SESSION

CATTLE AND BUFFALO: MILK

Two years of experience with an automatic milking system: 1. Time on machine and successful attachments

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RIASSUNTO – Due anni di esperienze con il robot di mungitura: 1. Tempi di mungitura dell'impianto e procedure di attacco corrette – *Vengono riportate alcune osservazioni relative ai tempi di mungitura e procedure di attacco in un sistema automatizzato, mostrando come solo pochi animali hanno problemi di attacco delle coppette di mungitura.*

KEY WORDS: robotic milking, time on machine, attachments.

INTRODUCTION – The installation of an automatic milking system (AMS) is not simply the replacement of an old traditional milking parlour with a new milking machine, but it requires a deeply modification of herd management (Spahr *et al.*, 1997). Robotic milking is now considered fairly reliable and friendly and more than 1100 commercial farmers have installed at least one milking unit (De Koning *et al.*, 2002). A lot of studies have been carried out on the interactions between milking robot, cows and farmer, but most of them referred to farm in the Northern Europe. On December 2000, an AMS (Voluntary Milking System, VMS™, De Laval) was installed at the Experimental Farm of Istituto Sperimentale per la Zootecnia in Cremona (Italy), in order to realize studies and experiments about the effects on farm management in Italian conditions.

MATERIAL AND METHODS – The AMS was installed inside the existing freestall barn, which has a central feeding alley; on the opposite side there are two feeding areas and two rows of cubicles; the total capability was of 160 cows. On one side there is the milking parlour. The AMS was installed at the opposite side; here cows can move from the feeding to the resting area through one-way gates and from the resting to the feeding area passing through the milking area. A small waiting area is close to the milking box and the access is possible through a pre-selection gate, which directs to feeding area the cows that have been milked too few hours early (*minimum* 5 hours); otherwise the cows are directed to milking unit. The VMS is located at the barn end in a little building inside the old structure (Figure 1). The milk room is close to the milking unit; we installed a main direct cooling tank and a buffer tank with an instant cooling system; an integrated washing system provides automatically for the cleaning of the system three time a day. The engine room lodges vacuum- and compressed air supply, the boiler for the hot water and a water softener. From the office the operator has direct vision of the milking box through a large window; an uninterruptible power supply supports the system server and the electronics of the robot to prevent the blackout problems. A small control room allows the VMS working control without cow inconvenience. The cows are fed a total mixed ration at about 07.00 AM, but an amount of concentrate is also fed in the VMS during the milking procedure. As a rule, we introduced the cows immediately after calving, but at beginning of the study we chose 45 cows of different stage of lactation and age, not keeping in mind of the characteristics of the udder. The first four days after the introduction of the cows we provided a constant presence in the barn to teach them the way, the use of the feeder of the milking box and of the one-way gates. From the seventh day the flow of the cows was stabilized during the day and the night, with constant passage through the robot and we reduced our presence to two hours a day to drive the lazy cows to the milking box. After 15 days we started the automatic milking. During three days we assured a constant presence at the milking box, to facilitate the work of the robot and to assure an immediately intervention when a cow was too nervous and could damage the robot. From the fourth day the presence systematically decreased and after a week from the beginning of the automatic milking it was only 4-5 hours a day to drive the cows with some problems to the robot. Afterwards the routine of the introduction of a new cow is changed; before the calving, the animals are guided to the robot twice for 2 or 3 days. During the first milking we attend to the teaching procedure, to insert into the VMS the udder characteristics. The second milking is automatic. The system server coordinates all the activities and automatically records all the events. The database holds 65683 observations, recorded between 13 February 2001 and 2 December 2002.

