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The Ultra Structural Studies of Duodenum of Goat (*Capra hircus*)

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ABSTRACT

The tissues from small intestine containing duodenum were collected from six young goats and processed for scanning and transmission electron microscopic studies. The villi of the duodenum varied in shape and size. The duodenal mucosal surface showed leaf shaped villi along with scanty population of goblet cells on the villi surface. The mucosal surface was having very faint corrugations and dense mat of microvilli. The basal surface of the villi, the number of goblet cells was more. The crypts openings were evident at some places. The transmission electron microscopic studies revealed the presence of different cell population which included columnar or absorptive cells and goblet cells in surface epithelium of the duodenum. The columnar cells were having many uniform regularly spaced microvilli. The goblet cells were very few in the villus epithelium and were interspersed in between the columnar cells and their cytoplasm was distended with mucus granules. The crypt region or glandular epithelium was consisted of polymorphic cell population which included the Paneth cells, enterochromaffin cells and goblet cells.

Keywords: Duodenum, enterochromaffin cell, Paneth cell, SEM, TEM

The rural poor who cannot afford to maintain a cow or a buffalo find goat or sheep as the best alternative source of supplementary income and milk. This is one reason why poor rural households maintain a few number of goats. Goats are among the main meat-producing animals in India and its meat is one of the choicest meat and has huge domestic demand. The goat is among the ruminant species best able to make use of marginal pasturelands (Boyazoglu *et al.,* 2005; Rancourt *et al.,* 2006), and is highly adapted to grazing over a wide range of vegetation (El-Gendy *et al.,* 2010). The intestine being the important segment of the digestive tract is prone to the various parasites and pathological conditions and it is largest endocrine gland of the body (Ahlman and Nilsson, 2001). There is a paucity of literature on ultrastructure of the intestine of small ruminants except some work reported in goat (Hassan and Moussa, 2015; Gautam *et al*., 2017). The present study was undertaken to study the ultra structure of duodenum in goats which may be helpful in understanding the mechanism of digestion and immunity.

MATERIALS AND METHODS

The small intestine containing duodenum was collected from six goats (8-10 months age) immediately after their sacrifice from local slaughter house. The fresh tissues from selected sites of duodenum of six goats were fixed in 2% glutaraldehyde solution for 6-8 hours after thorough washing with chilled 0.1M phosphate buffer (pH 7.4). The tissues were rewashed twice with 0.1M phosphate buffer and rest of the procedure was carried out at EM Lab., A.I.I.M.S, New Delhi. The tissues were dehydrated in grades of ethanol, critical point dried and sputter coated and the processed tissues were viewed in scanning electron microscope (Zeiss EVO-18) to record observations and photographs.

For transmission electron microscopy, tissues from selected sites of duodenum of six goats were primarily fixed in 2.5% glutaraldehyde solution and secondarily fixed in 2% osmium tetraoxide for one hour. The rest of the procedure was carried out at EM Lab., A.I.I.M.S, New

Delhi. The ultrathin sections (70-80 nm) were stained with uranyl acetate and lead citrate. The processed tissues were viewed in transmission electron microscope (Technai G^2) to record observations and photographs.

RESULTS AND DISCUSSION

Scanning electron microscopy

The scanning electron microscopic study of duodenal mucosa of goat in present study revealed that the shape, size and distribution of villi varied from stout to leaf shaped. The villi of abomaso-duodenal junction were very short, stout and club shaped with dome shaped apexes (Fig. 1a). The surface showed honeycomb appearance and each honeycomb unit showed polygonal epithelial cells (Fig. 1b). The duodenal mucosal surface changed to leaf shaped villi as progressed towards the duodenum (Fig. 1c), the duodenal villi were having broad base and leaf shaped similar findings were observed in goats (Hassan and Mousaa, 2015; Gautam *et al*., 2017). The duodenal villi were found to be broadest in human (David, 1987). In contrast, the duodenal villi were regular in shape and size and most of the villi were finger shaped as observed in young pigs and calves (Skrzypek *et al.,* 2005; Dubourguier *et al.,* 1978). The villi were reported as finger shaped in adult humans (Marsh and Swift, 1968; Toner *et al.,* 1970). The duodenal villi were also reported oval shaped at some places in duodenum of pigs (Waxler, 1972) whereas, the villi were having bifurcated, trifurcated and at some places there were formation of bridges in between the villi of calves (Pearson *et al.,* 1978). During present study, bifurcation of villi was observed at places (Fig. 1c). The goblet cells observed were scanty on the villi surface (Fig 1b) which was in agreement of findings in young pigs (Skrzypek *et al.,* 2005) and goats (Hassan and Mousaa, 2015). The present study showed that mucosal surface was having very faint corrugations (Fig. 1d) which were in agreement with the findings in goats (Hassan and Mousaa, 2015). In contrast, the villi had corrugations in young pigs (Skrzypek *et al.,* 2005) as observed in dogs (Johnson *et al.,* 1986) and calves (Po Po *et al.,* 2005). The villi surface had dense mat of microvilli and these microvilli were sparse and even absent at some places as reported in goat (Hassan and Mousaa, 2015), young pigs (Skrzypek *et al.,* 2005) and calves (Pearson *et al.,* 1978). Towards the basal surface of the villi, the number of goblet cells was increased. The crypts openings were evident at some places but these were not visible due to covering of villi (Fig. 1d) as reported in goat (Hassan and Mousaa, 2015), young pigs (Skrzypek *et al.,* 2005) and calves (Pearson *et al.,* 1978) and humans (Marsh and Swift, 1969).

