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PAPER

# Milk production and lactation curves of Bianca Val Padana and Italian Friesian dairy cows in relation to the management system

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## Abstract

The aim of this study was to evaluate milk production and lactation curve parameters of Bianca Val Padana (BVP) and Italian Friesian (IF) cattle reared in the same herds in relation to different housing-feeding systems. Therefore, 8488 test-day records of 103 BVP and 367 IF cows from 7 herds were used; 2 herds had free stalls and total mixed ration feeding (FS-TMR group) and 5 had tie stalls and traditional feeding (TS-TF group). Data for milk production (kg), fat, protein, lactose production (kg) and content (%), and somatic cell score (SCS) were submitted to analysis by ANOVA, using a model with breed, housing-feeding type, test day, herd within housing-feeding type, season of calving, lactation number, class of days in milk, and two- and three-way interactions as fixed factors. A mixed model according to Wood's equation in linear form was also performed. Interactions between breed and type of housing-feeding were always significant ($P<0.05$), except for milk fat percentage and SCS. Daily milk, fat, protein and lactose productions were lower in TS-TF compared to FS-TMR, but the reduction was significantly higher ($P<0.05$) in IF than in BVP. Protein percentage showed an opposite trend in the two breeds depending on the type of housing-feeding. The lactation curves were continuously decreasing for BVP in FS-TMR housing-feeding type. In TS-TF rearing conditions, BVP showed an earlier week at peak and a lower peak production than IF. In conclusion, BVP seems to be better adapted to TS-TF rearing conditions than IF.

## Introduction

The Bianca Val Padana (BVP) cattle breed, also called Modenese, is an autochthonous breed that originated in the province of Modena, in northern Italy. There are currently about 1,000 heads of which less than 500 are enrolled in the Herd Book of Italian endangered cattle breeds. It is considered a rustic cattle breed, with a medium-low milk production (an average of 4524 kg per lactation produced in 2010) and a high milk protein content (an average 3.46% in 2010) (AIA, 2011). Milk is used for the production of Parmigiano-Reggiano cheese, both from one-breed herds and, more frequently, from two-breed herds, mainly in association with the Italian Friesian (IF) breed. In the latter case, the association of the two breeds improves bulk milk protein content. In fact, compared to IF, BVP milk has been reported to show a significantly higher protein (3.48% *vs* 3.01%), and casein content (2.75% *vs* 2.32%) and number, i.e. the percentage ratio between casein and protein (79.05 *vs* 76.92) (Summer *et al.*, 2002). Moreover, among casein fractions, BVP cattle has shown a higher content of κ-casein (12.28% *vs* 11.25%) and $\alpha_{s2}$-casein (13.61% *vs* 11.39%) than IF cattle (Summer *et al.*, 2002). Autochthonous cattle breeds have been previously described as less productive than selected breeds when reared in high input, and more productive in low input management level herds (Bittante *et al.*, 1992). Differences in profitability between Burlina (an autochtonous cattle breed of the Veneto region in northern Italy) and Italian Friesian cows have been calculated by Pretto *et al.* (2009). They found a lower profitability in Burlina cattle (from -719 euros to -274 euros), with higher profitability when a cow's milk incentive payment was available and a specific cheese market strategy was adopted. Because of the small average herd size, in the province of Modena, 86.5% of herds adopted the tie stall housing system and the remaining the free stall (AIA, 2008). It has been previously reported that housing type affects efficiency, cow comfort, cow health and particularly udder disease status in cattle (Hoglund and Albright, 1970; Simensen *et al.*, 2010), and therefore milk output is also affected. The aim of the study was to compare the production and the lactation curves of BVP and IF cattle when reared in the same herds according to management conditions i.e. type of housing-feeding.

