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The Ultra Structural Studies on Jejunum of Goat (*Capra hircus*)

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ABSTRACT

The tissues from the small intestine containing jejunum were collected from six young goats and processed for scanning and transmission electron microscopic studies. The jejunum villi were of different heights having a broad base with tapering to blunt ends. The surface of the villi showed slight corrugation in the initial part of the jejunum. These corrugations were very faint in this region and also showed orifices for goblet cells. The caudal segments of the jejunum showed some structural changes in the form of more prominent corrugations on the villi surface. The villi surface showed orifices with irregular boundaries for openings of goblet cells in between the dense areas of the microvilli. Whereas the transmission electron microscopy revealed that the epithelium of the jejunum was of a columnar type having goblet cells and no Paneth cells were observed in the villous part of the jejunum. A very few goblet cells were interspersed in between the columnar cells. The glandular epithelium consisted of different cell populations consisted of columnar, Paneth, endocrine and goblet cells.

HIGHLIGHTS

- The ultrastructural studies jejunum goat reveals the presence of long finger like villi with different cell population of enterochromaffin cells, Paneth cells and goblet cells.

Keywords: Jejunum, Enterochromaffin cell, Paneth cell, Scanning electron microscopy, Transmission electron microscopy

The jejunum being the longest segment of the small intestine plays an integral role in digestive and absorptive functions. There is a paucity of literature on the ultrastructure of the intestine of small ruminants including jejunum, except some work reported in goat (Hassan and Moussa, 2015). The present study was undertaken to study the ultrastructure of jejunum in goats which may be helpful in understanding the anatomy and mechanism of digestion and absorption in goats. Although histological studies on other species like sheep and goat were reported but ultra structural aspect was very scanty.

MATERIALS AND METHODS

The small intestine containing jejunum was collected from six young goats immediately after their sacrifice from the local slaughter house. The fresh tissues from selected sites of the jejunum of six goats were fixed in 2.5% 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 the 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 the scanning electron microscope (Zeiss EVO-18) to record observations and photographs of different jejuna segments.

For transmission electron microscopy, tissues from

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selected sites of the jejunum 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 the transmission electron microscope (Technai G^2) to record observations and photographs of different jejuna segments

RESULTS AND DISCUSSION

Scanning electron microscopy

The mucosal surface of the jejunum had villi of variable height. The villi were having a broad base with tapering to blunt ends (Fig. 1a) as reported in the Egyptian goats (Hassan and Mousaa, 2015) where the villi were finger-shaped with pointed apexes as reported in young pigs (Skrzypek *et al.,* 2005), calves (Pearson *et al.,* 1978; Po *et al.,* 2005), dogs (Johnson *et al.,* 1986) and humans (Marsh and Swift, 1969). These were long and flat in calves (Dubourguier *et al.,* 1978). Some villi were having inclined apexes probably due to more length of the ends. The surface of the villi showed slight corrugation in the initial part of the jejunum (Fig. 1b). These corrugations were very faint in this region and also showed orifices for goblet cells. The apex of the villi showed a scaly appearance with very few goblet cells as also reported in goats (Hassan and Moussa, 2015). There were 3-4 crypt openings surrounded each villus (Figs. 1a, 1b). As many as 20 crypts may surround each villus (Cocco *et al.,* 1966), but a functional ratio of three crypts to one villus had been proposed in humans (Loehry and Creamer, 1969). The structural changes in the form of more prominent corrugations on the villi surface and density of villi were also increased towards the caudal aspect of the jejunum (Figs. 1c, 1d). The corrugations were deep, irregular clefts cutting into the side of the villus and dividing it into separate islands of tissue. The majority of these corrugations tended to run in a horizontal direction, similar observations were also reported in goats (Hassan and Moussa, 2015).

