

Histological and Histochemical Features of the local Male Goat's (*Capra hircus*) Cecum

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Abstract— The purpose of this study was to shed light on the histomorphometry structure of cecum of the goat (*Capra hircus*). Ten samples from the cecum of an adult male goat were used in this investigation. All samples were taken from research animals that were being killed in a local abattoir in the region of Al-Muthanna between November and December 2025. Five specimens obtained from each part of the cecum (apex, body, and base) for each histological and histochemical investigation. The four tunicae mucosa, submucosa, muscularis, and serosa or adventitia that make up the cecum wall were shown to have identical structures throughout the study. The structures were visible in the tunica mucosa; the muscularis mucosa, the lamina propria with Lieberkühn crypts, and the epithelium. The tunica's apex was thicker than its other sections, and its lining was made up of simple epithelium that more Lieberkühn crypt and goblet cell were found in the apex of the cecum epithelium than in other areas, and there were more well-developed, simple, tubular, unbranched glands there than elsewhere. Intestinal glands are located close to the lamina muscularis. In the tunica mucosa of the entire cecum, goblet cells were globular-shaped. In Lieberkühn crypts and epithelium, these goblet cells demonstrated a high positive response to periodic acid Schiff and periodic acid Schiff plus Alcian blue stains. The submucosa is made up of many blood arteries, collections of lymphatic nodules, dense irregular connective tissue, adipose tissue, and the absence of glands. In the base of the cecum, the tunica was thicker than in other places. The innermost circular and outside longitudinal smooth muscle fibers that made up the tunica muscularis were thicker at the apex than in other areas. The cecum's modified thickenings and smooth muscle layer of the muscularis externa were arranged at random. The loose connective tissue known as tunica serosa had a mean thickness in the apex that was greater than in other areas. In conclusion, the histological and histochemical features of the goat's cecum show how well it evolved to herbivorous food and how crucial it is for hindgut fermentation, immune system function, and efficient nutrient use.

Keywords — histological, histochemical, cecum, appendix, goat

INTRODUCTION

The primary purposes of goat breeding include the manufacturing of meat, skins, milk, and hair, as well as the

utilization of their waste materials to make fertilizer. Goats are small ruminants that consume less than sheep in relation to body weight, their gastrointestinal tracts are more effective at extracting nutrients, and they can use rough, poor plants. Goats have been treated as bred over thousands of years in all regions of Iraq, the birthplace of civilizations, in which agriculture and animal husbandry flourished since ancient times. Goats can withstand difficult conditions, thrive on inadequate and scant feed, preferring coarse grasses, assimilate fibers, thrive in arid environments, and produce large amounts of milk (1,2). The milk of goat is recommended for young children, the elderly, and those recovering from illness. It also helps to strengthen immunity and prevent cancer, heart disease, and allergies. "Catgut" is made from the intestines of sheep and goats and is still used for internal sutures for surgery (3,4). The caecum, colon, and rectum are sections of the large intestine, a hollow organ that is much larger in diameter than the small intestine. Its purpose is to break down food into small pieces that can be absorbed through tissues and used for bodily maintenance. It also absorbs a variety of vitamins, electrolytes, water and mucus (5,6). The only mechanism that can supply the body's energy needs through nutritional absorption is the digestive system, which also creates a close connection with nature by breaking down different kinds of food. Small herbivorous creatures are limited by their nutritional gear systems because they require more protein and energy per unit mass than big herbivores (7). In order to overcome the limitations of their relatively small body mass in contrast to larger animals, young herbivores need unique digestive strategies. Despite having a larger cecum, herbivorous animals show different patterns of flow and mixture in the large intestine (8,9). Impaction, perforation, which dilatation, inversion, intussusceptions, and neoplasia are among the conditions that can affect the colon and cecum (10,11). There are few studies on the goat's cecum and how it functions as a component of the digestive system. Animals undergo several modifications as a result of evolution in order to adapt to their surroundings. Every animal species has distinct traits that aid in their survival and allow them to eat a variety of feeds (12,13). However, in order to comprehend the connection between diet and metabolic needs, it is necessary to provide information on the cecum, such as how its level of development is directly tied to the surroundings in which it lives

(14). This study evaluates the cecum's histological characteristics and learns about its histochemical characteristics in adult Billy- goats.

