Comparison of Different Lactation Curves Models in Saanen Goats

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Abstract

Monthly 71 lactation records were collected from Saanen dairy goats in private farms. Three different lactation curve models were then comparatively examined for these data.The purpose of this study was to examine the models of lactation curve of purebred dairy goats and make some suggestions concerning appropriate mathematical model.

The following three models were used to describe the milk production:

R^2 values obtained from model (3) were all greater than those found from other models (1,2).In addition, the Mean Square Error (MSE) of model 3 was lower than the Mean Square Error (MSE) of the other 2 models.Hence model (3) was seen to be superior to other models.

Key words : *Lactation Curve, Persistency, Milk Yield, Coefficient of Determination, Multiple Regression Analysis.*

Introductıon

Characters of economic importance is livestock are influenced by numerous factors. If production is defined as a function of constants and variables, then a genetic control for these components may provide a useful device for livestock improvement.

So that a modelling of lactation curve in dairy cattle possesses some useful properties in its practical application. The characters which may be derived directly from the model of lactation curve are: the maximum daily milk yield, the time when the maximum daily milk yield reaches, the persistency of lactation that expresses the rate of decline in daily milk yield and estimated total milk yield (Kayaalp and Bek, 1991).

The goat is in the Capra genus of the Bovidae family. It is a horned ruminant. It has been highly valued by humans since the beginning of agriculture and animal husbandry. The goat was first domesticated in the region of the eastern Mediterranean called the "fertile crescent"

High productivity in terms of milk quantity and milk-percentage fat are the most desired characteristics in dairy goats. Dairy goats have an advantage over cows in that they have early development, high kid productivity, shorter gestation period and intergenerational period compared to other species, easy care and management, more resistant to diseases and parasites, have very high milk yields in relation to their live weight, and can give milk up to 10-15 times their own weight in one milking period (Güney, et.al.,2006).

The Alpine goat is a breed that takes its name and origin from the alps and is widely raised in France and the United States. Its ancestors are the Pashang goats that migrated to the alps approximately 15,000 years ago. The most well-known of the Alpine goats is the French alpine. Other members of this breed are the American and Swiss alpines. Dairying characteristics are prominent. The Alpine goat is a breed of Swiss origin and is known as excellent dairy goats with good shape and large teats. Most composite breeds contain the Alpine lineage.It attracts attention due to its large size and high milk yield and can easily adapt to most climates (Batra et.al.,1987).
Ferris et al. 1985, compared lactation curve patterns in dairy cattle to use as selection criteria.

In underdeveloped countries where cow milk is insufficient or cannot be consumed, goat milk and its products are very valuable as they constitute a daily source of food, protein, phosphorus and calcium for people.

The main purpose in animal husbandry is to increase the unit yield per animal. There are two ways to do this: improving the genotype and improving environmental conditions (Kayaalp and Bek 1991).

Damascus goats are considered the most locally important genetic resources in Syria, due to their higher productivity and reproductive ability under harsh environmental conditions. Therefore many countries in the world have important the Damascus goats to genetically improved their local breeds (Güney et al., 2006).

Ayasrah, et.al., 2013, estimated the lactation curve parameters and average milk yield in Syrian Damascus goats using Wood's model. They also estimated the heritability as 0.09+0.01.

Almasri, et.al., 2023, estimated the lactation curve parameters and average milk yield in Syrian Damascus goats using Wood's model.

Batra et al. (1997) estimated the parameters of different models of lactation curve in Holsthein cattle.

Shanks et al.(1981) studied the genetic aspects of the lactation curve.

Peak yield in goats usually occurs between 30-45 days after birth. To find the actual milk yield, milk should be measured every day, every milking throughout the lactation.

The term “lactation curve” is used to refer to the curve representing the ratio of lactation duration and milk yield (Almasri et.al,2023).

Takma, et.al. (2009) stated that many methods are used in determining the shape of the lactation curve and the model/models that best express lactation in Saanen and Bornova goats.

The daily yields determining the shape of the lactation curve of dairy cows are affected by genetic and environmental factors such as body weight, age of cow, dry period, rations, season, temperature and humidity (Schmidt and Van Vleck, 1974). The parameters of the lactation curve could be changed through selection (Shank et. al.,1981) changing the lactation shape by selection is small.

The first lactation curve model was introduced by Wood in 1967. Later, lactation curve models were studied by Grossman et al (1986), Goodall (1985), Nelder (1966) and many other researchers.

Kayaalp et al. (2025) comparatively examined the lactation curve models in Damascus goats.

Materıals And Methods

Monthly 71 lactation records were collected from Saanen dairy goats in private farms. Three different lactation curve models were then comparatively examined for these data.The purpose of this study was to examine the models of lactation curve of purebred dairy goats and make some suggestions concerning appropriate mathematical model The following three models were used to describe the milk production:

$Y_t = a\, t^{b}\, e^{-ct}$

$Y_t = a + b\,(t) + c\,(t^2$

$Y_t = a + b\,(t) + c\,(t^2) + d\,(t^3)$

Where,

Y_t : Milk yield on day t.,

a: Scaling factor to represent yield at the beginning of lactation,

b, c and d are factors associated with the inclining and declining slopes of the lactation curves.

A logaritmic transformation of the above models were carried out than the parameter estimations were made by using general multiple regression estimation techniques.

The parameters in equation were estimated, using the MINITAB statistical package programme.

The models were compared by using Coefficient Detemination value (R^2) and Mean Squre Error (MSE).

