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# Gross morphometrical studies of mammary gland in Kosali cow

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## Abstract
The present study was conducted on mammary glands of thirty six lactating and non-lactating Kosali cows divided into early, mid and late stages respectively. In general, the Kosali cows are reared on grazing and offered paddy straw only. While in urban and semi urban areas, this breed is rarely available, where it is reared in semi intensive farming system offering dry fodder along with little concentrates. This breed is preferred in rural areas of Chhattisgarh due to its adaptability and heat tolerance as well as disease resistance. The mammary gland is one of the few body organs that undergo repeated cycles of structural development, functional differentiation, and regression. Growth and development of the mammary gland (mammogenesis) occur through a series of phases that are intimately associated with the specific physiology of the animal's growth and reproduction. All the gross morphometrical parameters like circumference of the udder at the base, length and width of teat etc. were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cows. Further, they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages. The percentage decrease in all parameters between early and mid-stages were higher as compared to mid and late stages in lactating as well as non-lactating Kosali cow.

**Keywords:** Gross morphometry, mammary gland, Kosali cow

## Introduction
Kosali breed has been registered as the 36th breed of cattle in the year 2012 (Accession No.: India_Cattle_2600_Kosali_03036) and it is the first breed from the Chhattisgarh. Its breeding tract lies in between 19.8 to 22.7 degrees north altitude and 80.3 to 83.6 degrees east longitude. Kosali breed is mainly concentrated in the Central Plain region (15 districts) of the CG state with 31.32 lakh estimated population and spread in 68.49 lakh hectare geographical area. More than total 60% cattle are concentrated in the central plains of the CG state (Jain *et al.*, 2017, 2018) [5, 6]. The average milk yield per lactation is 210 kg with an average milk fat % of 3.5. The lactation yield ranges from 200 to 250 kg with average fat % from 3 to 4.5 (Sahu *et al.*, 2018) [12].

The secretion of mammary gland provides passive immunity and nutrition to young ones, which enables them to survive in the new environment. It is also a nutritive support to human being at any age. It is the most important livestock product followed by egg, meat and fish. It is also the second largest agricultural commodity next only to rice (Chaurasia *et al.*, 2018) [3]. Nature and amount of secretory material in the alveolar lumen reflects the physiological status of mammary gland parenchyma (alveoli and duct) and the lactation stage. Alteration of the functional and physiological status is the basis of continuous and constant milk secretion assurance. Further, there is a positive correlation between glandular parenchyma and milk production (Chaurasia *et al.*, 2019) [2].

The gross morphological study of mammary gland at different stages of lactation is very important to understand normal structure, to increase the background information in the physiology and reproduction, medicine, livestock production and management, genetics and pathology and to understand the mechanism of lactogenesis, galactopoisis and involution. Due to scarcity of literature for this newly established Kosali breed of cattle, present experiment has been undertaken to establish fundamental data on mammary gland of this breed. The outcome of this experiment will help to assess the milk production potential of this breed.

## Materials and Methods

The gross morphological studies were conducted at Department of Veterinary Anatomy, College of Veterinary Science & A.H., Anjora, Durg (C.G.), Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg (C.G.). The experiment was conducted on mammary gland of thirty six Kosali cows procured from central plain region of the Chhattisgarh. The samples were collected from animals immediately after death from farmers house, state veterinary hospitals etc. The different parameters of udder, teats and mammary lymph nodes were recorded with the help of Vernier calipers, thread and measuring tape. The data obtained from various parameters was analyzed by One Way ANNOVA and Independent Sample T-Test statistical methods (Snedecor and Cochran, 1994) [14]. The mammary glands were categorized into two groups (eighteen each) as lactating and no lactating by ascertaining the status of mammary gland for stage of lactation and dry period as below.

**Group I. Lactating stage - 18**

- Early lactating stage (1-90 days) – 6.
- Mid lactating stage (Above 90-150 days) – 6.
- Late lactating stage (Above 150-210 days) – 6.

