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Comparison of Different Lactation Models for Holstein Friesian Cows

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Abstract: This study carried out parameter estimations of the lactation curve of 371 lactation records that were obtained from 176 Holstein Friesian cows in the period of 2004-2009 at the Kazova Vasfi Diren Agriculture Facilities using three different models (Wood, Cobby and Le Du and Wilmink). For this purpose, coefficient of determination (R^2), mean squared error (MSE) and Durbin-Watson (dw) values were used to determine the best model. The highest coefficient of determination for the Wood model was found as 0.96 in the 3th lactation, while the mean squared error was found as 37,75. For the Cobby and Le Du model, the highest coefficient of determination value and mean squared error were found as 0.96 and 37,43 in the 3th lactations, respectively. For the Wilmink model, the highest coefficient of determination and the lowest mean squared error value were found as 0.45 and 40.49 respectively. In the study, it was determined that the Cobby and Le Du model with the minimum MSE, maximum R^2 and minimum dw were the best models for estimating lactation curves for Holstein cattle at the Kazova Vasfi Diren Agriculture Facilities.

Keywords: Cobby and Le du, Holstein, Lactation curve, Wilmink, Wood

Siyah Alaca Sığırlarında Farklı Laktasyon Modellerinin Karşılaştırılması

Öz: Bu çalışmada, Kazova Vasfi Diren Tarım İşletmesinde 2004–2009 yılları arasında yetiştirilen 176 adet Siyah Alaca ırkı ineğin laktasyon kayıtları kullanılmıştır. Toplam 371 adet laktasyon kayıdının üç farklı model (Wood, Cobby and Le Du ve Wilmink) ile parametre tahminleri yapılarak laktasyon eğrileri elde edilmiştir. Bu amaçla en iyi modeli belirlemek için laktasyon eğrisisi modellerinin belirtme katsayısı (R^2) değerleri, Hata Kareler Ortalaması (HKO) ve Durbin-Watson (dw) istatistiği kullanılmıştır. Wood modeli için en yüksek belirtme katsayısı, 0,96 olarak 3. laktasyonda bulunmuştur, hata kareler ortalaması ise 37,75 olarak elde edilmiştir. Cobby and Le Du modeli için belirtme katsayısı en yüksek 3. laktasyonda 0,96 olarak bulunmuştur, hata kareler ortalamaları ise 37,43 olarak bulunmuştur. Wilmink modeli için en yüksek belirtme katsayısı ve en düşük hata kareler ortalaması 3. laktasyonda sırasıyla 0,45 ve 40.49 olarak bulunmuştur. Yapılan çalışmada, Kazova Vasfi Diren Tarım İşletmesinde bulunan Siyah Alaca ırkı ineklerin laktasyon eğrisi tahmininde minimum HKO, maksimum R^2 ve minimum dw'ye sahip Cobby and Le Du modelinin en iyi model olduğu tespit edilmiştir.

Anahtar Kelimeler: Cobby and Le du, laktasyon eğrisi, Siyah Alaca, Wilmink, Wood

1. Introduction

Animal husbandry is one of the important branches of agriculture, and most significant income comes from milk and milk productions. Improvement of the genetic structure and environmental factors are important for increasing milk production. Another selection criterion that needs to be carefully considered to increase milk production of cows is determination of lactation curve parameters (Yuksel and Yanar, 2009). Lactation is the period that starts with birth of calves and ends with the date when calves are weaned based on the effects of genotype and environmental factors, while the lactation curve is the graphical representation of the time-related change in milk yield after birth. In the period following birth, milk yield reaches a maximum level by increasing for a certain time, this level of production continues for a certain time, it later

decreases with a slower speed than the increase at first, and lactation ends after the calves are weaned (Orhan and Kaygisiz, 2002). The level of persistency of lactation, which is defined as the rate of decrease in milk yield or the level of persistent maximum yield after reaching the maximum yield, is an important factor that determines lactation efficiency, and it is desired that this rate is high. Especially when the level of yield increases, the level of persistency of lactation becomes even more important. The level of persistency of lactation, which is an expression of the speed of decline in milk yield, is a good measure in understanding the negative effects of undesirable environmental conditions on milk yield (Orman et al., 2000).