## Materials and methods

The study was carried out using the test day (TD) records for milk production (kg), fat, protein and lactose content (%), and somatic cell count (SCC, no.*1000) of BVP and IF dairy cattle reared together in the same herds during years 2004 to 2009. Data were provided by the Modena Breeders' Association. This study compared two kinds of cattle management systems, putting together housing and feeding type: one with free stalls (FS) and total mixed ration (TMR) feeding system (FS-TMR group, 2 herds), and one with tie stalls (TS) and traditional feeding (TF) system (TS-TF group, 5 herds). The main parameters of the herds involved in the study are reported in Table 1. An automatic milking system was adopted in all herds involved in the study. Moreover, all herds were provided with automatic ventilation systems for warm temperature control. Both in the TF system (forages and concentrates given separately twice a day) and in the TMR system no silages were used in the rations, because milk was transformed into Parmigiano-Reggiano cheese. Rations were based on dry forages and concentrates, and designed for a forage/concentrate ratio of 50/50 (herds n. 4, 5) to 60/40 (herds n. 1, 2, 3, 6, 7).

After editing (removal of lactations with less than 6 controls), the original 8619 TD records were reduced to 8488 TD records of 103 BVP and 367 IF cows. Data for fat, protein and lactose production (kg) were then calculated from milk production and percentage composition.

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SCC was transformed into somatic cell score (SCS) according to Shook and Schutz (1994) by means of the following equation: $SCS=3+\log_2(SCC/100,000)$. Data were submitted to analysis of variance, using the following general linear model (SAS, 2008):

$y_{ijklmnop}=\mu+B_i+HFT_j+TD_k+H_{jl}+S_m+L_n+DIM_o+(B*HFT)_{ij}+(DIM*HFT)_{oj}+(DIM*L)_{on}+(DIM*S)_{om}+(DIM*B*HFT)_{oij}+(DIM*B*L)_{oin}+(DIM*B*S)_{oim}+\varepsilon_{ijklmnop}$

where

$y_{ijklmnop}$=dependent variable;

$\mu$=overall mean;

$B_i$=fixed effect of breed (2 levels);

$HFT_j$=fixed effect of housing-feeding type (2 levels);

$TD_k$=fixed effect of test day (561 levels);

$H_{jl}$=fixed effect of herd nested within housing-feeding type (7 levels);

$S_m$=fixed effect of season of calving (4 levels: December to February, March to May, June to August, and September to November);

$L_n$=fixed effect of lactation number (3 levels, 1st, 2nd and ≥ 3rd);

$DIM_o$=fixed effect of class of days in milk (30 ten days classes plus a class for lactations over 300 d);

$(B*HFT)_{ij}$; $(DIM*HFT)_{oj}$; $(DIM*L)_{on}$; $(DIM*S)_{om}$=two-way interactions;

$(DIM*B*HFT)_{oij}$; $(DIM*B*L)_{oin}$; $(DIM*B*S)_{oim}$=three-way interactions;

$\varepsilon_{ijklmnop}$=residual error.

The lactation curve parameters for the interaction between breeds and housing-feeding type were calculated by means of the application of Wood's (1967) model

$$y_n=A*n^Be^{(Cn)}$$

where $y_n$ is the production at day n, and *A, B, C* are the equation parameters (initial yield or scale factor, and slope during the ascendant and the descendent phase of the curve, respectively). The linear form of the model (Macciotta *et al.*, 2005) was used:

$$\log y_n=\log A+B\log n+C\,n$$

The parameters were fitted by means of a mixed model with breed/housing-feeding type interaction as a fixed factor and individual as a random factor. The mean equation parameters for breed/housing-feeding type interaction were combined to calculate the persistency ($-(B+1)*\ln C$), the peak week ($B/C$) and the peak production ($A*(B/C)^B*e^{-B}$).

## Results and discussion

The structure of the experimental data is reported in Table 2. Within each herd, TDs from BVP and IF cows were balanced (herds n. 1, 6),

**Table 1. Main parameters of the herds involved in the study.**

| Herd | Location | Altitude (m asl) | Total N of heads | Breed composition BVP | IF | Average milk production, kg | Housing type | Feeding type |
|---|---|---|---|---|---|---|---|---|
| 1 | Plain | - | 68 | 39 | 29 | 5354 | Free stall | Total mixed ration |
| 2 | Plain | - | 52 | 13 | 39 | 6278 | Tie stall | Traditional |
| 3 | Hill | 529 | 32 | 13 | 19 | 6241 | Tie stall | Traditional |
| 4 | Hill | 557 | 93 | 21 | 72 | 9125 | Free stall | Total mixed ration |
| 5 | Hill | 600 | 67 | 2 | 65 | 7957 | Tie stall | Traditional |
| 6 | Hill | 758 | 44 | 26 | 18 | 5249 | Tie stall | Traditional |
| 7 | Hill | 758 | 46 | 21 | 25 | 5103 | Tie stall | Traditional |

asl, above sea level; BVP, Bianca Val Padana; IF, Italian Friesian.