Ethical clearance

Every procedure was performed in compliance with the branch of histology and anatomy in College of Veterinary Medicine- AL-Muthanna university, Animal Care and Use Committee.

MATERIALS AND MTHODS

Animals: Ten samples of cecum were collected from the healthy adult male goat (Billy-goat) *Capra hircus*, the weight of animals between 95-100 kg and aged approximately two – three years that slaughtered at AL-Muthanna abattoir. The collection period about November and December 2025. The intestinal tract has been separated and removed from its connections to the anterior abdominal wall. From the top border towards the caeco-colic junction a blind-ending segment of intestine that emerges at the intersection between the ileum and colon the cecum was removed. Hematoxylin and Eosin (H&E) was used for histological characteristics, Masson's trichrome was used for muscle and collagen fibers, periodic acid Schiff (PAS), periodic acid Schiff plus Alcian blue (PAS-AB) for carbohydrates, and Verhoef was used for elastic fibers. Five specimens (0.8 cm) from various regions from each part of the cecum (apex, body, and base) had been washed with normal saline and fixed in 10% formalin for a period of 48 hours during room temperature (15).

STATISTICAL ANALYSIS; The study was analyzed using one-way examination of variance, or ANOVA, tests at 1% significant levels. The data was processed and controlled using social science statistical methods (16).

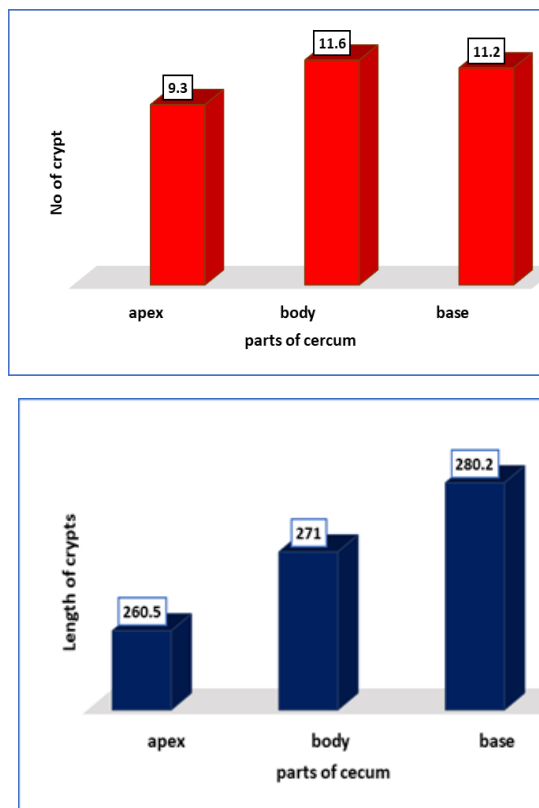
RESULT AND DISCUSSION

The cecum's wall was made up of four tunicae: the mucosa, submucosa, muscularis, and serosa or adventitia. Its exterior was smooth and devoid of bands or sacculation and the mucosal surface lacks villi (Fig. 1). This outcome is consistent with a camelid observation (8). The lining the epithelium lamina propria, as well as muscularis mucosa are the three layers that make up the tunica mucosa, which is the inner layer that lines the lumen (Fig. 2,3). The apex of the tunica was thicker than the body and base ($581\pm 0.8\mu\text{m}$), respectively (Table 1). are comparable in other ruminants, such as cows and sheep (17).

Table 1. Measurements wall layers of parts of cecum in goat, μm

Tunica Part	Mucosa	Submucosa	Muscularis externa	Serosa
Apex	581±0.8b	271.5±1.3b	449.5±0.53b	66.6±0.52b
Body	538.3±0.9b	257.9±0.2b	411.8±0.4b	58.6±0.1b
Base	513.9±0.3b	253.5±1.7b	405.2±0.3b	54.4±0.2b

Values in small letters in one column denote to significant differences (P>0.01)



Histogram 1,2. Measurements number and length μm of crypt in parts of cecum in goat,