The lactation curve is another criterion that is considered in combination with total or 305-day milk yield in assessing the milk yield of cow. A flatter lactation curve is an indicator of a good persistency of the cattle's lactation (Esenboga and Bilgin, 2004).Wood (1967) stated that the lactation curve is economically important, and a cow that produces milk without much change through the lactation process would be preferred rather than a cow that produces high amounts of milk in the beginning but produces low amounts towards the end.

In flat lactations where the slope of lactation is lower, there is less need for concentrate feed, and more economical and effective feeding may be achieved. Additionally, considering the number and duration of milking and time of feeding, it is possible to achieve equal labor usage in flatter lactations. Moreover, in cattle with steeper slopes of lactation, there is a higher risk, especially in the first periods of lactation where yield is high, of stress and physiological exhaustion, as well as reproduction problems, mastitis and some other diseases. A cow that displays a flat lactation in one period also usually has high yield levels in its next lactation (Ertugrul et al., 1999; Çagan et al., 2008; Ertugrul et al., 2001).

Lactation curves that are estimated based on milk yields that have been recorded at certain periods also provide information to be used in estimating milk yields in future periods. If the lactation curve is known, cows can be grouped based on these curves, intergroup differences can be considered, feeding programs specific to each group may be created, and selection programs may be applied towards animals with the desired lactation curves. This may increase the profitability of establishments (Bouallegue et al., 2014).

This study aimed to demonstrate the lactation curve parameters for all lactations using corrected coefficients of determination and mean squared error and 3 different lactation curve models based on test day milk yields.

2. Materials and Methods

The material of this study consists of milk yields obtained from the 371 lactation records of 176 Holstein cows bred at the Kazova Vasfi Diren Agricultural Facilities in the period of 2004-2009
(1st Lactation: 113, 2nd Lactation: 119, 3rd lactation: 85). The Wood, Cobby and Le Du and Wilmink models were used to obtain the lactation curves and parameters.

Wood (Y=〖at〗^b 〖exp〗^((-ct))+E),
Cobby And Le Du (Y=a-bt-a〖exp〗^((-ct))+E)
Wilmink (Y=a+b〖exp〗^((-0.05t))+ct+E),

Here, Y: is the milk yield (kg) on the day of checking, t is the day of checking and a, b and c are the parameters of the lactation curve. In this equation, the parameter 'a' corresponding to the initial milk yield, the parameter 'b' corresponding to the coefficient of increase, the parameter 'c' corresponding to the coefficient of decrease (Wood, 1970). The suitability of the lactation curve models was compared using lactation curve parameters of corrected R^2 and MSE. The model with the lowest MSE and highest coefficient of determination was selected as the best one. While preparing the data for analysis, a total of 371 yield records were used by eliminating yield records with fewer than 7 number of checks in one lactation period (total milk yield in lactation > 210 days) and those with more than 10 checks. The yield records were analyzed by using the SAS

statistical package software (version 8.01, 1998).

3. Results and Discussion

Table 1 shows the parameter values for the models that were used in this study to compare the lactation curve models of Holstein cows. It may be seen in Table 1 that the Wood and Cobby and Le Du models had very high goodness of fit values which were close to each other. However, the Wilmink model differed from these two models. The R^2 and MSE values of the Wood model were found respectively as 0.85 and 128.8. The R^2 and MSE values in this study were higher than the values found by Ferris et al. (1985), Kaygisiz et al. (2003) and Keskin et al. (2009), but lower than those found by Çankaya and Ünalan (2008). The R^2 and MSE values for the Cobby and Le Du model were respectively 0.85 and 128.5, while these were 0.46 and 129.3 for the Wilmink model, respectively. As the Wood and Cobby and Le Du models provided the lowest MSE and highest R^2 values with an explanation rate of 86% for the total variance, they were seen to be the most suitable models for explaining all lactation and milk yield characteristics.

