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A Study of Relationships Between Milk Yield and Some Udder Traits by Using of Path Analysis in Akkeçi Goats

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Abstract: The aim of this study was to determine relationships between some udder traits [Undder Bottom Height (UBH), Udder Depth (UD), Udder Circumference (UC), Left Teat Circumference (LTC), Right Teat Circumference (RTC) and Teat Angle (TA)] and Daily Milk Yields (DMY) of Akkeçi goats. For this purpose, data were collected from 30 goats. Correlations and path analysis were executed for identify the significant contribution of the udder traits on daily milk yields. As a result, this study indicated that these traits especialy, udder circumference and udder bottom height could be used as selection criterias for milk yields in Akkeçi goats.

Key words: Correlation, Daily milk yield, Direct and indirect effect, Path analysis and Udder traits

Introduction

Animal breeding may decrease the deficiency in milk production by developing higher yielding crosbreds under the severe conditions. For this purpose, higher yield breeds should be developed by selection from population. In selection programes, one of the important criterias is to investigate of relationships between milk yields and some udder traits used by animal breeders for selecting appropriate animals. The success of selection depends on choice of selection criteria for improving daily milk yields. Because, some traits that important for selection may affect directly and, inderectly on milk yields. For that reason, simple correlation coefficients between response variables and predictor variables may not be appropriate for explaining of complex relationships. However, path analysis can be more suitable for determining relationships between considered traits than correlation coefficients. Path analysis method measures a direct and indirect effect of one variable on another and also separates the correlation coefficient specified any variables into components of direct effect, indirect effect and compounds path according to the constructed path diagram. In other words, the method involves partitioning the correlation coefficient into direct effect, indirect effect through alternate pathway. Therefore, it provides a more precise determination than correlation analysis of relative importance of each factors. Path analysis as an analytical tool has potential application in studies for separating and quantifying closely associated variables (Ssango *at al.,* 2004). Furthermore, path analysis can be used to obtaine some selection criterias in animal breeding. Path analysis is closely related to multiple regression was originally developed by (Wright, 1921) and path coefficient is a partial regression coefficient obtained from the equation where all variables have been expressed as deviation from the mean in units of standart deviation (Sokal and Rholf, 1995)

The objective of this study was to obtain useful information on the relationhips between daily milk yields and some udder traits for developing the different selection criterias and present apropriate selection programe in Akkeçi Goats.

Materials and Methods

The primary aim of this study was to determine the effect of some udder traits on milk yields obtained from 30 Akkeçi crosbreeding goats (Saanen 75% x Kilis %25 breeds) in Turkey. To achieve this aim, common multiple regression procedures were used to fit the following model:

$$DMY = b_0 + b_1\, UBH + b_2\, UD + b_3\, UC + b_4\, LTC + b_5\, RTC + b_6\, TA + error$$

where daily milk yield was considered as a linear function of udder bottom height (UBH), udder depth (UD), udder circumference (UC), left teat circumference (LTC), right teat circumference (RTC) and teat angle (TA) independent traits. Because, the data for all traits were standardized, obtained partial regression coefficients from the above equation are called path coefficients or standardized partial regression coefficients. These allow direct comparison of values to reflect the relative importance of independent variables (traits) to explain variation in the dependent variables or traits (Leymaster *et al.,* 1985; Sihag *et al.,* 1986; Singh *et al.,*1998; Sokal *et al.,*1995 and Seker *et al.,* 2004).

In the above model, DMY is called dependent variable, endogenous variable or response variable and it is showed by "Y". Simillary, UBH, UD, UC, LTC, RTC and TA are called independent variables, exogenous variables or predictor variables and showed by $X_1, X_2, \ldots, X_p$ (p is the number of independent variables). Significance of each path coefficients in the statistical model were tested by t- test. In the path analysis, indirect effect of independent variables play an important role on the dependent variable (Ulukan *et al.*, 2003). Also indirect effect of all independent variables on dependent variable were calculated. For example, indirect effect of X_i (IE_{YXi}) via X_k on Y can be calculated by the following equation:

$$IE_{YXi} = r_{xixk} P_{YXk}$$

where, r_{xixk} is correlation coefficient between X_i and X_k variables, P_{YXk} is path coefficient of X_k variable. MINITAB for Windows (Ver: 13.0) statistical packet programme was used for all of the calculations (Anonymous, 2000).

Results and Discusion

Descriptive statistics and correlation coefficients for all traits were shown in Table 1 and Table 2.

Table 1: Descriptive statistics for all traits

Traits	N	V	Minimum	Maximum
UBH (cm)	30	29.967±0.600	22.50	35.50
UD (cm)	30	13.825±0.416	8.00	18.00
UC (cm)	30	46.070±1.300	26.00	61.00
LTC (cm)	30	2.115±0.140	1.40	4.60
RTC (cm)	30	2.025±0.133	1 .00	4.60
TA (°)	30	32.450±0.828	23.00	46.00
DMY (g)	30	624.000±47.000	100.00	1150.00

Table 2: Correlation coefficients among all traits

	UBH	UD	UC	LTC	RTC	TA
UD	0.003					
UC	-0.223	0.845^{**}				
LTC	-0.311	0.418^{*}	0.512^{**}			
RTC	-0.228	0.393^{*}	0.482^{**}	0.783^{**}		
TA	-0.447^{*}	0.491^{**}	0.544^{**}	0.454^{**}	0.526^{**}	
DMY	-0.671^{**}	0.473^{**}	0.721^{**}	0.703^{**}	0.606^{**}	0.663^{**}

*:P<0.05, **:P<0.01

All of the correlation coefficients between daily milk yields and udder traits were significant at 1% level. Furthermore, only 11 of the correlations among the udder traits were statisticaly significant. However, simple correlations measure all associations between two variables whether influenced directly or indirectly. Thus, it was needed path analysis. Path analysis results were illustrated in Table 3.