RESULTS AND CONCLUSIONS – *Time on machine*. Table 1 gives descriptive statistics of some variables regarding VMS. On average, 40.3 ± 3.3 cows were milked and 101.1 ± 9.9 milkings were done daily. The milking procedure time is 13.49.40 ± 1.18.12 hours a day, which 2.31.35 ± 0.19.41 for teat cleaning and 9.41.58 ± 1.04.19 for machine on time (time from attachment of the fist until the detachment of last teatcup). The mean milking procedure time is 8.14 ± 2.32 min; if we consider that the system cleaning time is about 1.15.00 hours a day, in our condition theoretically we can perform about 166 milkings a day. During a correct milking procedure, the robotic arm fetches the teat preparation cup, which then performs teat cleaning and foremilking on each teat, then the arm starts attaching the milking teat cups and each teat receives a particular cup. If an error occurs, the robot starts a new attaching procedure to milk the cow correctly and about 15% of milkings required more then one procedure of attachment of at least one quarter. The machine on time considers also the reattachment procedure. In our dataset we recorded 89.9 ± 10.9 of successful milkings every day (of which 89.8 % ± 5.0 without reattachments). In these cows all quarters have been milked correctly. In Figure 2 it appears that cows, which required several attachments, sometime are not completely milked, even though some exceptions have been observed. In this test only 4 cows of 84 had serious attachment trouble (less than 50% of successful attachment) and this cows perform a large number of unsuccessful milkings (over 30%). We concluded that only a few cows have serious problems of attachment and consequently an appropriate selection can improve the system productivity.

Table 1. Summary statistics of the period 13 February 2001 to 2 December 2002.

	Mean	STD
Cows milked per day (No.)	40.3	3.3
Milkings per day (No.)	101.1	9.9
Teat cleaning time per day (hh.mm.ss)	2.31.55	0.19.41
Teat cleaning time per cow (hh.mm.ss)	0.01.30	0.00.26
Machine on time per day (hh.mm.ss)	9.41.58	1.04.19
Machine on time per cow (hh.mm.ss)	0.06.03	0.02.23
Milking process time per day (hh.mm.ss)	13.49.40	1.18.12
Milking process time (hh.mm.ss)	0.08.14	0.02.32
Successful milkings per day (No.)	89.9	10.9
Successful milkings per day without reattachments (%)	89.8	5.0

Figure 1. Lay-out of the AMS.

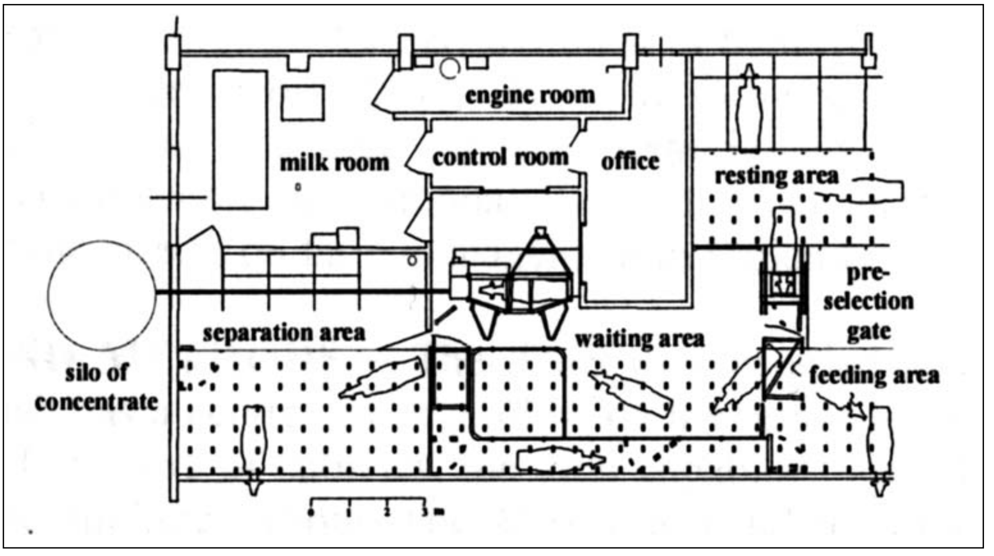
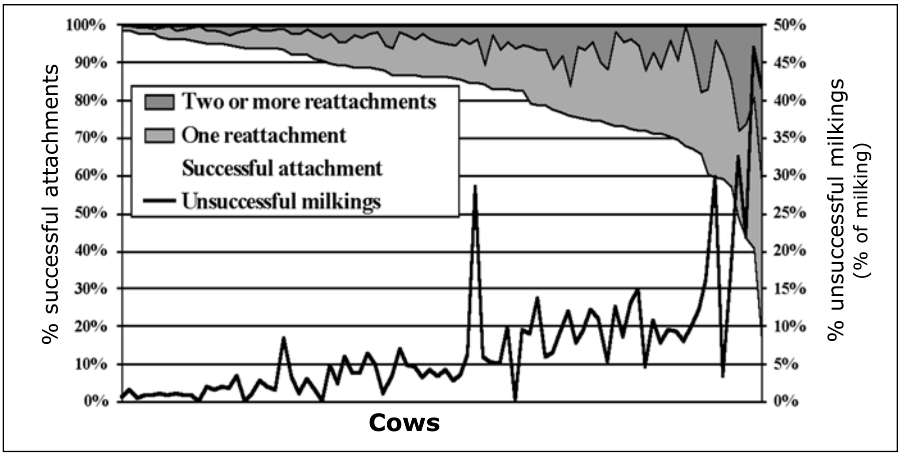


Figure 2. Successful milkings per cow.



