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Rumen Epithelium Development of Bovine Fetuses and Newborn Calves

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Abstract : The ruminant stomach is a complex and multi-chambered organ. Although the true stomach (abomasum) is fully differentiated and functional at birth, the same does not occur with the rumen chamber. At this moment, rumen papillae are small or nonexistent. The papillae only fully develop after weaning and during calf growth. Papillae development and ruminal epithelium specialization during the fetus growth and at birth must be two interdependent processes that will prepare the rumen to adapt to ruminant adult feeding. The microscopic study of rumen epithelium at these early phases of life is important to understand how this structure prepares the rumen to deal with the following weaning processes and its functional activation. Samples of ruminal mucosa of bovine fetuses (110- and 150 day-old) and newborn calves were collected (dorsal and ventral portions) and processed for light and electron microscopy and immunohistochemistry. The basal cell layer of the stratified pavimentous epithelium present in different ruminal portions of the fetuses was thicker than the same portions of newborn calves. The superficial and intermediate epithelial layers of 150 day-old fetuses were thicker than those found in the other 2 studied ages. At this age (150 days), dermal papillae begin to invade the intermediate epithelial layer which gradually disappears in newborn calves. At birth, the ruminal papillae project from the epithelial surface, probably by regression of the epithelial cells (transitory cells) surrounding the dermal papillae. The PCNA cell proliferation index (%) was calculated for all epithelial samples. Fetuses 150 day-old showed increased cell proliferation in basal cell layer (Dorsal Portion: 84.2%; Ventral Portion: 89.8%) compared to other ages studied. Newborn calves showed an intermediate index (Dorsal Portion: 65.1%; Ventral Portion: 48.9%), whereas 110 day-old fetuses had the lowest proliferation index (Dorsal Portion: 57.2%; Ventral Portion: 20.6%). Regarding the transitory epithelium, 110 day-old fetuses showed the lowest proliferation index (Dorsal Portion: 44.6%; Ventral Portion: 20.1%), 150 day-old fetuses showed an intermediate proliferation index (Dorsal Portion: 57.5%; Ventral Portion: 71.1%) and newborn calves presented a higher proliferation index (Dorsal Portion: 75.1%; Ventral Portion: 19.6%). Under TEM, the 110- and 150 day-old fetuses presented thicker and poorly organized basal cell layer, with large nuclei and dense cytoplasm. In newborn calves, the basal cell layer was more organized and with fewer layers, but typically similar in both regions of the rumen. For the transitory epithelium, fetuses displayed larger cells than those found in newborn calves with less electrondense cytoplasm than that found in the basal cells. The ruminal dorsal portion has an overall higher cell proliferation rate than the ventral portion. Thus we can infer that the dorsal portion may have a higher cell activity than the ventral portion during ruminal development. Moreover, the basal cell layer is thicker in the 110- and 150 day-old fetuses than in the newborn calves. The transitory epithelium, which is much reduced, at birth may have a structural support function of the developing dermal papillae. When it regresses or is sheared off, the papillae are “carved out” from the surrounding epithelial layer.

Keywords : bovine, calf, epithelium, fetus, hematoxylin-eosin, immunohistochemistry, TEM, Rumen
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