**Group II. Nonlactating/ Non-pregnant stage – 18.**

- Early nonlactating/nonpregnant stage (Date of dry - 60 days) – 6.
- Mid nonlactating/nonpregnant stage (Above 60-150 days) – 6.
- Late nonlactating/nonpregnant stage (More than 150 days) – 6.

## Results and Discussion

The mammary glands of Kosali cows were arranged in two rows on either side of the median line of the body in the inguinal region. There were two normal functional glands (the quarters) on each side. There was no definite septum between the front and rear quarters. The right and left halves of the udder were separated by a median longitudinal intermammary groove or sulcus intermammaricus. The skin over the udder was usually of fine texture and covered with hair, except on the teats (Fig. 1). These characters were similar to the findings of Turner (1952) [15], Sisson (1975) [13], Jacobson (1996) [4], Banerjee (1998) [1], Riservati (2009) [11], Nickerson and Akers (2011) [7], Pandey, *et al.* (2018) [9] and Qureshi (2019) [10].

The thickness of skin at the base of udder was significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cows and were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cows. Further, the skin thickness was significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages (Table 1). The percentage decrease in the thickness of skin at the base of udder between early and mid-stages was higher as compared to mid and late stages in lactating as well as non-lactating Kosali cows (Table 2).

Composition and disposition of lateral and median suspensory ligaments of Kosali cow (Fig. 2) were similar to the earlier reports of Turner (1952) [15], Sisson (1975) [13], Banerjee (1998) [1], Riservati (2009) [11], Nickerson and Akers (2011) [7] and Pandey *et al.* (2018) [9]. The length of median suspensory ligament were significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cows and were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cows. Further, they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages (Table 1). The percentage decrease in the length of median suspensory ligament between early and mid-stages were higher as compared between mid and late stages in lactating as well as non-lactating Kosali cow (Table 2).

The Gland Cistern and teat cistern of Kosali cow (Fig. 3) were in accordance with the findings of Turner (1952) [15], Sisson (1975) [13], Jacobson (1996) [4], Banerjee (1998) [1], Panchal and Vyas (2006) [8], Riservati (2009) [11], Nickerson and Akers (2011) [7] and Pandey, *et al.* (2018) [9]. The maximum diameter of gland cistern and maximum length of teat cistern were significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cows and were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cows. Further, they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages (Table 1). The percentage decrease in the maximum diameter of gland cistern and maximum length of teat cistern between early and mid-stages were higher as compared between mid and late stages in lactating as well as non-lactating Kosali cow (Table 2).

Streak canal (papillary duct) of Kosali cow was the only orifice of the gland between internal milk secretory system and the external environment. The patency of the canal decreased and streak canal length increased from early to late stage of lactation. Furstenberg's rosettes were mucosal folds of the streak canal lining at the internal end of the canal. Furstenberg's rosette was involved in the local defence against mastitis. The teat canal was also provided with keratin or keratin like substances which acts as a barrier for the pathogenic bacteria. During dry period (non-lactating period), the keratin plug effectively sealed the canal (Fig. 3). These statements were confirmed by Turner (1952) [15], Sisson (1975) [13], Jacobson (1996) [4], Banerjee (1998) [1], Panchal and Vyas (2006) [8], Riservati (2009) [11], Nickerson and Akers (2011) [7], Pandey, *et al.* (2018) [9] and Qureshi (2019) [10].

Circumference of udder at the base, maximum diameter of udder at the base, minimum diameter of udder at the base, maximum length of right quarters of udder at the base, maximum length of left quarters of udder at the base, maximum width of right quarters of udder at the base and maximum width of left quarters of udder at the base were significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cow and were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cow, further they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages. Maximum length and width of left quarters at the base of the udder were slightly higher as compared to right quarters (Table 1). The percentage decrease in the above parameters between early and mid-stages were higher as compared between mid and late stages in lactating as well as non-lactating Kosali cow (Table 2).

