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Comparative morphometric overview between the two milk systems of the mammary gland of one humped camel (Camelus dromedarius).

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ABSTRACT

The present study aimed to spot the light on the differences between the two milk systems of each quarter of the she camels' udder. Twelve mammary glands of lactating she camels (in mid-lactation) were dissected from the animals immediately after slaughter and prepared for different anatomical, histological, radiographical and ultrasonographical evaluations. The udder of the she camel consists of four quarters; each has two separate milk systems without external demarcation between them. The fluid produced from the cranial system was milky, while that of the caudal one was watery. The streak canal, teat cistern and the gland cistern of the cranial system was wider and with thicker wall than the caudal one. The size of the parenchymal tissue of the cranial system was larger. The number of Furstenberg's rosettes were larger in the caudal system. The number of the alveoli to the interstitial connective tissue were greater and the glands were more active in the cranial system in comparison to the caudal system where the number of the alveoli were smaller and the glands were less active.

Keywords: Dromedary camel; udder anatomy; ultrasound; x- ray.

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INTRODUCTION

Dromedary camel is widely distributed in the desert of the Arabian countries. It is characterized by its ability to tolerate greater than 30% water loss, which is generally impossible for other mammals. The camels' milk is rich with vitamin C and has some therapeutic uses (Khanna 1986; Al haj and Al Kanhal 2010). Some literatures provide a suitable data on the structure of the Dromedaries' camel udder (Kausar et al. 2001; Eisa et al. 2010; Ishag et al. 2011; Atigui et al. 2016). None of these gives attention to the differences between the cranial and caudal systems of each quarter.

Contrast radiography is valuable tool for study the normal anatomical features of the teat and mammary gland in the Dromedary camel (Saleh et al. 1971; Nosier 1973).

Ultrasonography is a rapid, effective and noninvasive diagnostic technique for examination of mammary gland and teats in different animals (Abshenas et al. 2007; Hassan et al. 2016).

MATERIALS AND METHODS

The present study was conducted on udders of twelve adults, apparently healthy, lactating Dromedary she camels during the mid-lactation.

Gross anatomical study:

Four udders were immediately dissected of the carcass after slaughter. Two were freshly dissected and the following measurements were taken: teat diameter (measured in the middle of the teat using a Vernier caliper), teat length (the distance from the base to the orifice of teat), udder depth (the distance between the udder attachment and the base of the teats), and udder horizontal circumference was measured from the median suspensory ligament between the front quarters till the median point between the rear quarters for both udder halves. Two udders cast were prepared by injection from the teat orifices (the cranial and caudal orifices with different color) of Kem Epoxy 150 then allowed to dry for two days in room temperature, then followed by Hcl 98% maceration until all soft tissue removed, finally rinsed with water and left to dry.

Ultrasonographical and contrast radiographical studies:

Ultrasonography and contrast radiography were conducted in each quarter of four apparently normal udders of she-camel after isolation from carcass.

The ultrasonographic procedures were performed on two udders using a Toshiba medical company ultrasound system, using multi frequency probe 8-10 MHz linear probe with displayed depth of 4-6 mm. Sagittal and transverse scans were taken.

The contrast medium (Urographin®) was injected in dosage of 10 ml in each orifice of the udder quarter (in two udders) through cannula 22G. Lateral and anterior posterior views of each quarter were done. Radiographic examination was taken by x ray machine (Fischer, Germany). The radiographic setting factors were 48 kvp, 2 mAs and 50 cm as focus film distance.

Histological study:

The samples (teat orifice, teat cistern, gland cistern and parenchyma) of four fresh udders were immediately dissected out and sectioned into small pieces. the specimens were fixed in neutral buffer formalin 10%. The blocks dehydrated in ethanol, cleared by xylene and embedded in paraffin wax. Serial sections were cut at a thickness of 5-6 µm using rotatory-microtome and stained with Hematoxylin and Eosin (H&E) to assess the morphology of the different parts of the milk system (Bancroft and Gamble 2008).

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RESULTS

Gross anatomy:

The mammary gland of the dromedary camel cow consisted of four quarters; two front and two rear quarters (Fig 1). Each quarter has single teat with double teat orifices; cranial and caudal (Fig 2/ A& B).

The rear teat length and diameter (7.23 ± 0.12 & 5.11 ± 0.13 cm.) was larger than that of the front teat (6.44 ± 0.17 & 4.19 ±0.10 cm.).

