THE RELATIONSHIP BETWEEN UDDER, TEATS AND MILK VEIN MEASUREMENTS WITH DAILY MILK YIELD IN SHE-CAMEL (*CAMELUS DROMEDARIUS*)

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ABSTRACT

Sixteen she-camels are chosen from a large herd of camel belonging to the Lahween tribe in Eastern Sudan (El- Showak). The breed is known locally as (Arabi-Lahwee). The animals are sub-divided into three groups: A, B and C according to the parity order, (3rd, 4th and 5th parity) respectively. In despite the increment of daily milk yield with advancing parity order, results revealed insignificant effect on daily milk yield. The daily milk yield of the three groups was 2.2 ± 0.94, 2.9 ± 0.45 and 3.5 ± 2.16 liters, respectively. The daily milk yield in group A was significantly ($P<0.05$) correlated with udder depth (15.3 ± 1.3cm), distance between fore teats (12.9 ± 2.9cm.), and distance between rear teats (9.9 ± 1.9cm). In group B measurements including udder height of fore quarters (108.0 ± 3.0cm.) and rear quarters (107.0 ± 3.0cm). The distance between the right teats (3.3 ± 0.2cm.) was significantly ($P<0.05$) correlated with daily milk yield. In group C the fore teats diameter (3.1 ± 0.4cm) and the distance between the right teats (3.7 ± 2.9cm) were found to be significantly ($P<0.05$) correlated with daily milk yield. Although others measurements were not insignificantly correlated with daily milk yield in the three groups.

الملخص:

تم إجراء هذه الدراسة في ستة عشر ناقة تم اختيارها من قطيع من الإبل العربية اللحوية التي تنتمي إلى قبيلة اللحويين في شرق السودان (الشوك) .لدراسة العلاقة بين القياسات المختلفة للضرع، الحلمات، والوريد اللبني مع الإنتاج اليومي للبن تم تقسيم النوق إلى ثلاثة مجموعات: (أ)، (ب) و(ج) وكانت حسب عدد الولادات في الثالثة، الرابعة والخامسة علي التوالي .علي الرغم من الزيادة الملحوظة في الإنتاج اليومي للبن مع التقدم في عدد الولادات إلا أنه لم يلاحظ أثر معنوي لعدد الولادات في الإنتاج اليومي للبن. كان الإنتاج اليومي للبن للثلاثة مجموعات 2.2 ± 0.94، 2.9 ± 0.45 و3.5 ± 2.16 لتر على التوالي. في المجموعة (أ)

الإنتاج اليومي للبن ارتبط معنوياً ($P < 0.05$) مع عمق الضرع (15.3 ± 1.3سم)، المسافة بين الحلمتين الأماميتين (12.9 ± 2.9سم) والمسافة بين الحلمتين الخلفيتين (1.9±9.9سم). في المجموعة (ب) ارتفاع الضرع عند الأرباع الأمامية (108.0 ± 3.0سم) وعند الخلفية (7.0 ± 3.0سم) والمسافة بين الحلمتين اليمين (3.3 ± 0.2سم) ارتبطت معنوياً ($P<0.05$) مع الإنتاج اليومي للبن. في المجموعة (ج) قطر الحلمتين الأماميتين (3.1 ± 0.4سم) والمسافة بين الحلمتين اليمين (3.7 ± 2.9سم) ارتبطت معنوياً ($P < 0.05$) مع الإنتاج اليومي للبن. بينما لم تسجل القياسات الأخرى اي ارتباطات معنوية مع الإنتاج اليومي للبن في الثلاث مجموعات.

INTRODUCTION

The udder of the she-camel like that of cattle consists of four quarters, each with it's own teat. A well developed mammary system comprises one of the major component of the dairy animal score card (Mishra *et al.*, 1978). Furthermore, dairy camels are characterized by the development of the udder and milk veins (Wardeh *et al.*, 1990), accordingly, well developed milk veins may reflect a greater milk secreting potential.

Zayeed *et al.*, (1991) demonstrated that, there is a great variation in udder and teat size and length in the she-camel, which may be attributed to variable factors including, camel type, lactation stage, parity number and disease.

Studies correlating udder, teat and milk vein measurements with those of milk yield are very scarcy. The present study is initiated to investigate the correlations between some udder and teat measurements including length, width, height together with milk vein diameter with milk yield with the ultimate goal to securing a valid indicator of dairy potential of the she-camel.