The teats of Kosali cow was cylindrical in shape (Fig. 1). In present study, one to two supernumerary teats was found. Length of right front quarter teat, length of left front quarter teat, length of right rear quarter teat, length of left rear quarter teat, diameter of right front teat at base, diameter of right front teat at middle, diameter of right front teat near the tip, diameter of left front teat at base, diameter of left front teat at

middle, diameter of left front teat near the tip, diameter of right rear teat at base, diameter of right rear teat at middle, diameter of right rear teat near the tip, diameter of left rear teat at base, diameter of left rear teat at middle, diameter of left rear teat near the tip, distance between front quarter teats at base, distance between rear quarter teats at base, distance between right front and rear quarter teats at base and distance between left front and rear quarter teats at base were significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cow and were significantly higher in early dry period as compared to mid and late periods in non-lactating Kosali cow, further they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages. Rear quarter teats were shorter and thicker than the front teats in lactating as well as non-lactating Kosali cows. Distance between front teats was higher as compared to rear teats (Table 1). The percentage decrease in the above parameters between early and mid-stages were higher as compared between mid and late stages in lactating as well as non-lactating Kosali cow (Table 2).

Supramammary lymph nodes were present on the dorso-caudal surface of the udder (Fig. 2). These statements were similar to the findings of Turner (1952) [15], Sisson (1975) [13], Jacobson (1996) [4], Banerjee (1998) [1], Panchal and Vyas (2006) [8], Riservati (2009) [11], Nickerson and Akers (2011) [7], Pandey *et al.* (2018) [9] and Qureshi (2019) [10]. Length and width of right and left supramammary lymph nodes were significantly higher in early lactation as compared to mid and late lactations in lactating Kosali cow and were significantly higher in early non lactating stage as compared to mid and late periods in non-lactating Kosali cow. Further they were significantly higher in lactating cows as compared to non-lactating cows in early, mid and late stages. Length and width of left mammary lymph node were slightly higher as compared to right mammary lymph node (Table 1). The percentage decrease in the length and width of right and left supramammary lymph nodes between early and mid-stages were higher as compared between mid and late stages in lactating as well as non-lactating Kosali cow (Table 2).

All recorded gross anatomical parameters of mammary glands in early, mid and late lactation and non-lactating stages indicated that the gross anatomical development of the gland is directly related to the secretory activity of the gland.

