Indian Journal of Veterinary Anatomy 37(2): 137-142, December 2025

Comparative Histological and Histochemical study of Corpora amylacea in the Mammary glands of Goats and Ewes

Shilpa S. Modekar[1*]
Department of Veterinary Anatomy and Histology, KNPCVS, Shirwal Dist. Satara (Maharashtra), India

Received: 17.01.2025; Accepted :12.12.2025

ABSTRACT

When it comes to the study of the process of tissue regression, the mammary gland is one of the most important and unique, organs which can be considered as the best experimental model. In each and every cycle of pregnancy and lactation, this gland undergoes massive expansion of the milk-producing secretory epithelium coupled with regression of adipocytes followed by reversal of this process during involution. The functional stage of mammary gland affects the incidence and distribution of corpora amylacea. Corpora amylacea were present in the mammary glands of both the small ruminants under investigation. Corpora amylacea occurred most frequently in the ewe, and were seen comparatively more in non-lactating mammary glands when compared with that of goat. In lactating stage these were situated mostly in the alveolus. During gestation they were located outside of the alveolus and in the interalveolar connective tissue. Only in very few cases corpora amylacea were found inside and outside of the alveolus in the same mammary gland. Their origin appeared to be cellular and the desquamated and infiltrated cells accumulate in the lumen became fragmented, degenerated and lysed to form a solid lump like structure.

Keywords: Mammary Gland, Small ruminate, Corpora amylacea histology and histo-chemistry.

INTRODUCTION

The importance of small ruminants, i. e. goat (*Capra hircus*) and sheep (*Ovis aries*) and has increased in recent years, as far as dairy industry is considered. To be very specific, in developing counties where these have high economic and social impact. Understanding the different mammary gland patterns throughout lactation is essential to improve dairy production, as it is an essential tool to overcome social and economic issues such as poverty and malnutrition, particularly in infants (McDermott *et al.* 2010). Therefore it is critical to understand the modifications occurring in the mammary gland in its various physiological stages associated with lactation in order to develop strategies to improve milk yield or reduce the effect of diseases that decrease milk production and milk quality, with particular relevance to mastitis. The occurrence of corpora amylacea was reported in mammary glands of both the goat as well as sheep. They were generally comparable to the cow regarding to its distribution, morphological structure, frequency and staining properties size, (Ludewig 1998). Reports are even available on histological and histochemical features of bovine and buffalo mammary glands (Uppal *et al.* 1994) during lactation.

The literature on comparative study on histomorphological and histochemical aspects of the mammary gland during various physiological phases. in small ruminants is limited. The investigation was undertaken to determine prevalence and location of amyloid bodies throughout the lactation cycle respective of infection status and lactation age, as well as to characterize structural relationships with milk synthesizing tissues, in an attempt to determine role of corpora amylacea in the small ruminant's mammary gland. This gland which is known to be a modified sebaceous gland i.e cutaneous gland. (Takagi *et al*, 1959). The gland undergoes lots of changes during various stages of pregnancy and onset of lactation as well, which is specifically governed by functional status and the hormones as well. From a histological point of view, the mammary gland is composed of two tissues: the parenchyma and stroma. The first corresponds to the secretory part of the gland and originates from

1 Associate Prof & Sectional Head,
*Corresponding author: drshilpa555@gmail.com

the ectoderm of the embryo. The stroma has a mesodermic origin and is constituted by blood and lymph vessels and adipose, connective and nervous tissues. During gestation and throughout lactation, the mammary gland undergoes several alterations, not only of its volume, but also of its internal structure and composition, which have a strong impact in milk production in terms of both quantity and quality (Fowler *et al.* 1990).