**Table 2. Structure of the experimental data.**

| Breed | | BVP | | IF | | Total |
|---|---|---|---|---|---|---|
| Type of housing-feeding | | TS-TF | FS-TMR | TS-TF | FS-TMR | |
| Cows | N | 44 | 59 | 285 | 83 | 471 |
| TD controls | N | 869 | 905 | 1461 | 5253 | 8488 |
| TD controls in | | | | | | |
| Herd 1 | N | - | 588 | - | 543 | 1131 |
| Herd 2 | N | 206 | - | 1087 | - | 1293 |
| Herd 3 | N | 189 | - | 560 | - | 749 |
| Herd 4 | N | - | 281 | - | 918 | 1199 |
| Herd 5 | N | 16 | - | 2301 | - | 2317 |
| Herd 6 | N | 478 | - | 515 | - | 993 |
| Herd 7 | N | 16 | - | 790 | - | 806 |
| TD controls/season of calving | | | | | | |
| December to February | N | 188 | 273 | 1754 | 450 | 2665 |
| March to May | N | 146 | 220 | 1096 | 267 | 1729 |
| June to August | N | 211 | 100 | 1038 | 316 | 1665 |
| September to November | N | 363 | 276 | 1362 | 428 | 2429 |
| TD controls/lactation number | | | | | | |
| 1 | N | 173 | 131 | 1270 | 247 | 1821 |
| 2 | N | 179 | 184 | 1372 | 288 | 2023 |
| ≥3 | N | 556 | 554 | 2608 | 926 | 4644 |

BVP, Bianca Val Padana; IF, Italian Friesian; TS, tie stall group; TF, traditional feeding group; FS, free stall group; TMR, total mixed ration group; TD, test day.

slightly unbalanced (herds n. 2, 3, 4), or strongly unbalanced (herds n. 5, 7). Nevertheless, also in the latter case, the data were likewise included in the statistical analysis.

The results of the analysis of variance are shown in Table 3. Housing-feeding type, test day, breed and DIM were highly significant factors for all the production traits studied, as herd, season of calving and lactation number failed to meet significance (P>0.05), respectively, for protein (%) and fat (%). The model explained quotes of variance of 34.2% (fat, %) to 77.5% (milk, kg/d). Fat, protein and lactose productions (kg/d) were better explained by the model than their content (%) because of higher $R^2$ and lower residual standard error (RSE). The interaction between breed and type of housing-feeding was always significant (P<0.01), except for milk fat percentage.

The least square means of milk production, fat, protein and lactose production and content, and SCS as affected by some selected main factors from the statistical model (breed, type of housing-feeding, season of calving, lactation number) are reported in Table 4. The daily production of milk, fat, protein and lactose was significantly more in Italian Friesian cows (P<0.05) than BVP, and showed a higher percentage of fat (P<0.05); percentages of protein and lactose in milk were higher in BVP than in IF (P<0.05). These results were largely expected because the IF breed has been subjected to a strong selection process since the 1980s, and BVP has never been selected for production but is currently reared only for conservation and for maintaining genetic variability (http://www.aia.it/downloads/disciplinare_ra). SCS was significantly higher (P<0.05) in BVP than in IF cattle.

