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Research Article

HISTOMORPHOLOGICAL STUDIES ON THE RUMEN OF THE SHEEP (OVIS ARIES)

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ABSTRACT

The present work was conducted on rumen of ten young sheep (aged 6-9 months) of local mixed breed. The mucosal surface of rumen at different regions presented the papillae which varied in density, size and shape. The rumen was lined by stratified squamous keratinized epithelium comprising of strata basale, spinosum, granulosum and corneum. An additional layer comparable to stratum lucidum was present at the oesophageo-ruminal junction. The lamina propria mucosae had a mixed distribution of collagen, reticular and elastic fibres. The core of papillae was formed by loose irregular connective tissue. The lamina muscularis mucosae was absent except at the oesophageo-ruminal junction where it was thin and interrupted. The tunica muscularis was comprised of a thicker inner circular and a thinner outer longitudinal muscle layer. A third layer of striated oblique muscle was also seen at the oesophageo-ruminal junction. The tunica serosa was present.

Key words: Rumen, histology, sheep

Sheep rearing is most popular among economically weaker population of India and considered as "mortgage lifter" for the poor farmers. In India, the sheep population is 61.4 million which contributes 44.9 thousand tonne of wool (Statistical Abstract of India, 2007) and 234 thousand tons of mutton (FAO, 2008). The fore-stomachs comprising of rumen, reticulum and omasum act as a microbial fermentation vat. The fermentation end product in the form of volatile fatty acids is absorbed and is used as a prime metabolic substrate. Sheep have greater capacity of dry matter intake than cattle and under extensive conditions; sheep may be used to convert useless plants unfit for browsing, into milk and meat. There is a paucity of literature on light microscopic structure of the stomach of small ruminants except goat (Chungath, 1985; Mahesh, 2008). Hence, the present study was conducted to understand the histology of the compound stomach in sheep which would be helpful to histologists, physiologists and pathologists to understand its histoarchitectural organization.

MATERIALS AND METHODS

The present study was conducted on ten young sheep (6-9 months age) of either sex of local mixed breed. The stomach along with a small portion of oesophagus and duodenum were procured from the local slaughter house immediately after dressing. A total of eight tissues (oesophageo-ruminal junction, dorsal wall of rumen, ventral wall of rumen, ventral wall transition of papillae, longitudinal pillar, ventral coronary pillar, dorsal wall fold and rumino-reticular junction) were collected from different parts of rumen of each animal. The tissues fixed in 10 % neutral buffered formalin solution for 48 hours were processed for routine paraffin technique of light microscopy. The paraffin sections of 5-6 µ were stained with routine Harris' hematoxylin and eosin stain (Luna, 1968). In addition, Gomori's method for reticular fibres, Weigert's method for elastic fibres, Mallory's method for iron, Ayoub- Shklar method for keratin and pre-keratin (Luna, 1968) and Crossman's trichrome stain for collagen fibres (Crossman, 1937) were used. Mucopolysaccharides were demonstrated by McManus' method for glycogen (PAS), PAS-Alcian blue method for mucosubstances (pH 2.5), Diastase digestion method for glycogen and Alcian blue method for mucosubstances (pH 2.5) (Luna, 1968).

RESULTS AND DISCUSSION

The mucosal surface of rumen at different

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regions presented papillae which varied in density, size and shape (Figs. 1, 2). The ventral blind sac and the ventral coronary pillar had very well developed ruminal papillae. The papillae at oesophageo-ruminal junction and dorsal wall were of intermediate type whereas the ventral sac region had the largest type of papillae. The tip of the ruminal longitudinal pillar presented small, blunt type of papillae whereas the tip of ventral coronary pillar presented comparatively large and elongated type of papillae. The shape of the papillae was elongated, cylindrical and leaf like at the rumino-reticular junction. Thin, narrow, pointed as well as a few small, triangular with rounded free ends papillae were also present. However, Wardrop (1961) had reported that the rumen papillae in adult sheep were generally conical or tongue shaped. Bastain and Menon (1963) reported that the ruminal mucosa of the cow presented three types of papillae viz. elongated filiform, short conical and short fungiform, whereas those of the buffalo were comprised of only two types viz. long foliaceous and blunt conical. The rumen papillae varied in size and shape from tongue shaped to conical in goat (Mahesh, 2008). These papillae provided a larger surface area for the biochemical activities such as absorption of volatile fatty acids, water and electrolyte (Dobson *et al.*, 1956; Henrikson and Habel, 1961; Cerny, 1977; Singh *et al.*, 1983).