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Two years of experience with an automatic milking system. 2. Milk yield, milking interval and frequency

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RIASSUNTO - Due anni di esperienze con il robot di mungitura. 2. Produzione, intervalli e frequenza di mungitura – *Si riportano alcune osservazioni relative alla produzione di latte, all'intervallo tra le mungiture ed alla frequenza di mungitura in un sistema di mungitura automatizzato. La variabilità individuale nella frequentazione volontaria dello stallo di mungitura, probabilmente legata a fattori comportamentali, ha portato ad una elevata variabilità individuale dell'intervallo tra le mungiture e della frequenza di mungitura. La frequenza di mungitura e la produzione di latte hanno un andamento simile nel corso del periodo considerato.*

KEY WORDS: automatic milking, milk yield, milking interval, milking frequency.

INTRODUCTION – The introduction of an automatic milking unit (AMU) changes milking procedures and routines: cows can be milked more than twice a day, and continuously over the day. Three milkings result in increased daily milk yield (MY) (Klei *et al.*, 1997); however, the automatic milking system (AMS) is very different from the three milkings system, because there are not fixed intervals between two consecutive milkings and because the daily milking frequency (DMF) varies among cows and among days. A long milking interval (MI) has a detrimental effect on MY. To maintain the maximum of milk secretion, the udder ought to be empty before the reaching of critical value of intra-mammary pressure. Irregular milking causes a reduction in milk yield (Kelly *et al.*, 1998). In AMS, some cows tend to have DMF less than two because of health problems, low MY or individual attitude. A study on several performance variables started, at the Istituto Sperimentale per la Zootecnia, Cremona (Italy), at the same time when a group of cows started to be milked automatically. In this paper, a descriptive analysis of MY, DMF and MI will be presented.

MATERIAL AND METHODS – Since 13 February 2001 until 1 December 2002, a total of 94 cows were automatically milked by an AMU (VMS™, DeLaval). A management information system, integrated in the AMS, analysed performance data at each milking, for each cow and for each udder quarter. Layout, cow traffic and management of the AMS are described in the companion paper (Capelletti *et al.*, 2003). The used database was referred to 65683 milkings. The cows that were milked automatically at least once a day for two consecutive weeks were 76; their distribution of milkings and MI during the day and the year were calculated and they were considered to calculate average MY and DMF.

RESULTS AND CONCLUSIONS – *Milk yield.* On average, 40.3 ± 3.3 cows were automatically milked daily. The average MY per milking was 9604 ± 4361 g. The large variability was expected because the dataset contained also incomplete and initial milkings. The milk of the front quarters was 41.4% and that of the rear quarters was 58.6% of total MY. These figures are consistent with those reported by Ogerwerf and Ipema (2000). The milkings were performed rather continuously, but not constantly over the day (Figure 1): the drops correspond with cleaning of AMU. The lowest number of milkings was observed early in the morning. The highest number of milkings was observed just few hours later. This peak is consistent with the schedule of the total mixed ration (TMR) distribution and the lazy cows fetching (between 06.00 and 09.00). On average, more than 5 milkings per hour were performed between 06.00 and 09.00 h. A second peak occurred when lazy were fetched again in the afternoon (between 16.00 and 17.00): almost 5 milkings per hour were performed, on average, between 15.00 and 20.00; then, the number of milkings decreased again; however, differences among cows were quite large, CV for milkings distribution varying from 25% to 77%. *Milking interval.* The overall MI mean was 9 h 23 m 50 s; 12.5% of the milkings occurred after an interval of 6 h or less and 19% longer than 12 h. The 4.5% of all MI were longer than 16 h. Although the minimum planned MI was 5 h, some MI shorter than 5 h were observed because of several reasons (incomplete milkings, double milkings etc.). Pattern of MI during the day is given in Figure 1. Data are very similar to those presented by Hogeveen *et al.* (2000). Two main peaks were observed in correspondence with the hours of the day when the lazy cows were fetched. Milking interval and DMF varied during the period of observation (Figure 2), probably depending on several managing and environmental factors (for instance, two main peaks occurred during hot seasons). *Daily milking frequency.* The average DMF for each cow varied between 1.5 and 3.7 with a mean of 2.5. Many cows (50%) had an average DMF of 2.5-3.0 milkings per day and more than 30% had an average of 2.0-2.5. However, almost 12% of the cows had an average DMF of less than 2 times per day and 6.6% of the cows had an average DMF of more than 3 times. Hogeveen *et al.* (2000) observed a greater proportion of cows milked 2.0-2.5 than that of cows milked 2.5-3.0 times a day. Average DMF per cow varied over the period following the same pattern of average daily MY (Figure 3), with an overall correlation of 0.50 (P < 0.0001). Because we found a large variability in individual diurnal patterns of milking number, we concluded that behavioural aspects should be investigated in order to clarify the reasons of differences among cows.

