

**COMPARATIVE STUDY OF THE UDDER STRUCTURE  
IN BUFFALOES AND CATTLE:  
MORPHOLOGICAL AND ANATOMICAL CHARACTERISTICS  
OF THE MAMMARY TISSUE****Safaa, S. El-Ghousien, G. Ashour, M. M. Shafie, A. L. Badreldin****Summary**

Twenty six Egyptian buffaloes and thirty Friesian cattle in adult age and comparable lactation number were used to study the morphological feature of the udder. The study comprised: circumference, fore and rear width; depth of front and rear quarters; longitudinal distance between the two fore teats and the two rear teats alongside, the length and diameter of the teats. Anatomical comparative study was executed on the udder of Egyptian buffaloes and cattle and Friesian cattle, two from each, to find out any structural differences which could explain their species and breed deference in milk production. The anatomical studies comprised; Teats structure (teat wall thickness and teat cistern), gland cistern, vascular system (venous and arterial), and lymph glands. The morphological measurements increased with the progress in lactation number. Friesian udders showed vider distance between the two fore and the two rear teats, with larger width and depth and greater length of the rear teats than buffaloes. However, the average length and diameter of the fore teats and the distance between the two fore teats and between the two rear teats were equal in both species. In both species, the measurements increased with the progress within the lactation season. Buffaloes possessed thicker teat wall, larger teat cistern, longer teat canal in comparison to cattle and a particular construction of the gland cistern showing pouches. Also, buffaloes showed more valves of the main venous system. The supermammary lymph gland was no lobulated in buffaloes. It could be concluded that the three types of animals express the same pattern in the structural functional relationship.

Key words: udder, morphology, anatomy, buffaloes, cattle.

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### *Introduction*

The morphological features of the bovine udder is, to a great extent, expressing the status (anatomy and activity) of its mammary glands. Suzuki et al. (1963) found significant positive correlations between 12 udder size features and milk yield for 118 Holstein cows. Hladky (1964) and Buben (1969) reported such positive relation in Czechoslovak Red Pied cows and in Russian cattle, respectively. The morphological measures vary, extensively, between the bovine species and breeds, either in absolute values or relative to body weight. The apparent sizes of the udder quarters is related to their share in milk yield. In Egypt, Ragab et al. (1969) showed the following share (%) of rear quarters in daily milk yield of Friesian, buffaloes and Egyptian cattle; 62, 69 and 58, respectively. The buffaloes show difference in the udder constitution between the different types and individuals. This lack of uniformity of quarters and teats causes difficulty in applying machine milking.

The present work was carried out to compare the morphological construction of Friesian cows and Egyptian buffaloes (reverine type) alongside the general anatomical features of these species plus Egyptian cattle.

### *Materials and methods*

This work was carried out in the Faculty of Agriculture, Cairo University, Egypt. The morphological study was executed on lactating cows; 30 Friesian and 26 buffaloes at different parities and lactation stages, as available in the Faculty farm and the farm of Fac. of Agric., Ain Shams Univ., Cairo. The measured features were; the udder circumference at conjunction with the abdominal skin, width and depth of fore and rear quarters, length and diameter of fore and rear teats, the cross distances between each fore and each rear teats, and the longitudinal distance between fores and rears.

The anatomical study was undertaken on 2 udders from each of Friesian, Egyptian i buffaloes and cattle, one at early of lactation, the other at late lactation stages as defined in Table (1). Each udder was detached completely after slaughtering the cow without milking. To follow and demarcate the blood vessels, a coloured (blue and red) gelatine solutions was injected through the orifices of the subcutaneous abdominal vein and artery on both sides the solutions appeared from the posterior orifices. A 10% formol saline was injected that each teat canal, then all the udder was placed in the same solution for two days to hardly tissue and facilitate tracing the blood vessels. Bisection was operated from the tip of the till the gland cistern to define the pertaining structures.

## Results and discussion

### I. Morphological characteristics of the udder

#### 1. Udder measurement:

At the same stage of lactation (5-7 mon.) in the 1<sup>st</sup> parity, the Friesian possessed udders with larger width and depth in the fore and rear quarters than buffaloes (Table 1). The species difference in the circumference of the udder was in favour of buffaloes, this seems to be due to the great thickness of buffaloes skin causing lack of proper delineation of udder skin from abdomen

Table 1. - MORPHOLOGICAL FEATURES OF THE UDDER OF FRIESIANS AND BUFFALOES IN THE FIRST LACTATION (PARITY) AT IDENTICAL LACTATION STAGES.