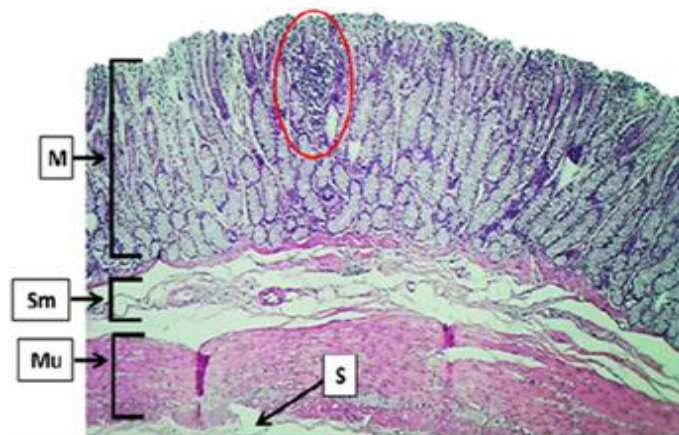


Figure 1. Cross microscopic section of the apex of cecum in goat, mucosa (M), submucosa (Sm), muscularis (Ms), serosa (S), aggregation of lymphocyte (red circle). H&E Stain 40X

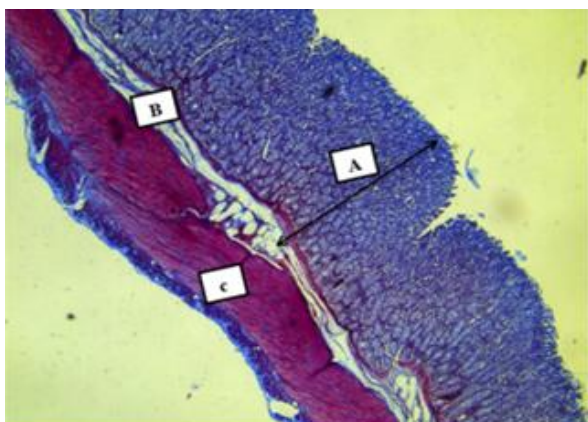


Figure 2. Longitudinal microscopic section of the body of cecum in goat, mucosa (A), submucosa (B), muscularis externa (C), Masson Stain 40X

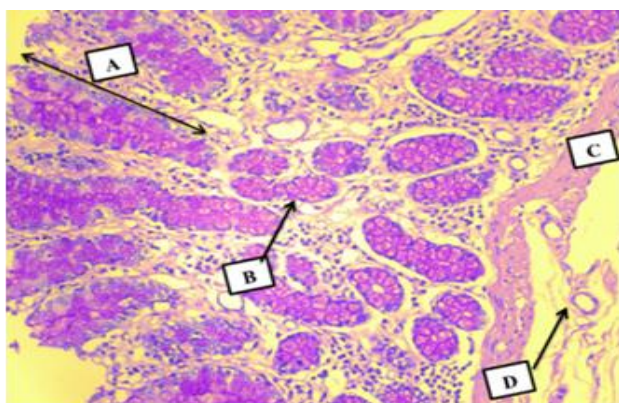


Figure 3. Longitudinal microscopic section of the Mucosa in base of cecum in goat, crypt (A), goblet cell (B), muscularis mucosa (C), blood vessels (D), PAS Stain 200X

The basic columnar epithelium is supported by a thin basement membrane that lines the lumen, which is made up of many cell types, including goblet cells of the Cecum and absorptive columnar cells (Fig. 4,5). These findings were consistent with (18) in sheep and cows. In order to provide a physical barrier against pathogen or commensal microorganism invasion, which could be detrimental to the ductal tissue parenchyma, mucosal epithelium and produced mucus coating those organs are essential (7).

The epithelium's mucosal folds were blunt and short (Fig. 4–10), which is typical (19) in sheep. Ruminants' gastrointestinal tract biometry in relation to their nutrition, as well as variations in the papillae's surface area, length, and width over time, have been observed (20). According to the histogram (1), the apex of the cecum had an increased amount and length of Lieberkühn crypts than the other sections; this finding is consistent with earlier camel research (17). This epithelium's primary roles included lipid absorption and the provision of a barrier that is selectively per against various antigens to control interactions between the body and the outside world. In this study, the height of the epithelium in the first part of the cecum increased in the protective mucosal immune reaction and suggested the absorptive role of the outermost epithelium in the first part of the cecum more than that in the other portions. The height of

the epithelium decreased significantly toward the last parts of the cecum. The two layers of smooth muscle fiber that make up the muscularis mucosa an outer longitudinal layer and an inner circular layer separate the crypts and the submucosa underneath (Fig. 1,3). These results were consistent with (21) that the muscular mucosa has a role in moving and combining the meal and digestive juices as well as preparing in goats, pigs, and dogs. high microbial fermentation. Dense microbial populations that produce ammonia, VFAs, and other metabolites can be found in the cecum. A thicker epithelium offers superior defense against irritation from chemicals and microorganisms. According to (6), each gastrointestinal tract segment has a mucosal specialty for the best possible secretion, absorption, and digestion efficiency. In addition to being an active immune tissue and the gut's natural defense against infections, the gastrointestinal lumen is home to dangerous microbes and toxins which would kill the animal. Goblet cells, immunological cells, and neuroendocrine cells make up this barrier in the epithelial layer (11, 22).

