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Comparative Histological Study on Teat of Domestic Animals

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ABSTRACT

The present study was executed at Department of Veterinary Anatomy, College of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India during the period of July, 2020 to October, 2021 to find the possible differences in histology of teat among domestic animals. The study was conducted on teat of domestic animals i.e., 6 adult buffalo, 6 cattle, 15 sheep, 15 goats, 6 dogs and 6 pigs. The wall of the teat consisted of three layers in buffalo, cattle, sheep, goat and pig i.e., outer skin, middle muscular and inner connective tissue layer. But in dog only two layers were present i.e., outer skin and inner fibromuscular layer. Each teat consisted of single teat sinus in buffalo, cattle, sheep and goat, whereas in pig each teat showed two teat sinuses and eleven sinuses in dog. In buffalo and cattle, isolated clusters of glandular structures were seen between the smooth muscle fibers which were absent in sheep, pig and dog. Further, in sheep and goat, accessory glands were noted in the dermis and in middle layer. Sweat glands were noticed only in sheep and goat. In cattle and pig, hair follicles were not distinct and they were surrounded by numerous sebaceous glands. The number of collagen fibers in dermis of teat were more dense in cattle than other domestic animals. Elastic fibers were numerous in dog and moderate in the dermis of teat in buffalo, cattle, sheep and very few in goat.

KEYWORDS: Accessory glands, collagen fibers, sweat glands, teat sinus

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

As the mammary gland is the milk producing organ of the domestic animals, for optimal production, it should be healthy. The primary defence mechanism of the mammary gland is represented structurally in the teat canal which acts as both a physical barrier and a source of antimicrobial substances (Alnakip et al., 2014). The physical barrier is provided by the smooth muscle sphincter which surrounds the teat preventing escape of milk and act as a barricade against the entry of different pathogens by maintaining tight closure (Sudhan et al., 2010; Zecconi et al., 2002; Paulrud, 2005). Apart from the natural protective barriers in the teat end such as keratin produces by teat canal epithelium and teat skin, there is a rosette like structure that comprises numerous antibody producing cells and phagocytes to fight entering antigens from the external environment (Senthilkumar et al., 2020). Teat is the primary route of entry of ascending infections by microorganisms that causes mastitis in mammary gland of ruminants. Teat affections always lead to economic loss in milk yield. Teat canal serves as first line of defense (Modekar and Dhande, 2022). Normally, the healthy teat skin is coated with a protective mantle of fatty acids that slow the growth of bacterial pathogens (Sudhan et al., 2010). Also, the teat duct, lined by stratified squamous epithelium produces keratin, a waxy material lining the teat canal, which traps invading bacteria and hinders the migration of microorganisms into the gland cistern (Alnakip et al., 2014). In cows, at the union of teat cistern and teat canal, the double-layered epithelium of teat cistern, abruptly changed ventrally to stratified squamous epithelium of teat canal. This region is called Furstenberg's rosette (Nickerson and Akers, 2011). In sheep, the epithelium lining the streak canal changed from stratified squamous keratinized to two cell layered cuboidal epithelium on the Furstenberg's rosette. The accessory lactiferous glands were well developed in lactating teats (Subban et al., 2013). The teats of Barbari goats consisted of only one sinus, one teat canal and one teat orifice. The epithelium of streak canal transformed from stratified squamous keratinized into two-cell layered cuboidal epithelium (Singh et al., 2022). In teat of sheep and goat, smooth muscle elements condense towards the streak canal and abundant arteries occur with thick tunica media. The sweat gland have a wide acinous element, which are regarded as a part of the excretory duct. The teat in the goat has smaller and less coiled apocrine sweat glands whereas the ovine teat shows solid coiled apocrine sweat glands (Ludewig, 1998). In dogs, there are no hair follicles in the teat, occasional sebaceous glands may be present. The dermis often has a more prominent superficial dermis consisting of fine collagen fibers, whereas the deep dermis consists of larger collagen fibers interspersed with numerous smooth muscle trabeculae and elastin fibers. The smooth muscle fibers that encircle the upper teat duct form a sphincter. Opening onto the slightly blunted surface of the canine teat are 6 to 22 teat ducts lined by a stratified squamous epithelium (Schulman et al., 2021). The present study was planned to explore the normal histoarchitecture of teat of different domestic animals in view of its importance in understanding the pathology of teat. In goats and pigs, unlike cow and sheep, there are no studies that focus on histological structure of teat. Hence, this study aims to find the possible differences in histology of teat among domestic animals. Further, this also provides information to clinicians and pathologists to understand the normal structure of the teat of different domestic animals.

