MILK PRODUCTION AND BODY WEIGHT AT WEANING AND THEIR RELATIONSHIPS WITH BODY AND UDDER MEASUREMENTS IN MERIZ GOATS

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ABSTRACT

To investigate the correlation coefficients among the anatomical body structure and udder characteristics with each of body weight and milk production, 54 lactating Meriz does were randomly selected, kidded within 2 weeks in March, 2018. At weaning body weight as well as 6 body measurements and 8 udder and teat measurements were recorded. Also, Milk yield was recorded at weekly intervals till the does are dried-off. Results revealed moderate positive correlations between body measurements and milk production, while highest correlations were observed between udder measurements and milk production. Also, there was a strong positive correlation between body weight and body measurements. Four components were found meaningful; the first component was labeled as the 'teat dimensions' factor, 'udder dimensions' factor is a second component and the combination of the third and fourth component was interpreted as the 'body dimensions' factor. Therefore, the best predictors for body weight was rump height, heart girth and body length. Also, udder length, udder width, distance between teats and teat dimension were best predictors for milk production.

***Keywords*: milk yield, body weight, body conformation, udder dimension, goat**

انتاج الحليب ووزن الحيوان عند الفطام وعلاقتهم بقياسات الجسم والضرع في ماعز المرعز

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المستخلص

لدراسة معامل الارتباط بين قياسات الجسم وقياسات الضرع وعلاقته بوزن الحيوان و انتاج الحليب،تم استخدام 54 معزة مرعز حلوب والدة خلال اسبوعين في شهر اذار، 2018. عند الفطام تم وزن الحيوانات واخذ 6 قياسات للجسم و8 قياسات للضرع كما تم تسجيل انتاج الحليب اسبوعيا لحين جفاف الاناث. اظهرت النتائج بوجود ارتباط موجب متوسط بين قياسات الجسم وانتاج الحليب، بينما كان الارتباط بين انتاج الحلي وقياسات الضرع عالي المعنوية. تبين وجود اربعة مكونات، والاول تمت تسميته بعامل "قياسات الحلمة" والثاني "قياسات الضرع" وخليط من الثالث والرابع اطلق عليه بعامل "قياسات الجسم" وعليه فان افضل تنبوء لوزن الجسم هما ارتفاع الحيوان عند منطقة الورك ومحيط الصدر وطول الجسم. كما يعد طول الضرع وعرضه والمسافة بين الحلمات وقياسات الحلمة افضل المؤشرات لانتاج الحليب.

الكلمات المفتاحية: انتاج الحليب، وزن الحيوان، ابعاد الجسم، ابعاد الضرع، الماعز

***Received:5/8/2018, Accepted:15/11/2018**

INTRODUCTION

Meriz goats are found in the northern border of Iraq (Kurdistan region), and it is utilized mainly for hair production as well as it is a source of milk and meat production (2, 3). The direct measurement of the udder was used for appraisal of udder morphology (9). The relationships between udder measurements and milk yield in Meriz goats have been demonstrated by Merkhan and Alkass, (11) who observed a positive and highly significant correlation among milk production and each of udder circumference and udder length in black goats, whereas others found low correlations between udder measures and level of milk production (10). Traditionally, farmers depend on milk production for selection criteria, rather than taking an account for udder morphology (4). Similarly, Pesmen and Yardimci (13) in lactating Saanen goats and Khan et al. (7) at different ages and sexes of goats observed that body weight were strongly correlated with different body measurements and Kominakis et al. (8) found that body weight can be predicted by using body measurements. Yet, so far inter-relationship among body and udder measurement within body weight and milk yield is not fully elucidated. Previously, correlation coefficient and multiple regressions are being used to analyze the relationship between morphological traits and production. However, this finding has restrictions due to interrelation of large number of traits (8). However, in case of availability of possible important independent variable list, the variable selection, i.e. the 'subset' choice of variables becomes an important task to provide the best prediction model. The multiple regression stepwise (MRS) is a common method and automatic procedure that deals with this. In spite of the problem and limitation of this technique, it is enjoys widespread use (8). The model selection bias is the first problem. The selected model may be affected by the number of candidate parameters and level of parameter entry and the algorithm used is the second problem. A third and last problem is that a single stepwise regression includes a considerable number of tests performing in high likelihood of Type I and II errors and does not illustrate one hypotheses test. A sole product of analysis is identifying a single "best" model aiming as a final source of concern (15). In Iraq, there is a paucity of information on body structural measurements and its association with body weight in goat, particularly in Meriz. Therefore, the objective of the current study was to depict the best subset of 12 bodies' structural and udder morphological characteristics that could be used as predictors of body weight and milk yield after weaning in Meriz goat by means of multiple regressions stepwise techniques.

