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Organogenesis and Histogenesis of Mammary Gland in the Female Goat (*Capra hircus*)

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ABSTRACT

The present study was carried out on the development of the mammary glands of 42 female foetii at different stages of their development ranging from 4.4 cm to 38.6 cm crown rump length (44-139 days). The mammary bud was observed between 4.4-6.0 cm crown rump length (44-49 days) as a group of undifferentiated epidermal cells below the stratum basale. The formation of primary sprout was initiated at 9.5 cm crown rump length (58 days) and its luminization was observed during 12.5 cm-13.0 cm crown rump length (64-66 days). At proximal end of primary sprout, the secondary sprouts were observed at 68 days and tertiary sprouts at 69-78 days. The teat cistern and gland cistern were observed at the age of 21.7 cm crown rump length (91 days) and were lined by double layer epithelium with superficial tall columnar and basal low cuboidal to flattened cells. At 32.5 cm crown rump length (122 days), the completely luminized streak canal, rosette of Furstenberg and teat canal were clearly noticed. At 38.6 cm crown rump length (139 days), the mammary glands showed high proliferative growth of gland cistern and surrounding ducts.

Key words: Goat, Histogenesis, Mammary gland, Organogenesis

The shifting interest in rearing of sheep and goat at grass root level made revolutionary change in the betterment of the livelihood of poor people and small farmers. The importance of the goat is increasing day by day as its milk is easily digestible and is used for nourishing the young babies (Carroll, 1980).

MATERIALS AND METHODS

The study was conducted on 42 healthy and normal female foetii of non-descript goats ageing from 4.4 cm to 38.6 cm crown rump length (CRL) i.e. (44-139 days) procured from the local abattoirs of the Palanpur and Deesa towns (Dist. Banaskantha, Gujarat). The foetii were fixed in 10% neutral buffered formalin immediately after measuring their CRL. The approximate age of foetus was calculated on the basis of CRL as per the normograph of Lyngset (1971). The foetus ranging from 4.4 cm-7.9 cm CRL were processed as a whole for serial sectioning whereas, caudal parts after umbilicus were separated from the foetii above 7.9 cm CRL and were fixed in 10% buffered formalin. The tissues from the gland were processed for paraffin sectioning to get longitudinal and transverse sections of 8-10 μ thickness and sections were stained with Harris' hematoxylin and eosin (Luna, 1968).

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RESULTS AND DISCUSSION

Mammary buds: The formation of the mammary bud was observed between 4.4 cm to 6.0 cm CRL (44-49 days) stage below the stratum basale of the epidermis. It was comprised of epidermal cells surrounded by concentrically arranged undifferentiated mesenchymal cells with prominent nuclei and more eosinophilic cytoplasm (Fig. 1). Blood capillaries invading the bud were also noticed. At 7.9 cm CRL, the cells of the mammary bud progressed deeper into the dermis. However, Turner (1952) observed the mammary bud in cattle at 2.4-2.5 cm CRL. Whereas, Kon and Cowie (1961) reported the appearance of the mammary bud in cow at 4-8 cm CRL and in sow at 5 cm CRL. Panchal *et al.* (1998 a) observed mammary bud at 1.9-3.0 cm CRL in Surti buffalo.

Primary sprout: At 9.5 cm CRL (58 days), a papilla like teat was discernible on either side of midline in inguinal region between two thighs of female foetus. It was formed by an elevation of epidermal cone surrounding the mammary bud. The cells of the mammary bud extended

deep in the dermis along the length of the teat. They appeared as an elongated cellular cord surrounded by formation of a cyst like empty space around its deeper part. The empty space around the cellular cord was lined by flat cells. These structures differentiated from cells of the mammary bud as developing primary sprout (Fig. 2). Turner (1952) and Kon and Cowie (1961) described that the primary sprout in cattle appeared at 12-15 cm CRL of the foetii. Sonstegard (1973) reported the formation of primary sprout in the cattle and stated that the growth, cell rearrangement and cell death played an important role in the structural differentiation. Panchal *et al*. (1998 a) observed the primary sprout at 12.0 cm CRL in Surti buffalo.