MATERIALS AND METHODS

The mammary glands of sheep and goat were collected immediately after slaughter at Deonar abattoir, Chembur Mumbai. The total number of examined animals was 30, which were divided in two groups, fifteen (15) in their dry period and fifteen (15) in the lactation. The samples of the mammary gland were taken from several sites, from the left and right halves of the udder, being careful to not to damage the active part of the gland parenchyma. The samples were stored containers with lids, filled with 10% formalin, until moulded in paraffin blocks. The mammary tissue samples of 03-05mm thickness were collected and fixed in 10% neutral buffered formalin fixative for histological studies. After fixation of the tissues for 24-72 Hrs, they were subjected to dehydration in ascending grades of alcohol, cleared in xylene and the paraffin wax blocks were prepared as per method (Singh, *et al.* 1996). Here after the tissue sections of 03-06µm. were mounted on clean albumenized glass slides. These were dried on hot plate at 28-45ºC for ½ hr. The prepared sections were stained by Hematoxylin and Eosin stain, Best caramine and PAS-AB stains for histological studies. Histological examinations were done with light microscope with various magnifications. Only apparently healthy and normal appearing mammary glands were taken after examination.

RESULTS AND DISCUSSION

The present comparative study performed in goat and sheep mammary gland, showed a common pattern of histological appearance through the several phases considered, as there was a mutual increment of lobule-alveolar system throughout lactation, as well as a reduced amount of stroma tissue. Additionally, during early and mid-lactation there was an increment of alveolus number, size and differentiation.Epithelial cells with a columnar shape and secretory vesicles were even seen. (Fig No. 1) During early lactation, a reduction of epithelial cells number was observed for goat as well as sheep, but war having higher percentage of cells in goats as compared to sheep. These histological processes corroborate with the findings of (Weber, 1977)., who stated that, during late gestation and lactation, it is indeed necessary to progressively increase the alveoli size/number and lumen area, which replace the stroma tissue, in order to have enough secretory cells to start producing milk after partum. (Hennighausen & Robinson, in 2001) have studied that mammary remodeling was determined by a combination of cell differentiation, proliferation and programmed death controlled not only by systemic hormones, but also by proteins produced either in the stromal or in the epithelial compartments. For goats, several authors investigated histological modifications of the mammary gland during the course of lactation. Li *et al.*in 1999b observed alveoli development occurred as a result of cellular proliferation, as well as the presence of secretions inside alveoli and ducts in Saanen goats during both gestation and lactation periods. (Fig No. 2)

The present study revealed that, there was presence of large fat droplets in epithelial cells' apical membranes throughout early lactation, and the reduction of stromal tissue percentage due to its substitution by the secretory tissue (parenchyma) in both goat as well as sheep in their lactating stage. Further, with the onset of lactation epithelial cells assume a columnar morphology, alveoli are surrounded by a thin layer of fibroblasts and capillaries and there is the presence of highly distended alveoli. These findings are in agreement with the findings of (Elsayed *et al.* 2009) who studied the mammary gland patterns throughout lactation in Damascus goats, and noted that there was an increase in alveolar secretory cells number during early and mid-lactation and a diminishment in late lactation. It was even noted that, the mammary gland underwent structural alterations in its alveoli at the end of the gestation period, which passed from immature to mature at early

lactation. These results corroborate with the reports of (Akers, 2002) marked in lactating cows.