Young pigs also showed a similar pattern in the form of transversal furrows (Skrzypek *et al.,* 2005) and calves

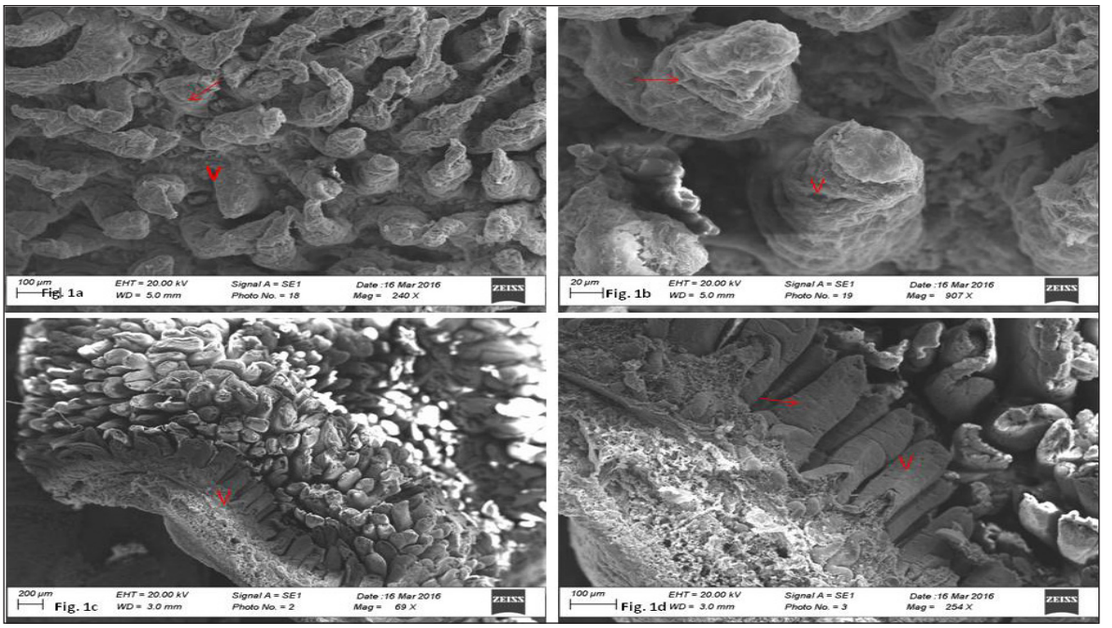


Fig. 1: Scanning electron micrograph of Jejunum of Goat. **(a)**Scanning electron micrograph showing villi (V) and crypts (↑) on the mucosal surface of jejunum. × 240; **(b)** Scanning electron micrograph showing jejunal villi (V) and faint corrugations (↑). × 907; **(c)** Scanning electron micrograph showing densely arranged jejunal villi (V). × 69; **(d)** Scanning electron micrograph showing finger-shaped jejunal villi (V) with faint corrugations (↑) on villi surface of jejunum. × 254

(Dubourguier *et al.,* 1978). The corrugations end abruptly and did not form a continuous system of clefts. At higher magnification, the villi surface showed hexagonal-shaped enterocytes and there was the presence of dense mat of microvilli throughout the villi surface (Figs. 2a, 2b) as observed in young pigs (Skrzypek *et al.,* 2005). They also revealed that the villi surface had raised convex dome-shaped structures at places towards the apex which were similar to the findings of the present study. At some regions where desquamation of upper surface took place presented the underlying submucosa and columnar cells were also seen in this region (Fig. 2c). The villi surface showed orifices with irregular boundaries for openings of goblet cells (Figs. 2b and 2d) in between the dense areas of the microvilli. There was the presence of some areas which were devoid of microvilli which were also observed in young pigs (Skrzypek *et al.,* 2005). Towards the basal part of the villi, there was the presence of crypts or openings of intestinal glands.

Transmission electron microscopy

The epithelium of the jejunum was made up of columnar and goblet cells but no Paneth cells were observed in the villous part as reported in gnotobiotic dogs (Johnson *et al.,* 1986). They also reported a single large or multiple moderate sizes, membrane-bound, supranuclear, cytoplasmic vacuoles. The columnar cells were with the well-marked microvilli (Figs. 3a and 3b). The microvilli contained a core made up of fine filaments forming thick bundles which extended deeply into the terminal web of the apical cytoplasm as reported in lambs (Gray *et al.,* 1980) and mice (Mukherjee and Williams, 1967). The columnar cells were joined at the apical surface by typical junctional