**Table 1:** Mean±SE (cm) gross parameters of mammary gland of lactating and non-lactating Kosali cows

| S. No. | Parameters | Groups | Stages | | |
|---|---|---|---|---|---|
| | | | Early | Mid | Late |
| 1. | Circumference of udder at the base (cm) | Lactating | 74.83±2.77$^{a*}$ | 65.00±1.82$^{b*}$ | 59.92±0.91$^{c*}$ |
| | | Non lactating | 49.17±1.79$^{a}$ | 45.00±0.78$^{b}$ | 39.25±0.40$^{c}$ |
| 2. | Maximum diameter of udder at the base (cm) | Lactating | 23.42±0.95$^{a*}$ | 20.83±0.86$^{ab*}$ | 19.92±0.81$^{b*}$ |
| | | Non lactating | 17.58±0.67$^{a}$ | 17.08±0.61$^{a}$ | 14.50±0.52$^{b}$ |
| 3. | Minimum diameter of udder at the base (cm) | Lactating | 21.67±0.91$^{a*}$ | 18.08±0.55$^{b*}$ | 16.92±0.30$^{b*}$ |
| | | Non lactating | 15.42±0.83$^{a}$ | 13.83±0.20$^{b}$ | 12.00±0.10$^{c}$ |
| 4. | Maximum length of right quarters at the base (cm) | Lactating | 23.17±0.79$^{a*}$ | 20.92±0.55$^{b*}$ | 17.36±0.45$^{c*}$ |
| | | Non lactating | 16.83±0.89$^{a}$ | 15.42±0.83$^{a}$ | 13.00±0.35$^{b}$ |
| 5. | Maximum length of left quarters at the base (cm) | Lactating | 23.33±0.87$^{a*}$ | 21.83±0.65$^{a*}$ | 17.70±0.49$^{b*}$ |
| | | Non lactating | 16.92±1.08$^{a}$ | 15.58±0.78$^{a}$ | 13.25±0.45$^{b}$ |
| 6.. | Maximum width of right quarters at the base (cm) | Lactating | 12.02±0.65$^{a*}$ | 11.33±0.59$^{a*}$ | 9.44±0.25$^{b*}$ |
| | | Non lactating | 8.12±0.56$^{a}$ | 6.75±0.18$^{b}$ | 5.75±0.11$^{b}$ |
| 7. | Maximum width of left quarters at the base (cm) | Lactating | 12.10±0.62$^{a*}$ | 11.47±0.60$^{a*}$ | 9.48±0.22$^{b*}$ |
| | | Non lactating | 8.32±0.49$^{a}$ | 7.08±0.14$^{b}$ | 6.00±0.10$^{c}$ |
| 8. | Thickness of skin at the base of udder (cm) | Lactating | 0.38±0.05$^{a*}$ | 0.37±0.02$^{a*}$ | 0.32±0.01$^{b*}$ |
| | | Non lactating | 0.31±0.02$^{a}$ | 0.30±0.02$^{a}$ | 0.24±0.01$^{b}$ |
| 9. | Length of right front teat (cm) | Lactating | 3.90±0.24$^{a*}$ | 3.70±0.23$^{ab*}$ | 3.20±0.20$^{b*}$ |
| | | Non lactating | 3.12±0.12$^{a}$ | 2.93±0.07$^{ab}$ | 2.55±0.06$^{b}$ |
| 10. | Length of left front teat (cm) | Lactating | 4.07±0.27$^{a*}$ | 3.90±0.19$^{a*}$ | 3.32±0.13$^{b*}$ |