MATERIALS AND METHODS

Experimental animals and data :The study was implemented in a commercial flock of Meriz goat, where 54 lactating does kidded during two weeks in March, 2018. Kids were kept with their dams till weaning (2-3 months). During the suckling period, does were milked once daily whereas at post weaning does were milked twice daily, until drying. Milk yield (MY) was recorded at a weekly intervals beginning from weaning because usually the farmers allowed the kids to suckled their dams till weaning only, and after that they milked the does for commercial purposes, as well as body weight was recorded at weaning by digital balance.

Body and udder measurements

Following weaning and prior to milking 6 body measurements and 8 udder measurements were recorded for all does by means of T-ruler, tape measure and digital caliper. The following body anatomical structures were measured: rump height (RH), wither height (WH), sternum height (SH), body length (BL), and chest depth (CD) measured by the aid of T-Ruler and heart girth (HG) was measured by measuring tape, as described by (8). The udder traits were measured as described by Merkhan, (12), including: udder circumference (UC) and udder length (UL): from the udder cleft to the fore attachment by using tape. By using a digital caliper, the udder width (UW) and distance between teats (DBT), as well as length and diameter of both teat were measured and averaged to be teat length (TL) and teat diameter (TD) as one measure for each (Figure 1).

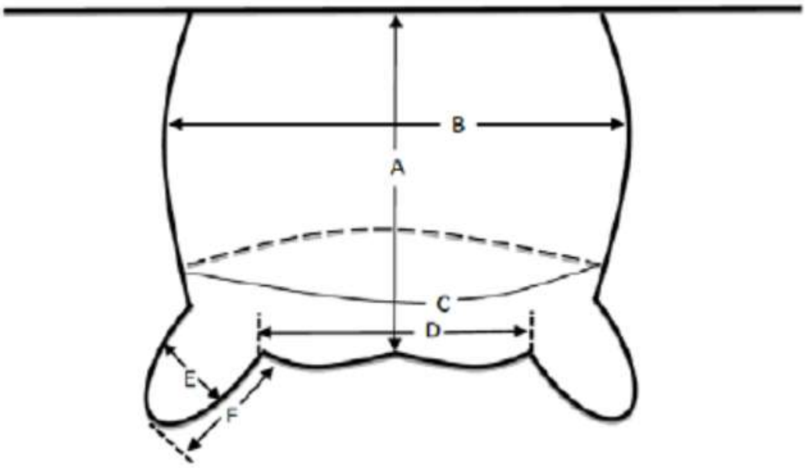

Figure 1. Morphological parameters measured on udder and teats of ewes. A: udder length, B: udder width, C: udder circumference, D: distance between teats, E: teat diameter, F: teat length (Merkhan, 2014).

Data management and analysis

At first, descriptive statistics were calculated. These included means, standard error, standard deviation and coefficient of variation for all traits. In order to test for any associations among studied traits, Pearson's correlation coefficients for the body, udder and teat measurements, were computed, whereas, Principal Component Analysis (PCA) was used to perform further exploration of the body, udder and teat measurements traits and to form new uncorrelated variables. Only principal components (PCs) with eigenvalues >1 were considered (Kaiser's rule) and was used as new uncorrelated variables. Multiple regression stepwise (MRS) analysis was also employed to detect significant associations between the dependent variables, i.e. body weight (BW), milk yield at weaning (MY1), test day milk yield (TDMY) and post weaning milk yield (TMY) as well as with the individual independent measurement traits, i.e. the body structural, the udder measurements and teat measurements. All data analyses were performed using SAS version 9.1 (14).