The udder depth was (34.11± 0.80 cm.), while the udder circumference was (89.92 ± 9.12 cm.).

The produced fluids of the two milk systems showed variation in color and consistency. The fluid from the cranial system was milky, while that the caudal system was watery. The amount of the produced fluid was larger from the cranial system.

The lumen of the cranial teat cistern was larger in diameter than the caudal one and with thicker wall (Fig 3, 4/ A& B).

The gland cistern of the cranial milk system was divided by mucosal folds into different chambers (Fig 5/ D) in contrast with the caudal gland cistern where the folds were absent. The cavity of the cranial gland cistern was wider in diameter from that of the caudal system (Fig 6/ A& B).

The parenchyma of the cranial system showed increased size in comparison of the caudal parenchymal system (Fig 4/ C& D).

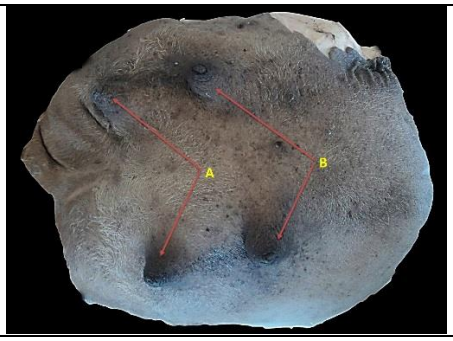

Fig 1: Udder of the lactating camel cow A. front quarters, B. rear quarters.

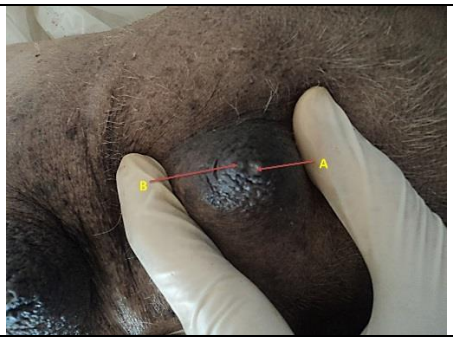

Fig 2: Teat of the lactating camel cow A. cranial teat orifice, B. caudal teat orifice.

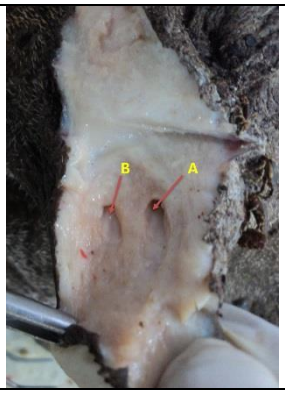

Fig 3: Teat cistern (opened) of the udder of the lactating camel cow A. cranial teat cistern, B. caudal teat cistern.

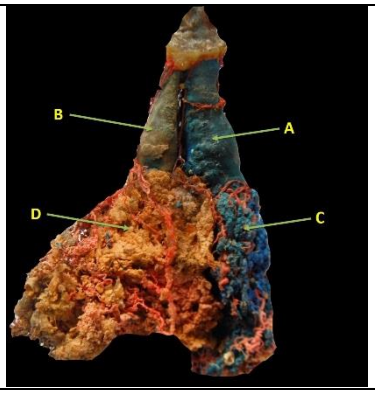

Fig 4: Cast of one quarter of the lactating camel cow A. cranial teat cistern, B. caudal teat cistern, C. cranial gland parenchyma, D. caudal gland parenchyma.

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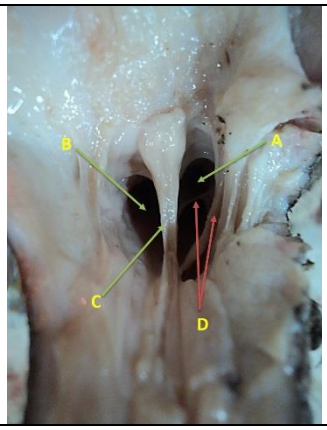

Fig 5: Gland cisterns of one quarter of the lactating camel cow A. cranial gland cistern lumen, B. caudal gland cistern lumen, C. inter cisternal wall, D. mucosal folds.