		Friesians				
		Measurements of the udder and quarters (cm)				
Cow No.	Lactation stage (mon.)	Circumference	Width		Depth	
			Fore	Rear	Fore	Rear
1	5	72	25	16	15	21
2	5	56	18	16	13	27
3	7	50	17	18	7	20
4	7	57	21	18	18	30
5	7	63	23	16	17	28
6	7	58	20	17	13	21
Mean		59	21	17	14	25
Range		50-72	17-25	16-18	7-18	20-30

		Buffaloes				
		Measurements of the udder and quarters (cm)				
Cow No.	Lactation stage (mon.)	Circumference	Width		Depth	
			Fore	Rear	Fore	Rear
1	5	73	22	20	10	27
2	5	73	15	18	11	24
3	7	77	16	17	11	22
4	7	74	14	13	10	25
5	7	73	10	10	8	22
6	7	82	16	12	7	25
Mean		75	16	15	10	24
Range		73-82	10-22	10-20	7-11	22-27



skin. Garkavijs et al. (1965) found that the average udder circumference, depth and width in cattle were 90-100, 22-27 and 22-29 cm, respectively. In both species the measurements increased with the progress in parity, in agreement with Garkavijs et al. (1965) and Nowak (1969).

Table 2. - MORPHOLOGICAL FEATURES OF THE UDDER OF FRIESIANS IN THE SECOND AND SUCCESSIVE LACTATIONS (PARITY) AT DIFFERENT LACTATION STAGES.

Cow No	Parity	Lactation stage (mon)	Measurements of the udder and quarters (cm)				
			Circumference	Width		Depth	
				Fore	Rear	Fore	Rear
1	2	3	64	25	21	15	31
2	2	4	79	32	25	15	28
3	2	4	71	31	21	14	33
4	2	7	57	26	20	17	26
5	2	7	77	23	13	16	30
6	3	8	70	20	17	17	32
7	3	9	76	31	19	15	35
8	3	2	70	31	26	13	26
9	4	1	60	21	16	17	33
10	4	1	76	28	21	22	32
11	4	3	78	26	21	15	35
12	4	5	78	18	18	21	35
13	5	8	77	25	20	20	30
14	5	9	79	22	21	17	29
15	5	5	74	22	18	21	31
16	6	5	71	24	18	17	31
17	6	6	72	27	21	17	35
18	6	3	75	30	19	17	32
19	7	5	70	21	20	12	31
20	7	6	75	31	22	20	28
21	7	10	80	32	31	20	27
22	8	1	84	30	23	17	21
23	8	1	94	31	19	27	29
24	9	7	90	23	27	27	38
	Mean		75	26	21	18	31
	Range		57-94	18-32	13-31	12-27	21-38

Table 3. - MORPHOLOGICAL FEATURES OF THE UDDER OF BUFFALOES IN THE SECOND AND SUCCESSIVE LACTATIONS (PARITY) AT DIFFERENT LACTATION STAGES.

Buff. No	Parity	Lactation stage (mon)	Measurements of the udder and quarters (cm)				
			Circumference	Width		Depth	
				Fore	Rear	Fore	Rear
1	2	8	70	25	21	11	26
2	5	5 days	93	33	24	11	30
3	5	1	97	31	22	12	30
4	7	12	100	28	21	12	31
5	>7	3	67	29	20	10	33
	Mean		85.4	29.2	21.6	11.2	30.0
	Range		67-100	25-33	20-24	10-12	26-33

## 2. Teat measurements:

Teats measurements showed no difference between Friesians and buffaloes in length and diameter of the fore teats which averaged 6 and 2 cm., respectively. The rear teats were longer in buffaloes than Friesians, 6.3 and 5.2 cm., respectively (Tables 4 & 5). The Friesians had wider cross distance between the two fore and between the two rear teats than buffaloes 11.9 and 5.3 vs. 9.0 and 4.6 cm., respectively. This wider spacing of the teats in Friesian caused by the wider udder in this breed in comparison to buffaloes (Tables 4 & 5). In both species the distance between the fore teats was double to that between the rear teats. Garkavijs et al. (1965) found that the average teat length and diameter were 6-9 and 2-3 cm., respectively in cattle.

## II. Anatomical features of the udder

### 1. Teat wall:

The teat wall was very thick in buffaloes being double to that of Friesian followed by that of Egyptian cattle, 10.5 and 8 mm., respectively (Plate 1). This species and breed differences in the teat wall is related to the differences in the skin thickness in buffaloes and Egyptian cattle as reported by Shafie (1954 and 1985) and Hafez et al. (1955), 6, 5 and 4 mm., respectively. Moreover, Friesians had thin walled teats in comparison to the thickness of the skin as reported by Dowling (1955).

Table 4. - MEASUREMENTS OF FRIESIANS TEATS (CM).