Dense connective tissues infiltrated with lymphoid nodules and blood arteries makes up the submucosal layer (Fig. 4). In the mucosal glands, the lymphoglandular structure expanded, revealing depressions in the mucous membrane covering the lymphoglandular complex. There is no muscularis mucosa where the holes are located (Fig.4,10). The deep component of the muscularis mucosa is strongly associated with submucosal lymphatic nodule that are a component of lymphoglandular complexes, and they rarely occupy the entire thickness of the submucosa. Round or oval in shape, submucosal lymphoglandular aggregates are closely associated with the deep feature of the muscularis mucosa (22, 23).

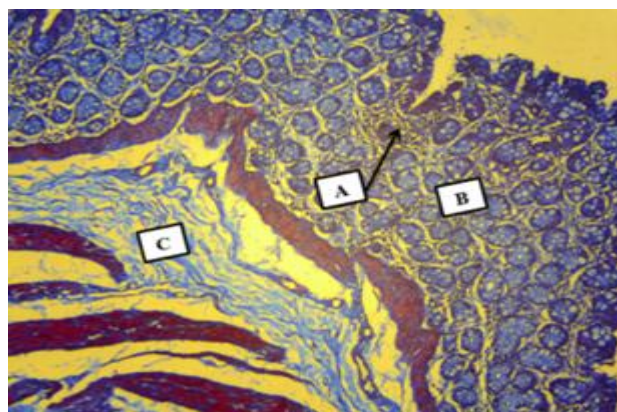


Figure 4. Longitudinal microscopic section of the apex of cecum in goat, lymphatic tissue (A), crypt (B), connective tissue (C), Masson Stain 100X

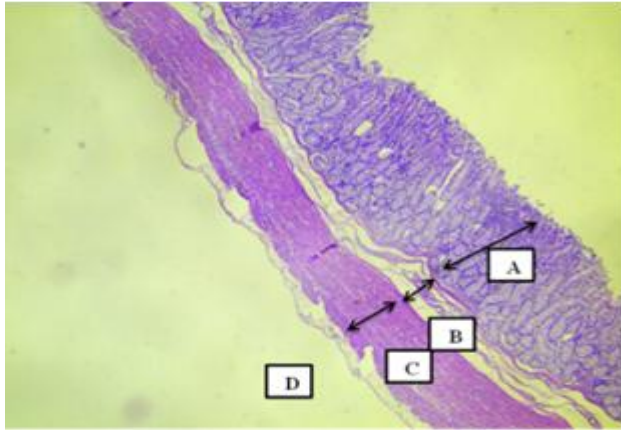


Figure 5. Cross microscopic section of the apex of cecum in goat, mucosa (A), submucosa (B), muscularis externa (C), serosa (D), H&E Stain 40X

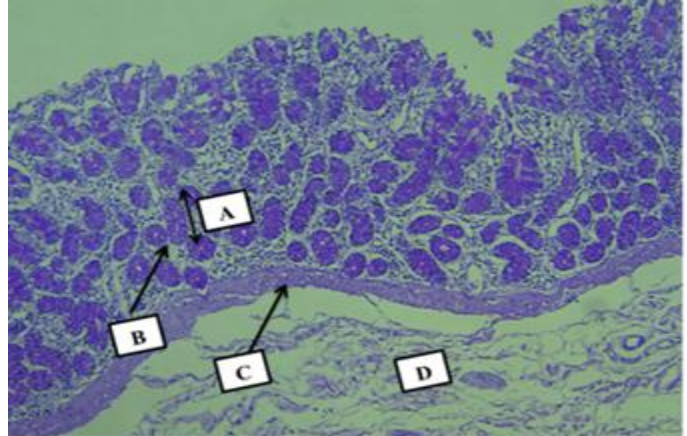


Figure 8. Cross microscopic section of the body of cecum in goat, crypt (A), goblet cell (B), muscularis mucosa (C), connective tissue (D), PAS Stain 100X