| | | Non lactating | 3.22±0.12$^{a}$ | 3.10±0.06$^{a}$ | 2.95±0.02$^{b}$ |
| 11. | Length of right rear teat (cm) | Lactating | 3.53±0.15$^{a*}$ | 3.10±0.14$^{b*}$ | 2.98±0.13$^{b*}$ |
| | | Non lactating | 2.90±0.14$^{a}$ | 2.82±0.12$^{a}$ | 2.30±0.11$^{b}$ |
| 12. | Length of left rear teat (cm) | Lactating | 3.68±0.29$^{a*}$ | 3.23±0.15$^{ab*}$ | 3.07±0.20$^{b*}$ |
| | | Non lactating | 2.96±0.12$^{a}$ | 2.93±0.17$^{a}$ | 2.55±0.08$^{b}$ |
| 13. | Diameter of right front teat at base (cm) | Lactating | 2.32±0.08$^{a*}$ | 2.03±0.06$^{b*}$ | 1.93±0.02$^{b*}$ |
| | | Non lactating | 1.57±0.15$^{a}$ | 1.56±0.11$^{a}$ | 1.23±0.08$^{b}$ |
| 14. | Diameter of right front teat at middle (cm) | Lactating | 1.53±0.11$^{a*}$ | 1.50±0.07$^{a*}$ | 1.37±0.05$^{b*}$ |
| | | Non lactating | 1.32±0.04$^{a}$ | 1.29±0.03$^{a}$ | 1.04±0.02$^{b}$ |
| 15. | Diameter of right front teat near the tip (cm) | Lactating | 1.05±0.09$^{a*}$ | 1.04±0.04$^{a*}$ | 0.98±0.01$^{b*}$ |
| | | Non lactating | 0.92±0.03$^{a}$ | 0.91±0.02$^{a}$ | 0.81±0.02$^{b}$ |
| 16. | Diameter of left front teat at base (cm) | Lactating | 2.35±0.09$^{a*}$ | 2.08±0.08$^{b*}$ | 1.93±0.04$^{b*}$ |
| | | Non lactating | 1.63±0.12$^{a}$ | 1.59±0.08$^{a}$ | 1.33±0.07$^{b}$ |
| 17. | Diameter of left front teat at middle (cm) | Lactating | 1.68±0.06$^{a*}$ | 1.60±0.05$^{ab*}$ | 1.48±0.03$^{b*}$ |
| | | Non lactating | 1.41±0.09$^{a}$ | 1.34±0.08$^{a}$ | 1.11±0.04$^{b}$ |
| 18. | Diameter of left front teat near the tip (cm) | Lactating | 1.07±0.05$^{a*}$ | 1.06±0.03$^{a*}$ | 0.99±0.02$^{b*}$ |
| | | Non lactating | 0.97±0.03$^{a}$ | 0.93±0.02$^{a}$ | 0.74±0.02$^{b}$ |
| 19. | Diameter of right rear teat at base (cm) | Lactating | 2.53±0.16$^{a*}$ | 2.10±0.10$^{b*}$ | 2.07±0.09$^{b*}$ |
| | | Non lactating | 1.83±0.14$^{a}$ | 1.70±0.13$^{a}$ | 1.50±0.04$^{b}$ |
| 20. | Diameter of right rear teat at middle (cm) | Lactating | 1.70±0.08$^{a*}$ | 1.53±0.06$^{b*}$ | 1.47±0.05$^{b*}$ |
| | | Non lactating | 1.46±0.07$^{a}$ | 1.40±0.05$^{a}$ | 1.27±0.04$^{b}$ |