Luminization of primary sprout: Primary sprout sunk deeper into the teat base at 12.5 cm CRL (64 days) that was comprised of stratified cell layers with a lumen inside. The pink mass of degenerated cytoplasm present in the lumen indicated the formation of lumen by disintegration or lysis of cells in the core of the sprout. Cells of the hillock gradually reduced in size and number around the primary sprout. The lumen appeared to be bordered by wavy line of internal cell layers indicating the formation of mucosal folds. Luminized primary sprout developed further deep into the base of the teat at 12.8 cm CRL (65 days). The goat foetus at 13 cm CRL showed that the luminized primary sprout continued its development deep into the future glandular part of udder (Fig. 3). Panchal *et al*. (1998 a) reported in Surti buffalo that luminization progressed down its length at 108 days and primary sprout was completely luminized at 120 days. However, Turner (1952) and Kon and Cowie (1961) reported the luminization of primary sprout at 19 cm CRL in cattle. Turner (1952) also opined that the central cells at the proximal end of primary sprout began to separate forming a lumen. The luminization at this stage might be due to widening of the sprout resulting in the formation of lumen.

Secondary sprouts, tertiary sprouts and cisterns: From proximal end of primary sprout there was appearance of secondary sprouts at 13.8 cm CRL (68 days). There were several secondary sprouts into the surrounding mesenchymal tissue with the lumen developing inside it (Fig. 4). Similar findings were reported in cattle of 19-20 cm CRL (Turner 1952; Kon and Cowie, 1961), Surti buffalo (Panchal *et al*., 1998 b) during 120-126 days (18.5-19.5 cm CRL) and Murrah buffalo (Singh and Roy, 2003) during 90-109 days. The secondary sprouts were budding off at different angles to the proximal end of the primary sprout in various directions and the development of the tertiary sprouts occurred in between 14-17 cm CRL (69-78 days) female foetus. They got luminized and lined by double layered epithelium. These sprouts were anlagen of the duct system of the udder. Branching of the tertiary sprouts was observed between 19.5-21.0 cm CRL (84-89 days) that progressed towards the fat pad.

At 21.7 cm CRL (91 days) well-developed teat canal and gland cistern with their wide lumen were present. Mucosal folds of the teat canal, teat cistern and gland cistern were also noticed. Luminized ducts around the gland cistern lined by stratified epithelium were also well evident. Teat canal, teat cistern as well as gland cistern, were lined by double layer epithelium with superficial tall columnar and basal low cuboidal to flattened cells (Fig. 5). Cross sections of few tubules lined by stratified epithelium and surrounding connective tissue capsule with 2 to 3 layers of fibroblast cells indicated the presence of accessory glands of the teat cistern and gland cistern. Parmar (2003) observed the accessory glands in the form of small lobules in the connective tissue core of the mucosal folds in non-lactating black Bengal goat. The well outlined gland cistern and teat cistern were reported in cattle by Turner (1952) at 29.5 cm CRL and 30 cm CRL, respectively. These structures appeared during later stages than the present study. The dilated portion of the primary sprout developed secondary buds at 16-23 cm CRL stage in cow (Kon and Cowie, 1961). Soon at 23-29 cm CRL stage, the streak canal, teat cistern, gland cistern and secondary ducts were observed leaving the gland cistern and penetrating in various directions into the mesenchyme as anlagen of the duct system.