The present comparative study, the corpora amylacea were observed as round, oval or irregular cauliflower shaped concentrically laminated bodies with few droplets like structures in the centre. The number of corpora amylacea was higher in non-lactating non-pregnant animals throughout the study. This indicated that the occurrence and distribution of corpora amylacea was influenced by functional stage of mammary gland. Usually, these amylacius bodies are comparable with the cow in context with its distribution, frequency of appearance, size, morphological structure, and staining properties. Their origin appeared to be cellular and the desquamated and infiltrated cells accumulate in the lumen became fragmented, degenerated and lysed to form a solid lump like structure of the corpora amylacea as has been described by (Kuinken *et al.* 1956) in heifers and (Reid. 1972) in cows. These were seen in their various stages of formation and located both in the lumen of alveoli (intra-alveolar bodies) and septal connective tissue (Interstitial bodies).The interstitial amylacea concretions were more in the involuting mammary glands (Fig 4). The corpora amylacea to appeared in numerous amount in the lactating and involuting dry mammary gland of sheep as compared with that of goat. The occurrence of corpora amylacea increased gradually from lactating mammary glands and observed more in dry mammary glands and was found both in the alveolar lumen and interstitial connective tissue. The corpora amylacea were recorded to be numerous in the lactating and involuting dry mammary gland in sheep as compared with the goat, which corroborate with the recordings recorded by (Sulochana *et al.* 1990) who observed the amylaceous bodies of different shapes and sizes in the mammary gland of sheep during pregnancy as well as (Sordillo and Nickerson 1986) who described that in bovines, Corpora amylacea were most abundant during the later stages of lactation and least abundant during involution and early lactation. (Arnold and Weber 1977) also described the presence of corpora amylacea in the alveoli of the mammary gland in lactating cows. There occurrence increased gradually from lactating mammary glands and were observed more in dry mammary glands and were found both in the alveolar lumen and interstitial connective tissue of both, sheep as well as goat. (Fig No.3) These findings corroborate with findings of (Rajathi, *et al.* 2024). In the present study, it was observed that in lactating stage, the percentage distribution of corpora amylacea was more in alveoli. The ratio of distribution of corpora amylacea, between alveoli and stroma varied from 80:20 in to 90:10. However, in dry stage, these were more in the stroma which apparently gave a reverse picture and the ratio varied from 10:90 to 00:100. The present, comparative histo-chemical study of the mammary gland of sheep and goat revealed that, as far as the occurrence of the mucopolysaccharides is considered, the present study, basement membrane of the alveoli, lamina propria of ducts, alveolar and ductal secretions, blood vessels and corpora amylacea showed strong activity for PAS in both the sheep as well as goat, similar findings were also noted by (Parekh, 2002) in buffalo, (Singh and Roy, 2006) in Indian buffalo, (Naik *et al.* 2015) in Malnad Gidda cows, (Senthil Lumar *et al*. 2019) in Madras Red ewes and (Sai Urmila *et al*. 2021) in domestic animals. Alveolar epithelial cells and connective tissue septa showed strong activity for PAS and PAS-AB in all animals (Fig. 3) as reported by (Panchal and Vyas, 2005) in buffalo. The alveolar epithelial cells and their secretions did not show PAS-AB activity in sheep. However, in goat some secretions showed strong activity was observed. (Fig No. 3) Both in sheep and goat, PAS- AB positive secretions in intralobular ducts were recorded. Similar findings were recorded by (Naik *et al*. 2015) in Malnad Gidda cows. Blood vessels showed moderate activity in sheep but showed mild activity in goat. These findings corroborate with findings of (Sai Urmila *et al*. 2021). Whereas, (Panchal and Vyas 2005) noted mild activity of acid mucopolysaccharides but (Naik *et al*. 2015) noted strong activity in blood vessels in lactating gland of buffalo and Malnad Gidda cows respectively. As far as alveolar secretion and its protein content, the present study revealed that the alveolar

secretions were strongly positive for proteins in both sheep as well as in goat, similar finding was also noted by Singh and Roy and Naik *et al.* 2015 (2006) in Indian buffalo, El-sayed *et al.* (2009) and Naik *et al.* 2015 in Damascus cows reported strong activity of proteins in corpora amylacea in Indian buffalo and Malnad Gidda cows respectively similar to the present findings. (Fig No. 4). The present comparative study even revealed that the lamina propria of ducts was strongly positive for proteins, in both the species. The neutral lipids in alveoli and ducts in both, sheep and goat were recorded as well. The alveolar lumen was filled with the lipid droplets and some ducts even showed fat droplets within. large amount of fat was also present in the connective tissue septa. The amount of fat was more in sheep as compared with that goat. Further the number of calcium deposits were recorded more in non - lactating gland stage as compared with lactating one. However, (Senthil Kumar *et al.* 2019) recorded calcium deposits in alveoli and in basal lamina of ducts in Madras Red ewes goats.