Figure 1. Pattern of milkings (grey line) and of milking interval (black line) during the day. CL= AMS cleaning. TMR= TMR distribution

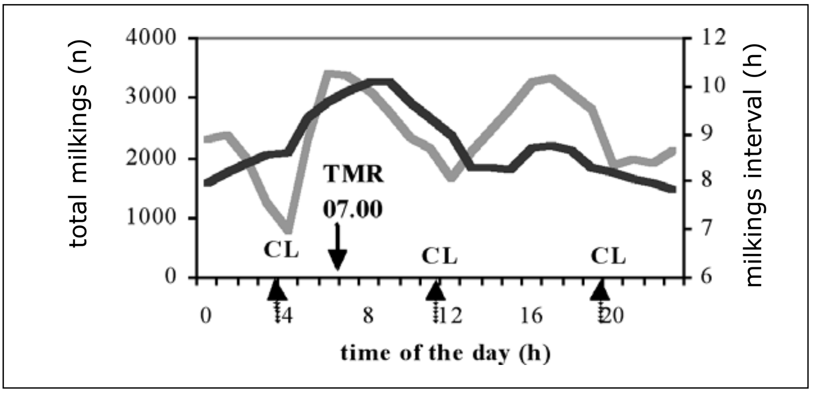


Figure 2. Pattern of milking interval (black line) and daily milking frequency (grey line) per cow.

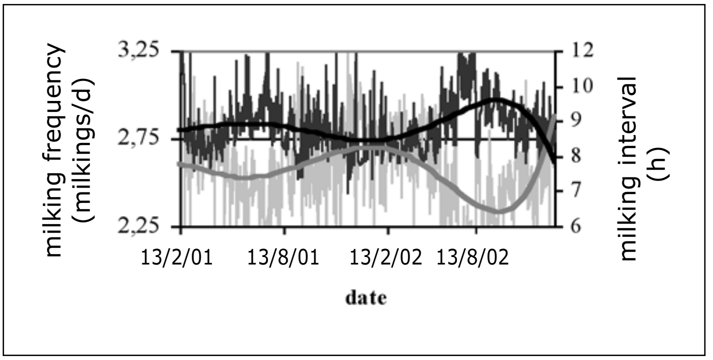
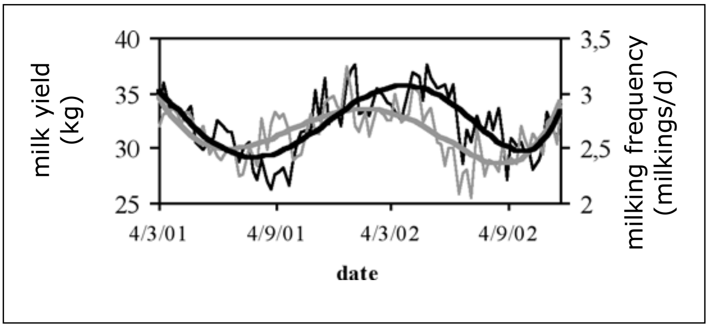


Figure 3. Pattern of average milk yield (black line) and of average daily milking frequency (grey line) per cow.