RESULTS AND DISCUSSION

Descriptive statistics

Means, standard error, standard deviations and coefficient of variation of various milk, body and udder traits are given in Table 1. Average milk yield at weaning, post-weaning test day milk yield and total post-weaning milk yield were 351.6 ml, 300.2 ml and 14.38 Lt, respectively. udder circumference, udder length, udder width, distance between teats, teat diameter and teat length were 29.61 cm, 5.35 cm, 104.17 mm, 77.83 mm, 19.94 mm and 35.33 mm, respectively. Rump height, wither height, sternum height, chest width, heart girth and body length and body weight averaged 60.03 cm, 57.09 cm, 28.97 cm, 17.02 cm, 76.8 cm, 54.86 cm and 36.37 kg, respectively (Table 1).

Table 1. Means, standard errors (SE), standard deviations (StDev) and coefficient of variation (CV) for milk, body weight, as well for body, udder and teat traits of Meriz does

Variable	Abbreviation	Mean	SE Mean	StDev	CV
Body weight	BW	36.37	0.667	4.67	12.83
Milk yield at weaning (ml)	MY1	351.6	21.7	151.9	43.19
Post-weaning test day milk yield (ml)	TDMY	300.2	17.3	121.2	40.37
Total post-weaning milk yield (Lt)	TMY	14.38	1.08	7.57	52.59
Rump height (cm)	RH	60.03	0.56	3.89	6.48
Wither height (cm)	WH	57.09	0.47	3.29	5.76
Sternum height (cm)	SH	28.97	0.75	5.22	18.03
Chest width (cm)	CW	17.02	0.22	1.55	9.09
Heart girth (cm)	HG	76.81	0.66	4.60	5.99
Body length (cm)	BL	54.86	0.46	3.26	5.93
Udder circumference (cm)	UC	29.61	0.66	4.64	15.67
Udder length (cm)	UL	5.35	0.21	1.47	27.47
Udder width (mm)	UW	104.17	2.44	17.11	16.43
Distance between teats (mm)	DBT	77.83	2.58	18.04	23.18
Teat diameter (mm)	TD	19.94	1.19	8.31	41.66
Teat length (mm)	TL	35.33	1.84	12.88	36.47

Correlation coefficient

Correlation coefficients of the body measurements are demonstrated in Table 2. There was a positive correlation of moderate to high magnitude among the rump height and other body measurements ranging from 0.34 (with CW) to 0.845 (with WH). Also, wither height was positively and significantly correlated with each of sternum height, body length and heart girth (0.468, 0.401 and 0.362, respectively). Similarly, Pesman and Yardimci, (13) observed a strong relationship among different body measurement in two groups of lactating saanen goats.

Table 2. Correlation coefficient between body measurements of Meriz does

Trait	RH	WH	SH	CW	HG
WH	0.845**				
SH	0.377**	0.468**			
CW	0.340*	0.275	-0.033		
HG	0.272	0.362*	0.170	0.287	
BL	0.405**	0.401**	-0.012	0.218	0.152

RH: rump height; WH: wither height; SH: sternum height; CW: chest width; HG: heart girth and BL: body length Non significant or p > 0.05. * p≤0.05. ** p≤0.01.

Correlation coefficients of udder and teat measurements are illustrated in Table 3. Udder circumference was positively correlated with UL (r=0.329) and UW (0.482) as well as UL with UW (r=0.399). Also, UW positively and highly significantly correlated with DBT (r=0.505), TL (r=0.462) and TD (r=0.390). While, DBT were negatively and highly significantly correlated with teat measurements (TD and TL) (r=-0.416 and r=-0.417, respectively). Furthermore, TD was positively and highly significantly correlated with TL (r=0.907). The strong relationships among udder measurements observed in the current study, is in agreement with the finding of Merkhan and Alkass, (11) under farm condition in Meriz goats who found that UW was positively (P<0.01) correlated with DBT (0.62) as well as UC with UL (0.895) (P<0.01). Also, Akpa et al. (1) reported that the udder measurements are positively and highly significant correlated with each other.

Table 3. Correlation coefficient between udder and teat traits of Meriz does

Trait	UC	UL	UW	DBT	TD
UL	0.329*				
UW	0.482**	0.399**			
DBT	0.256	0.162	0.505**		
TD	0.273	0.279	0.390**	-0.416**	
TL	0.237	0.215	0.462**	-0.417**	0.907**

UC: udder circumference; UL: udder length; UW: udder width; DBT: distance between; TD: teat diameter; TL: teat length. * p≤0.05. ** p≤0.01.