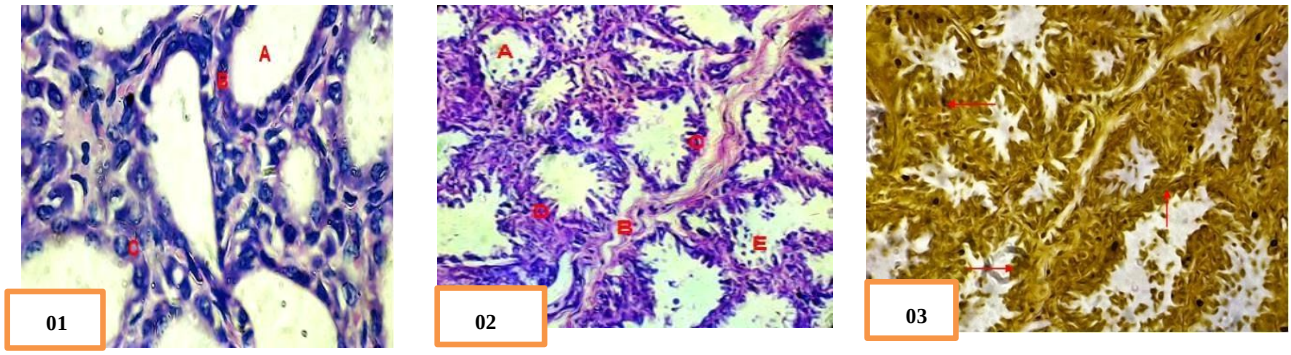

Fig.No 1: Microphotograph of sheep udder in lactating stage **(H & E 1000X)** showing **A)** Secretory alveoli with secretory material **B)** Spherical flattened nuclei **C)** Myoepithelial cells with nuclei. **Fig.No 2:** Microphotograph of goat udder in lactating stage **(H & E 400X)** showing **A)** Active secretory alveoli **B)** Interlobular CT **C)** Epithelium **D)** Basement membrane **E)** Secretory material. **Fig.No 3:** Microphotograph of goat udder in lactating stage **(**Best Carmine Stain 400X) Arrow showing yellowish brown colored glycogen.