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Comparison between two methods of measurement of milking speed in dairy cattle reared in Trento province

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RIASSUNTO – Confronto tra due metodi di rilievo della velocità di mungitura nei bovini da latte allevati in provincia di Trento – *La velocità di mungitura è considerata un importante carattere funzionale per la salute della mammella e per incrementare il profitto aziendale. Lo scopo di questa ricerca è stato di comparare i dati di mungibilità registrati dagli impianti di mungitura informatizzati con quelli rilevati da controllori mediante l'uso di cronometri. L'analisi è stata condotta, dopo un filtro sui dati incompleti ed anomali, su 444 vacche in lattazione, di razza Bruna e Frisona, presenti in 17 allevamenti con impianti di mungitura informatizzati della provincia di Trento. I coefficienti di correlazione dei due metodi di misura analizzati sono risultati pari a 0,87 e 0,91, rispettivamente per il tempo totale di mungitura e per il flusso di latte nell'unità di tempo (kg/min).*

KEY WORDS: dairy cattle, milking speed, methods of measurement.

INTRODUCTION – Milking speed can be considered an important functional trait in dairy cattle, with regard to udder health, and to improve the dairy profits (Mein, 1998, Blake and McDaniel, 1978; Meyer and Burnside, 1987; Luttinen and Juga, 1997; Dodenhoff *et al.*, 2000, Bagnato *et al.*, 2001). National Breeders Association of Italian Brown and Friesian cattle are official recording milking speed using a flowmeter (Lactocorder by Foss Electric) and subjective evaluation given by the farmer, respectively. The flowmeter is an instrument easily adaptable on different milking machine (Santus and Bagnato, 1999), but it does not allow a complete recording of all cows in all dairy herds, especially when located in mountain area. Therefore, the Superbrown Consortium of Bolzano-Bozen and Trento started to record milking speed, using a chronometer, in order to help in the future the national recording system and to provide service for all dairy farmers. Electronic data might integrate the milking speed data recorded using chronometer. This might contribute to the milking speed data base used for breeding values estimation. Aim of this research is to compare chronometer and computerised milking devices as two methods of measurement milking speed collected on Italian Brown and Friesian cows.

MATERIAL AND METHODS – The study was carried out in July 2002 in 17 computerised herds located in the Trento province measuring 539 lactating cows. Editing of data regarded days in milk (from 6 to 500 days) and animals with calving age and parity known. After this editing the statistical analysis was performed on 346 Brown and 98 Holstein Friesian cows. The computerised milking devices (MD) were of two different commercial types: DeLaval® (DL) with lactometer FloMaster, used in 10 herds with 134 total recorded cows, and Westfalia® (W) with lactometer Metatron, used in 7 herds with 310 total recorded cows. The milking speed traits were: milking time (MT), expressed in minute, and direct flow rate (DFR), expressed as ratio between milk yield (kg) and milking time (min). The MT of each cow was simultaneously timed from three adequately trained controllers, and moreover, the MD milking speeds

(MMS) was recorded. Total MT recorded by the controllers through a standard chronometer was defined as the interval from attaching the last teat cup and the cluster's complete removal (Meyer and Burnside, 1987). The MD milking time (MMT) is the interval among the two minimum levels of milk flow from the start to the end of regular milking procedure, defined by a sensor.

Table 1. Descriptive statistics of timed cows (444 records).

	Mean	SD	*Minimum*	*Maximum*
Milk yield (kg)	26.2	9.1	7.1	64.3
Parity	2.5	1.7	1.0	9.0
Calving age (month)	52.7	24.5	24.3	147.4
Days in milk	179.6	95.0	5.0	481.0

A preliminary analysis of variance, using a GLM procedure (SAS, 1990), was conducted for both traits (MT and DFR) in order to study the sources of variation: herd, milking controller, parity, calving age, breed, class of milk yield and stage of lactation. Only herd and days in milk (DIM) were statistically significant for this sample of data. The final analysis of variance was performed in order to study the relation between methods of measurement of milking speed using the following linear model:

$$Y_{ijkl} = \mu + MD_i + H_{ij} + DIM_k + b*MMS_{ijkl} + e_{ijkl}$$

where: Y_{ijkl} = MT recorded by chronometer; μ = general mean; MD_i = fixed effect of milking device on herd (i = DL and W); H_{ij} = fixed effect of herd within MD (j = 1,…,17); DIM_k = fixed effect of DIM (k = 1,…,7 classes of 45 days, except to class 7: >275 days); b = linear regression coefficient of milking machine speed (MMS) on MT timed by chronometer; e_{ijkl} = random effect of error ~ $N(0, \sigma_e^2)$.