Cow No.	For Teats		Rear Teats		Distance between teats		
	Length	Diameter	Length	Diameter	Fore-Rear	Fores	Rears
1	6	1.6	5	1.2	5	11	5
2	6	1.8	3	1.4	3	10	4
3	8	2.0	5	2.0	3	10	5
4	7	1.5	8	2.0	3	7	3
5	6	2.0	4	2.0	3	8	3
6	6	1.6	5	1.6	3	11	6
7	6	2.0	5	2.2	4	13	7
8	6	2.2	4	1.8	5	12	6
9	5	1.8	5	1.9	6	10	5
10	7	1.8	6	2.2	4	12	6
11	7	1.6	5	1.6	4	10	4
12	6	2.4	5	2.2	5	12	3
13	6	2.2	4	2.2	5	11	4
14	6	1.6	4	1.6	5	15	6
15	6	2.0	5	2.4	4	8	3
16	7	2.4	6	1.8	8	16	7
17	4	2.2	5	2.8	5	11	4
18	10	2.4	8	2.2	3	11	4
19	6	1.8	6	2.0	5	11	6
20	9	2.4	7	2.0	4	13	6
21	7	1.8	4	2.0	6	12	2
22	6	2.2	4	2.0	5	12	5
23	5	2.4	5	1.8	5	11	5
24	7	2.4	7	2.5	4	12	5
25	5	2.2	4	2.0	4	14	7
26	7	1.8	5	1.8	5	11	5
27	7	2.2	5	2.0	5	12	6
28	8	2.6	7	2.0	5	17	9
29	7	2.0	6	2.0	6	16	9
30	7	2.2	6	2.8	8	18	10
Mean	6.5	2.0	5.3	2.0	4.7	11.9	5.3
Range	4-10	1.5-2.6	3-8	1.2-2.8	3-8	7-18	2-10

Table 5. - MEASUREMENTS OF BUFFALOES TEATS (CM).

Bull. No.	For Teats		Rear Teats		Distance between teats		
	Length	Diameter	Length	Diameter	Fore-Rear	Fores	Rears
1	9	2.6	10	2.4	3	7	4
2	7	2.5	7	2.0	5	7	2
3	8	2.2	11	3.2	3	8	6
4	5	2.0	7	1.6	5	12	4
5	4	2.2	6	2.0	6	12	4
6	6	2.8	5	2.4	3	11	5
7	5	1.6	5	2.0	4	7	4
8	7	2.0	7	1.4	6	6	3
9	6	1.6	5	2.2	7	9	5
10	6	2.0	6	1.8	5	8	2
11	5	1.8	5	2.4	5	13	5
12	4	2.0	5	2.0	4	7	3
13	5	1.8	6	1.8	4	9	4
14	4	1.2	5	1.8	5	7	4
15	7	2.4	5	2.0	4	11	6
16	6	2.8	5	2.4	4	9	7
17	6	2.0	6	2.4	4	9	4
18	6	1.8	6	2.2	3	7	4
19	4	2.2	4	2.0	4	11	5
20	6	1.8	7	2.4	3	9	7
21	6	1.6	5	1.8	4	8	5
22	6	2.6	7	2.9	5	11	4
23	6	2.8	6	2.8	5	10	6
24	7	2.7	8	2.5	7	10	7
25	7	3.0	7	3.0	5	10	7
26	9	2.4	7	3.4	4	9	3
Mean	6.0	2.2	6.3	2.3	4.7	9.0	4.6
Range	4-9	1.2-3.0	4-11	1.4-3.4	3-7	6-13	2-7

## 2. Teat cistern and canal :

The teat cistern was the largest in buffaloes followed by Friesian than Egyptian cattle (Plate 1). The buffaloes also had the longest teat canal, the



length was 13, 12 and 9 mm. in buffaloes, Egyptian cattle and Friesian, respectively. McDonald (1968) stated that the canal length of fore and rear quarters were 10.7 and 10.9 mm., respectively. The measurements of wall thickness and the canal length showed the same values for the four quarters in each individual. This short length of the canal in Friesian could help in facilitating the release of milk during the milking process, especially that the whole length of the ducts in the three breeds is surrounded by controlling sphincter muscle. Loppnow (1959) and Folly (1973) stated that the teals of cows with a low speed of milk flow usually have longer teat canals than cows with a high speed of milk flow. Shafie et al. (1969) and Ragab et al. (1969) reported longer milking time for buffaloes than Friesian, 8.7 and 5.1 min. for morning and evening milking of buffaloes versus 6.4 and 4.6 min. for Friesian. The species difference in milking time was not corresponding to milk yield which was greater by Friesian, 6.3 and 4.0 kg in morning and evening milkings versus 5.5 and 2.5 kg for buffaloes, respectively. Consequently the rate of milking varied, being around 1 kg/min. for Friesian versus 0.5 kg/min. for buffaloes. The Egyptian cattle had milking time almost equal to Friesian, 6.38 and 4.6 min., respectively with a yield equal to buffaloes (0.5 kg/min) due to less milk yield (4.2 and 1.7 kg; respectively).