Correlation coefficient of the body structures, udder and teat measurements with each of live body weight and milk production are presented in Table 4. It appears from Table 4, with the exception of body length and chest depth, there is a positive and significant correlation among body measurements and milk production. Whereas, the highest correlations were observed between udder measurements and milk production *r*=0.572 (MY1-UW), *r*=0.625 (TDMY-UL) and *r*=0.577 (TMY-UW). With regard to body weight, there were a positive correlations of moderate (teat measurements) to high magnitude (body measurements) with body weight ranging from *r*=0.437 (BW-TD) to *r*=0.617 (BW-WH). Also, Pesmen and Yardimci (13) in lactating Saanen goats and Khan et al. (7) at different ages and sexes of goats observed that body weight were strongly correlated with different body measurements. Also, Kominakis et al (8) using 14 body and udder measurements to predict body weight and test day milk yield at first and second test in Frizarta dairy sheep, reported that body weight were strongly associated with body measurements. The present study revealed a moderate relationship among udder measurements and milk production in Meriz goats. Similarly, Merkhan and Alkass (11) observed that TMY was positively and significantly related with UL and DBT and none significantly with UC and UW. Das and Sidhu (5) reported that there were positive correlation coefficients among milk yield and udder measurements.

Table 4. Correlation coefficients between body, udder and teat measurements with milk production and live body weight in Meriz goats.

Traits*	MY1	TDMY	TMY	BW
Rump height	0.319*	0.391**	0.302*	0.590***
Wither height	0.342*	0.396**	0.291*	0.617***
Sternum height	0.543***	0.473***	0.539***	0.240
Body length	0.063	0.094	0.081	0.490***
Heart girth	0.353*	0.331*	0.215	0.602***
Chest Depth	0.046	0.135	-0.073	0.440**
Udder circumference	0.460***	0.431 **	0.261	0.263
Udder width	0.572 ***	0.609***	0.577***	0.557***
Distance between teats	0.158	0.172	0.135	0.139
Udder length	0.544 ***	0.625***	0.445 ***	0.526***
Teat diameter	0.375 **	0.427**	0.275	0.437**
Teat length	0.365*	0.391**	0.299*	0.467***

*** BW: body weight, MY1: milk yield at weaning, TDMY: test day milk yield and TMY: post weaning milk yield.**
*** p≤0.05. ** p≤0.01. *** p≤0.001**

Principal components analysis

The component matrix describing the relationships between the principal components and studied traits are tabulated in Table 5. It appears only the first four components were found meaningful and thus, were retained for orthogonal rotation, and explained 52.53, 29.05, 13.41 and 7.85 of the total variation among the 12 studied traits. The two teat measurements, i.e. TD and TL were found to load on the first component with factor loadings 0.83 and 0.89, respectively. This component was thus labeled as the 'teat dimensions' factor. A second component formed by the udder measurements with highest loading scores was UW (0.76) followed by DBT (0.69) and finally UC (0.51); therefore, it could be characterized as the 'udder dimensions' factor. Rump height (RH), WH and BL were found to load on factor 3 with scores 0.70, 0.66 and 0.54, respectively, and RH, WH and SH were found to load on the fourth component. The combination of the two factors was interpreted as the 'body dimensions' factor. In this study, a linear combination were derived with the use of Principle Components (PCs) which gain enough information found in original variables (udder traits) as well as additional hypotheses concerning Meriz does morphological patterns. Teat, udder and body dimensions were the three main respective PCs, while the fourth component was merged with the third one. Genetic improvement programs could be based on these three PCs for the selection purposes. However, it's not desirable to depend on single trait for such selection programs which might cause the disruptions to other correlated traits and due to this, such inconvenience should be avoided while calculating and using PCs. Labour demand and high cost are the main difficulties when using linear combination of directly udder traits measurement in such genetic improvement schedules (6). However, based on the selection purpose, reduction in number of measurement required might make this program feasible and the end selection could be based on fewer selection traits. Although effort and cost might remain the main problems, implementation of such practice should be done in flocks which are nucleus pure-bred (6).

Table 5. Rotated factor pattern and final communality estimates (c) from principal components analysis on body, udder and teat traits.