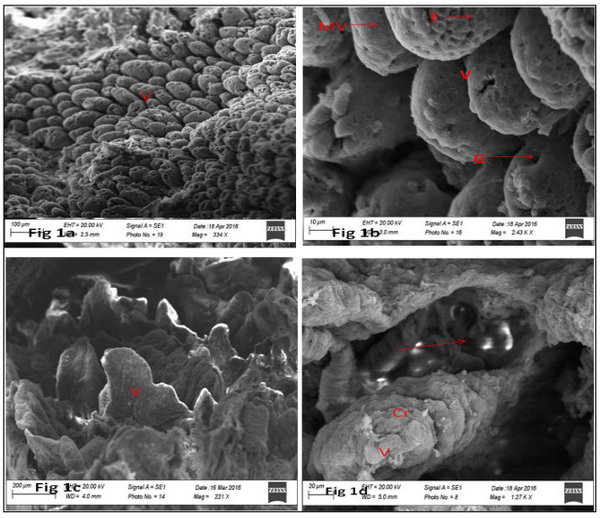

Fig. 1a-d. (1a) Scanning electron micrograph showing villi (V) at abomaso-duodenal junction of goat. x334; **(1b)** Scanning electron micrograph showing villi (V) and goblet cells (G) on villi surface goat. X243K; **(1c)** Scanning electron micrograph showing leaf shaped duodenal villi (V) of goat x221; **(1d)** Scanning electron micrograph showing villi (V), corrugations (Cr) and cryptal opening (arrow) on duodenal villi surface of goat. X127K

Transmission electron microscopy

The surface epithelium of the duodenum was made up of different cell population which included columnar or absorptive cells and goblet cells (Fig. 2a, 2b). The columnar cells were having many uniform, regularly spaced microvilli (Fig. 2b) and well developed terminal web as reported in gnotobiotic dogs (Johnson *et al.,*1986), lambs (Gray *et al.,*1980), humans (Kelley, 1973) and mice (Mukherjee and Williams, 1967). The columnar cells were joined at the apical surface by typical junctional complexes including zona occuludens, zona adherens and desmosomes (Fig. 2c). A similar pattern of junctional complexes was also reported along the apical border, cell membrane and beneath the developing terminal web in humans (Kelley, 1973) and mice (Mukherjee and Williams,

1967). The mitochondria of various shapes were present in different planes and they were abundant towards the apical part of the cytoplasm (Fig. 2c) which was in agreement with the findings reported in gnotobiotic dogs (Johnson *et al.,* 1986). The present study also showed presence of other cell organelles like Golgi bodies, ribosomes, endoplasmic reticulum along with lysosomes which were also observed in the gnotobiotic dogs (Johnson *et al.,* 1986), humans (Kelley, 1973), mice (Mukherjee and Williams, 1967) and lambs (Gray *et al.,* 1980). The goblet cells were very few in the villus epithelium and were interspersed in between the columnar cells and their cytoplasm was distended with mucus granules. The cytoplasm appeared dark as compared to the adjacent cells and their nuclei were pushed towards the base (Fig. 2c). Granular endoplasmic reticulum and mitochondria were also observed as reported in humans (Kelley, 1973) and mice (Mukherjee and Williams, 1967), whereas, the goblet cells were scattered throughout the villus epithelium in lambs (Gray *et al.,* 1980).

