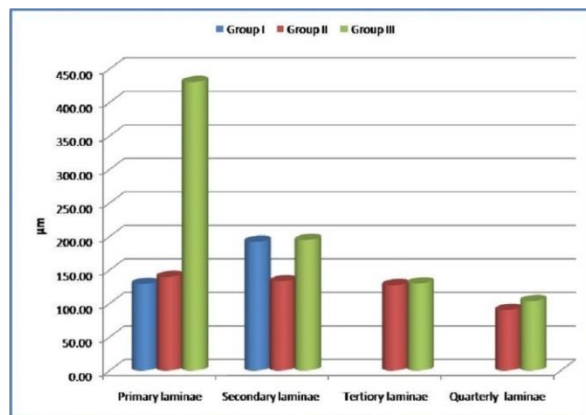
then quarterly and least in secondary laminae. In group III, width was equal at the origin in primary and secondary laminae then decreased into tertiary and quarterly laminae (Bar diagram 7).



**Bar diagram 5:** Bar diagram showing the width of the tip of different omasal laminae at different stages of gestation in prenatal goat



**Bar diagram 6:** Bar diagram showing the width of quarterly laminae of omasum at different stages of gestation in prenatal goat



**Bar diagram 7:** Bar diagram showing the width of the base of different omasal laminae at different stages of gestation in prenatal goat.

## Conclusion

From the above study it is concluded that the organogenesis and histogenesis of omasum was almost completed in prenatal life. However, to become functional they still required more time as the process of keratinization of epithelium is incomplete. The narrow spaces between the laminae and development of horny corial papillae which reduced the food to a fine pulp yet to be completed on all the laminae.

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