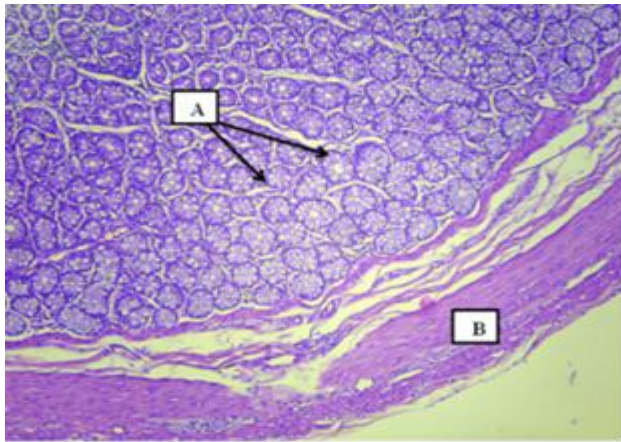


Figure 6. Cross microscopic section of the apex of cecum in goat, mucosa (A), submucosa (B), muscularis externa (C), serosa (D), H&E Stain 200X

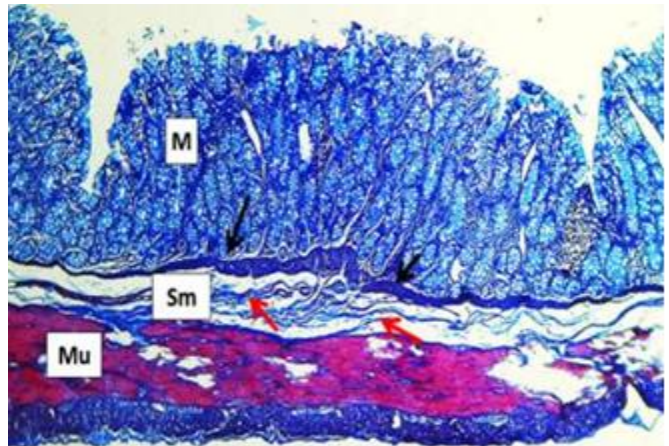


Figure 9. section of body of cecum show: mucosa (M), muscularis mucosa (black arrow), submucosa (Sm), collagen bundles (red arrow), muscularis (Ms). Masson trichrom stain. X40.

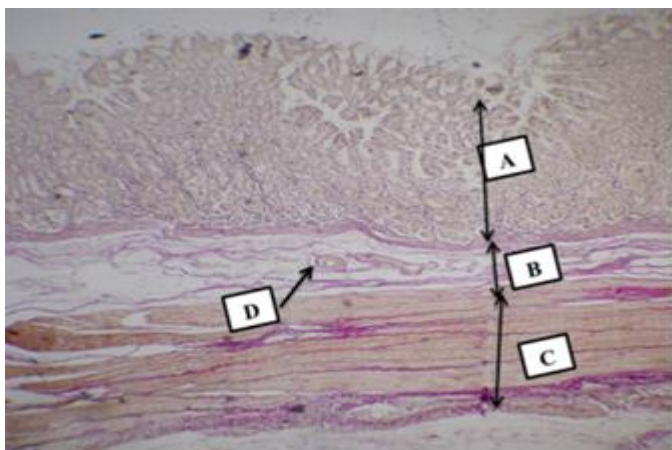


Figure 7. Cross microscopic section of the apex of cecum in goat, mucosa (A), submucosa (B), muscularis externa (C), blood vessels (D), Verhoef's Stain 40X

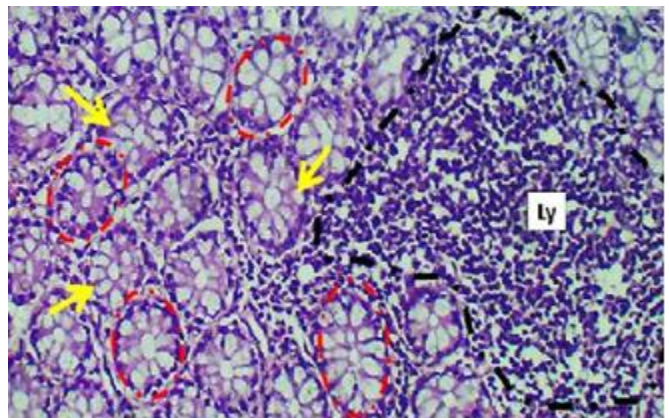


Figure 10. Cross histological section of apex of cecum show: crypt of liberkhan (red circle), goblet cell (yellow arrow), lymphocyte (Ly). H&E stain. X200.

