



Relationship of udder morphometry with milk yield and body condition traits in Beetal goats

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ABSTRACT

Present study was conducted to find the relationship of udder morphometry with milk yield and body condition traits in Beetal goats. Beetal goats (60) having 4 different parities were used. Udder (length, column width, row width, depth, circumference, volume) and teat (length, diameter, circumference, height from ground, inter teat distance) morphological traits were recorded just before morning milking at fortnightly interval up to 3 months post-kidding stage. Simultaneously, milk yield (morning and daily) and body condition parameters (body condition score (BCS), sternal and lumbar thickness) were also recorded. All the udder morphological traits were positively correlated with morning as well as daily milk yield. Similarly, teat morphological traits were also positively correlated with morning as well as daily milk yield except teat height from ground which had negative correlation. Whereas some of the udder and teat morphological traits showed positive correlation with body condition parameters. Milk yield had positive correlation with BCS, sternal and lumbar thickness. It can be concluded that the udder and teat morphological traits have direct relationship with milk yield and body condition parameters in Beetal goats.

Key words: Beetal goats, Body condition traits, Milk yield, Udder traits

The goat population of India is 135.17 million which constitutes 26.4% of total livestock population (19th Livestock Census 2012). In Punjab, goat population has registered 11.9% increase from 0.29 million to 0.33 million between last two censuses (2007–2012). India is a leading goat milk producer in the world with 5.18 MT of goat milk (FAOSTAT 2014). Goat milk is recommended in the diets of children, adults and convalescents (Ribeiro and Ribeiro 2001). The increasing demand for goat milk is due to rising consumers' knowledge about nutritional and health benefits of goat milk products. Beetal or Amritsari goat has good potential as milch animal.

In goats, udder characteristics, milk production, milking time and rate are traits with adequate genetic variation to allow selection responses. A relationship between morphological udder measures and milk production has been noted in goats, although diverse criteria exist. Keskin *et al.* (2007) investigated the relationship between daily milk yield (DMY) and 10 udder traits (udder upper height (UH), udder bottom height (UBH), udder depth (UD), udder

width (UW), udder circumference (UC), left teat length (LTL), right teat length (RTL), left teat circumference (LTC) and right teat circumference (RTC), and teat angle (TA)) in Akkeci (Kilis × Saanen) crossbred goat. Studies have suggested that milk yield is positively associated with body condition score (BCS) in goats (Graff *et al.* 2012 and Susilorini *et al.* 2012, 2014). Koyuncu and Altincekic (2013) found that the body fat reserve in dairy goats bears importance in terms of milk production, fertility, feed consumption and general health of the animal. Morphological traits of udder in Beetal goats have not been studied in detail so far. Therefore, study of udder traits in Beetal goats and its relationship with milk production potential or body condition traits can be helpful in identifying most important udder or teat parameters for selection of high yielding animals.

MATERIALS AND METHODS

Experimental design: Study was conducted at Goat Research Farm, Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. A total of 60 female Beetal goats (1.5 to 5 years of age) kidded during year 2017–18 were used for taking observations. The goats belonged to 4 different parities i.e. first (30), second (11), third (10) and fourth (9).

Management of animals: Experimental Beetal goats in

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advanced stage of pregnancy (10–14 days before expected date of kidding) were shifted to kidding pen. These were housed in kidding pen having east-west orientation of long axis till the end of observational period of 95 days. Goats were fed maize-soybean meal-wheat bran-deoiled rice polish based concentrate mixture @ 500 g during lactation period. Concentrate feed (8:00 AM and 2:30 PM) as well as green fodder (11:00 AM and 4:00 PM) was offered twice in a day. Goats had been vaccinated against FMD, HS, PPR and ET as per schedule recommended by CIRG, Makhdoom.

Udder morphological traits: The udder morphological traits recorded at fortnightly interval were udder length (UL, length from rear to the front attachment of udder along with its sole, where the udder blends smoothly with the body); udder row width (URW, distance between the widest part of the udder measured from the rear end); udder column width (UCW, distance between the widest part of the udder measured from the lateral side); udder depth (UD, distance from the base to the lowest point of the udder at the place of attachment of the teats); udder circumference (UC, measured at maximum diameter of udder); udder circumference at base (UCB, circumference of the udder was measured at base of udder) and udder volume (UV, udder volume was measured by water displacement method).

Teat morphological traits: Various teat morphological traits recorded at fortnightly interval were teat length (TL, measured between line parallel to bifurcation of udder and tip of teat for right as well as left side); teat diameter (TD, measured at mid of the teat length using vernier calipers for right as well as left side); teat circumference (TC, measured at maximum diameter of teat for right as well as left side); teat height from ground (THG, distance between teat end and ground measured with the help of rigid measuring scale for right as well as left side) and distance between teats (DBT, distance between sphincter of the teats).