Cows in TS under a TF system produced significantly less milk, fat, protein and lactose, and showed a lower fat and lactose percentage than cows in FS with TMR (P<0.05). The latter also showed a lower percentage of protein and a lower SCS (P<0.05). Previous studies have shown that milk production and udder health

**Table 3. Analysis of variance of milk production and quality (F values). Among the factors contained in the model, only the main factors and breed*housing-feeding type interaction are reported.**

| | Main factors | | | | | | | Interaction | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Breed | Housing-feeding type | Test day | Herd | Season of calving | Lactation number | DIM | B*HFT | RSE | $R^2$ |
| df | 1 | 1 | 560 | 5 | 3 | 2 | 30 | 1 | 7435 | |
| Milk, kg/d | 999.5$^{***}$ | 200.9$^{***}$ | 4.3$^{***}$ | 197.6$^{***}$ | 7.2$^{***}$ | 56.2$^{***}$ | 52.9$^{***}$ | 12.2$^{***}$ | 4.34 | 0.775 |
| Fat, % | 33.3$^{***}$ | 15.5$^{***}$ | 2.2$^{***}$ | 13.1$^{***}$ | ns | ns | 10.3$^{***}$ | ns | 0.58 | 0.342 |
| Protein, % | 749.5$^{***}$ | 7.5$^{**}$ | 2.1$^{***}$ | ns | 7.3$^{***}$ | 23.5$^{***}$ | 65.0$^{***}$ | 43.7$^{***}$ | 0.26 | 0.608 |
| Lactose, % | 18.4$^{***}$ | 22.0$^{***}$ | 2.0$^{***}$ | 17.3$^{***}$ | 3.5$^{*}$ | 162.5$^{***}$ | 7.5$^{***}$ | 12.4$^{***}$ | 0.23 | 0.353 |
| Fat, kg/d | 822.7$^{***}$ | 200.5$^{***}$ | 4.0$^{***}$ | 135.8$^{***}$ | 5.0$^{**}$ | 44.6$^{***}$ | 31.3$^{***}$ | 28.7$^{***}$ | 0.18 | 0.708 |
| Protein, kg/d | 712.3$^{***}$ | 246.5$^{***}$ | 4.6$^{***}$ | 231.6$^{***}$ | 6.9$^{***}$ | 51.0$^{***}$ | 31.7$^{***}$ | 18.5$^{***}$ | 0.13 | 0.756 |
| Lactose, kg/d | 910.8$^{***}$ | 212.8$^{***}$ | 4.3$^{***}$ | 185.2$^{***}$ | 6.2$^{***}$ | 32.4$^{***}$ | 57.0$^{***}$ | 19.0$^{***}$ | 0.21 | 0.769 |
| SCS | 6.03$^{**}$ | 84.8$^{***}$ | 1.7$^{***}$ | 34.1$^{***}$ | 2.9$^{*}$ | 51.8$^{***}$ | 7.9$^{***}$ | 12.9$^{***}$ | 1.68 | 0.399 |

DIM, days in milk; RSE, residual standard error; B, breed; HFT, housing-feeding type; df, degree of freedom; SCS, somatic cell score. $^{*}$P<0.05; $^{**}$P<0.01; $^{***}$P<0.001; ns, not significant.

**Table 4. Least squares means (±SE) of milk production, fat, protein, lactose production and content, and somatic count stall as affected by some of the main factors in the model (breed, type of housing, season of calving, lactation number).**