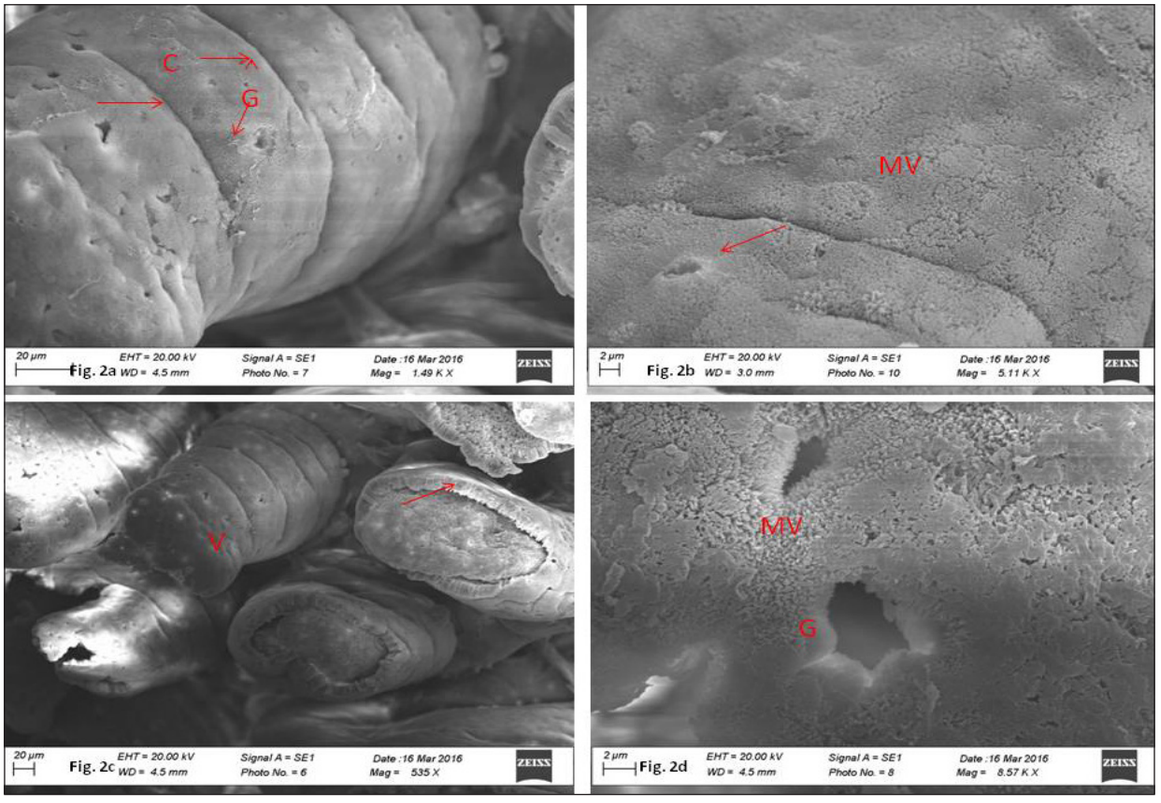
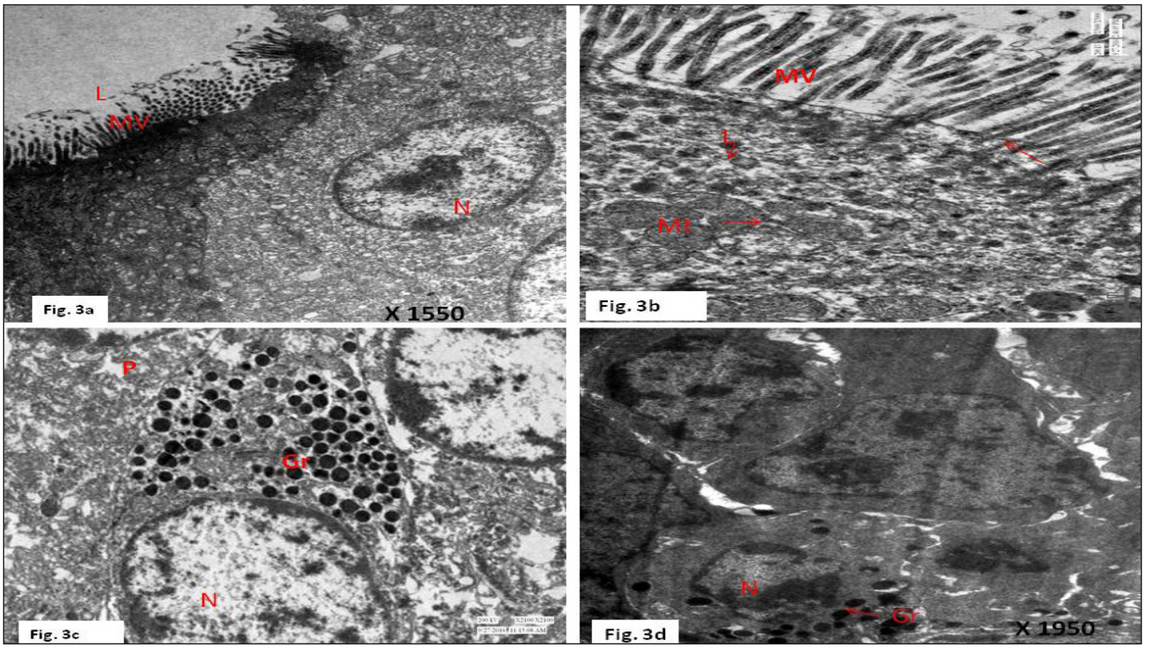