2. MATERIALS AND METHODS

The present study was executed at Department of Veterinary Anatomy, College of Veterinary Science, Tirupati, Andhra Pradesh, India during the period of July, 2020 to October, 2021. The tissue samples of teat of 6 buffalos, 15 sheep and 15 goats were collected immediately after their slaughter at municipal slaughter house, Proddatur and Tirupati, whereas tissue samples of 6 pigs were collected from AICRP on pigs, Tirupati and tissue samples of 6 dogs were collected under willed animal body programme from Veterinary Clinical Complex, College of Veterinary Science, Proddatur and Tirupati. The tissue samples of 6 cattle were collected from animals brought to department of Veterinary Pathology, College of Veterinary Science, Tirupati and Veterinary dispensaries in Chittoor district for postmortem examination. The experimental protocol was approved by IAEC vide proceeding number.

The tissue samples of teats were taken and washed them thoroughly in running tap water. Then the tissue samples were fixed in 10% Neutral buffered formalin (Singh and Sulochana, 1997). The fixed tissues were subjected to routine tissue processing and paraffin blocks and sections of 4–5 μm thickness were taken and these were stained by the following methods for histomorphological study:

1. Standard Haematoxylin and Eosin method for the routine histological study (Singh and Sulochana, 1997).

2. Masson's Trichrome method for demonstration of collagen fibres (Singh and Sulochana, 1997).

3. Verhoeff's method for elastic fibres (Luna, 1968).

3. RESULTS AND DISCUSSION

In the present study the wall of the teat consisted of three layers in buffalo, cattle, sheep, goat and pig *i.e.,* outer skin, middle muscular and inner connective tissue layers. Lee and Ladds (1975) also described three layers i.e. skin, a muscular layer and a mucous membrane in teat of cows

and Trautmann and Fiebiger (2002) in domestic animals. Whereas, Dyce et al. (2010) and Paul et al. (2013) described that the teat wall consisted of three layers i.e., the outer skin, middle connective tissue layer inter mingled with smooth muscle and the third mucosal layer in ruminants and desi and crossbred cows respectively. Paramasivan et al. (2013) reported that the wall of the teat consisted of epidermis, dermis, subcutaneous tissue and mucous membrane in Madras red sheep. Modekar (2018) noted three layers in teat i.e., outer skin, second fibromuscular, third epithelial lining of teat orifice in sheep and goat. The above observations almost similar to the present study in different domestic animals except dog.

But in dog only two layers were present i.e., outer skin and inner fibromuscular layer unlike in other domestic animals. Silver (1966) also noted two layers similar to the present findings in bitch, contrary to the above, Trautmann and Fiebiger (2002) stated that fibromuscular layer was absent in carnivores.

Each teat consisted of single teat sinus in buffalo, cattle, sheep and goat, whereas in pig each teat showed two teat sinuses and eleven sinuses in dog. (Figures 1, 2, 3, 4) Whereas, Turner (1939) and Silver (1966) noted eight to twenty-two teat ducts in bitch. Dellmann and Eurell (2006) reported a single papillary duct in ruminants, 2 to 3 ducts in pigs, 7 to 16 in dogs. In the present study, the mucosa of teat sinus was lined by stratified cuboidal epithelium in buffalo, sheep, goat, pig and dog and surrounded by thin lamina propria. Similarly, Dellmann and Eurell (2006) in domestic animals, Modekar (2018) in sheep and goat noted stratified cuboidal epithelium in teat sinus. Contrary to present observation, Silver (1966) noted squamous epithelium and Sorenmo et al. (2011) noted bilayered columnar epithelium