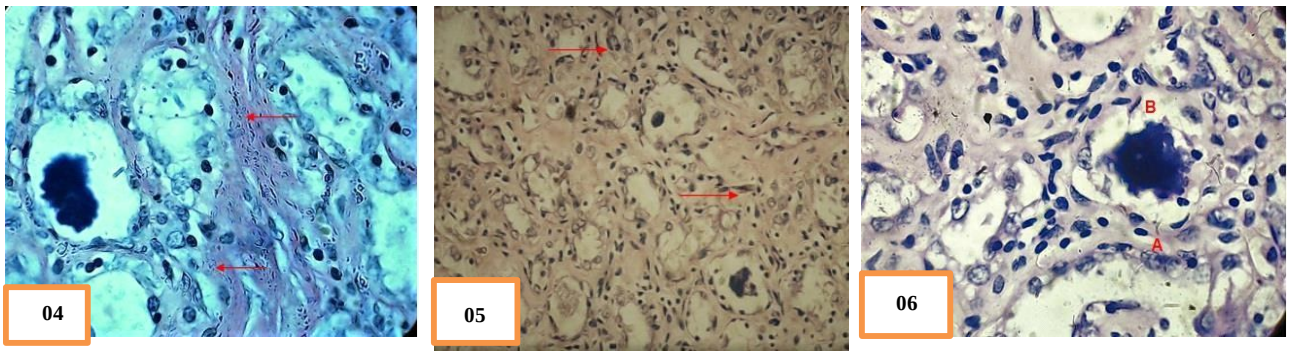

Fig No. 4 : Microphotograph of udder of sheep in non- lactating stage (PAS Acid Schiff Stain 1000X) Arrow showing pinkish coloured mucopolysaccharide & interalveolar corpora amylacea.**Fig.No. 5 :** Microphotograph of udder of sheep in non-lactating stage (Best Carmine Stain 400X) Arrow showing **A)** Glycogen **B)** Corpora amylacea. **Fig.No. 6:** Microphotograph of udder of sheep in non- lactating stage (PAS AB Stain 1000X) Arrow showing **A)** neutral mucopolysaccharide **B)** Corpora amylacea

CONCLUSION

In general, common mammary gland patterns have been shown for both goats and sheep throughout the several lactation stages, although the number of studies is limited. The present study highlights the mammary glands morphological patterns underlying milk production during the lactation cycle for small ruminants, which is helpful for to describe potential differences between goats and sheep, hence this comparative study is a small contribution to a better description of mammary gland development during lactation for these two poorly studied species. Comparative analysis of mammary gland in small ruminants in their lactating and non-lactating stage, and the histological appearances and variations in various components of the productive gland is essential to understand its functionality as a milk production organ. Indeed, with the progressive increase in the importance of small ruminants in milk production, it is essential to understand mammary gland

modification pattern during lactation in both the goat as well as sheep. Nonetheless, it is apparent that there is indeed a similar mammary gland pattern between both species along the whole lactation cycle. As a general rule for small ruminants, early/mid-lactation was defined by the occurrence of cell proliferation, a higher level of cell activity and alveoli number and an increase in udder volume. During mid/late lactation, a reduction of epithelial cell number, a reduction in alveolar size and number and a diminishment of udder volume occurred and can be correlated with the reduction in milk yield. As herein discussed, it is essential to study further the mammary gland in dairy animals, since future progress in dairy animal production depend on the improvement of our knowledge regarding mammary gland modifications throughout lactation. The study revealed that the functional stage of mammary gland affects the incidence and distribution of corpora amylacea This research paves the way for a deeper understanding of the mammalian mammary glands, particularly in relation to the function and implications of corpora amylacea in these glands. This could be vital for health as well as production related studies associated with these small ruminants in the future.

REFERENCES

Akers, R. M. "Overview of mammary development," in Lactation and the Mammary Gland, R. M. Akers, Ed., pp. 3– 44, Lowa State Press, Ames, Iowa, USA, 2002.

Arnold, J. P. and A. F. Weber.1977. Occurrence and fate of corpora amylacea in bovine udder. American. *Jour. Vet. Res.* 38 (6): 879 – 81.

El sayed, E.H., M.H. EL-Shafie, E.O.H. Saifelnasr and A.A. Abu El-Ella. 2009. Histological and histochemical study on mammary gland of Damascus goats through stages of lactation. *Small Rum. Res.* 85:11-17.

Fowler, P.A., Knight, C.H., Cameron, G.G., and Foster, M.A. 1990 In-vivo studies of mammary development in the goat using magnetic resonance imaging (MRI). *Journal of Reproduction and Fertility*. 89 367–375

Hennighausen L & Robinson GW. 2001. Signaling pathways in mammary gland development. *Developmental Cell* 1: 467–475

Kuiken, J.R., Hill, D.L. and Lundquist, N.S. 1956.J. *Dairy Sci*. 39: 1299.

Li P, Wilde CJ, Finch LMB, Fernig DG & Rudland PS 1999b Identification of cell types in the developing goat mammary gland. *Histochemical Journal* 31: 379–393

Ludewig 1998. Comparative histological investigations on the teats of sheep and goats1998 May;26 (3):151-6. German. PMID: 9646404.