Traits	Component				
	1	2	3	4	(c)*
Rump height	0.06	0.19	0.70	0.50	0.79
Wither height	0.01	0.23	0.66	0.59	0.83
Sternum height	0.13	0.10	-0.002	0.70	0.52
Body length	0.16	-0.07	0.54	-0.01	0.31
Heart girth	0.31	0.33	0.23	0.20	0.30
Chest Depth	0.20	0.07	0.38	-0.01	0.19
Udder circumference	0.15	0.51	-0.09	0.38	0.43
Udder width	0.07	0.76	0.12	0.20	0.64
Distance between teats	-0.56	0.69	0.11	-0.02	0.80
Udder length	0.07	0.34	0.16	0.41	0.32
Teat diameter	0.83	0.05	0.21	0.18	0.77
Teat length	0.89	0.05	0.20	0.12	0.86
Eigenvalue	3.46	1.91	0.88	0.52	Total=6.77
Variance explained (%total)	52.53	29.05	13.41	7.85	

*** (c): final communality estimates**

Multiple regression analysis

Results of the different variable selection criteria are shown in Table 6. The highest R^2 and the lowest AIC were used to select the best model for predicting body weight and milk productions from body, udder and teat measurements. In case of BW, variables selected were: RH, HG and BL recording the highest R^2 (62.28), and these known as a third and fourth factor of PCs (body dimensions). With regards to the milk productions there were, however, various results observed between the MY1, TDMY and TMY. More specifically, TMY selected the highest number of predictors namely: UL, UW, DBT and TL followed by the TDMY (UL, UW and TD) and the MY1 (UL and UW). As a result, the predictive ability as depicted by R^2 was highest in TDMY (56.58), and lowest (44.58) in MY1, and these known as a first and second factors of PCs (teat and udder dimensions). Therefore, the best equations for predicting BW and milk productions will be as follow:

BW=-46.9+0.423 RH +0.471 HG+0.397BL

MY1 = - 246 + 38.9 UL+ 3.74 UW

TDMY= -213+35.5 UL+ 2.65 UW+2.34 TD

TMY= - 8.96+1.26 UL+0.445 UW-0.256 DBT-0.278 TL

In the present study, a strong relationship between body measurements and body weight in Meriz goat was found. All the body measurements that accounted for a remarkable amount of the body weight variation could be represented as a one component. Furthermore, individual body measurements particularly rump height, heart girth and body length could be adequately used to predict body weight. Similarly, Kominakis et al. (8) found that body weight can be predicted by using body measurements, while, this was not the case for milk yield, and observed that CG, BL, CW and WH were used as predictors in selecting body weight. The significant predictor of milk productions is the combination of the udder length with udder width (or distance between teats) as well as TL and/or TD. Similar finding has been reported by Kominakis et al (8) who observed that UC, UW, UH and TL can be used as a predictors in selecting TDMY at first and second tests in Frizarta dairy sheep. Also, Merkhan (12) indicated that UC, TD and TL could be used as predictors for selecting milk productions in Awassi ewes.

Table 6. Prediction variables of body weight and milk productions according to the subset variables selection module.

Dependent variable*	Independent variable**	R^2 (X100)	AIC***
BW	RH, HG, BL	62.28	110.19
MY1	UL, UW	44.58	468.32
TDMY	UL UW TD	56.58	436.2406
TMY	UL UW DBT TL	46.57	176.5871

*** BW: body weight, MY1: milk yield at weaning, TDMY: test day milk yield and TMY: post weaning milk yield.**

**** RH: rump height, HG: heart girth, BL: body length, UL: udder length, UW: udder width, TD: teat diameter, DBT: distance between teats and TL teat length**

***** AIC: Akaike information criteria**

According to the mentioned results, it's concluded that body measurements strongly related with the body weight was established with most important predictors for body weight being: rump height, heart girth and body length. Body and udder measurements were found to be moderately and strongly associated with milk productions, respectively in Meriz goats with most important predictors for milk productions being: udder length, udder width, distance between teats and teat dimensions. Finally, further studies are needed to scan genome of Meriz goats for any possible Quantitative Trait Loci that might affect udder morphology.

ACKNOWLEDGMENTS

The author wishes to thank Prof. Dr. Jalal E. Alkass, Animal Production Department, College of Agriculture, Duhok University for his valuable help in reading the manuscript.

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