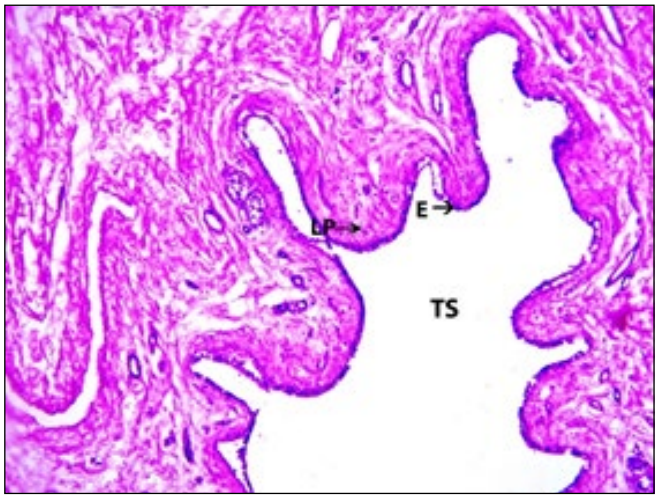

Figure 1: Photomicrograph of teat of buffalo showing teat sinus (TS) with stratified cuboidal epithelium (E) and lamina propria (LP). Haematoxylin and Eosin method×100

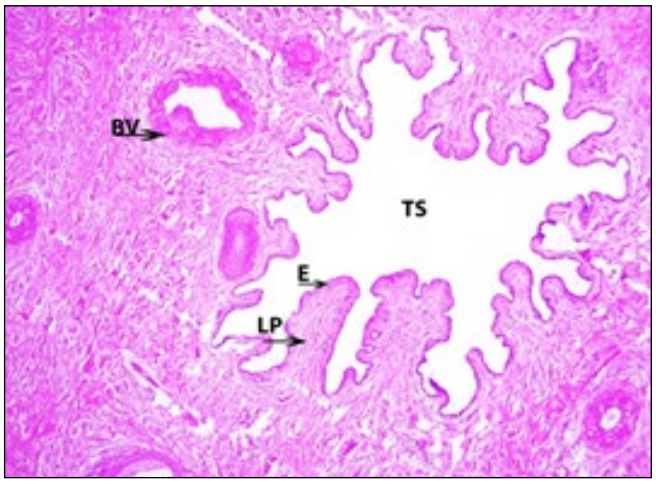

Figure 2: Photomicrograph of teat of goat showing teat sinus (TS) with stratified cuboidal epithelium (E) and lamina propria (LP). BV-Blood vessel. Haematoxylin and Eosin method×40

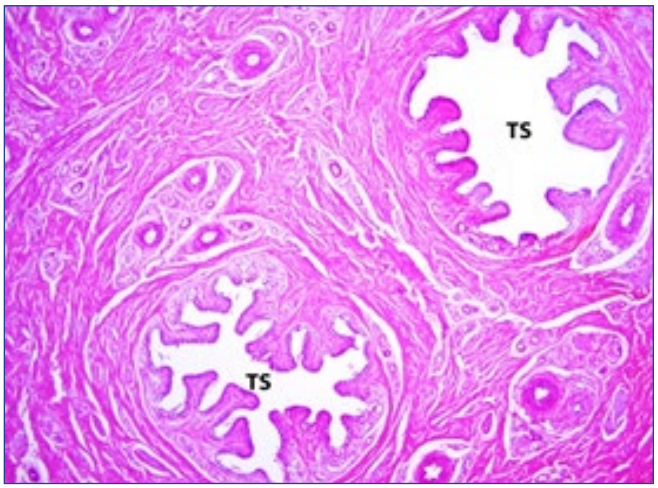

Figure 3: Photomicrograph of teat of pig showing two teat sinuses (TS) with stratified cuboidal epithelium and lamina propria. Haematoxylin and Eosin method×40

