Fit of the Wood function to milk yield data collected by different recording systems in Mediterranean Italian buffalo

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ABSTRACT: The aim of this study was to check if two different recording systems utilized by AIA and a typical buffalo herd influence the lactation curve characteristics of dairy buffalo, such as peak yield and day to peak. Two different recording systems of milk yield data for 569 Mediterranean Italian buffalo primiparous farmed in the same herd were compared. The AIA's system (RS1), consisting in monthly collections of individual milk yield data, and the pedometer system (Dairy Plan C21–Westfalia) (RS2), consisting in daily collections of individual milk yield data, were compared. Lactation curves were obtained with the Wood function (1967). The different estimates of peak yield and day to peak obtained from the data collected with the two systems, indicate that the type of system may influence these two characteristics. The lower coefficient of determination from fitting the Wood function to the data collected with RS1 compared to that of data collected with RS2, also suggests that the second system may be more accurate. However, cumulative milk yields estimated at 270 days of lactation did not differ between the two systems.

Key words: Lactation curve, Wood function, Mediterranean Italian buffalo.

INTRODUCTION – Milk production is largely dependent on the shape of the lactation curve. The key elements that describe the pattern of milk secretion are the peak yield, which represents the maximum output during the lactation, and its persistency. Mathematical modelling of lactation curves, such as the Wood function (1967), provides a valuable tool for extrapolating lactation curve information when data are not available, and aids farmers in management. Modelling is also used to benefit the industry by aiding in the development of breeding programs (Groenewald et al., 1995). The buffalo recording system in Italy is organized as dairy cattle recording (AIA). Milk recording is performed following the International Committee for Animal Recording (ICAR) guidelines. Each animal production is recorded with the A4 method; the average interval between subsequent controls is 30 days. The aim of this study was to check if two different recording systems utilized by AIA vs. a daily collections of individual milk yield influence the lactation curve characteristics, such as peak yield and day to peak.

MATERIAL AND METHODS – Two different recording systems of milk yield data for 569 Mediterranean Italian buffalo primiparous (MIBp), fed with constant diet through the year, milked twice a day, and bred in the Flli Garofalo farm were compared. The AIA's system (RS1), consisting in monthly collections of individual milk yield data, and the pedometer (RS2) system (Dairy Plan C21–Westfalia), consisting in daily collections of step number and individual milk yield data (actual data). Lactation curves were obtained by the Wood function (1967). Average milk yields per day of the standard lactation (270 days) were computed starting from day 4. Lactation curves were described by the Wood function (1967): $Y_n = an^b e^{-cn}$ where: $Y_n$ is the milk production measured at time period $n$ of lactation; $e$ is the base of natural logarithms; $a$ is the constant level of initial yield of the buffalo milk; $b$ is the rate of increase to peak; $c$ is the rate of decline after peak;
and n is the day of lactation. The estimates of the three parameters describing the lactation curve were obtained by the MTDFREML program (Boldman et al., 1995). Peak yield ($y_{\text{max}}$), day to peak ($t_{\text{max}}$), and total yield ($y_{\text{tot}}$) were also computed.