MATERIALS AND METHODS

Study Area: The present study was conducted at Al-Khalefa Hawa Alnabi rain-fed mechanized scheme (30km. North weast of El-Showak), located in Al-Gadaref state, within latitudes 14°3N and 35°8E. The area is surrounded by rain-fed mechanized sorghum and sesame fields. The area vegetation is comprised of annual grasses, acacias, euphorbias and dwarf bushes. Annual rainfall varies between 400 to 600mm, and maximum temperature varies between

40°-45°C during the dry season (December–June). El-Showak is dominantly inhabited by two camel owning tribes Rashaida and Lahween. Both tribes are ancient camel breeders and have maintained pastoralist life for centuries. In El-Showak area camels serve primarily as milk producers, but are also used as pack and meat animals.

Experimental Animals: Sixteen lactating she-camels of type (Arabi-Lahwai), at different parities, stage of lactations and age, were randomly selected from the village herd. They represented the typical features of the Arabi camel such as heavy weight, big hump, long neck, big head with long hair on the hump and shoulder and sandy grey or fawn colour.

Identification: Each of the selected females was identified by a plastic tag with a numerical No. placed around the neck. A record for each animal containing age, parity order, calving date, chest girth, udder, teats, and milk vein measurements and daily milk yield were compiled.

Herd Managements: The camel herd was managed by husbandry system deeply rooted in the society based on superstition and practices that were founded down and inherited from father to son over the ages. The herd was managed in a pastoral system (Transhumant) dictated by the prevailing ecological habitat. The area was characterized by a long dry season (December–June), fluctuation in rainfall and scarcity of pasture especially during the dry season created a practice of transhumant mode of range utilization where nomad move with their herd from one area to another following certain migratory routes. The herd spent the dry season at Al-Khalefa scheme grazing sorghum residues and some *Acacia sp.* Then, they moved to Alfeel forest during the rainy season. The herd was driven to hafeers (constructed water reservoirs) once every three days. Young calves were allowed to stay freely with their mothers, and were only separated at milking time which was practiced three times a day.

Milking Practice: Because of the height of the udder the milking process was done in standing position with one knee raised to support the plastic pail. The milker stood on one leg putting the plastic pail in his other bented leg and used both hands for milking.

Data Collection:

Daily Milk Yield: Daily milk yield was measured using 2measuring cylinders, each of (500ml). The part of the milk left for the young calves in the udder was not counted in the daily milk yield and therefore was not included in the calculations.

Age of the Dam, Parity Order and Date of Calving: The data pertinent to the above parameters were offered by the herdmen, who seemed to be very knowledgeable about these parameters.

Udder Measurements: Each measurement in the present study was taken twice before milking and the average of the two reading was then adopted as the base of calculations.

Udder Depth: In this study the udder depth was considered as the distance between the abdominal wall at the base of the udder and the base of the teat. Four such measurements (one for each teat) were taken and averaged to represent the depth of the udder.

Udder Horizontal Circumference: The widest horizontal circumference across the udder was taken as the udder circumference. It was measured by matching the tape to the surface distance of right half from the median suspensory ligament between the fore quarters extending along the right udder half till the median point between the rear quarters. The same procedure was done with the left half of the udder and the sum of the two readings was considered as the udder circumference.

Udder Size: The size of the udder was estimated by multiplying it's horizontal circumference with the udder depth (Maskovskaja, 1967).

Udder Vertical Semi-circumference: the vertical semi-circumference of the udder was measured by the surface distance from the abdominal wall at the base of the udder on one side extending along the udder between the fore and rear teats till the abdominal wall on the other side of the udder.

Udder Height: Defined as the distance from the ground to the base of the teats, and was measured as the distance from the ground to udder floor at the points directly in front of the fore and rear teats.

Udder Levelness: Levelness of the udder floor was measured as the difference between the fore and rear udder heights.

Teat Measurements:

Teat Length: was measured as the distance between the base of the teat to the tip of the teat, by stretching the tape a long the teat.

Teat Diameter: Measured with a vernier caliper at the middle point of the teat.

Distance between Teats: Defined as the distance between: Fore teats, Rear teats, Right teats and Left teats.

Estimated by measuring the distance between every two teats from the middle point of the teats.

Milk Vein Measurements:

Milk Vein length: The linear length of the milk vein was recorded by measuring the linear distance in straight line covered by the milk vein visible in front of the fore quarters up to the milk well where the vein entered in to the abdomen.

Milk Vein Diameter: measured with a vernier caliper.

Body Weight Estimation:

Estimation of body weight were calculated according to Wilson (1984): formula for linear regression of chest girth

$$Y = 5.071X - 457$$

Where: Y = Body weight in kg.