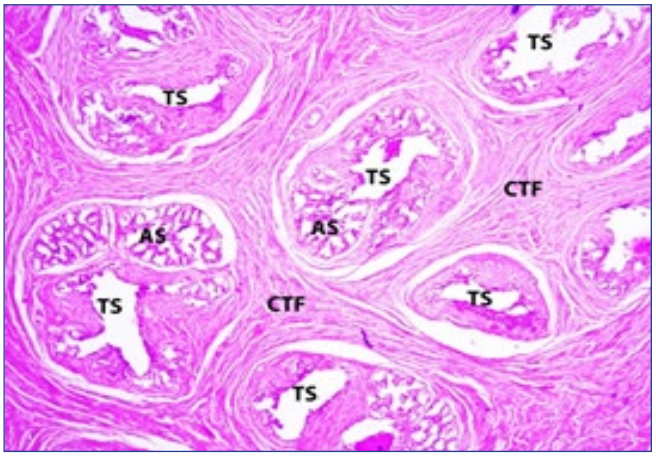

Figure 4: Photomicrograph of teat of dog showing two teat sinuses (TS) surrounded by accessory sinuses (AS). CTF – Connective tissue fibers. Haematoxylin and Eosin method×40

in teat sinus of canine. In cattle, the teat sinus was lined by stratified squamous non-keratinized epithelium unlike other domestic animals, but Paul et al. (2013) noted stratified cornified squamous epithelium in desi and crossbred cows.

In the present study, in dog, each teat sinus was surrounded by accessory sinuses, which were grouped together by a continuous layer of connective tissue. Each group consisted of accessory sinuses and one principal lactiferous sinus. The adjacent lactiferous sinus separated from each other by large amount of connective tissue fibers, hence these fibers were very distinct and present in a circular manner (Figure 4).

The dermis consisted of dense irregular connective tissue with blood vessels, hair follicles and associated sebaceous and sweat glands. The middle layer comprised of connective tissue, smooth muscle fibers and numerous blood vessels. Venzke (1940) stated that the muscle fibres were arranged in all directions and supported by a connective tissue framework and interspersed with a vascular network in teat of bovine similar to the present observation in buffalo. The innermost layer also contained loose connective tissue with small clusters of capillaries in buffalo, cattle, sheep, goat and pig.

The hair follicles and sebaceous glands were noticed in dermis of buffalo, sheep and goat (Figure 5). However, their number was more in sheep and goat than that of buffalo. Sweat glands were noticed only in sheep and goat but they were comparatively larger in size in sheep (Figure 6). Dellmann and Eurell (2006) in sheep and goats, Paramasivan et al. (2013) in Madras red sheep, Modekar (2018) in sheep and goat noted fine hairs, sweat and sebaceous glands.

In cattle and pig, hair follicles were not distinct and they were surrounded by numerous sebaceous glands. Contrary

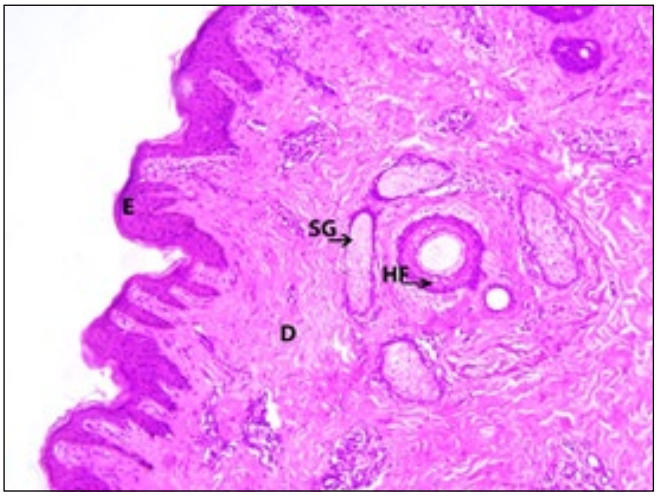

Figure 5: Photomicrograph of teat of goat showing epidermis (E), dermis (D), Hair follicle (HF) and Sebaceous glands (SG). Haematoxylin and Eosin method×100