**RESULTS AND CONCLUSIONS** – Estimated lactation curve parameters with standard errors and coefficient of determination ($R^2$), day to peak production and peak for actual and estimated milk yield data by the Wood function are in Table 1. The parameter estimates were all statistically significant ($P<0.0001$), based on the asymptotic standard errors. The highest value of the initial milk yield ($a$) was in RS1 (5.053 vs. 3.37). In contrast, the highest rate of increase to peak production ($b$) was in RS2 (0.255 vs. 0.368). The rate of decline after peak ($c$) was similar between the two recording systems (0.005 and 0.006 for RS1 and RS2, respectively). The $R^2$ was higher for milk yield recorded by RS2 ($R^2 = 0.95$) than for milk yield recorded by RS1 ($R^2 = 0.83$). This result indicated that RS2 may be more accurate than RS1. Day to peak production estimated by the Wood function was earlier for RS1 (day 50) than for RS2 (day 61). Within each recording system, day to peak estimated by the Wood function was later respect to the actual data (day 50 vs day 32, respectively for the Wood function and the actual data within RS1; day 61 vs day 59 for the Wood function and the actual data within RS2). Peak yield estimated by the Wood function was slightly higher for RS1 (10.63 kg) than for RS2 (10.60 kg). Within each recording system, the estimated peak yield obtained by the Wood function was lower than that of the actual data (10.63 vs 13.87 kg, respectively for the Wood function and the actual data within RS1; 10.60 vs 10.95 kg for the Wood function and the actual data within RS2). However the difference between the estimated and actual data peak yield was larger for RS1 (3.24 kg) than for RS2 (0.35 kg). The plots of the average milk yield of MIBp belonging to the Flli Garofalo’s farm fitted with the Wood function (1967) showed that the actual data of milk yield recorded by RS1 were more variable than the actual data of milk yield recorded by RS2 (Figure 1). Previous studies on milk recording performed following the ICAR guidelines found a day to peak between day 28 and day 32 (Dimaruto et al., 2005) and approximately day 40 (Zullo et al., 2001). The earlier day to peak estimates reported by the above authors may be due to the type of recording system utilized. Milk yield recorded in this study was higher (> 2,200 kg) than milk yield reported in the previous studies (< 2,000 kg). Also in the present investigation, the day to peak for RS1 was earlier than that of RS2 (day 50 vs. day 61). However, cumulative milk yields estimated at 270 days of lactation did not differ between the two systems (2,239 vs. 2,249 kg for RS1 and RS2, respectively).

| Recording System | Lactation curve parameters | Peak Wood function | Actual milk yield |
|------------------|---------------------------|--------------------|------------------|
|                  | a   | b        | c        | $R^2$ | Day | Yield | Day | Yield |
| RS1              | 5.053 | 0.255** | 0.005** | 0.83 | 50  | 10.63 | 32  | 13.87 |
|                  | (-)+ | (0.0005) | (0.00006) |      |     |       |     |       |
| RS2              | 3.370 | 0.368** | 0.006** | 0.95 | 61  | 10.60 | 59  | 10.95 |
|                  | (-)  | (0.0002) | (0.00001) |      |     |       |     |       |

The Wood function: a is a constant representing the level of initial yield (liters) of the buffalo milk, b is a parameter representing the rate of increase to peak and c is the rate of decline after peak.

** Significant at $P<0.0001$; + Standard error; $R^2$ is the coefficient of determination.
yield for the lactation curve while monthly milk recording tend to bias the estimated day to peak. However, cumulative milk yields estimated at 270 days of lactation did not differ between the two systems. These findings regardless day to peak and peak yield may be helpful for farmers to improve diet efficiency and milk yield in buffalo cow.

Figure 1. Plots of actual (△--△) and estimated (—) lactation curves of daily average milk yield for RS1 (AIA’s recording system) and RS2 (pedometers’ recording system).

REFERENCES – Dimauro, C.; Catillo G.; Bacciu, N.; Macciotta, N.P.P.; 2005. Fit of different linear models to the lactation curve of Italian water buffalo. Ital. J. Anim. Sci. 4: 22-24. Groenewald, P., Ferreira, A.; Van Der Merwe, H.; and Slippers, S.; 1995. J. Anim. Sci. 61: 95-101. Wood, P. D. P.; 1967. Algebraic model of the lactation curve in cattle. Nature. 216: 164-165. Wood, P. D. P.; 1969. Factors affecting the shape of the lactation curve in cattle. Animal Production. 11: 307-316. Zullo, A.; Barone, C. M. A.; Colatruglio, P.; Occidente, M.; Troisi, M.; Matassino, D; 2001. Primo Contributo alla conoscenza dell’effetto di alcuni fattori ambientali sulla galattopoiesi individuale di bufale allevate in Italia e sottoposte ai controlli funzionali. Proc. I Cong. Naz. All. Buf. Capaccio (SA). P. 322-326.