Naik, S.G., Prasad, R.V. Jamuna, K.V., Chandrashekar Murthy, V., Isloor, S., Ramesha, K.P., Kotresh, A.M. and Ramkrishna, V. 2015. Histological and histochemical studies on the mammary gland of Malnad Gidda cows of Karnataka. *Indian Journal of Veterinary Anatomy;* 27(2): 52-55.

Panchal, K.M. and Vyas, Y.L. 2005. The Anatomy of Udder of Buffalo: A Complete Monologue. Department of Anatomy and Histology, Anand Agricultural University, Anand.

Parekh, B. 2002. Gross and microscopic studies on the udder of lactating and non-lactating adult buffalo (*Bubalis bubalis), M.V.Sc*. thesis, Gujarat Agricultural University, Anand.

Parmar, M.L.1983. Ph.D. thesis, Birsa Agricultural University, Ranchi, Bihar, India.

Reid, I. M.1972. Corpora amylacea of bovine mammary gland. Histochemical and electron microscopic evidence for their amyloid nature. *Journal of Comparative Veterinary Sciences*, 14: 334-340.

Rajathi, S., Aarthi, G., Abirami, K., Adhidharshini, P., Adhithyavinod, V., Aishwarayalakshmi, E., Aksharavinu, Akalya, C., & Muthukrishnan, S. 2024. Comparative Histological Investigation of Lactating and Non-lactating Mammary gland in Kanni Breed of Goat. *Indian Journal of Veterinary Anatomy*, 35 (1): 4 - 7.

Roy, K.S. 2007 Morphogenesis of mammary gland in the buffalo (*Bubalus bubalis*): Lead Paper, Souvenir of XXII Annual Convention and National Symposium on Recent Advances in Animals with Special Reference to Developmental Anatomy, pp. 13

Senthil Kumar, S., Kannan, T.A., Ramesh,G. and Sumathi, D. 2019. Histochemical and immuno-histochemical studies in udder of Madras red ewes. *International Journal of Chemical Studies* 7: 392-395.

Singh, N. and Roy, K.S. 2006. Histochemical study on the mammary gland of Indian buffalo (Bubalus bubalis). *Indian Journal of Animal Sciences* 76: 43-45.

Sulochana S., Y. Singh, D. N. Sharma.1990. Amylaceous bodies in the mammary gland of pregnant sheep. *Harayana Agri. Univ. J. Res.* 20: 243 – 246.

Sulochana, S., M. Hafeezuddin and U.B. Singh. 1989., Histological and histochemical studies of the mammary gland of the Indian goat (*Capra hircus*). *Hy. Agri. Uni. J. Res., 11*: 287-291.

Singh, U.B. and Sulochana, S. 1990. Hand book of Histological and Histochemical Techniques. Premier Publishing House, Hyderabad.

Singh, N. and Roy, K.S. 2006. Histo-chemical study on the mammary gland of Indian buffalo (*Bubalus bubalis*). *Indian Journal of Animal Sciences* 76: 43-45.

Sordillo, L.M and S.C. Nickerson,1988. Morphologic changes in the bovine mammary gland during involution and lactogenesis. *American Journal of Veterinary Research.* 49 (7): 1112-20

Sai. Urmila, T., Jagapathi Ramayya,P., Santhi Lakshmi,M., Suresh kumar, R.V., and Amaravathi, P. 2021. Histochemical studies on the mammary gland of domestic animals. *Ind. Journal of vet. Anatomy;* 33(2): 113-115.

Takagi, S. and M. Tagawa 1959., A Cytological and Cytochemical study of the Sweat Gland of the Horse. *Jap. J. Physio.*, 09: 153-159.

Uppal S,K,, K.B. Singh., K.S.Roy., D.C.Nauriyal and B.K.Bansal. 1994. Natural defense mechanism against mastitis. A comparative histo-morphology of buffalo and cow teat canal, *Buffalo J.* , 2: 125-131

Weber, A. F. 1977. The bovine mammary gland: Structure and function. *J. Am. Vet. Med. Asso.* 10 (2): 1132 – 1136.