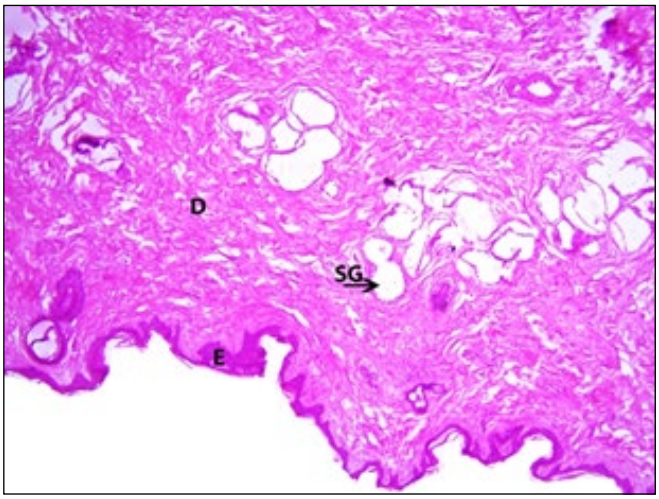

Figure 6: Photomicrograph of teat of sheep showing epidermis (E), dermis (D), Hair follicle (HF) and Sweat glands (SG). Haematoxylin and Eosin method×40

to the present observation, Lee and Ladds (1975) in cows, Trautmann and Fiebiger (2002) and Dellmann and Eurell (2006) in cow and sow stated that the dermis of the teat was devoid of hair follicles, sweat or sebaceous glands. In dog, the dermis consisted of large number of connective tissue fibers with intervening smooth muscle fibers. The dermis also consisted of hair follicles and distinct sebaceous glands. Similar findings were also noted by Trautmann and Fiebiger (2002) in bitch.

Smooth muscle fibers were arranged longitudinally in the wall of teat in the mammary gland of domestic animals. Lee and Ladds (1975) stated that the superficial bundles of smooth muscle are largely longitudinal in cow. Whereas, Dellmann and Eurell (2006) reported that that the smooth muscle bundles oriented parallel to the long axis of the teat in domestic animals. Further, in buffalo and cattle, isolated clusters of glandular structures were seen between the smooth muscle fibers. These structures were more in buffalo but they were absent in sheep, pig and dog (Figure 7). Further, in sheep and goat, accessory glands were noted in the dermis and in middle layer. Similarly, Smallwood (1993) also noted similar glands in ewe and named these glands as scent glands. The presence of these accessory glands in sheep and goat attributed that the secretions of these glands may produce a unique marker scent, which help the sheep and goats to identify their own lambs and kids respectively.

The number of collagen fibers in dermis of teat were more dense in cattle than other domestic animals i.e., in buffalo and sheep than goat (Figure 8) Inner layer contained moderate number of collagen fibers. In pig, they were uniformly distributed throughout the teat and were numerous and more dense in dog. Further, collagen fibers

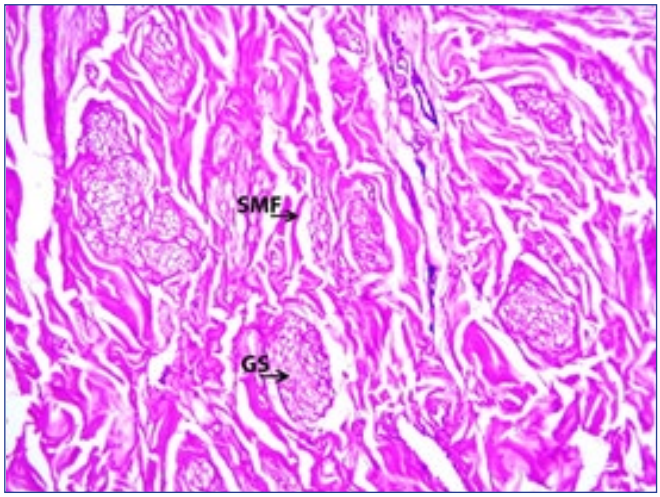

Figure 7: Photomicrograph of teat of buffalo showing glandular structures (GS) and smooth muscle fibers (SMF) in the middle layer. Haematoxylin and Eosin method×100

