

Fit of different linear models to the lactation curve of Italian water buffalo

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RIASSUNTO – Adattamento di alcuni modelli lineari alle curve di lattazione di bufali italiani. *I dati della produzione giornaliera di latte di 4183 bufale sono stati analizzati con quattro modelli lineari della curva di lattazione tra i più comunemente utilizzati per i bovini da latte. L'adattamento di tutti i modelli alle curve medie di gruppi omogenei di animali è risultato soddisfacente (r-quadro aggiustato 0,88-0,97) mentre quello relativo alle curve individuali (in cui è stato riscontrato circa il 30% di curve atipiche) ha mostrato una notevole variabilità, non attribuibile al tipo di modello utilizzato, ma alla grande eterogeneità delle forme individuali della curva di lattazione.*

KEY WORDS: buffalo cow, lactation curve, mathematical model.

INTRODUCTION – Mathematical modelling of lactation curve by suitable functions of time, widely used in the dairy cattle industry, can represent also for buffaloes a fundamental tool for management and breeding decision, where average curves are considered, and for genetic evaluation by random regression models, where individual patterns are fitted. Average lactation curves of Italian Buffalo cows have been fitted with good results (Catillo *et al.*, 2002) whereas there is a lack of information on individual fitting. Aim of the present work is to check performances of some of the most currently used empirical models in fitting both average and individual lactation curves of Italian water buffaloes.

MATERIALS AND METHODS – Data were 30296 TD records of milk yield belonging to 4183 Italian water buffalo cows, classified according to: Herd (3), Age at calving (6), Calving season (4), Year (5). The following four linear models of the lactation curve were used.

The log linear form of the Wood function (WD):

$$\log Y_t = \log a + b \log t + ct$$

The Wilink function (WIL) is:

$$Y_t = a + be^{-kt} + ct$$

with the k parameter set to a fixed value of 0.169 estimated by fitting the WIL function on the whole data set by a non-linear regression technique. WD and WIL function allow to separate different shapes of lactation curves on the basis of the combination of parameter signs (Macciotta *et al.*, 2004). Moreover, two five-parameter models were used.

The Ali and Schaeffer polynomial regression (AS) is:

$$Y_t = a + b(t/340) + c(t/340)^2 + d \log(340/t) + g(\log(340/t))^2$$

and a fourth-order Legendre orthogonal polynomials (LEG):

$$Y_t = \alpha_0 + \alpha_1 * P_1 + \alpha_2 * P_2 + \alpha_3 * P_3 + \alpha_4 * P_4$$

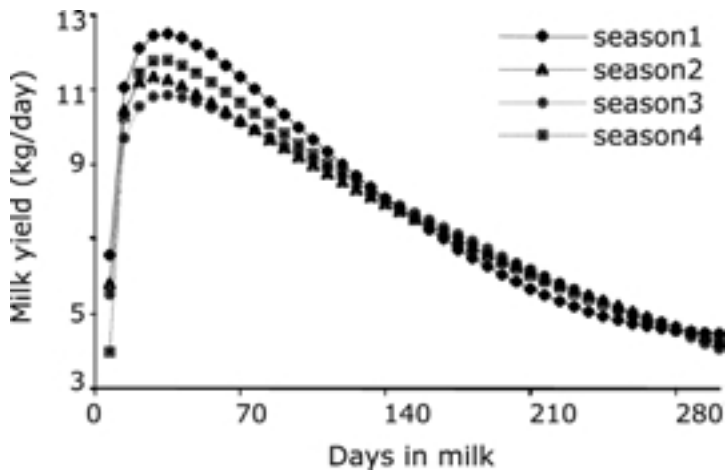
Functions of time (P_t) of LEG model were calculated using values published by Schaeffer (2004). In all models Y_t is the daily milk yield at time t (in days) from parturition. All models were fitted to: a) overall curve; b) average curves grouped according to the herd, age at calving, season of calving; c) individual curves. Goodness of fit was assessed by comparing the adjusted r-square (R^2).

RESULTS AND CONCLUSIONS – All functions were able to describe average lactation curves with an high degree of accuracy (table 1), even if differences in some features of estimated lactation curves, such as time at peak (PPD), peak yield (PY) and 300d yield (TY) among models, can be noticed.

Table 1. Main features of estimated lactation curves and adjusted r-square for the different models.

Model	PPD (days)	PY (kg/d)	TY (kg)	R ²
WD	33	10.9	2327	0.937
WL	26	11.3	2319	0.944
AS	29	11.5	2311	0.967
LEG	53	11.0	2249	0.879

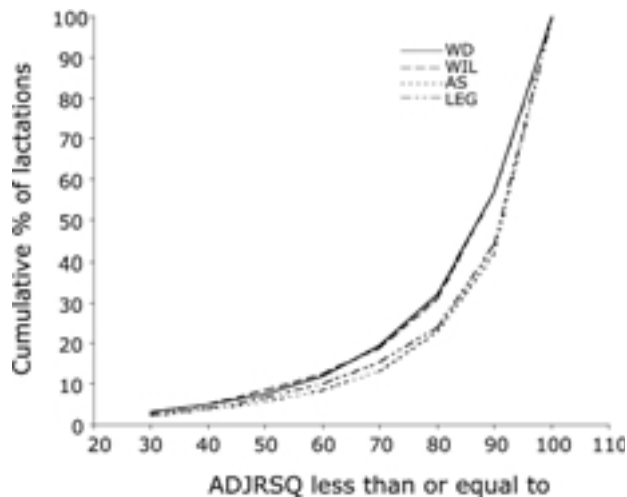
Figure 1. Estimated lactation curves for milk yield of different calving seasons.



All models were also able to disentangle patterns pertaining to different levels of fixed effects. As an example, in figure 1 are reported curves of different season calving classes estimated with the AS model.

The fitting of individual patterns yielded quite different results. WD and WIL models were able to detect two main shapes of the lactation curve: about 70% with standard shape and 30% of atypical (without the lactation peak). The goodness of fit shows a rather wide range (figure 2). Moreover, no relevant differences in fitting performances among models can be noticed.

Figure 2. Cumulative distribution of R² (%) values from fitting different models to individual lactation.



Results of the present work demonstrate that the models commonly used for dairy cattle are able to describe with a high degree of accuracy average curves of water buffaloes. On the other hand, analysis of individual patterns results in a wide range of fitting performances. Such variability seems to be related mainly to the great random variation in individual lactation curve shapes rather than to the kind of model.

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