The rumen of sheep was lined by the stratified squamous keratinized epithelium (Figs. 1, 2, 3). The epithelium was comprised of strata basale, spinosum, granulosum and corneum with varying number of rows of cells (Fig. 3) at different places in the rumen as reported earlier (Scala *et al.*, 2011). The absorptive and metabolizing functions of rumen were suggested by the presence of eccentric nucleoli in the stratum spinosum and stratum granulosum cell layers. A layer comparable to stratum lucidum was present at the oesophageo-ruminal junction which disappeared in the rumen (Fig. 4). Ayoub-Shklar method demonstrated the presence of well defined keratinization (Fig. 5) of the ruminal epithelium including oesophageo-ruminal junction. The physical protection against potentially sharp fibres consumed by an animal was offered by the well pronounced keratinized epithelium as reported in buffalo (Singh *et al.* 1982; Taluja and Saigal, 1987). Iron granules were present in the superficial layer of stratum corneum. According to Mahesh (2008), the iron reaction was positive only in the cells of stratum corneum and adhering vesiculated cells. The presence of iron has been correlated with the degree of microbial activity, high energy ration and pigmentation (Brownlee and Elliot 1961; Tiwari and Jamdar, 1969; Taluja and Saigal, 1989b).

A rich network of capillaries and small blood vessels was present in the area immediately below the stratum basale of ruminal papillae. Small foldings in the basal layer of epithelium formed papillary bodies or pegs as reported earlier in lambs (Wardrop, 1961), buffalo (Sengar and Singh, 1970; Taluja and Saigal, 1987), buffalo calves (Singh *et al.*, 1982) and adult goats (Chungath *et al.*, 1985). The formation of papillary bodies caused the reduction in the distance between the mucosal surface and the absorptive site and it also led to the increased absorptive surface area. The reactions for PAS and acidic mucopolysaccharides were negative in the ruminal epithelium in the present study as reported in cattle, sheep and goat (Habel, 1963) and buffalo (Taluja and Saigal, 1989a). However, Lavker *et al.* (1969) in Hereford cows and Taluja and Saigal (1989a) in buffalo reported that the stratum corneum contained neutral, sulfated acidic and non sulfated acidic mucosubstances.

The basement membrane was formed by the fine reticular fibres which provided support and lend firmness to the rumen. The lamina muscularis mucose was absent in the ruminal wall. However, it was thin and interrupted at the oesophageo-ruminal junction. The lamina propria mucosae and tunica submucosa merged with each other to form propria submucosa. The core of the ruminal papillae was formed by the loose irregular connective tissue which contained collagen fibres (Fig. 6) and a few elastic and reticular fibres. The connective tissue was comparatively denser at the base of the papillae

The tunica muscularis of rumen was consisted of two layers i.e. a thicker inner circular and a thinner outer longitudinal muscle layer (Fig. 1) as reported in adult goats (Chungath *et al.*, 1985; Mahesh, 2008). A third layer of striated oblique muscles was seen extending towards the outer longitudinal layer at the transitional region of oesophageo-ruminal junction. The tunica muscularis had been reported to play important role in

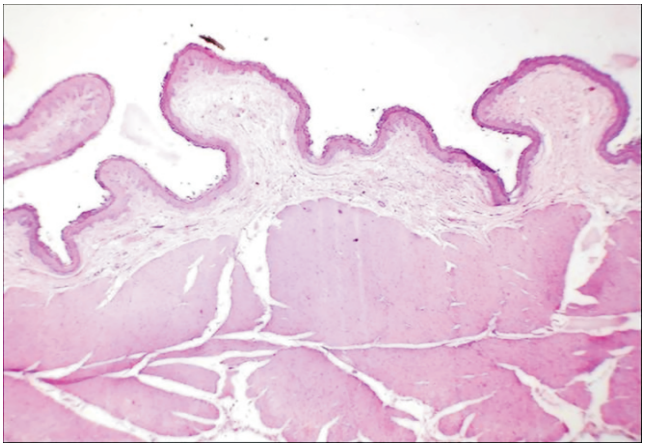

Fig 1. Photomicrograph of dorsal wall of rumen showing papillae lined by stratified squamous keratinised epithelium. (H. & E. x 40)

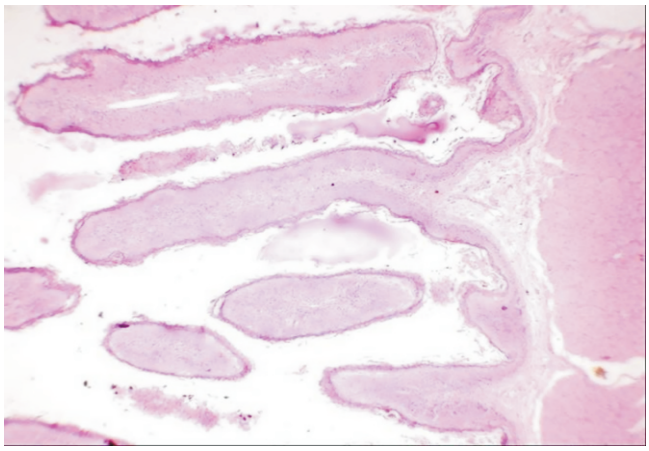

Fig 2. Photomicrograph of the large papillae in the ventral wall of rumen showing stratified squamous keratinized epithelium. (H. & E. x 40)