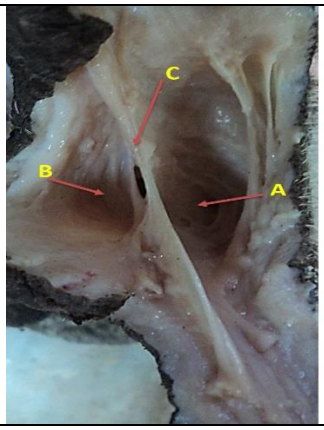

Fig 6: Gland cisterns of one quarter of the lactating camel cow A. cranial gland cistern lumen, B. caudal gland cistern lumen, C. inter cisternal wall.

Contrast radiographic findings:

Contrast radiography showed that each quarter consisted of two separate teat canals, teat cisterns and gland cisterns which detected in anterior posterior views. There was obvious variation in thickness between the two systems of each quarter; the cranial system was larger than the caudal one (Fig 7).

Ultrasonography findings:

In sagittal scan, the teat was identified as cone shaped structure and the teat wall was consisted of 3 layers; hyperechoic outer layer, thick hypoechoic middle layer and a more echogenic inner layer. The teat canal appeared as anechoic line ended with small rounded anechoic teat cistern. Each teat cistern opened into gland cistern which appeared as large round anechoic structure (Fig 8).

The transcutaneous ultrasound of camel mammary gland revealed two distinct gland cisterns. The cranial one is larger than the caudal, which detected in both sagittal (Fig 9) and transverse scans (Fig 10). The lactiferous duct appeared as anechoic branching structure without echogenic wall within hypoechoic parenchyma (Fig 11).

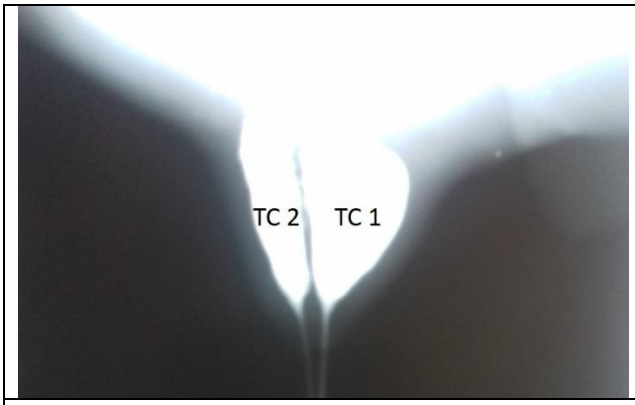

Fig 7: Anterior posterior contrast radiography showing that each quarter had two separate teat canal, teat cistern and gland cistern. There's variation in size between the two compartment of the same quarter. cranial teat cistern (TC 1), caudal teat cistern (TC 2).

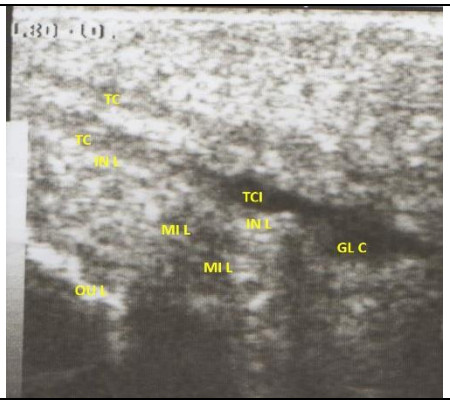

Fig 8: Sagittal scan of teat showing three layers of the teat wall can be identified. OUL (outer layer), MIL (middle layer) and INL (inner layer); teat cistern (TCI) and gland cistern (GLC). The sonogram was obtained with 10 MHz linear array transducer.

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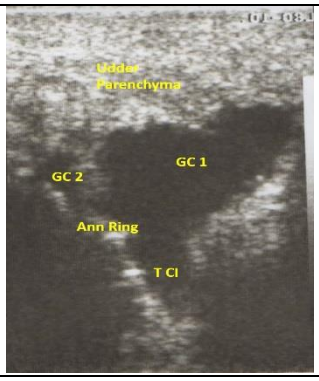

Fig 9: Sagittal scan showing hyperechoic annular ring and the variation in size between the two gland cisternae in the same quarter. cranial gland cistern (GC 1), caudal gland cistern (GC 2), annular ring (Ann Ring), teat cistern (TCI).