The crypt region or glandular epithelium was consisted of polymorphic cell population which included the Paneth cells, enterochromaffin cells, goblet cells, few plasma cells and lymphocytes (Fig. 2d). The cells lining the crypts were columnar with striated border. The microvilli appeared to be less numerous and shorter than those in the villus enterocytes as similar findings were reported in gnotobiotic dogs (Johnson *et al.,* 1986) and human crypt epithelium (Kelley, 1973).

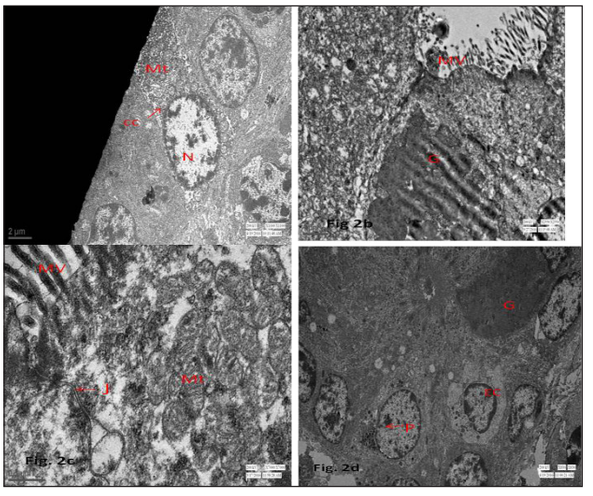

Fig. 2a-d. (2a) Transmission electron micrograph showing columnar cells (CC) and nucleus (N) in surface epithelium of duodenum of goat. x1100; **(2b)** Transmission electron micrograph showing microvilli (MV) and goblet cell (G) and mitochondria in surface epithelium of duodenum of goat. x2550; **(2c)** Transmission electron micrograph showing microvilli (MV), junctions (J) and mitochondria (Mt) in surface epithelium of duodenum of goat. x7000; **(2d)** Transmission electron micrograph showing Paneth cell (P), enterochromaffin cell (EC) and goblet cell (G) in cryptal epithelium of duodenum of goat. x830

The Paneth cells were accumulated towards basal part of crypts as reported in sheep (Ergun *et al.*, 2003) and various other animals (Satoh *et al.*, 1990). These were pyramidal shaped cells with their broad base resting on the basement membrane and narrowed towards the apical border. The nucleus was located at the basal half of the cell and cytoplasm consisted of numerous cytoplasmic granules located towards the apical part of the cell (Fig. 3a) along with endoplasmic reticulum and Golgi bodies as observed in equines (Takehana *et al.*, 1998) and sheep (Ergun *et al.*, 2003).

The cryptal epithelium showed presence of maximum number of enterochromaffin cells among all the segments of the intestine in goat. In calves, these cells were also reported in basal part of crypts and they usually occurred singly or sometimes two were seen in close proximity (Pearson and Logan, 1983). The electron-dense argyrophillic granules in the cytoplasm were infranuclear in position (Fig. 3b) as reported in other mammalian species (Dawson, 1970; Carvalheiar, *et al.,* 1968).

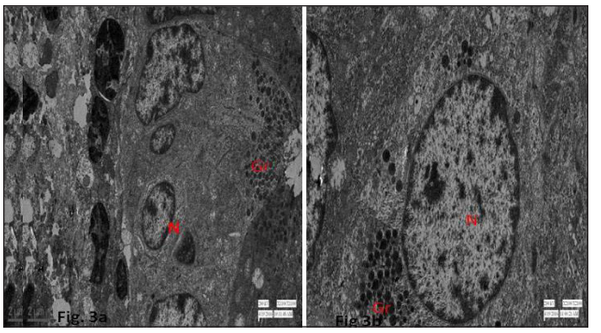

Fig. 3a-b. (3a) Transmission electron micrograph showing nucleus (N) and osmeophilic granules (Gr) in cytoplasm of Paneth cell cell in cryptal epithelium of duodenum of goat. x1100; **(3b)** Transmission electron micrograph showing nucleus (N) and osmeophilic granules (Gr) in cytoplasm of enterochromaffin cell in cryptal epithelium of duodenum of goat. x2100

CONCLUSION

The scanning electron microscopy of duodenum showed mainly leaf shaped villi with faint corrugation on surface. The transmission electron microscopy showed presence of simple columnar cells with dense mat of microvilli in the surface epithelium. The cryptal epithelium was having Paneth, enterochromaffin and goblet cells.

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