During the age of 22.0-22.4 cm CRL (92-93 days) in female foetus, no more structures were apparently found developing except, luminized tubules with mucosal

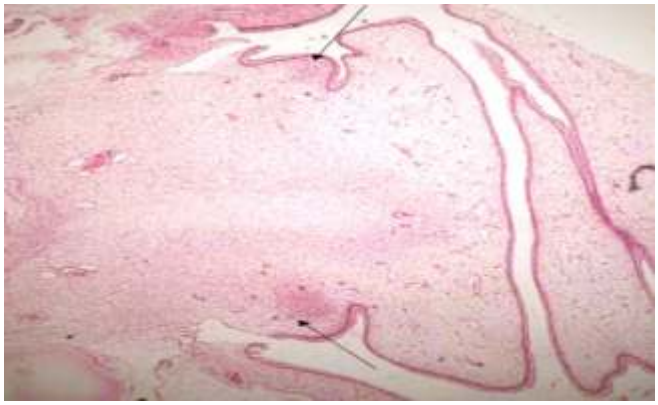

Fig. 1. Development of mammary bud (arrow) at 4.4 cm CRL (44 days). H. & E. × 40

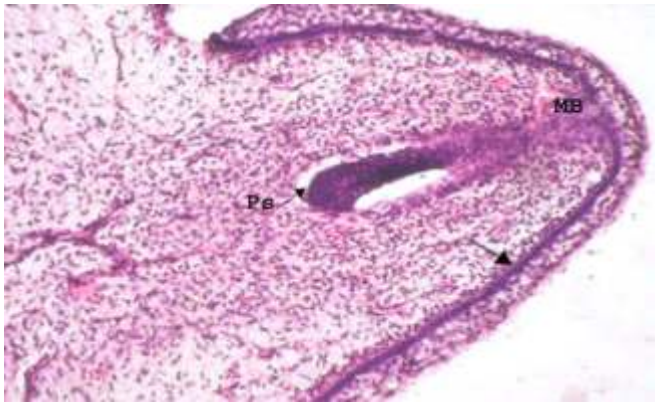

Fig. 2. Primary sprout (Ps), mammary bud (MB) and distinct basal lamina (arrow) supported by cells of epidermis at 9.5 cm CRL (58 days). H. & E. × 200

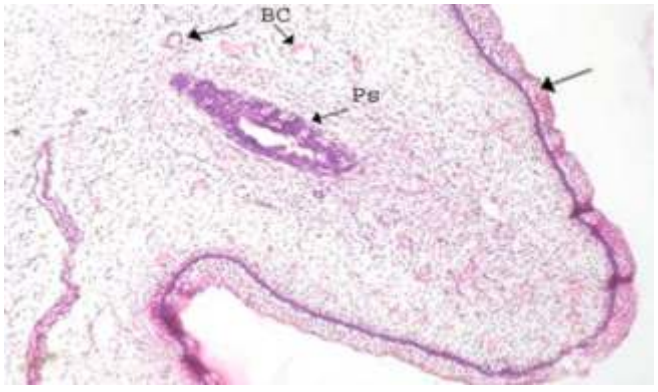

Fig. 3. Well luminized primary sprout (Ps) lined by stratified epithelium, blood capillaries (BC) and stratum corneum (arrow) at 13.0 cm CRL (66 days). H. & E. × 100

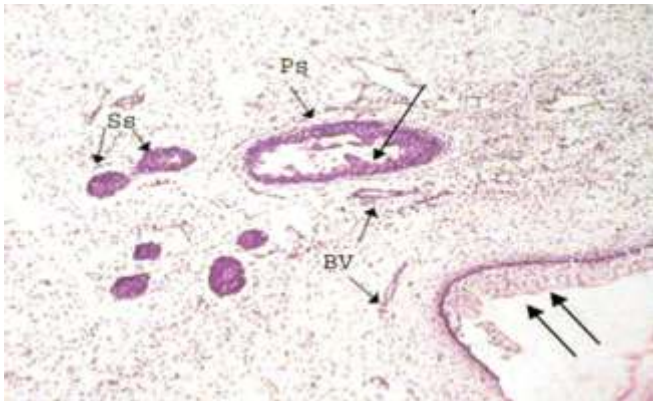

Fig. 4. Luminized primary sprout (Ps), secondary sprouts (Ss), blood vessels (BV), mucosal folds in primary sprout (arrow) and stratum corneum (double arrow) at 13.8 cm CRL (68 days). H. & E. × 100