X = Animal chest girth in cm.

Statistical Analysis: The data were compiled according to the lactation number of the experimental animal into three She-Camel Groups (**S.C.G**):

A: 3rd lactation/**B**: 4th lactation/**C**: 5th lactation

The collected data was subjected to statistical analysis program (SPSS), to find out the effect of parity order on milk yield. And to find out the pearsons correlation between udder, teats, and milk vein measurements with the daily milk yield.

RESULTS

Daily Milk Yield: The means and standard deviation of daily milk yield (liter) according to the parity order are presented in (Table 1). The results indicated that, the daily milk yield for A, B, and C groups were 2.2±0.94, 2.9±0.45 and 3.5±2.16 liters, respectively. The statistical analysis of the Data revealed insignificant difference ($P > 0.05$) for the parity order.

Table (1): Average milk yield (liters) of the tested parity groups.

S.C.G	Parity	N	Means	Standard deviation
A	3	8	2.2[a]	0.94
B	4	3	2.9[a]	0.45
C	5	5	3.5[a]	2.16

S.C.G = she-camel group. .

(Table 2) showed that group C was superior than both A and B and produced 6.8liters as maximum daily milk production. Group A yielded the least daily production 0.96 liter as compared to 1.4 and 2.4liter, for groups C and B, respectively.

Table (2): Minimum and maximum daily milk yield (liter).

S.C.G	Minimum	Maximum
A	0.96	4.13
B	2.42	3.32
C	1.40	6.81

S.C.G = she-camel group.

Udder Measurements: The data describing the udder measurements in (cm) are tabulated in (Table 3). It was evident from the data that, the udder depth value for A, B and C groups were 15.3±1.3, 16.0±1.9 and 19.9±1.1cm, respectively. Concerning the udder circumference, the data documented that, the maximum value was recorded in-group C (100.9±8.9cm), followed by 91.1±3.6cm and 85.7±7.8cm for B and A, respectively. The data also revealed that, udder semi-circumference measurements were 48.1±3.1, 54.0±1.0 and 57.0±6.1cm, for A, B and C, respectively.

The data in (Table 3) also indicated that the maximum udder size in group (C) was 2018.6±271.6cm^3, followed by group B and A, the value for which were 1454.9±230.3 and 1311.8±200.7 cm^3, respectively.

Concerning the udder height of fore quarters the measurements for the three groups A, B and C scored 114.6±5.2, 108.0±3.0 and 106.8±9.0cm, respectively, and that of the rear quarters scored114.3±4.4, 107.0±3.0 and 104.8±10.0cm, respectively. While the levelness of udder for A, B and C groups were 1.4±0.9, 1.0±0.0 and 2.4±2.6cm, respectively (Table 3).

Table (3): Udder measurements (cm).

Measurements	S.C.G*		
	A	B	C
Udder depth	15.3±1.3	16.0±1.9	19.9±1.1
Udder circumference	85.7±7.8	91.1±3.6	100.9±8.9
Udder vertical semi- circumference	48.1±3.1	54.0±1.0	57.0±6.1
Udder size (cm^3)	1311.8±200.7	1454.9±230.3	2018.6±271.6
Udder height of fore quarter	114.6±5.2	108.0±3.0	106.8±9.0
Udder height of rear quarter	114.3±5.2	107.0±3.0	104.8±10.0
Levelness of udder	1.4±0.9	1.0±0.0	2.4±2.6

S.C.G = she-camel group.

Correlation Between Udder Measurements And Daily Milk Yield: The pearsons correlation between udder measurements and daily yield for the three groups are given in (Table 4), the results indicated that udder depth was positively and significantly ($P<0.05$) correlated ($r=0.623$) with milk yield in group A. The result, however indicated insignificant correlation between the two traits in both group B and C, ($r=0.622$ and 0.048, respectively). On the other hand, measurements including circumference, vertical semi-circumfere-nce, size and levelness of the udder revealed insignificant correlation with milk yield in the three groups.

The height of the udder measured for both fore and rear quarter was negatively correlated with daily milk yield in group B ($r = -0.990$; $P< 0.05$), while the correlation was negative but, insignificant in groups A and C.

Teats Measurements: Data pertaining to the teats measurements, in (Table 5) showed that, fore teats length for A, B and C groups were, 3.4±0.8, 4.1±1.0 and 6.0±0.7cm, respectively, while rear teats length scored 3.4±0.6, 4.1±0.9 and 6.1±1.3cm, respectively. Measurements of fore teats diameter indicated values of 1.7±0.3, 1.7±0.2 and 3.1±0.4cm, for groups A, B and C, respectively.