Body condition traits: Body condition traits included body condition score (BCS), thickness of sternal fold and lumbar thickness. Body condition scoring was done using visual cum palpation technique following nine-point scale i.e. 1 to 5 scale with increment of 0.5 point. The observations

were made in the morning before feeding. For sternal and lumbar thickness measurements, skin fold caliper with least count of 1 mm was used. In lumbar region at the L₄ position (4th lumbar vertebrae) measurement was taken with the help of skin fold caliper at approximately half distance of horizontal process away from the vertebral column. In the sternal region, thickness of brisket fold was measured at 3rd sternbrae position i.e. about two inches away from anterior end of sternum.

Milk yield: Milking of experimental goats was done twice a day i.e. morning and evening. Morning milk yield and total daily milk yield was recorded at fortnightly interval as per the schedule followed for all other parameters i.e. on 5th day to 95th day post-kidding.

Statistical analysis: Collected data were arranged and analyzed using standard statistical methods with SAS 9.3 software. Pearson's correlation technique was used for finding relationship between pairwise udder and teat morphological traits, body condition traits and milk yield.

RESULTS AND DISCUSSION

Correlations of udder morphological traits with milk yield were estimated and presented in Table 1. The udder morphological traits were positively correlated ($P < 0.01$) with morning as well as daily milk yield in Beetal goats, which indicates that increase in dimension of any of the observed udder morphological trait leads to increase in morning as well as daily milk yield during early lactation period. Akpa *et al.* (2003) reported correlation coefficients of udder circumference with each of total milk yield, initial milk yield and peak milk yield similar to present study. Earlier, Kumar *et al.* (1983) also indicated that the different levels of relationship appeared logical since the different measurements and udder volumes are a function of milk secreting activity of the mammary gland and the quantity of milk produced and stored in the udder. Emediato *et al.* (2008) suggested that all the udder measures had lower coefficients of correlation and, with the exception of udder depth, all were negative during pre-weaning period. While after weaning, measures of circumference, depth and volume of the udder had all significantly positive coefficients of correlation with milk yield. Significant

Table 1. Correlation of udder morphological traits with milk yield in Beetal goats

	MMY	DMY	UL	URW	UCW	UD	UC	UCB	UV
MMY	1								
DMY	0.872**	1							
UL	0.506**	0.423**	1						
URW	0.458**	0.351**	0.383**	1					
UCW	0.255**	0.328**	0.355**	0.163**	1				
UD	0.495**	0.500**	0.535**	0.414**	0.398**	1			
UC	0.568**	0.613**	0.492**	0.503**	0.382**	0.654**	1		
UCB	0.511**	0.578**	0.547**	0.421**	0.433**	0.642**	0.865**	1	
UV	0.713**	0.618**	0.500**	0.472**	0.188	0.539**	0.621**	0.565**	1

**Significant correlation at 1% level; UL, udder length; UCW, udder column width; URW, udder row width; UD, udder depth; UC, udder circumference; UCB, udder circumference at base; UV, udder volume; MMY, morning milk yield; DMY, daily milk yield.

correlations between udder traits, udder volume, body weight, milk yield, and milking traits in Murciano-Gradina dairy goat was suggested by Peris *et al.* (1999). Significant correlations between udder traits, viz. udder length, udder width, udder circumference, teat length, teat width, teat circumference, and udder volume etc. were obtained by Amao (2003) in Red Skoto goats. Similarly, positive significant ($P < 0.01$) correlation between udder traits, viz. udder depth, udder circumference, teat circumference and daily milk yield in Akkeci goats was noted by Siddik *et al.* (2005). A positive and significant correlation between average daily milk yield and doe's body weight at different intervals with udder morphological traits was found by Upadhayay *et al.* (2014).

Similarly, correlations of teat morphological traits with milk yield were estimated (Table 2). The teat morphological traits showed positive correlation ($P < 0.01$) with morning as well as daily milk yield in Beetal goats except that of teat height from ground. Teat height from ground was negatively correlated ($P < 0.01$) with milk yield as well as with other teat morphometric traits which showed that increase in teat height from ground leads to decrease in morning as well as total daily milk yield. Similar to present study, Upadhayay *et al.* (2014) observed that teat parameters, viz. teat length, distance between the teats, teat

diameter, and teat circumference had positive correlation with most of the teat parameters. THG had negative correlation with most of the udder parameters, which was similar to the study of Peris (1994) *i.e.* there was a negative correlation between milk production and teat-floor distance in Murciano-Granadina dairy goats. The correlation for distance between teats with milk yield was reported previously by Peris (1994) and Capote *et al.* (2000). Akporhwarho *et al.* (2010) also observed that there was a significant and high positive phenotypic correlation ($P < 0.05$) between udder and teat traits.