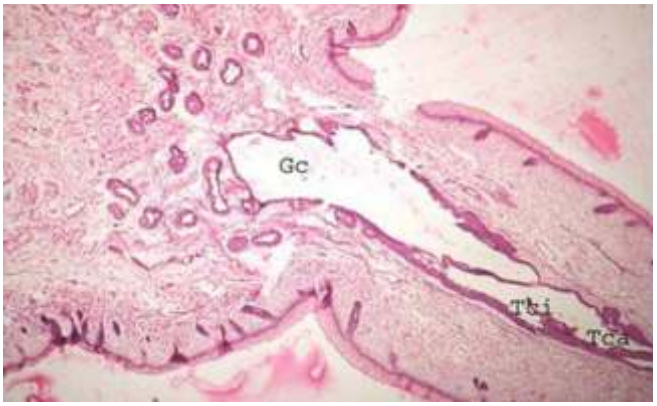

Fig. 5. Teat canal (Tca), teat cistern (Tci) and gland cistern (Gc) at 21.7 cm CRL (91 days). H. & E. × 40

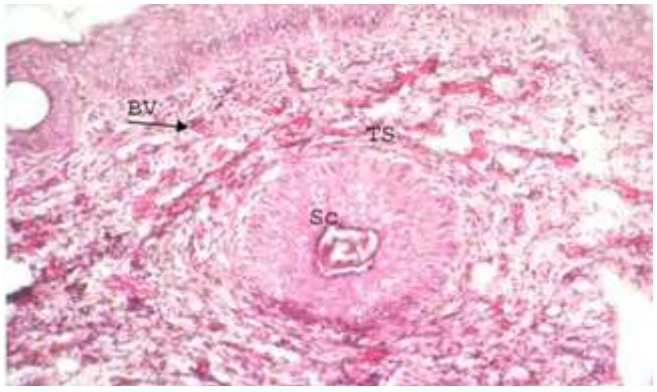

Fig. 6. Streak canal lined by stratified squamous epithelium (Sc), teat sphincter made up of smooth muscle (TS) and blood vessels (BV) around streak canal at 32.5 cm CRL (122 days). H. & E. × 200

folds. At 22.6 cm CRL (94 days), longitudinal folds of mucosa were lined by double layer of epithelium. The top layer of epithelium was covered by fuzy coat of glycocalyx. At the age of 23.4-24.0 cm CRL (95-96 days) widening of teat cistern and gland cistern with increased lumen size and number of mucosal folds were clearly evident. The mammary glands of the goat foetus at age between 25 cm-27 cm CRL (98-104 days), showed teat cistern with wide lumen and increased height of the primary and secondary mucosal folds. The goat foetus at the age of 27-31 cm CRL (104-117 days) did not show any new

structure developed except well developed stroma looking like adult type.

The cross section of the teat at 32.5 cm CRL (122 days) showed completely luminized teat canal with mucosal folds, which were lined by double layer of epithelium. At this age the streak canal was lined by stratified squamous keratinized epithelium filled up with the keratin plug. Sub-epithelial connective tissue surrounded by circularly arranged 3 to 4 layers of smooth muscle indicated the appearance of sphincter muscles (Fig. 6). The rosette of Furstenberg revealed the initiation of the mucosal folds by forming 'S'-shaped luminized wall as reported earlier in cattle (Turner ,1952; Kon and Cowie, 1961) and buffalo (Panchal *et al*., 1998 b; Singh and Roy, 2003). At 38.6 cm CRL (139 days), the mammary gland showed highly proliferative growth of gland cistern and surrounding ducts. All the ducts were luminized, and lined by cuboidal type of epithelium.

For the present study, it can be concluded that the prenatal development of the mammary glands was sluggish, dormant and confined to the area above the teat base near the fat pad. The stroma was fully developed which formed chiefly the massive fat pad. The teat wall was predominantly of connective tissue fibres, particularly collagen fibres and blood vessels. The cellularity was very sparse and it included the fibroblast, erythrocytes and rarely leucocytes and also smooth muscles. The sphincter muscles surrounding the streak canal had not become well developed during late foetal stage and could not be identified definitely.

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