| | | | | | |
|---|---|---|---|---|---|
| 21. | Diameter of right rear teat near the tip (cm) | Lactating | 1.10±0.04$^{a*}$ | 1.08±0.03$^{a*}$ | 1.03±0.01$^{b*}$ |
| | | Non lactating | 1.02±0.03$^{a}$ | 1.00±0.02$^{a}$ | 0.82±0.01$^{b}$ |
| 22. | Diameter of left rear teat at base (cm) | Lactating | 2.55±0.14$^{a*}$ | 2.23±0.07$^{b*}$ | 2.20±0.07$^{b*}$ |
| | | Non lactating | 1.90±0.05$^{a}$ | 1.71±0.03$^{b}$ | 1.60±0.02$^{c}$ |
| 23. | Diameter of left rear teat at middle (cm) | Lactating | 1.85±0.04$^{a*}$ | 1.62±0.03$^{b*}$ | 1.54±0.03$^{c*}$ |
| | | Non lactating | 1.50±0.03$^{a}$ | 1.40±0.02$^{b}$ | 1.31±0.01$^{c}$ |
| 24. | Diameter of left rear teat near the tip (cm) | Lactating | 1.12±0.05$^{a*}$ | 1.10±0.03$^{a*}$ | 1.04±0.02$^{b*}$ |
| | | Non lactating | 1.03±0.03$^{a}$ | 1.00±0.02$^{a}$ | 0.95±0.01$^{b}$ |
| 25. | Distance between front quarter teats at base (cm) | Lactating | 6.52±0.48$^{a*}$ | 5.43±0.44$^{b*}$ | 4.98±0.15$^{b*}$ |
| | | Non lactating | 4.58±0.31$^{a}$ | 4.23±0.25$^{a}$ | 3.75±0.11$^{b}$ |
| 26. | Distance between rear quarter teats at base (cm) | Lactating | 3.30±0.13$^{a*}$ | 2.83±0.11$^{b*}$ | 2.77±0.06$^{b*}$ |
| | | Non lactating | 2.55±0.09$^{a}$ | 2.48±0.06$^{a}$ | 2.35±0.02$^{b}$ |
| 27. | Distance between right front and rear quarter teats at base (cm) | Lactating | 3.60±0.17$^{a*}$ | 3.55±0.15$^{a*}$ | 3.30±0.07$^{b*}$ |
| | | Non lactating | 3.22±0.06$^{a}$ | 3.20±0.05$^{a}$ | 3.08±0.03$^{b}$ |
| 28. | Distance between left front and rear quarter teats at base (cm) | Lactating | 3.75±0.18$^{a*}$ | 3.72±0.16$^{a*}$ | 3.40±0.15$^{b*}$ |
| | | Non lactating | 3.38±0.06$^{a}$ | 3.20±0.06$^{b}$ | 3.17±0.04$^{b}$ |
| 29. | Length of right supramammary lymph node (cm) | Lactating | 5.07±0.10$^{a*}$ | 4.66±0.09$^{b*}$ | 4.23±0.04$^{c*}$ |
| | | Non lactating | 4.40±0.04$^{a}$ | 3.43±0.03$^{b}$ | 3.32±0.01$^{c}$ |
| 30. | Length of left supramammary lymph node (cm) | Lactating | 5.08±0.14$^{a*}$ | 4.70±0.09$^{b*}$ | 4.50±0.10$^{b*}$ |
| | | Non lactating | 4.34±0.18$^{a}$ | 3.46±0.03$^{b}$ | 3.41±0.02$^{b}$ |
| 31. | Width of right supramammary lymph node (cm) | Lactating | 3.30±0.28$^{a*}$ | 3.25±0.16$^{a*}$ | 2.78±0.14$^{b*}$ |
| | | Non lactating | 2.65±0.07$^{a}$ | 2.59±0.03$^{a}$ | 2.42±0.02$^{b}$ |
| 32. | Width of left supramammary lymph node (cm) | Lactating | 3.45±0.27$^{a*}$ | 3.35±0.16$^{a*}$ | 2.88±0.12$^{b*}$ |
| | | Non lactating | 2.73±0.06$^{a}$ | 2.62±0.04$^{a}$ | 2.51±0.02$^{b}$ |
| 33. | Length of median suspensory Ligament (cm) | Lactating | 18.27±0.72$^{a*}$ | 15.68±0.55$^{b*}$ | 13.32±0.30$^{c*}$ |
| | | Non lactating | 12.13±0.23$^{a}$ | 10.53±0.20$^{b}$ | 8.00±0.10$^{c}$ |
| 34. | Maximum diameter of gland cistern (cm) | Lactating | 5.34±0.14$^{a*}$ | 3.62±0.06$^{b*}$ | 2.43±0.05 $^{c*}$ |
| | | Non lactating | 1.74±0.03$^{a}$ | 1.36±0.02$^{b}$ | 0.47±0.01$^{c}$ |
| 35. | Maximum length of teat cistern of front quarter teat (cm) | Lactating | 2.80±0.06$^{a*}$ | 2.45±0.05$^{b*}$ | 2.12±0.03$^{c*}$ |
| | | Non lactating | 1.43±0.03$^{a}$ | 1.13±0.02$^{b}$ | 0.84±0.01$^{c}$ |
| 36. | Maximum length of teat cistern of rear quarter teat (cm) | Lactating | 2.30±0.05$^{a*}$ | 2.05±0.04$^{b*}$ | 1.62±0.03$^{c*}$ |
| | | Non lactating | 1.03±0.02$^{a}$ | 0.65±0.01$^{b}$ | 0.32±0.01$^{c}$ |