Results

The regression equations were estimated in turn as folows:

For Model 1 :

$\ln Y = \ln(0.3539) + (0.3900)\ln(t) - (0.1040)(t)$

For Model 2 :

$Y = 1.1164 + (0.2454)(t) - (0.0294)(t^2)$

For Model 3 :

$Y = 0.339 + (1.341)(t) - (0.4494)(t^2) + (0.0470)(t^3)$

The regression analysis tables of equation are given in Tables 1, 2, 3.

According to Table1, the R^2 value of estimation equation at Model 1 was 41.81% and all parameters,(a, b,c) were significant ($p < 0.01$).

Table 1. The Regression Analysis of Model 1

Term	Coef.	SE Coef.	t Value	P-Value
Constant (a)	0.3539	0.0367	9.65**	0.000
b	0.3900	0.09610	4.06**	0.000
c	-0.1040	0.03940	-2.64**	0.010

** : $p < 0.01$

It is seen from Table 2, R^2 value of estimation equation was found 30.67% . a and b parameters were significant ($p < 0.01$) . But c parameter was significant ($p< 0.05$)

Table 2. The Regression Analysis of Model 2

Term	Coef.	SE Coef.	t Value	P-Value
Constant (a)	1.1164	0.0952	11.72**	0.000
b	0.2454	0.0736	3.33**	0.001
c	-0.0294	0.0123	-2.40*	0.019

*: $p < 0.05$

** : $p < 0.01$

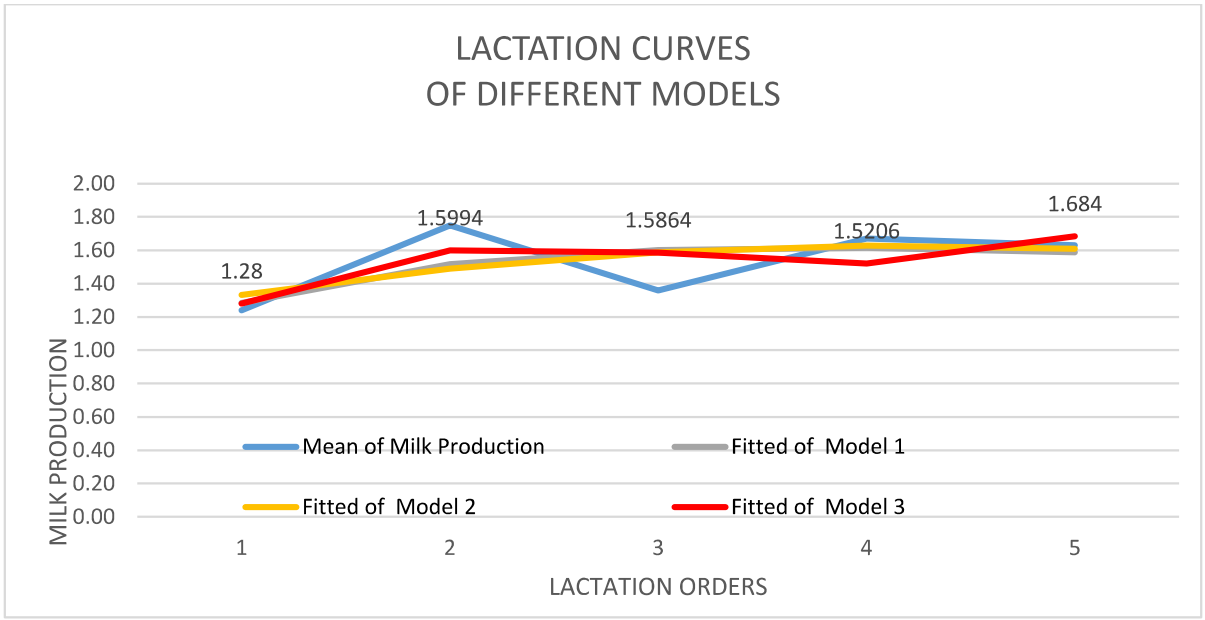
Table 3 indicates that the R^2 value of estimation equation was 46.96 % .a parameter was not significant ($p > 0.05$) but other parameters b, c and d of the equation were significant ($p < 0.01$).

Table 3. The Regression Analysis of Model 3

Term	Coef.	SE Coef.	t Value	P-Value
Constant (a)	0.3390	0.191	1,78	0.08
b	1.3410	0.250	5.36**	0.000
c	-0.4494	0.0932	-4.82**	0.000
d	0.04700	0.0104	4.54**	0.000

** : $p < 0.01$

Estimation values which were obtained from regression equations for all models and the curves of estimated and observed values were formed. These curves given as Figure 1.



Looking at Figure 1, it is seen that the predicted values in 3rd model are closer to the actual values.

Discussion

In this study, lactation curve parameters of third model was different**.** The coefficient of determination of the 3rd model was higher than the other two models.

The fitted curves from first and second models displayed underestimated milk yields at the beginning of the lactation. Sakul and Boylan (1992) explained this problem reporting that possible cause for such underestimation was resulted in delayed collection of milk data when the curve begins to decline.

Moreover, third model fit the Saanen goat data better than the first model, in other words. This finding is consistent with results of the Montaldo et al. (1997) revealed that the first model over predicts milk production during early and late lactation.

Generally, the Wood model (Model 1) provides a good fit to the lactation data in dairy cattle, while the 3rd model provides a better fit to the lactation data of dairy goats.

In the study conducted by Kayaalp et al. (2025) on Damascus goats, Model 3 was the best fitting model.

R^2 values obtained from model (3) were all greater than those found from other models (1,2).In addition, the Mean Square Error (MSE) of model 3 was lower than the Mean Square Error (MSE) of the other 2 models.Hence model (3) was seen to be superior to other models.

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