### 3. Gland cistern:

Friesian possessed a well defined cavernous cistern, into its surface open a number of ducts, the milk ducts (Plate 2), similar pattern was found in native cattle (Plate 2). On the contrary, the buffaloes cistern showed several interceptions of large ducts with elastic thin walls, thus forming numerous pockets instead of a single cavity cistern (Plate 2). Could this pockets and septa delay the milk descent from the cistern to the teat? The larger milk ducts were generally short and wide in all udders of the three breeds. The branching and direction of the ducts were very irregular in all cases. Although the udders were full with milk (unmilked, the cisterns and large ducts were empty. The larger ducts were folded. These structural features support the physiological findings reported by Aliev (1969) that milk was expelled from the alveoli only during active milk ejection in buffaloes.

### 4. Vascular system

The vascular system showed a general picture in the three types of animals, with some variations in the branching of the main arteries and veins (Plate 3).



#### 4.1. Venous system

The mammary venous system consisted of the two major longitudinal veins which connect the external pudic with the subcutaneous abdominal vein on the corresponding sides. These major veins were connected by transverse large veins in the posterior and anterior parts of the udder. The posterior connection was located just in front of the supramammary lymph glands. The anterior connecting veins were more numerous and prominent in buffaloes than in both of the cattle breeds. The buffaloes possessed numerous large branches in the venous system connecting the circulation in the two halves, right and left, of the udder. Friesians and native cattle showed less large branches from the main veins (Plate 3). This variations in the branching of large veins may be very effective on the blood flow in the udder. The numbers and locations of the valves in the large veins of the mammary venous plexus showed wide variation between breeds and even between individuals within breed. It is questionable to notice from the direction of the valves in the perineal vein that it is not draining the udder but is bringing blood towards the udder. The direction of the valves in the transverse connecting veins insure the distribution of the venous blood between the major veins on both halves of the udder.

#### 4.2. Arterial system

There was no difference between the species breeds in the main arteries. In all cases the udder lacked any conspicuous direct connection of the main arteries between its two halves (Plate 3).

#### 5. Lymph glands

The shape and tabulation of the supramammary lymph gland showed clear species differences (Plate 3). Buffaloes possessed non tabulated glands, in one buffalo it was disc shaped, in the other kidney shaped. The cattle breeds had tabulated glands formed of separate lobules, one of the lobule, however, is large enough to provides the majority of the gland (Plate 2). Individual variation within breed was clear in the size and tabulation of the gland. Moreover, there was clear difference between the halves of the udder in the number and location of the lobules.

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## KOMPARATIVNO ISTRAŽIVANJE STRUKTURE VIMENA BIVOLA I GOVEDA: MORFOLOŠKE I ANATOMSKE KARAKTERISTIKE MLIJEČNOG TKIVA

### Sažetak

Dvadeset šest egipatskih bivola i trideset frizijskih goveda odrasle dobi i usporedivog broja laktacija upotrijebljeno je za istraživanje morfoloških značajki vimena. Istraživanje je obuhvatilo opseg, prednju i stražnju širinu, dubinu prednjih i stražnjih dijelova, longitudinalnu udaljenost između dvije prednje sise i dvije stražnje sise te duljinu i promjer sisa. Anatomske komparativno istraživanje obavljeno je na vimenu egipatskog bivola i goveda i frizijskog goveda, od svakoga po dva, kako bi se otkrile strukturne razlike koje bi mogle objasniti razliku njihove vrste i pasmine u proizvodnji mlijeka. Anatomske istraživanje obuhvatilo je strukturu sisa (debljinu stijenke sise i

spremište sise), spremište žlijezde, vaskularni sustav (venozni i arterijski) i limfne žlijezde. Morfološke mjere su rasle s povećanjem broja laktacija. Frizijska vimena su ispoljila veću udaljenost između dvije prednje i dvije stražnje sise, veće širine i dubine te veće duljine stražnjih sisa od bivola. Međutim, prosječna duljina i promjer prednjih sisa, te udaljenost između dvije prednje sise i dvije stražnje sise bili su jednaki u obje vrste. U obje vrste mjere su se povećavale s napredovanjem razdoblja laktacije. Bivoli su imali deblje stijenke sisa, veće spremište u sisi i dulji sisni kanal u usporedbi s govedom, te osobitu konstrukciju spremišta žlijezde s vidljivim vrećicama. Isto tako, bivoli su imali više zalistaka u glavnom venskom sustavu. Super mliječna limfna žlijezda u bivola nije bila reznjasta. Može se zaključiti da ova tri tipa životinja pokazuju isti uzorak u strukturnom funkcionalnom odnosu.

Ključne riječi: vime, morfologija, anatomija, bivoli, govedo

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