RESULTS AND CONCLUSIONS – Descriptive statistics for milk yield, parity, calving age and DIM are given in Table 1. Data sample is comparable with dairy cattle population under milk recording system in Trento province (AIA, 2002). Analysis of variance is presented in Table 2. The effects of MMS and herd within MD were highly significant for both traits (MT and DFR) and they absorbed the major percentage of total variation (71% and 28% for MT, respectively; 65% and 30% for DFR, respectively). The R^2 of model were high and equal to 83% and 87% for MT and DFR, respectively. Least square means for milking speeds and relative standard errors are shown in Table 3. The MD effect showed as the milking time recorded by W device was lower then DL device (6.40 *vs* 7.36, respectively), while W device showed

Table 2. Analysis of variance for milking time (MT) and direct flow rate (DFR).

Source of variation	d.f.	Mean square	
		MT (min)	DFR (kg/min)
Milking device (MD)	1	61.95 *	8.01 *
Herd within MD	15	5.26 ***	1.76 ***
MD milking speed	1	1178.15 ***	487.93 ***
Days in milk	6	2.14 *	1.14 **
Error	420	0.89	0.29
R^2		83	87

**** = P<0.0001;** = P<0.001;* = P<0.05*

Table 3. Least square means and standard error for milking time (MT) and direct flow rate (DFR).

Fixed effects	MT (min)	DFR (kg/min)
DL device	7.36 ± 0.39	3.86 ± 0.22
W device	6.40 ± 0.00	4.22 ± 0.00
Farm (average of 17 records)	6.96 ± 0.04	4.01 ± 0.02
DIM 1 (from 6 to 50 days)	7.17 ± 0.20	4.03 ± 0.02
DIM 2 (from 51 to 95 days)	7.05 ± 0.21	4.14 ± 0.11
DIM 3 (from 96 to 140 days)	6.83 ± 0.17	4.06 ± 0.12
DIM 4 (from 141 to 185 days)	6.60 ± 0.16	4.23 ± 0.10
DIM 5 (from 186 to 230 days)	6.76 ± 0.16	4.04 ± 0.09
DIM 6 (from 231 to 275 days)	6.76 ± 0.17	3.98 ± 0.09
DIM 7 (> 275 days)	7.00 ± 0.00	3.80 ± 0.10

an higher DFR respect to DL device (4.22 *vs* 3.86, respectively). Least square means of DIM classes showed a no-linear effect with a *minimum* MT and a *maximum* DFR on the 4th DIM class.

The simple correlation between TMT and MMS was high (0.87 for MT and 0.91 for DFR) suggesting that milking speed recorded by the computerised MD might be helpful to integrate the provincial database of milking speed records, especially in farms not computerised. The rapidity achieved for data recording using electronic devices might be helpful for breeding value estimation because it allows a quicker collection and a larger number of data in dairy herds located in mountain area.

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Proteose-peptone content in the milk of Italian Friesian cows with moderate and high somatic cell values

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RIASSUNTO – Contenuto di proteoso-peptoni nel latte di vacche frisone italiane con moderati ed elevati valori di cellule somatiche – *Sono state studiate le principali caratteristiche ed il contenuto in proteoso-peptoni di piccole miscele di latti individuali di vacche di razza Frisona, distinti secondo tre differenti livelli di cellule somatiche (basso: 110·000, moderato: 529·000 ed elevato: 1·699·000 unità per ml). I latti con elevati valori di cellule sono risultati poveri di lattosio, ricchi di cloruri e caratterizzati da una acidità nettamente inferiore. I contenuti di N proteoso-peptoni sono risultati significativamente diversi, pari a 11,5 – 15,9 – 17,6 mg per 100 g, rispettivamente per le tre classi di cellule somatiche.*