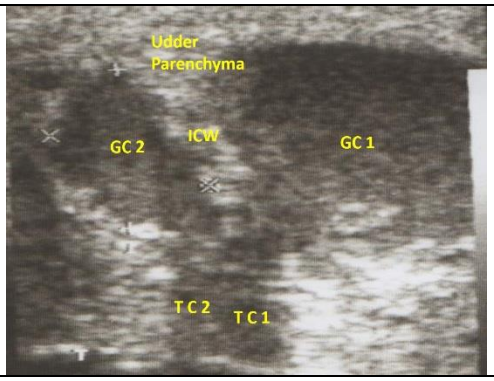

Fig 10: Transverse scan showing the variation in size between two gland cisterns in the same quarter. cranial gland cistern (GC 1), caudal gland cistern (GC 2), annular ring (Ann Ring), inter-cisternal wall (ICW), cranial teat cistern (TC 1), caudal teat cistern (TC 2).

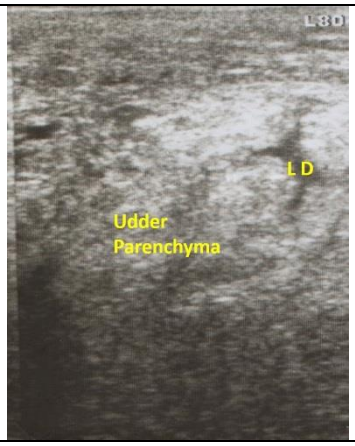

Fig 11: Transverse scan showed branched lactiferous duct (LD) within hypoechoic udder parenchyma.

Histological findings:

Teat:

The microscopic examination of the teat revealed that, the lining epithelium was of stratified squamous keratinized in the both systems (Fig 12/ A). The lumen of the streak canal of the cranial system was wider than the caudal system (Fig 12/ B). The submucosa of the cranial streak canal was thicker than the caudal streak canal (Fig 12/ C). The number of Furstenberg's Rosettes were larger in the caudal system (14 folds) than the cranial system (10 folds). (Fig 12/ D).

The skin of the teat of the cranial system was thicker with abundant dermis than that of the caudal system. (Fig 13/ A). The epidermis was of stratified squamous keratinized in the both systems (Fig 13/ B).

Gland cistern:

The histological findings of the gland cisterns of both milk systems showed that, the lumen of the cranial gland cistern was wider than the caudal cistern (Fig 14, 15/ A). The lining mucosa of the cranial gland cistern was of pseudo stratified columnar epithelium, while those of the caudal cistern was of simple cuboidal epithelium (Fig 14, 15/ B). The submucosa of cranial gland cistern presented a group of alveoli (Fig 14, 15/ C) which was not found in the caudal gland cistern. There were aggregations of the dense irregular connective

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tissue in the submucosa of the cranial gland cistern, which was of less amount in the caudal gland cistern (Fig 14, 15/ D).

Glandular parenchyma:

The parenchyma of the glandular tissue of lactating mammary gland of dromedaries she camel showed arrangement of lobules in between the interlobular connective tissue (Fig 16/ A). Each lobule presents a group of alveoli in between the inter-alveolar connective tissue (Fig 16/ B). The lining mucosa of the alveoli was of simple columnar epithelium in both milk systems (Fig 16/ C). The number of alveoli to the connective tissue was larger in the cranial system than the caudal one (Fig 16). The glands of the cranial system were more active (contains secretions) than the caudal system which was less active (Fig 16).

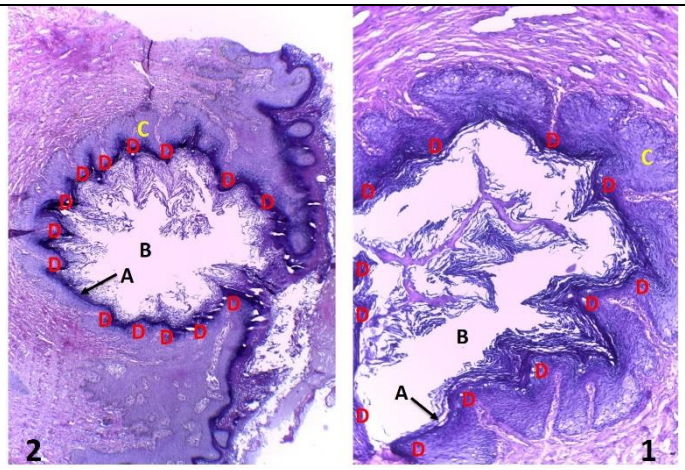

Fig 12: Two streak canals of the same teat of lactating she camel showing variation in luminal width, the number of Furstenberg's Rosettes and thickness of lining mucosa. 1. Cranial system, 2. Caudal system, A. streak canal lumen, B. streak canal epithelium (stratified squamous keratinized epithelium), C. Furstenberg's Rosettes. (H & E, X100).