| | Milk, kg/d | Fat, kg/d | Protein, kg/d | Lactose production, kg/d | Fat, % | Protein, % | Lactose, % | SCS |
|---|---|---|---|---|---|---|---|---|
| Breed | | | | | | | | |
| Bianca Val Padana | 14.75±0.20$^{a}$ | 0.506±0.008$^{a}$ | 0.504±0.006$^{a}$ | 0.715±0.010$^{a}$ | 3.37±0.02$^{a}$ | 3.51±0.01$^{b}$ | 4.81±0.01$^{b}$ | 3.26±0.08$^{b}$ |
| Italian Friesian | 20.88±0.14$^{b}$ | 0.737±0.006$^{b}$ | 0.657±0.004$^{b}$ | 1.005±0.007$^{b}$ | 3.52±0.02$^{b}$ | 3.20±0.01$^{a}$ | 4.77±0.01$^{a}$ | 3.08±0.06$^{a}$ |
| Type of housing-feeding | | | | | | | | |
| TS-TF | 15.68±0.16$^{a}$ | 0.532±0.007$^{a}$ | 0.510±0.005$^{a}$ | 0.751±0.008$^{a}$ | 3.37±0.02$^{a}$ | 3.38±0.01$^{b}$ | 4.75±0.01$^{a}$ | 3.71±0.06$^{b}$ |
| FS-TMR | 19.95±0.25$^{b}$ | 0.710±0.010$^{b}$ | 0.650±0.007$^{b}$ | 0.969±0.012$^{b}$ | 3.53±0.03$^{b}$ | 3.33±0.01$^{a}$ | 4.83±0.01$^{b}$ | 2.63±0.10$^{a}$ |
| Season of calving | | | | | | | | |
| December to February | 18.02±0.20$^{bc}$ | 0.631±0.008$^{bc}$ | 0.590±0.006$^{b}$ | 0.867±0.010$^{bc}$ | 3.49±0.03 | 3.39±0.01$^{b}$ | 4.78±0.01$^{a}$ | 3.10±0.07$^{a}$ |
| March to May | 18.34±0.21$^{c}$ | 0.638±0.009$^{c}$ | 0.592±0.006$^{b}$ | 0.887±0.010$^{c}$ | 3.35±0.03 | 3.33±0.01$^{a}$ | 4.76±0.01$^{a}$ | 3.34±0.08$^{b}$ |
| June to August | 17.22±0.21$^{a}$ | 0.600±0.009$^{a}$ | 0.563±0.006$^{a}$ | 0.835±0.010$^{a}$ | 3.43±0.03 | 3.35±0.01$^{a}$ | 4.81±0.01$^{b}$ | 3.11±0.08$^{a}$ |
| September to November | 17.67±0.19$^{ab}$ | 0.616±0.008$^{ab}$ | 0.575±0.006$^{a}$ | 0.852±0.009$^{ab}$ | 3.44±0.03 | 3.34±0.01$^{a}$ | 4.79±0.01$^{a}$ | 3.13±0.07$^{a}$ |
| Lactation number | | | | | | | | |
| 1 | 16.46±0.23$^{a}$ | 0.569±0.010$^{a}$ | 0.540±0.007$^{a}$ | 0.806±0.011$^{a}$ | 3.42±0.03 | 3.38±0.01$^{b}$ | 4.88±0.01$^{c}$ | 2.70±0.09$^{a}$ |
| 2 | 18.15±0.20$^{b}$ | 0.638±0.008$^{b}$ | 0.594±0.006$^{b}$ | 0.878±0.010$^{b}$ | 3.49±0.03 | 3.38±0.01$^{b}$ | 4.80±0.01$^{b}$ | 3.24±0.08$^{b}$ |
| ≥3 | 18.84±0.14$^{c}$ | 0.657±0.006$^{c}$ | 0.607±0.004$^{c}$ | 0.896±0.007$^{c}$ | 3.45±0.02 | 3.31±0.01$^{a}$ | 4.69±0.01$^{a}$ | 3.57±0.05$^{c}$ |

SCS, somatic cell score; TS, tie stall group; TF, traditional feeding group; FS, free stall group; TMR, total mixed ration group. $^{a,b,c}$P<0.05.

vary between FS and TS. In general, cows reared in FS showed a lower milk production, and a lower incidence of mastitis (Bakken *et al.*, 1988; Hovinen *et al.*, 2009). Bielfeldt *et al.* (2006) observed that cows in loose housing systems showed the lowest risk ratios of being culled compared to those reared in tie-stall barn. Norell and Appleman (1981) studied the changes in milk production related to housing system during herd expansion. They concluded that the production changes in the passage from stanchion to free stalls were 200 kg less milk per cow, because during this passage herd management and cow environment changed. In our study, there were no changes in the farming system, but cattle of the two breeds were simultaneously affected by the same housing-feeding conditions. This could explain the higher production figures observed in FS-TMR than in TS-TF.