KEY WORDS: cow milk, somatic cells, nitrogen fractions, proteose-peptone

INTRODUCTION – Milk with elevated somatic cell count has an impaired quality and reduced value, especially for the manufacture of cheese (Schællibaum, 2002). If the milk has a high cell count, the deterioration during syneresis with a longer clotting time and weak curd leads to an increased moisture content and a lower dry matter yield (Politis and Ng-Kwai-Hang, 1988; Urech *et al.*, 1999; Cooney *et al.*, 2000). Most of proteose-peptones (PP) and γ-caseins of the milk result from the enzymatic hydrolysis of the native casein (Pâquet, 1989; Bastian and Brown, 1996). In particular, PP5 e PP8 components arise from the specific degradation of β-casein by the plasmin (Eigel *et al.*, 1984), which presence in milk can vary depending on several physiological and, above all, pathological factors (Barry and Donnelly, 1981; Andrews and Alichanidis, 1983; Ballou *et al.*, 1995; Baldi *et al.*, 1996). Proteolysis can alter micellar integrity, with important negative repercussions at level of milk technological behaviour (Barbano *et al.*, 1991; van Boekel and Crijns, 1994). The aim of this research was to study the variations of milk proteose-peptone content in relation to somatic cell count.

MATERIAL AND METHODS – The study was carried out on 45 milk samples (each constituted by a small mixture of 3÷5 individual milks from morning milking), distinguished by a different somatic cell content and subdivided into three classes: milk with less than 250,000, milk from 250,000 to 750,000 and milk with more than 750,000 units per ml. Samplings were taken in different seasonal periods from medium-size and medium-high-size herds of Italian Friesian cows, located in the Parma province. On milk samples, added with sodium merthiolate (0.02 % w/v), the following analyses were carried out: pH with potentiometer; titratable acidity on 50 ml of milk with 0.25N NaOH according to Soxhlet-Henkel method (Anon., 1963); total nitrogen (TN), non-casein N (NCN), non-protein N (NPN), respectively on milk, acid whey at pH 4.6 and 12% TCA filtrate of milk, by Kjeldahl, according to Aschaffenburg and Drewry (1959); from which casein N (CN = TN - NCN); proteose-peptone N (PPN) according to Aschaffenburg and Drewry (1959), after precipitation with anhydrous sodium sulphate from pH 4.6 acid whey and analysis of filtrate by Kjeldahl; urea, by enzyme reaction catalysed by urease (Pecorari *et al.*, 1993), with Bun Analyzer 2 apparatus, by means of P/N 667510 kit Bun reagent and values expressed as urea N (MUN); fat and lactose by mid infrared analysis (Biggs, 1978), with Milkoscan 134 A/B; somatic cells by fluoro-opto-metric method (Schmidt-Madsen, 1975), with Fossomatic 250; chloride, Cl^-, by titration ($AgNO_3$), according to the volumetric method of Charpentier-Volhard (Savini, 1946); freezing point with a thermistor cryoscope, according to Hortvet. The statistical significance of the differences among the observed mean values was tested by ANOVA after control of variance homogeneity (Bartlett test).

RESULTS AND CONCLUSIONS – The mean somatic cell values for the three groups resulted significantly different for experimental condition: 110,000 (L), 529,000 (M) and 1,699,000 (H) units per ml, for the milk with low, moderate and high somatic cell content, respectively. Milks with moderate and high somatic cell content (Table 1) resulted significantly poorer of lactose (4.85 L *vs* 4.66 M *vs* 4.57 H, g per 100 g; P<0.0001) and richer of chloride (98.5 L *vs* 111.5 M *vs* 117.9 H, mg Cl^- per 100 g; P<0.0001). In comparison to milk with low somatic cell content, the milk with high somatic cell content had a concentration of lactose 6% lower and chloride values about 20% higher. pH and titratable acidity values were significantly different (Table 1). As regards to nitrogen fractions, a progressive increase of non-casein N corresponded to the somatic cell increase (112.8 L *vs* 120.0 M *vs* 125.5 H, mg per 100 g; P<0.01). On the contrary, N casein variations were statistically not significant; however, milk with the higher content of somatic cells had a lower content of casein. The combined effect of these two *phenomena* determined significant variations of the casein number (77.36 L *vs* 76.16 M *vs* 74.87 H; P<0.001), that resulted markedly lower in the milk with high content of somatic cells (Table 1). Milks with moderate and high somatic cell content were characterised (Fig. 1) by a higher concentration of proteose-peptone N (11.5 L *vs* 15.9 M *vs* 17.6 H, mg per 100 g; P<0.05). In these conditions, proteose-peptones represent more and more increasing percent amount of casein N (3.01 L *vs* 4.16 M *vs* 4.73 H, %; P<0.05). The results of this study suggest that proteose-peptone content of milk varies in relation to milk somatic cell content. In effect,

Table 1. Characteristics and proteose-peptone content of milks with different somatic cell count (SCC). g or mg per 100g of milk. Means±SD.