Table 1. Tüm laktasyonların ortalama değerleri baz alınarak eğri tahminlerinde kullanılan modellerin parameter tahminleri
Çizelge 1. *Parameter estimates of the models that were used in curve estimations based on the mean value of all lactations*

Models	**a** $\pm S_{\bar{a}}$	**b** $\pm S_{\bar{b}}$	**c** $\pm S_{\bar{c}}$	R^2	**MSE**
Wood	33.87 ± 0.590	0.16 ± 0.032	0.08 ± 0.008	0.85	128.81
Cobby and Le Du	36.13 ± 0.589	1.43 ± 0.094	2.19 ± 0.192	0.85	128.53
Wilmink	117.92 ± 29.270	-4.45 ± 1.150	-85.44 ± 29.89	0.46	129.34

For the parameter ‘a’ corresponding to the initial milk yield, the Wood, Cobby and Le Du and Wilmink models provided values of 33.87, 36.13 and 117.9 respectively. These values were found to be much higher in comparison to those found in the research by Keskin et al. (2009) and Keskin and Tuzluca (2004). The parameter ‘b’ corresponding to the coefficient of increase was found for the same models as 0.16, 1.43 and -4.45, respectively. For the parameter ‘c’ corresponding to the coefficient of decrease, these were 0.080, 2.19 and -85.44, respectively. The a, b and c values were respectively determined as 25.5, 0.43 and 0.11 by Cobby and Le Du (1978).

Figure 1 shows that actual milk yields and the lactation curves estimated for all lactations .

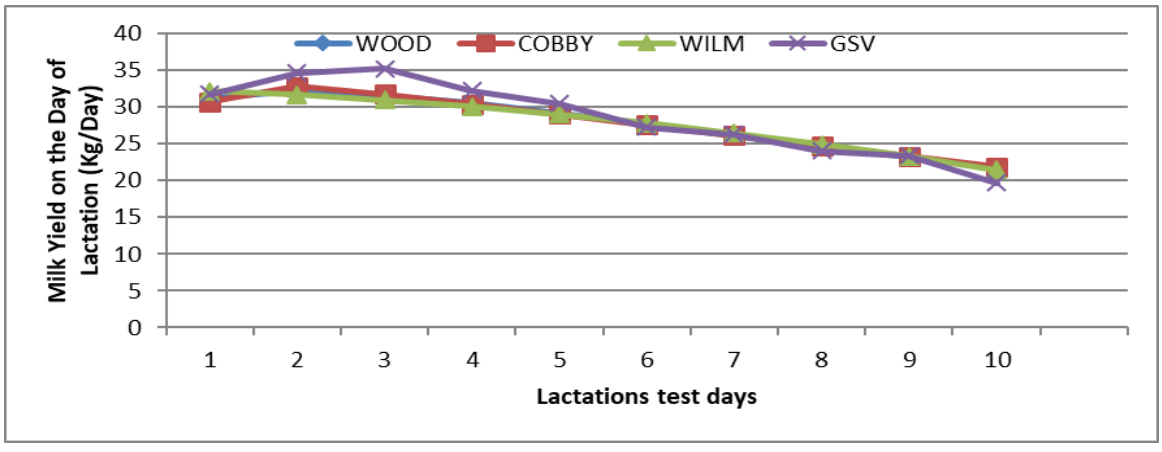

Figure 1. Actual milk yields and the lactation curves estimated for all lactations test days.
Şekil 1. *Tüm laktasyon test günleri için hesaplanan laktasyon eğrileri ve gerçek süt verimleri*

As seen in Figure 1, the curves that were not the good fit for the actual milk yields in all lactations until the fifth test day.

Table 2 shows the models that were used in the estimations about all the lactations and the parameter values of these models.

Table 2 shows that the Wood and Cobby and Le Du models had very high goodness of fit levels that were close to each other, while the results of the Wilmink model were different. The models R^2 and MSE values were found respectively as 0.93 and 33.13 for the Wood model, 0.94 and 33.04 for the Cobby and Le Du model and 0.33 and 33.92 for the Wilmink model. As they provided the smallest MSE and highest R^2 values with 94% of explanation rate for the total variation, the Wood and Cobby and Le Du models were found to be the most suitable models in explaining the milk yield characteristics of all lactations. The R^2 and MSE values here were in agreement with those found by Orhan and Kaygısız (2002).