Several udder morphological traits were positively correlated ($P < 0.01$) with BCS and other body condition traits (lumbar and sternal thickness) in Beetal goats (Table 3). BCS had strong positive correlation ($P < 0.01$) with lumbar and sternal thickness traits. Udder depth and circumference were positively correlated with all three body condition traits (BCS, lumbar and sternal thickness). Some other udder morphological traits also showed positive correlation with certain body condition traits.

All the teat morphological traits (teat length, diameter, circumference, distance between teats) except teat height from ground were positively correlated ($P < 0.01$) with lumbar thickness trait in Beetal goats (Table 4). Teat height from ground was negatively correlated ($P < 0.01$) with all the body condition traits. Whereas, BCS had positive correlation ($P < 0.05$) with teat circumference alone. Results indicate that good body condition goats should have good teat morphometric traits as well. Alphonsus *et al.* (2010) noted positive correlation between BCS and udder height, udder width, teat length and teat placement while BCS had negative correlation with udder hock distance in crossbred cows. Relationship between BCS and udder or teat morphometric traits could not be cited with regard to goats for comparison with this study.

Milk yield had positive correlation with sternal thickness ($P < 0.01$), lumbar thickness ($P < 0.01$) as well as BCS ($P < 0.05$) (Table 5). During early lactation, BCS had positive association with milk production, negative with milk protein and no association with milk fat in *Peranakan Etawah* goats

Table 2. Correlation of teat morphological traits with milk yield in Beetal goats

	MMY	DMY	TL	TD	TC	THG	DBT
MMY	1						
DMY	0.872**	1					
TL	0.453**	0.334**	1				
TD	0.574**	0.480**	0.626**	1			
TC	0.617**	0.509**	0.587**	0.900**	1		
THG	-0.395**	-0.411**	-0.516**	-0.436**	-0.432**	1	
DBT	0.427**	0.292**	0.238**	0.360**	0.406**	-0.279**	1

**Significant correlation at 1% level; TL, mean teat length; TD, mean teat diameter; TC, mean teat circumference; THG, mean teat height from ground; DBT, distance between the teats; MMY, morning milk yield; DMY, daily milk yield.

Table 3. Correlation of udder morphological traits with BCS in Beetal goats

	UL	URW	UCW	UD	UC	UCB	UV	Sternal thickness	Lumbar thickness	BCS
UL	1									
URW	0.383**	1								
UCW	0.355**	0.163**	1							
UD	0.535**	0.414**	0.398**	1						
UC	0.492**	0.503**	0.382**	0.654**	1					
UCB	0.547**	0.421**	0.433**	0.642**	0.865**	1				
UV	0.500**	0.472**	0.188**	0.539**	0.621**	0.565**	1			
Sternal thickness	0.044	0.088	0.065	0.124*	0.195**	0.186**	0.038	1		
Lumbar thickness	0.130**	0.326	0.005	0.170**	0.206**	0.132	0.267**	0.551**	1	
BCS	0.069	0.225**	0.014	0.152**	0.180**	0.192**	0.099	0.543**	0.468**	1

Significant correlation at *5% and **1% levels, respectively; UL, udder length; UCW, udder column width; URW, udder row width; UD, udder depth; UC, udder circumference; UCB, udder circumference at base; UV, udder volume; BCS, body condition score.

Table 4. Correlation of teat morphological traits with BCS in Beetal goats

	TL	TD	TC	THG	DBT	Sternal thickness	Lumbar thickness	BCS
TL	1							
TD	0.626**	1						
TC	0.587**	0.900**	1					
THG	-0.516**	-0.436**	-0.432**	1				
DBT	0.238**	0.360**	0.406**	-0.279**	1			
Sternal thickness	0.031	0	0.026	-0.176**	0.014	1		
Lumbar thickness	0.310**	0.187**	0.213**	-0.207**	0.202**	0.551**	1	
BCS	0.046	0.084	0.097*	-0.193**	0.045	0.543**	0.468**	1

Significant correlation at *5% and **1% levels, respectively; TL, mean teat length; TD, mean teat diameter; TC, mean teat circumference; THG, mean teat height from ground; DBT, distance between the teats; BCS, body condition score

Table 5. Correlation of body condition traits with milk yield in Beetal goats

	DMY	Sternal thickness	Lumbar thickness	BCS
DMY	1			
Sternal thickness	0.156**	1		
Lumbar thickness	0.153**	0.551**	1	
BCS	0.109*	0.666**	0.813**	1

Significant correlation at *5% or **1% levels, respectively; DMY, daily milk yield; BCS, body condition score.

between BCS 2 to 4 as suggested by Susilorini *et al.* (2014). Few other studies also showed that BCS has high correlation with milk production and composition (Zahraddeen *et al.* 2009, Ahmed *et al.* 2010 and Pambu *et al.* 2011) as well as it affects the reproduction performance of dairy animals (Suharto *et al.* 2008 and Serin *et al.* 2010).

It is concluded that most of the udder as well as teat morphological traits have positive relationship with milk yield and body condition traits in Beetal goats which can be utilized as selection criterion.

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