The season of calving significantly affected the production of milk, fat, protein and lactose, the percentages of protein and lactose in milk, and the SCS. In particular, summer calving cows produced less milk, fat, protein and lactose than those with spring or winter calving and showed a higher lactose content (P<0.05). The highest protein content (P<0.05) was shown by winter calving cows, as the highest SCS was in spring calving cows (P<0.05). A significant effect of the season of calving on milk production and quality has been previously reported by Sabbioni *et al.* (2008, 2011) for other local breeds in Italy, namely Valdostana and Grigio Alpina. In Grigio Alpina cattle, summer parities are associated to a lower production of milk, fat and protein, and lower somatic cell content, and to a higher percentage content of fat and protein than winter and spring parities.

From 1st to 3rd lactation and over, milk production and SCS increased (P<0.05) as protein and lactose percentage significantly decreased (P<0.05). Also in this case, the results agree with previous studies on other local cattle breeds reared in Italy (Sabbioni *et al.*, 2003, 2008, 2011; Matassino *et al.*, 2011).

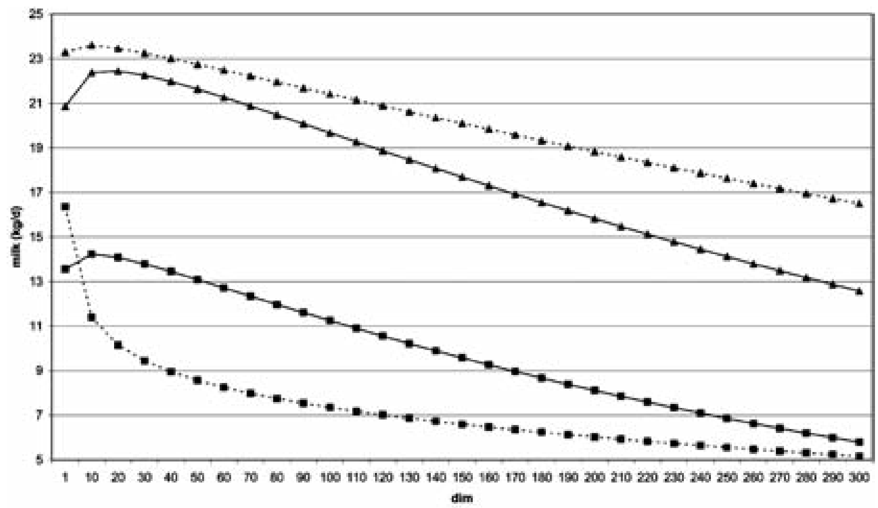


**Figure 1. Lactation curves for milk production (kg/d).**

**Table 5. Least squares means of milk production, fat, protein, lactose production and content, and somatic count stall as affected by breed and type of housing-feeding.**

| Breed | | Bianca Val Padana | | Italian Friesian | |
|---|---|---|---|---|---|
| Type of housing-feeding | | TS-TF | FS-TMR | TS-TF | FS-TMR |
| Milk | kg/d | 12.94±0.24ᵃ | 16.57±0.32ᵇ | 18.43±0.15ᶜ | 23.33±0.24ᵈ |
| Fat | kg/d | 0.437±0.010ᵃ | 0.574±0.013ᵇ | 0.627±0.006ᶜ | 0.846±0.010ᵈ |
| Protein | kg/d | 0.445±0.007ᵃ | 0.562±0.010ᵇ | 0.575±0.004ᵇ | 0.739±0.007ᶜ |
| Lactose | kg/d | 0.626±0.012ᵃ | 0.805±0.016ᵇ | 0.876±0.007ᶜ | 1.134±0.012ᵈ |
| Fat | % | 3.31±0.03ᵃ | 3.44±0.04ᵇ | 3.43±0.02ᵇ | 3.62±0.03ᶜ |
| Protein | % | 3.57±0.01ᶜ | 3.45±0.02ᵇ | 3.19±0.01ᵃ | 3.21±0.01ᵃ |
| Lactose | % | 4.79±0.01ᵇ | 4.83±0.02ᵇ | 4.71±0.01ᵃ | 4.82±0.01ᵇ |
| SCS | | 3.67±0.09ᶜ | 2.85±0.12ᵇ | 3.74±0.06ᶜ | 2.41±0.10ᵃ |

TS, tie stall group; TF, traditional feeding group; FS, free stall group; TMR, total mixed ration group; SCS, somatic cell score. [a,b,c]P<0.05.