Fig. 2. (a) Scanning electron micrograph showing goblet cell opening (G), corrugations (C), FAE (↑) on villi surface of jejunum. × 1490. **(b)** Scanning electron micrograph showing goblet cell opening (↑), dense mat of microvilli (MV) on villi surface of jejunum. × 5110. **(c)** Scanning electron micrograph showing columnar cell (↑) in jejunal villi (V). × 535. **(d)** Scanning electron micrograph showing the opening of goblet cell (G), dense mat of microvilli (MV) on villi surface of jejunum at higher magnification. × 8570

complexes. The mitochondria of different shapes were abundant in number in the apical part of the cytoplasm (Fig. 3b) and their size appeared to be slightly more as reported in gnotobiotic dogs (Johnson *et al.,* 1986) and lambs (Gray *et al.,* 1980). A very few goblet cells were interspersed in between the columnar cells. The cytoplasm of goblet cells was distended with mucus granules. The nucleus was located towards the base, granular endoplasmic reticulum and mitochondria were also present in the supranuclear part of the cytoplasm as observed in mice (Mukherjee and Williams, 1967).

The cryptal epithelium consisted of columnar, Paneth, endocrine and goblet cells. The columnar cells possessed luminal microvilli, nuclei placed towards the base and polymorphic mitochondria were as compared to the surface epithelial cells as reported in gnotobiotic dogs (Johnson *et al.,* 1986). The microvilli appeared less numerous and short than those in enterocytes. The junctional complexes were also observed along with free ribosomes, Golgi bodies in the apical cytoplasm.

The Paneth cells were accumulated at the base of the crypts. They were pyramidal-shaped cells with their broad base resting on the basement membrane and narrowed towards the apical end. The osmiophilic granules located towards the apical portion of the cytoplasm also contained granular endoplasmic reticulum and Golgi bodies (Fig. 3c) and this was in agreement with the findings in sheep (Ergun *et al.,* 2003). The enterochromaffin cells were observed in the present study but their occurrence and number were decreased. These cells showed electron-dense osmiophilic granules which were infranuclear in position in the cytoplasm (Fig. 3d) as reported in calves (Pearson and Logan, 1983) and other mammalian species (Dawson, 1970; Carvalheiar *et al.,* 1968) and equine small intestine (Takehana *et al.,* 1998) and several studies had been carried out in various animals (Satoh *et al.,* 1990). The goblet cells were fewer in the epithelium of the crypts. They were generally flanked by the columnar cells through occasional goblet cells and Paneth cells were found. The cytoplasm was appeared dark as compared to the adjacent



Figs. 3: Transmission electron micrography of goat Jejunum. **(a)**Transmission electron micrograph showing a columnar cell with microvilli (MV) towards Lumen (L) and nucleus (N). × 1550; **(b)** Transmission electron micrograph showing microvilli (MV), terminal web (↑) in cytoplasm, lysosomes (L) and mitochondria (Mt) in jejunum. × 5000; **(c)** Transmission electron micrograph showing Paneth cell (P) with osmiophilic granules (Gr) and nucleus (N) in the cryptal epithelium of jejunum. × 2100; **(d)** Transmission electron micrograph showing an enterochromaffin cell with osmiophilic granules (Gr) and nucleus (N) in the cryptal epithelium of jejunum. × 1950

cells and their nucleus was pushed towards the base and granular endoplasmic reticulum and mitochondria were also observed as reported in humans (Kelley, 1973) and mice (Mukherjee and Williams, 1967). The goblet cells were scattered throughout the villus epithelium in lambs (Gray *et al.,* 1980).

CONCLUSION

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

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