Table (4): Pearson's correlation between udder measurements and daily milk yield

Measurements	S.C.G*		
	A	B	C
Udder depth	0.623*	0.622	0.048
Udder circumference	0.378	0.939	0.168
Udder vertical semi- circumference	0.165	- 0.374	0.075
Udder size (cm^3)	0.578	0.720	0.132
Udder height of fore quarter	- 0.068	- 0990*	- 0.223
Udder height of rear quarter	- 0.168	- 0.990*	- 0.004
Levelness of udder	- 0.260	-	- 0.461

S.C.G = she-camel group, * = significant ($P < 0.05$), ** = highly significant ($P < 0.01$).

Rear teats diameter were 1.9±0.4, 2.3±0.4 and 3.7±0.5cm, respectively, indicating that rear teats in the three groups maintained a larger diameter compared to fore teats. The data in (Table 5) also showed that, for A, B and C groups, the distance between fore teats were 12.9±2.9, 13.2±1.2 and 13.5±2.9cm, respectively, while that between rear teats were 9.9±1.9, 10.1±1.1 and 10.2±1.9cm, respectively, suggesting that fore teats are generally positioned widely a part compared to rear teats. The distance between right teats were 2.6±1.3, 3.3±0.2 and 3.7±2.9cm, while that between left teats were 2.6±1.7, 2.4±0.6 and 3.7±1.3cm, for the three groups respectively.

Table (5): Teats measurements (cm).

Measurements	S.C.G		
	A	B	C
Fore teat length	3.4±0.8	4.1±1.0	6.0±0.7
Rear teat length	3.4±0.6	4.1±0.9	6.1±1.3
Fore teat diameter	1.7±0.3	1.7±0.2	3.1±0.4
Rear teat diameter	1.9±0.4	2.3±0.4	3.7±0.5
Distance between fore teat	12.9±2.9	13.2±1.2	10.2±1.9
Distance between rear teat	9.9±1.9	10.1±1.1	10.2±1.9
Distance between right teat	2.6±1.3	3.3±0.2	3.7±2.9
Distance between left teat	2.6±1.7	2.4±0.6	3.7±1.3

S.C.G = she-camel group.

Correlations between Teats Measurements and Daily Milk Yield: The data in (Table 6) showed that, the teat measurements including fore and rear teats length, rear teat diameter and distance between left teats did not score any significant correlation with daily milk yield in all groups. The fore teat diameter is found to be negatively correlated with daily milk in group C, ($r = -0.816$; $P < 0.05$).

Table (6): Pearsons correlation between teats measurements and daily milk yield

Measurements	S.C.G		
	A	B	C
Fore teat length	0.404	- 0.73	- 0.537
Rear teat length	0.605	0.214	- 0.227
Fore teat diameter	0.394	0.617	- 0.816*
Rear teat diameter	0.359	0.617	- 0.700
Distance between fore teat	- 0.697*	- 0.329	0.646
Distance between rear teat	- 0.678*	- 0.325	0.800
Distance between right teat	- 0.249	0.990*	0.899*
Distance between left teat	- 0.500	- 0.456	0.669

S.C.G = she-camel group, * = significant ($P < 0.05$), ** = highly significant ($P < 0.01$).

The distance between fore and between rear teats were also found to be negatively correlated with daily milk yield in group A, (r = - 0.697 and – 0.678, respectively, P < 0.05). On the other hand the distance between right teats was positively correlated with daily milk yield in both B and C groups (r = 0.990 and 0.899, respectively P < 0.05).

Milk Vein Measurements: The measurements of milk vein length and diameter were shown in (Table 7). The length of the milk vein in group C is the longest (93.3±1.8cm) followed by B (87.5±5.6) and the shortest milk vein was found in group A (84.9±9.3), pointing out that milk vein length increases with parity order. Similarly, for milk vein diameter group C scored 2.2±0.2cm, followed by A and B, which recorded 1.6±0.4 and 1.5±0.4cm, respectively.

Table (7): Milk vein measurement (cm)

Measurements	S.C.G		
	A	B	C
Length	84.9±9.3	87.5±5.6	93.3±1.8
Diameter	1.6±0.4	1.5±0.4	2.2±0.02

S.C.G = animal group

Correlations between Milk Vein Measurement and Daily Milk Yield: Pearsons correlation between milk vein measurements with milk yield are presented in (Table 8). No significant correlation is found between neither milk vein length nor diameter with milk daily yield in all groups (P > 0.05).