Çizelge 2. Laktasyon eğrilerinin tahminde kullanılan modellerin parameter değerleri
Table 2. *Parameter values of the models that were used to estimate lactation curves*

	Models	**a ± $S_{\bar{a}}$**	**b ± $S_{\bar{b}}$**	**c ± $S_{\bar{c}}$**	R^2	**MSE**	**dw**
1st Lactation	Wood	28.20 ± 0.466	0.38 ± 0.037	0.17 ± 0.010	0.93	33.13	1.639
	Cobby and Le Du	32.12 ± 0.587	1.97 ± 0.092	1.57 ± 0.102	0.94	33.04	1.512
	Wilmink	152.20 ± 16.42	-127.6 ± 16.96	-7.45 ± 0.799	0.33	33.92	1.741
2d Lactation	Wood	37.62 ± 0.621	0.42 ± 0.036	0.18 ± 0.010	0.94	54.31	2.315
	Cobby and Le Du	43.70 ± 0.790	2.69 ± 0.119	1.49 ± 0.092	0.94	54.18	2.300
	Wilmink	210.5 ± 21.32	-177.9 ± 22.04	-10.26 ± 1.03	0.36	56.26	2.478
3rd Lactation	Wood	39.34 ± 0.61	0.39 ± 0.034	0.17 ± 0.009	0.96	37.75	18.564
	Cobby and Le Du	45.22 ± 0.75	2.70 ± 0.114	1.53 ± 0.090	0.96	37.43	1.799
	Wilmink	188.8 ± 20.93	-153.7 ± 21.66	-9.15 ± 1.012	0.45	40.49	21.485

The parameter ‘a’ corresponding to the initial milk yield for the Wood, Cobby and Le Du and Wilmink models were found respectively as 28.20, 32.12 and 152.20. These were found to be higher in comparison to those found by Orman and Ertuğrul (1999) and Kaygısız and Orhan (1999). The parameter ‘b’ corresponding to the coefficient of increase was found respectively as 0.38, 1.97 and -127.6. The parameter ‘c’ corresponding to the coefficient of decrease was found respectively as 0.17, 1.57 and -7.45. In their study, Wood (1970) found the b and c values for the 1st lactation as 0.28 and 0.036, respectively (Table 2).

4. Conclusions

This study aimed to determine the model that is the most suitable for the milk yield characteristics of Holstein Friesian cows using different lactation curve models. For the purpose of determining the suitability of the models R^2, MSE and lactation parameters (a, b and c) were considered.

Consequently, it was seen that the Wood and Cobby and Le Du models provided close results but, while these results agreed with those found by previous studies on the topic. Although the Wilmink model provided desired results based on the mean values of lactation parameters, it had a low value of R^2 and a high value of MSE. Therefore, the Wilmink model is not recommended in forming lactation curves as it did not provide reliable values in estimation of the lactation curves, and the estimated parameters were statistically insignificant.

When all the lactation parameters were examined, the parameter ‘a’ that shows the initial milk yield and the parameter ‘b’ corresponding to the coefficient of increase were found to be high for the Wood, Cobby and Le Du and Wilmink models. As the parameter ‘c’ denoting the speed of decline in the curve was low for the Wood, Cobby and Le Du and Wilmink models, it was seen that more milk was obtained in the lactation period.

In dairy cattle farming activities, for herd management to be successful and increasing accuracy in selection, it is important to firstly know the lactation curve and basic characteristics related to it, in addition to milk and reproductive yield characteristics of cows based on the reproductive activity of bulls. The lactation curve is shaped by both genetic and environmental effects, while related parameters not only determine the type of the curve but also are directly related to lactation yield. Accordingly, characteristics such as the initial yield that is determined in the early period of lactation, the time between calving and the first measurement, peak yield, time and speed of reaching peak yield may be used as criteria in selection. By determining the lactation curve, mistaken decisions related to lactations that result in weaning based on the negative effects of environmental conditions and kept out of the assessment process as they are assumed to be incomplete may be solved, while the time between generations in the herd is shortened, and accurate selection may be made in earlier periods. Additionally, cattle with low yield values can be culled from the heard at an earlier time. This study showed that using the Cobby and Le Du models in breeding activities towards milk yield in Holstein cows will provide important contributions to studies towards breeding.

References

Bouallegue MN, M'hamdi M, Ben H, Haddad B (2014). Study of non-genetic factors on the shape of lactation curves for milk yield, fat and protein percents of Holstein-Friesian cows under hot Mediterranean climate. Archiva Zootechnica, 17: 55-75.