a, b, c, d in each row, means with different superscripts are significantly different ($p$<0.05)
* in each column, means with different superscripts are significantly different ($p$<0.05)

**Table 2:** Percentage decrease in different parameters between different stages of lactating and non-lactating Kosali cows

| S. No. | Parameters | Groups | Percentage decrease between early and mid-stages | Percentage decrease between mid and late stages |
|---|---|---|---|---|
| 1. | Circumference of udder at the base (%) | Lactating | 74.18 | 64.40 |
| | | Non lactating | 48.72 | 44.61 |
| 2. | Maximum diameter of udder at the base (%) | Lactating | 23.21 | 20.63 |
| | | Non lactating | 17.41 | 16.94 |
| 3. | Minimum diameter of udder at the base (%) | Lactating | 21.49 | 17.91 |
| | | Non lactating | 15.28 | 13.71 |
| 4. | Maximum length of right quarters at the base (%) | Lactating | 22.96 | 20.75 |
| | | Non lactating | 16.68 | 15.29 |
| 5. | Maximum length of left quarters at the base (%) | Lactating | 23.11 | 21.65 |
| | | Non lactating | 16.76 | 15.45 |
| 6. | Maximum width of right quarters at the base (%) | Lactating | 11.91 | 11.24 |
| | | Non lactating | 8.05 | 6.69 |
| 7. | Maximum width of left quarters at the base (%) | Lactating | 11.99 | 11.38 |
| | | Non lactating | 8.25 | 7.02 |
| 8. | Thickness of skin at the base of udder (%) | Lactating | 0.38 | 0.37 |
| | | Non lactating | 0.31 | 0.30 |
| 9. | Length of right front teat (%) | Lactating | 3.86 | 3.67 |
| | | Non lactating | 3.09 | 2.90 |
| 10. | Length of left front teat (%) | Lactating | 4.03 | 3.87 |
| | | Non lactating | 3.19 | 3.07 |
| 11. | Length of right rear teat (%) | Lactating | 3.50 | 3.07 |
| | | Non lactating | 2.87 | 2.80 |
| 12. | Length of left rear teat (%) | Lactating | 3.65 | 3.20 |
| | | Non lactating | 2.93 | 2.90 |
| 13. | Diameter of right front teat at base (%) | Lactating | 2.30 | 2.01 |
| | | Non lactating | 1.55 | 1.55 |
| 14. | Diameter of right front teat at middle (%) | Lactating | 1.52 | 1.49 |
| | | Non lactating | 1.31 | 1.28 |
| 15. | Diameter of right front teat near the tip (%) | Lactating | 1.04 | 1.03 |
| | | Non lactating | 0.91 | 0.90 |

| | | | | |
|---|---|---|---|---|
| 16. | Diameter of left front teat at base (%) | Lactating | 2.33 | 2.06 |
| | | Non lactating | 1.61 | 1.58 |
| 17. | Diameter of left front teat at middle (%) | Lactating | 1.66 | 1.59 |
| | | Non lactating | 1.40 | 1.33 |
| 18. | Diameter of left front teat near the tip (%) | Lactating | 1.06 | 1.05 |
| | | Non lactating | 0.96 | 0.92 |
| 19. | Diameter of right rear teat at base (%) | Lactating | 2.51 | 2.08 |
| | | Non lactating | 1.81 | 1.69 |
| 20. | Diameter of right rear teat at middle (%) | Lactating | 1.68 | 1.52 |
| | | Non lactating | 1.45 | 1.39 |
| 21. | Diameter of right rear teat near the tip (%) | Lactating | 1.09 | 1.07 |
| | | Non lactating | 1.01 | 0.99 |
| 22. | Diameter of left rear teat at base (%) | Lactating | 2.53 | 2.21 |
| | | Non lactating | 1.88 | 1.69 |
| 23. | Diameter of left rear teat at middle (%) | Lactating | 1.83 | 1.60 |
| | | Non lactating | 1.49 | 1.39 |
| 24. | Diameter of left rear teat near the tip (%) | Lactating | 1.11 | 1.09 |
| | | Non lactating | 1.02 | 0.99 |
| 25. | Distance between front quarter teats at base (%) | Lactating | 6.47 | 5.38 |
| | | Non lactating | 4.54 | 4.19 |
| 26. | Distance between rear quarter teats at base (%) | Lactating | 3.27 | 2.80 |
| | | Non lactating | 2.53 | 2.46 |
| 27. | Distance between right front and rear quarter teats at base (%) | Lactating | 3.56 | 3.52 |
| | | Non lactating | 3.19 | 3.17 |
| 28. | Distance between left front and rear quarter teats at base (%) | Lactating | 3.71 | 3.69 |
| | | Non lactating | 3.35 | 3.17 |
| 29. | Length of right supramammary lymph node (%) | Lactating | 5.02 | 4.62 |
| | | Non lactating | 4.37 | 3.40 |
| 30. | Length of left supramammary lymph node (%) | Lactating | 5.03 | 4.66 |
| | | Non lactating | 4.31 | 3.43 |
| 31. | Width of right supramammary lymph node (%) | Lactating | 3.27 | 3.22 |
| | | Non lactating | 2.62 | 2.57 |
| 32. | Width of left supramammary lymph node (%) | Lactating | 3.42 | 3.32 |
| | | Non lactating | 2.70 | 2.59 |
| 33. | Length of median suspensory Ligament (%) | Lactating | 18.11 | 15.55 |
| | | Non lactating | 12.02 | 10.45 |
| 34. | Maximum diameter of gland cistern (%) | Lactating | 5.30 | 3.60 |
| | | Non lactating | 1.73 | 1.36 |
| 35. | Maximum length of teat cistern of front quarter teat (%) | Lactating | 2.78 | 2.43 |
| | | Non lactating | 1.42 | 1.12 |
| 36. | Maximum length of teat cistern of rear quarter teat (%) | Lactating | 2.28 | 2.03 |
| | | Non lactating | 1.02 | 0.65 |