Table (8): Pearsons correlation between milk vein measurements and daily milk vein yield

Measurements	S.C.G		
	A	B	C
Length	0.369	0.369	– 0.147
Diameter	0.172	0.4491	– 0.176

S.C.G = she-camel group, * = significant (P < 0.05), ** = highly significant (P < 0.01).

DISCUSSION

The actual milk secreted was higher than the recorded values in this study, because calves were freely joining their dams and no sucking preventing measure were adopted. Moreover, milk yield was calculated from only three milking frequence, with consideration that the she-camel can be milked five

time or more. The daily milk yield in the present study coincide with values reported by (Mariam, 1988); (Bakheit, 1999) and (Salman, 2002) who referred that, daily milk yield under nomadic husbandry varied from 1.4 to 5liters. The three authoress practiced milking of 2 to 3time/day. Other authoress (Rao, 1974); (Al-Amin, 1979) and (Knoess, 1979) reported higher daily milk yield that ranging between 5 to 18kg. The daily milk yield showed progressive increase with the advancement of parity order. The daily milk yield in group A (parity 3) was 2.2±0.94 liters, which increase to 2. 9±0.45 liters in group B (parity 4) and further increased to 3.5±2.16liters in group C (parity 5). This phenomenon may be attributed to the normal physiological growth and development of the mammary gland. (Kulaeva, 1979) and (Bakheit, 1999) postulated similar justification for this trend. The difference in milk yield between the three parities, however did not indicate statistical significance, which may be referred to the small size of observation (only 8, 3 and 5observation for each parity). The majority of the udder measurements evaluated in the present study seemed to increase with increasing parity order. (Kamieniecki, 1980) reported that, in Polish Black–and – White low land cows, udder measurement increase with advancing lactation from lactation 1 to lactation 5. (Tibary and Anouassi, 2000) also confirmed this trend by reporting that, conformation of the udder can change according to breed, age and stage of lactation. The depth of the udder was reported to be highly correlated with milk yield in exotic cows as reported by the study of (Mali *et al.*, 1983), and (Saiyed and Patel, 1989). Their results is further confirmed by the preset data, especially for group A, which prooved that milk was significantly correlated with udder depth ($P<0.05$), while, for the other two groups (B and C) the analysis revealed insignificantly impact of udder depth on milk yield. The small number of observation in both group, may be responsible for the discrepancy, since only 3 and 5observations were recorded for groups B and C, respectively. Significant correlation between udder depth and milk yield was further confirmed by (Akhtar and Thakuria, 1998) in their study on Buffaloes. Despite the fact that the cited literature investigated udder depth and milk yield in cattle and not in camel as the present study, yet the difference of species in the present study and others in cattle does not jeopardize the value of the result. Depth of the udder is considered as one of the external feature on which selection of dairy cattle is based on, and its positive correlation with milk

yield is justified. The reasons underlying why compare-isons are cited with cows was the scarcity of such studies on camels. The impact of udder size on milk yield was found to be positive but insignificant, which was in disagreement with (Maskovskaja, 1967) and (Bogatyreva, 1970), who reported positive and significant correlation between udder size and milk yield in their study of exotic dairy cows. Furthermore, the measurements on udder vertical semi-circumference also verified insignificant correlation with milk yield. (Mishra *et al.*, 1978) postulated contradicting evidence in their finding that udder vertical semi-circumference was positively and significantly correlated with milk yield.

In this study, no correlation was found between daily milk yield and teat length. This finding is incompatible with the findings reported by (Hafeez and Nadiu, 1981) in buffaloes and (Narian *et al.*, 1986) in Jamunapari goats. Both authors documented the positive correlation between teat length and milk yield in the two species studied. The present results coincided with the data reported by (Wojcik and Czaja, 2002), and (Weiss *et al.*, 2004) who emphasized the negative correlation between teat length and milk yield in dairy cows.

CONCLUSION AND RECOMMENDATIONS

The results of this study concluded that some of the measurement of the she-camel udder proved to have an impact on milk yield. Parameters like udder depth, height of fore and rear quarters, fore teat diameter and distance between teats clearly indicated significant correlation between these traits and daily milk yield. Though, the results were not uniform in the three groups concerning these traits, it is likely that, the small number of observations recorded for groups B and C might have exerted their influence on the results obtained. The impact of milk vein measurements in milk yield need to be studied in large populations to verify more in this aspect.

The meager and scanty research in the literature dealing with these measurement in the camel and their correlation with milk yield added another facet of difficulty in the discussion chapter. Nevertheless, the present results offer a good base data upon which more studies and investigations would be welcomed.

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