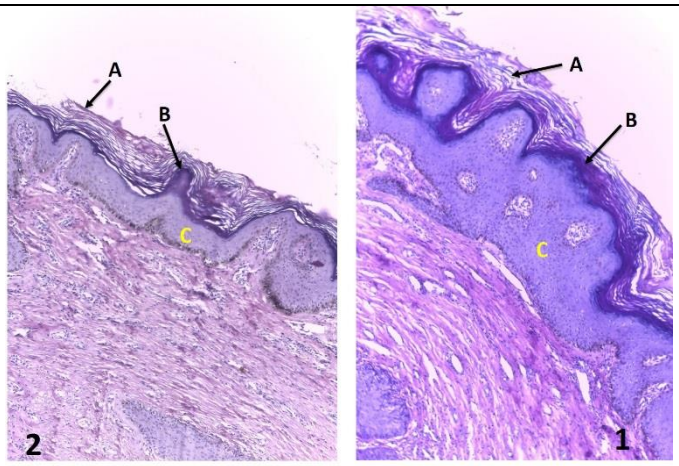

Fig 13: Skin of the teat of the two milk systems of lactating she camel showing variation in thickness. 1. Cranial system, 2. Caudal system, A. Keratin layer, B. Epidermis (stratified squamous keratinized epithelium), C. Dermis. (H & E, X100).

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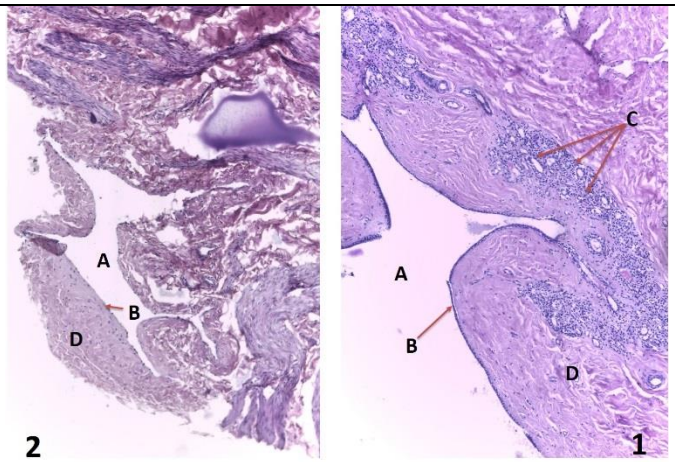

Fig 14: Two gland cisterns of lactating she camel showing variation in lumen and lining mucosa of the two milk systems. 1. Cranial system, 2. Caudal system, A. Gland cistern lumen, B. lining epithelium, C. alveolar tissue, D. Connective tissue (H & E, X100).

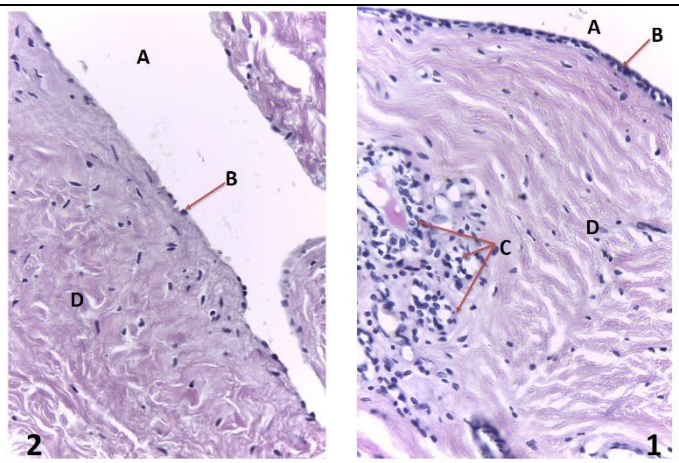

Fig 15: Two gland cisterns of lactating she camel showing variation in lumen and lining mucosa of the two milk systems. 1. Cranial system, 2. Caudal system, A. Gland cistern lumen, B. lining epithelium, C. alveolar tissue, D. Connective tissue (H & E, X400).