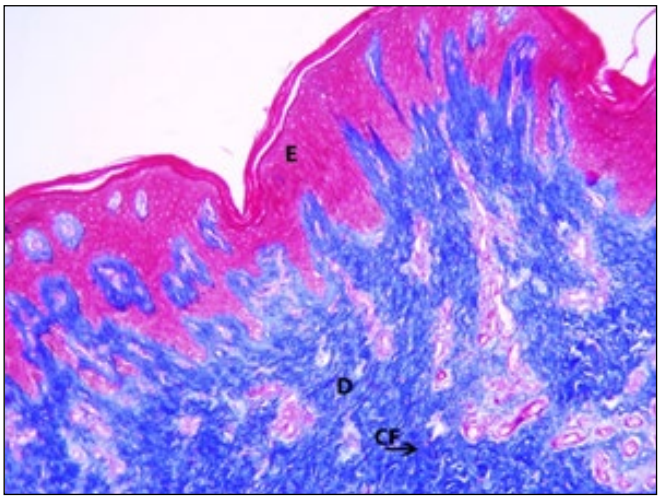

Figure 8: Photomicrograph of teat of cattle showing Epidermis (E) and collagen fibers (CF) in the dermis (D). Masson's Trichrome method×100

around the teat sinus were more in sheep, buffalo, pig and dog, but fibers were fine and thin in cattle and goat.

Elastic fibers were numerous in dog (Figure 9) and moderate in the dermis of teat in buffalo, cattle, sheep and very few in goat. Middle layer also showed elastic fibers in buffalo, cattle and goat and very few fibers in sheep. But inner layer contained few elastic fibers in cattle and absent in buffalo, sheep, goat and pig. In teat elastic fibers were less wavy in buffalo, cattle, sheep, goat and dog and almost straight in pig. Lee and Ladds (1975) noted bundles of collagen and elastic fibres in muscular layer of the teat wall in cow, whereas Trautmann and Fiebiger (2002) noted collagen and elastic fibers in the mucosa of the teat wall in domestic animals.

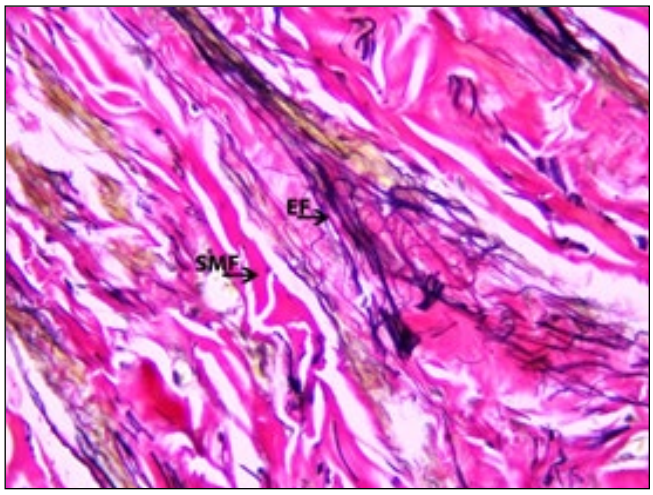

Figure 9: Photomicrograph of teat of dog showing elastic fibers (EF) and smooth fibers (SMF) in inner layer. Verhoeff's method×400

4. CONCLUSION

The wall of teat consisted of three layers in buffalo, cattle, sheep, goat and pig i.e., outer skin, middle muscular and inner connective tissue layer. But in dog only two layers were present i.e., outer skin and inner fibromuscular layer. Each teat consisted of single teat sinus in buffalo, cattle, sheep and goat, whereas in pig each teat showed two teat sinuses and eleven sinuses in dog. The hair follicles and sebaceous glands were noticed in dermis of buffalo, sheep, goat and dog.

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