According to the current study's histological structure, the submucosal layer of the cecum contained lymphoglandular complexes (Fig. 10). In these lymphoglandular complexes,

lymphocytes predominated together with a small number of phagocytes, which are crucial for immunological defense. On gross examination, these lymphoglandular complexes exhibit holes in the mucosal surface. The apertures are dispersed at random and cover the mucosal folds. Our findings concur with those reported by (24) who reported that there were significant lymphoid tissue infiltrations in the mucosal and submucous coats in the apical region of the cecum. Additionally, it was noted by (25) that the cecum contains an important amount of lymphatic nodules dispersed along its length. There are particularly many lymphatic nodules at the ileal ostium. According to our findings, there are also lymphoid patches near the ileocecal opening along with in proximal colon, as well as lymphoid follicles creating structures known as lymphoglandular complexes, which are lymphoid lymphocytes in submucosa which include epithelial splits that extend from the mucosa. The cecum does not have cortical as well as medullary regions of lymphoid structure, nor can germinal centers be detected. These compartments receive the partially digested, undigested, and unabsorbed feed components, while the large intestine is where additional absorption and digestion of minerals, water, and vital nutrients occur. The big intestine's role is to facilitate the greater digestion of these compounds by microbes (26–29).

Smooth muscle fiber fasciculae make up the outside longitudinal layer and the inner circular layer of the tunica muscularis. In addition to reticular and collagen fibers, the tunica muscularis also had a small number of elastic fibers in its blood channels (Fig. 1, 2,8). Because mixing, ferment control, and ingesta propulsion all depend on powerful, coordinated contractions, muscularis externa appears thickest in the cecum. Connective tissue and a thin layer of the cells that make up make up the tunica serosa. The connective tissue, known as tunica adventitia, was made up of blood vessels, fibrocytes, and collagenous fibers in certain areas that lacked mesothelium (Fig. 1,5). The cecum is comparatively movable inside the abdominal cavity, according to (30). Smoother movement and less friction against adjacent organs are made possible by a thicker serosa. Fermentation gasses and ingesta volume cause the cecum to significantly expand. A strong serosa lowers the chance of adhesions and allows for stretching. As a mobile, intraperitoneal structure that experiences considerable distension, serosa appears thickest in the apex of cecum and needs an outer covering that reduces friction and provides support. The mesocecum, which transports blood vessels, nerves, which are and lymphatics, is formed in part by the serosa; this calls for a more robust outer layer of connective tissue. Because the cecum is entirely intraperitoneal, a healthy serosa is necessary (31, 32).

Histochemical analysis: The intestinal glands and epithelial surface goblet cells react strongly with PAS from every section of the cecum (Fig. 9,10). Due to the columnar cell's low response to PAS, this indicator discovered mucus neutral, which enables the passage of excrement. Additionally, goblet cell and intestinal gland were also found to be PAS positive, and the cecum epithelium was stained with PAS (30). This study, however, contradicts (2), which found that the Lieberkuhn crypts exhibited a predominance of acidic muco-

polysaccharides in sheep cecum. This discrepancy could be attributed to the food's quality.

CONCLUSION

According to the current study, a goat's cecum has a precise histological architecture that is consistent with its vital role in microbial fermentation and water absorption. the mucosa, exhibiting vigorous secretion and absorption mechanisms. Their protective and lubricating functions in promoting digesta movement and preserving mucosal integrity were demonstrated by the epithelial wall and goblet cells' strong histochemical reactions to mucopolysaccharides, especially acidic and neutral mucins. The cecum's a foundation and motility functions were confirmed by the distinctive staining affinities of the muscular layers and connective tissue components. Overall, the goat's cecum's histological and histochemical characteristics demonstrate how well it adapted to a herbivorous diet and how important it is for immune system function, hindgut fermentation, and effective nutrient utilization.

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Conflict of interest: According to the writers of the manuscript, there were no disputes related to interest throughout the writing process.

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