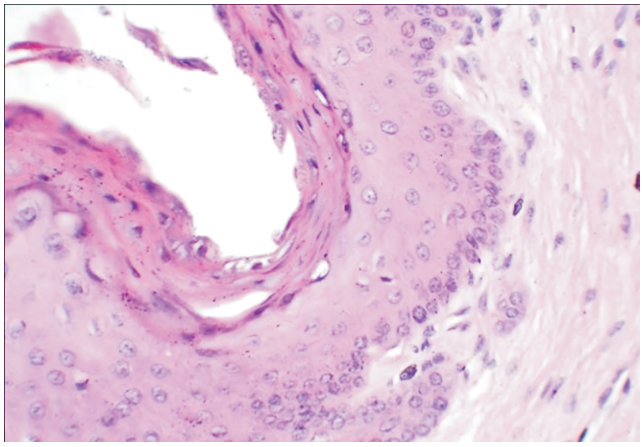

Fig 3. Photomicrograph at higher magnification of the epithelium lining the ventral coronary pillar of rumen showing different cell layers of stratified squamous keratinized epithelium. (H. & E. x 400)

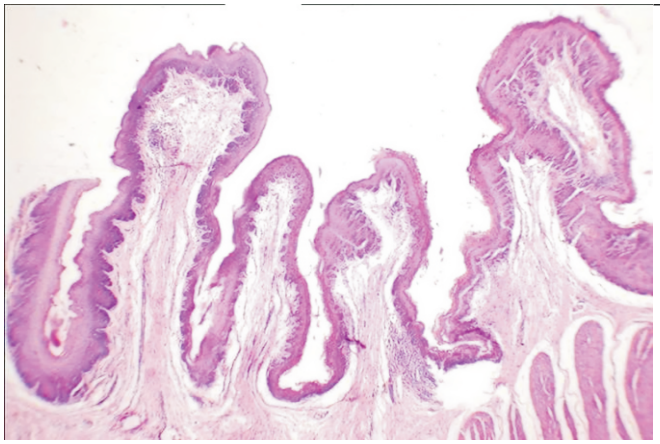

Fig 4. Photomicrograph of oesophageo-ruminal junction showing the thick stratified squamous epithelium with an extra layer comparable to stratum lucidum. (H. & E. x 40)

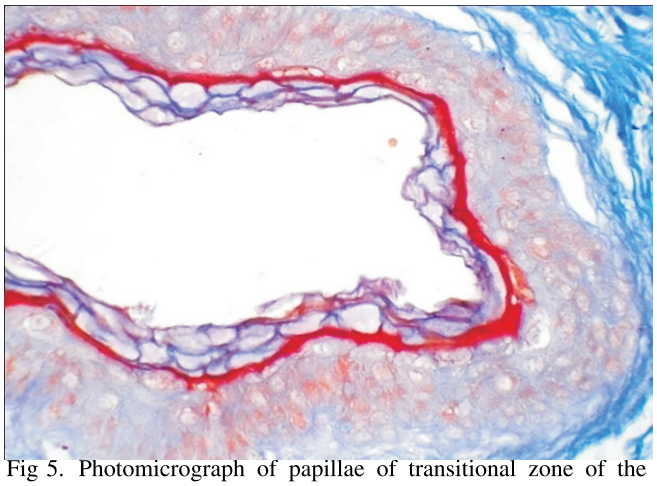

Fig 5. Photomicrograph of papillae of transitional zone of the ventral wall of rumen showing the presence of keratin layer in stratum corneum layer. (Ayoub Shklar method x 400)

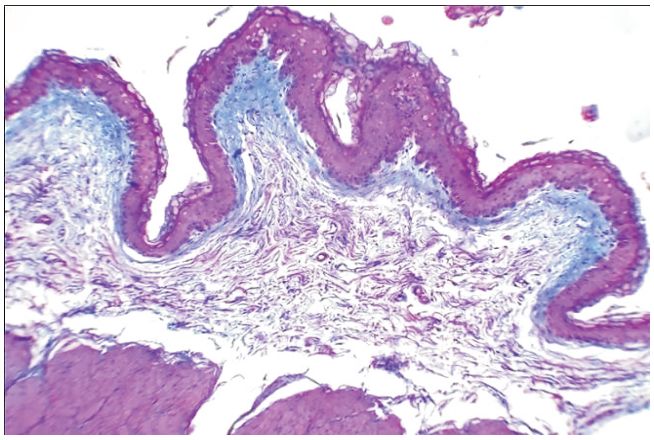

Fig 6. Photomicrograph of ventral wall of rumen showing the distribution of collagen fibres in the propria submucosa and the core of the papillae. (Crossman's trichrome stain x 100)

mechanical mixing of ingesta and the removal of gas through eructation, contractions, and also for regurgitation. The tunica serosa of the rumen was consisted of outer flat mesothelial cell layer and an inner loose irregular connective tissue having fine blood capillaries and fatty tissue. Isolated collagen fibres and very few elastic fibres were present in the subserosa. This was in accordance with Taluja and Saigal (1988) in buffalo, where they mentioned three layers in the tunica serosa, an outer mesothelial layer, middle loose connective tissue layer and an inner dense fibro-elastic layer.

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