**Fig 1:** Photograph of ventral view of mammary gland of early non-lactating stage of Kosali Cow showing, a. Right fore quarter teat,

b. Left fore quarter teat, c. Right hind quarter teat, d. Left hind quarter teat, e. Intermammary groove

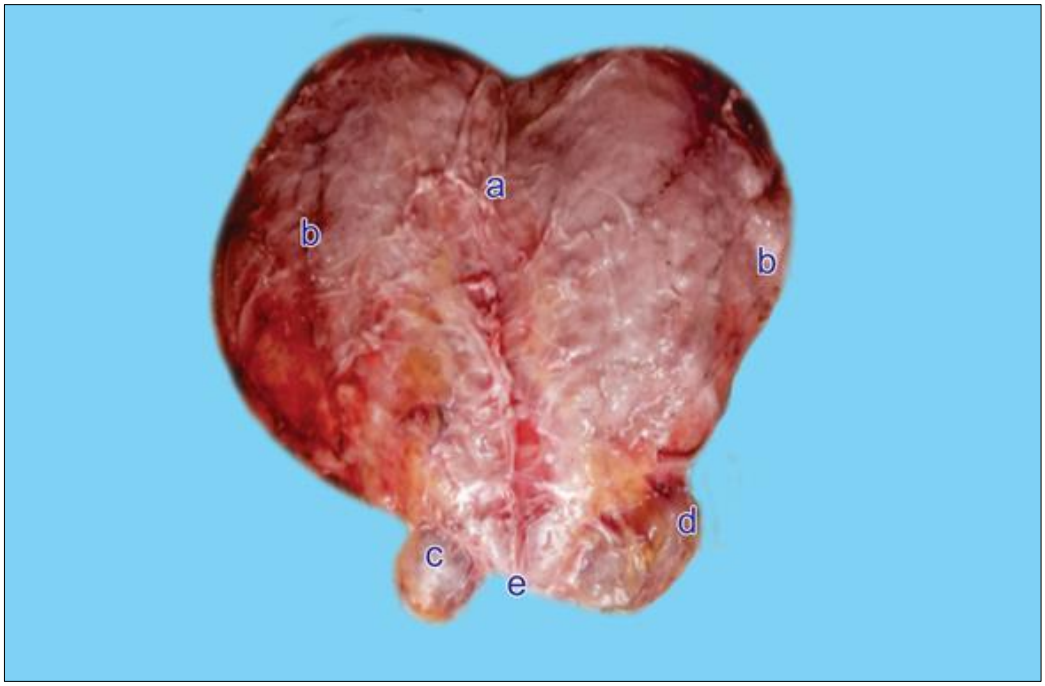


**Fig 2:** Photograph of dorsal view of mammary gland of early lactating stage of Kosali Cow showing, a. median suspensory ligament, b. Lateral suspensory ligament. C. Right supramammary lymph node, d. Left supramammary lymph node, e. Subpelvic tendon


**Fig 3:** Photograph of longitudinal section (sub-gross) of mammary gland of early lactating stage of Kosali Cow showing, a. Streak canal, b. Rosette of Furstenberg, c. Teat cistern, d. Annular fold, e. Gland cistern, f. Mammary parenchyma

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