**Table 6. Wood equation parameters for milk production as affected by breed and housing-feeding type.**

| Breed | Housing-feeding type | *A*, kg | *B* | *C* | Persistency | Week at peak | Peak production, kg |
|---|---|---|---|---|---|---|---|
| Bianca Val Padana | TS-TF | 13.61[a] | 0.0348 | -0.00152 | 6.71 | 3.27 | 14.66 |
| | FS-TMR | 16.39[b] | -0.1539 | -0.00040 | 6.62 | - | - |
| Italian Friesian | TS-TF | 20.91[c] | 0.0401 | -0.00107 | 7.12 | 5.37 | 23.23 |
| | FS-TMR | 23.32[d] | 0.0111 | -0.00059 | 7.52 | 2.67 | 23.82 |

TS, tie stall group; TF, traditional feeding group; FS, free stall group; TMR, total mixed ration group. [a,b,c,d]P<0.05.

Least square means of the interaction between breed and housing-feeding system are reported in Table 5. In both breeds, the lowest milk, fat, protein and lactose productions have been registered in TS-TF system compared to the FS-TMR ($P<0.05$), but the differences between the two housing-feeding systems were significantly higher ($P<0.05$) in IF than in BVP (kg 4.91 *vs* 3.63; kg 0.219 *vs* 0.137; kg 0.164 *vs* 0.117; kg 0.258 *vs* 0.179, respectively, for milk, fat, protein and lactose). The percentage of protein showed an opposite trend in the two breeds depending on the type of housing-feeding system: IF -0.02%, BVP +0.12%, from FS-TMR to TS-TF; $P<0.05$. There was no difference in SCS between the two breeds in TS-TF conditions ($P>0.05$), as in FS-TMR it was lower ($P<0.05$) in IF than in BVP. Svensson and Hultgren (2008) showed that Swedish Red and Swedish Holstein cows housed in short stalls (tie stall) after calving produced more milk than those in cubicles (free stall), but they did not study the interaction between type of housing and breed.

The lactation curves for milk production were well fitted ($R^2$: 0.469) by Wood's model. Moreover, the shape of the lactation curve was different in the two breeds (Figure 1): while IF cows showed standard curves, BVP curves in the FS-TMR system were continuously decreasing atypical curves (Macciotta *et al.*, 2005) with *B* and *C* parameters both negative (Table 6). This result is related to the fact that the BVP breed never underwent a selection process for milk production, and that when reared together with IF in FS-TMR systems, they are probably disadvantaged during interactions with other animals. Rekik *et al.* (2003) observed a significant effect of type of herd on the percentage of atypical curves and on the shape of the lactation curves of Holstein cattle in Tunisia. A negative *B* parameter for BVP in the FS-TMR system did not allow week at peak and peak production to be calculated. In TS-TF conditions, BVP showed an earlier week at peak and a lower peak production than IF. Regardless of the management system, persistency was always higher in IF than in BVP.

## Conclusions

In the area of origin, BVP cattle are often reared together with the IF breed, the most productive cattle breed in Italy. The two breeds can be compared as long as this is carried out under the same environmental conditions. Cows reared in the same herd are submitted to the same management conditions; the environmental conditions of the present study allowed some strengths of the BVP breed to be found compared with the IF. The results confirm the observations of previous studies in which a low management level was shown to affect mainly a selected breed rather than an autochthonous breed. The shape of the lactation curve showed that BVP cows seem to be better adapted to rearing conditions with tie stall and traditional feeding than free stalls and total mixed rations. On the contrary, IF cows showed higher peak production and persistency in FS-TMR conditions. Since the breeding of BVP cattle will be developed not only in relation to milk production but also to milk composition, aimed at the production of Parmigiano-Reggiano cheese, the higher protein content of milk from BVP under TS-TF conditions could be an important factor in the maintenance of the breed in the area of origin, characterized by a high incidence of tie stall herds. Further research must be carried out in the future in order to achieve a comprehensive improvement in milk production and quality in the BVP breed.

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