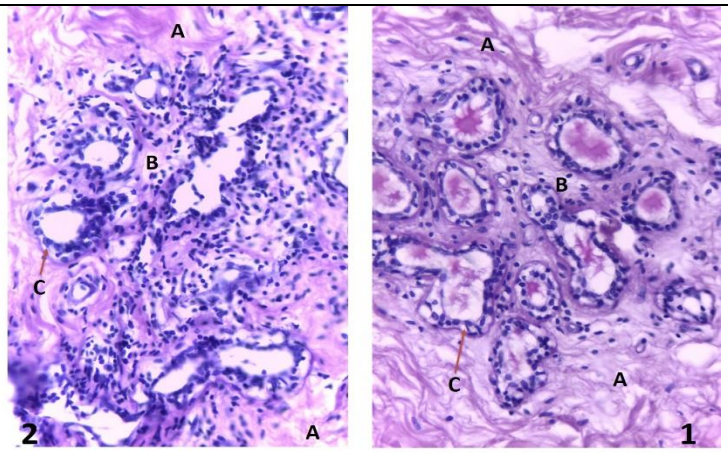

Fig 16: Two parenchyma of lactating she camel showing variation in activity and number of the glandular tissue. 1. Cranial system, 2. Caudal system, A. interlobular connective tissue, B. inter-alveolar connective tissue. C. alveolar epithelium (simple columnar epithelium), (H & E, X400).

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CONCLUSION

The anatomical, histological and imaging studies of the udder of the dromedary's camel stated that, each quarter composed of two systems of milk production differs in structure from each other. The differences between the two milk systems of each quarter may refer to the adaptation to water deprivation or the medicinal use of the camels' milk as well as to physiological rest by changing the systems between the successive births.

RECOMMENDATIONS

To declare the causes behind this variation between the two milk systems, a complete chemical analysis of the produced fluid should be repeated for more than two to three births of the same animal combined by gross and microscopic anatomical study.

DISCUSSION

The four quarters of the dromedary camel udder in this study was reported by (Kausar et al. 2001; Eisa et al. 2010; Ishag et al. 2011; Atigui et al. 2016; Ayadi et al. 2016).

There was a difference in length and diameter between the rear and front teats, this was in accordance with (Eisa, 2006; Eisa and Hassabo 2009; Atigui et al. 2016; Ayadi et al. 2016). This was disagreed with (Saleh et al. 1971; Kausar et al. 2001) who found that there are no considerable variations between the teats.

The radiological findings of this study were in accordance with (Fowler 1998) in the south American camel where the udder is composed of eight (8) separate glands; each quarter divided into two gland system.

The ultrasound investigation of the teat revealed two separate teat canals connected to two teat cisterns separated by inter-cisternal wall, these agreed with (Abshenas et al. 2007; Atigui et al. 2016).

The three layers forming the wall of the teat found by ultrasound examination in this study was mentioned by (Abshenas et al. 2007) in the same animal.

The lactiferous duct appeared as anechoic branching structure without echogenic wall within hypoechoic parenchyma, this agreed with (Abshenas et al. 2007 in she camel and Cartee et al. 1986 in cows)

In accordance with (Kausar et al. 2001) there was two streak canals in each teat, lined by stratified squamous epithelium. The lumen dimeter was decreased in the non-lactating animals, which was like that found in the caudal system in our study. This result may refer to the inactivity of the caudal system.

The number of Furstenberg's Rosette was like that recorded by (Kausar et al. 2001 in she camel and Nickerson 1994 in buffalo).

The histological findings of the glandular tissue showed a group of lobules separated by interlobular connective tissue; each lobule consists of alveolar structures and inter-alveolar connective tissue, these agreed with (Nosier 1973) in the same animal.

The number of alveoli per lobule decreased in the caudal system, these results recorded by (Nosier 1973; Banks 1993; Kausar et al. 2001) in the whole udder of non-lactating animals. This may indicate the low activity of the caudal system.

The lining epithelium of the alveoli was of columnar epithelium, this was in accordance with the results of (Nosier 1973; Kausar et al. 2001) in lactating she camel. They mentioned that the lining epithelium of alveoli was flattened in non-lactating camel cow which does not found in this study.

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