Table 3: Results of path analysis

	UBH	UD	UC	LTC	RTC	TA
UBH	-0.405^{**}	-0.001	-0.131	-0.092	-0.008	-0.034
UD	-0.001	-0.195	0.494	0.124	0.014	0.037
UC	0.090	-0.164	0.585^{**}	0.152	0.017	0.042
LTC	0.126	-0.082	0.299	0.297^{*}	0.028	0.035
RTC	0.092	-0.077	0.282	0.233	0.036	0.040
TA	0.181	-0.096	0.318	0.135	0.019	0.076

*:P≤0.05, **:P≤0.01, R^2 = 0.848

According to the results, coefficients of the variables in the model can be written as following;

$$DMY = -0.405\,UBH - 0.195UD + 0.585UC + 0.297LTC + 0.036RTC + 0.076TA.$$

The direct effect of the traits on daily milk yield were significant, except for direct effect of udder depth, right teat circumference and teat angle (Table 3).

Daily Milk Yield vs Udder Bottom Height: The correlation coefficient between udder bottom height and milk yield

(-0.671) was negative and significant as well as direct effect of this trait on milk yield (P< 0.01). The negative correlation between daily milk yield and udder bottom height was largely due to the direct effect of udder bottom height on milk yields.

Daily Milk Yield vs Udder Depth: The correlation between udder depth and daily milk yields (0.473) was significant (P<0.01), but the direct effect of udder depth was negative and non-significant. So, it can be concluded that the correlation between udder depth and daily milk yields was largely due to indirect effect via udder circumference and left teat circumference.

Daily Milk Yield vs Udder Circumference: Path Coefficient (PC) or direct effect of udder circumference on daily milk yields has the highest value (PC = 0.585). The indirect effect of this variable via udder depth on milk yield (-0.164) was negative while indirect effect via left teat circumference was positive. Similary, other indirect effects via udder bottom height, rigth teat circumference and teat angle were positive and negligable. So, it can be seen that the correlation coefficient between udder circumference and daily milk yields (0.721) was largely due to the direct effect of udder circumference. Path coefficient value indicated that the 34.2 % of variation ($0.585^2 = 0.342$) in milk yield was accounted for by direct effect of udder circumference.

Daily Milk Yield vs Left Teat Circumference: The correlation coefficient between left teath circumference and daily milk yield (0.703) and also direct effect of left teath circumference (0.297) were significant. Furthermore, indirect effect of this trait via left teat circumference was nearly equal to the direct effect of this variable. On the other hand, indirect effect via udder bottom height on daily milk yield was positive and moderately high.

Daily Milk Yield vs Rigth Teat Circumference: The right teat circumference had positive and non-significant direct effect while the correlation coefficient between this trait and daily milk yield was significant. The indirect effect of this traits via udder circumference (0.282) and left teat circumference (0.233) on milk yield were considerable high. It can be seen that largely amount of correlation coefficient between daily milk yields and rigth teat circumference consists of indirect effecs of this traits via udder circumference and left teat circumference. Rigth teat circumference doesn't affect the daily milk yields directly. However, it affects via udder circumference and left teat circumference indirectly.

Daily Milk Yield vs Teat Angle: The correlation between teat distance and daily milk yields (0.663) was significant but direct effect of this trait non-significant. The indirect of this trait via udder circumference on milk yield was considerable high as well as udder bottom height and left teat circumference. So it can be seen that the positive correlation coefficient between daily milk yield and teat angle consists of indirect effects of this trait via udder circumference, udder bottom height and left teat circumference.
The determination coefficient of the model was found as 84.8 % ($R^2 = 0.848$) and it can be purposed that this model may be adequate for explaining of daily milk yield by using of these udder traits

Conclusions

In the study, path analysis indicated that udder circumference have the highest direct effect on daily milk yields followed by the udder bottom height. Increased daily milk yields was associated with increased udder circumference. The animals have higher udder circumference have also higher daily milk yield. On the other hand, because of negative direct effect of the udder bottom height, high udder bottom height animals have low daily milk yields. The high correlation coefficient (0.663) between daily milk yield and teat angle could give erroneous impression that teat angle has a large direct effect on daily milk yield, however, path analysis revealed that its direct effect was negligable and influence on daily milk yield was indirect via udder circumference, udder bottom height and left teat circumference. Similar impression is valid udder dept. In both these instances, the contradiction between two analysis is due to the fact that correlation simply measures mutual association without considering the causality whereas path analysis specfies the basic causes and measures their relative importance. Therefore, it would appear that as a supplement to simple correlation and the path analysis can provide a true picture of association between daily milk yield and some udder traits.
It can be purposed that these traits especialy udder circumference and udder bottom height may be used as criterias for selecting animals, because these don't require any special analytical equipment and training.

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