Çagan V, Ozyurt A (2008). Polatlı Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırlarda Laktasyon Eğrisine İlişkin Parametrelerin Tahmini. Hayvansal Üretim, 49(1): 5-12.

Cankaya S, Unalan A (2008). Jersey Sığırlarında Süt Verimine Ait Genetik Parametrelerin Farklı Yöntemlerle Tahmini ve En İyi Laktasyon Eğrisi Modelinin Belirlenmesine Yönelik Pilot Çalışma: Karaköy Tarım İşletmesi. Proje Kesin Raporu, Proje No: 107 O 338. Samsun.

Cobby JM, Le Du, YLP (1978). On Fitting Curves To Lactation Data. Animal Production. 26: 127-133.

Ertugrul O, Orman NM. (1999). Holstein İneklerin Süt Verimlerinde Üç Farklı Laktasyon Modelinin İncelenmesi. Turkish Journal of Veterinary And Animal Sciences, 23: 605–614.

Ertugrul O, Orman NM, Guneren G (2001). Holstain Irkı İneklerde Süt Verimine Ait Bazı Genetik Parametreler. Turkish Journal of Veterinary And Animal Sciences, 26: 463–469.

Esenboga N, Bilgin OC (2004). İvesi Koyunlarının Laktasyon Eğrisinin Tahmini ve Tanımlanması için Farklı Matematik Modellerin Mukayesesi, IV. Ulusal Zootekni Bilim Kongresi, 1–4 Eylül, Isparta, 166–169.

Ferris TA, Mao I, Anderson CR (1985). Selecting For Lactation Curve and Milk Yield İn Dairy Cattle. Dairy Science. Abstract, 47: 670.

Kaygisiz A, Vanli Y, Yılmaz I (2003). Esmer Sığırların Laktasyon Eğrisi Özellikleri Üzerine Bir Araştırma, Hayvansal Üretim Dergisi, 44 (2), 69–80.

Kaygisiz A, Orhan H (2002). Siyah Alaca Sığırlarda Farklı Laktasyon Eğrisi Modellerinin Karsılastırılması. Hayvansal Üretim Dergisi, 43(1): 94-99.

Kaygisiz A, Orhan H (1999). Siyah Alaca Sığırlarda Farklı Laktasyon Eğrisi Modellerinin Karşılaştırılması. Kahramanmaraş Sütçü İmam Üniversitesi Araştırma Fonu Başkanlığı Proje Kesin Raporu. Kahramanmaraş.

Keskin I, Cilek S, İlhan F (2009). Polatlı Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Laktasyon Eğrisi Özellikleri. Kafkas Univ. Veteriner Fakültesi Dergisi, 15 (3): 437-442.

Keskin I, Tozluca A (2004). Süt Sığırlarında Laktasyon Eğrilerinin Farklı Matematik Modellerle Belirlenmesi ve Kontrol Aralığının Tespiti, Selçuk Üniversitesi, Ziraat Fakültesi Dergisi, 18, 11-19

Orhan H, Kaygısız A (2002). Siyah Alaca Sığırlarda Farklı Laktasyon Eğrisi Modellerinin Karşılaştırılması. Hayvansal Üretim Dergisi, 43(1): 94–99.

Orman MN, Ertuğrul O (1999). Holstein İneklerin Süt Verimlerinde Üç Farklı. Turkish Journal of Veterinary and Animal Sciences, 23: 605-614.

Orman MN, Ertugrul O, Cenan N (2000). Güney Anadolu Kırmızısı Sığır Irkında Laktasyon Eğrisinin Özellik. Lalahan Hayvancılık Arastırma. Enstitüsü Dergisi 40(2): 17-25.

SAS Institute, User's Guide, Release 8,0 (1998). SAS Institute Inc. Cary, N.C. Wood, PDP (1967). Algebraic model of the lactation curve in cattle. Nature (Land.) Abstract.216:164-165.

Wood PDP (1970). A Note On The Repeatability of Parameters of The Laction Curve in Cattle. Animal Production, 12: 535-538.

Yuksel S, Yanar M (2009). Esmer Irkı İneklere Ait Laktasyon Eğrisi Parametrelerinin Farklı Matematiksel Modellerle Tespiti ve Bazı Çevresel Faktörlerin Etkisi. Lalahan Hayvancılık Araştırma Enstitüsü Dergisi, 49(1) :17-26.