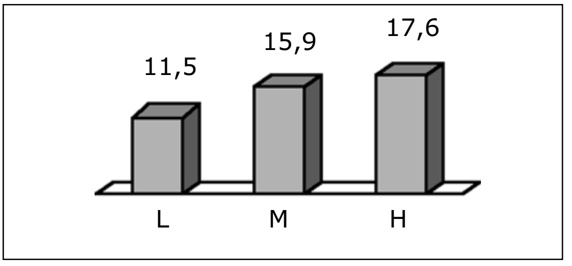
		Low (15)		Moderate (15)		High (15)	
SCC	10^3/ml	110 ± 52		529 ± 79		1699 ± 876	
SCC	log/ml	4.998 ± 0.199		5.719 ± 0.064		6.193 ± 0.173	
pH	—	6.64 ± 0.08	A	6.69 ± 0.06	A	6.73 ± 0.06	B
TA(1)	°SH/50ml	3.61 ± 0.24	C	3.38 ± 0.25	B	3.17 ± 0.19	A
Freezing point	Δ°C	0.527 ± 0.005		0.526 ± 0.004		0.526 ± 0.003	
Protein	g	3.18 ± 0.20		3.21 ± 0.19		3.19 ± 0.20	
Fat	g	3.03 ± 0.97		3.30 ± 0.60		3.39 ± 0.67	
Lactose	g	4.85 ± 0.11	B	4.66 ± 0.15	A	4.57 ± 0.16	A
Cl^-	mg	98.53 ± 8.60	A	111.50 ± 8.84	B	117.90 ± 9.43	B
CN	mg	385.5 ± 26.0		383.0 ± 22.3		374.3 ± 25.6	
NCN	mg	112.8 ± 11.3	A	120.0 ± 8.7	AB	125.5 ± 10.9	B
NPN	mg	25.3 ± 3.8		24.7 ± 3.2		24.0 ± 2.7	
PPN	mg	11.5 ± 4.9	A	15.9 ± 5.0	AB	17.6 ± 8.0	B
MUN	mg	12.82 ± 3.75		12.29 ± 2.98		11.73 ± 4.23	
CN / TN	%	77.36 ± 1.83	c	76.16 ± 0.68	b	74.87 ± 1.72	a
PPN / TN	%	2.31 ± 0.98	a	3.17 ± 0.98	ab	3.52 ± 1.58	b
PPN / NCN	%	10.07 ± 3.90	a	13.24 ± 3.92	b	13.76 ± 4.93	b
PPN / CN	%	3.01 ± 1.32	A	4.16 ± 1.31	AB	4.73 ± 2.30	B

a, b, c: different for P<0.05; A, B, C: different for P<0.01;

(1) TA = Titratable acidity.

milk with high somatic cell content resulted significantly more provided of proteose-peptones. The increase of this nitrogen fraction seems to be a clear index of a greater proteolytic activity, with a detriment for the integrity of the casein micelle.

Figure 1. PPN contents of milk with low (L), moderate (M) and high (H) somatic cell content (mg NPP per 100 g of milk).



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Effect of breed, parity and stage of lactation on milk conjugated linoleic acid content in Italian Friesian and Reggiana cows

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RIASSUNTO – Effetto della razza, dell'ordine di parto e dello stadio di lattazione sul contenuto di acido linoleico coniugato nel grasso del latte di bovine Frisone e Reggiane – *Sono stati raccolti campioni di latte individuali con cadenza mensile da 22 vacche di razza Frisona Italiana e 24 vacche di razza Reggiana, mantenute nello stesso allevamento dal parto fino al settimo mese di lattazione, al fine di stimare l'effetto della razza, dell'ordine di parto e dello stadio di lattazione sul contenuto di acido linoleico coniugato (CLA) e di altri acidi grassi a media e lunga catena nel grasso del latte. Il contenuto di CLA non è risultato influenzabile né dalla razza né dall'ordine di parto, ma è variato sensibilmente nel corso della lattazione, evidenziando un aumento del 50% fra il primo e il settimo controllo. All'inizio della lattazione la sintesi degli acidi grassi a media catena è risultata inibita dalla maggior presenza di acido oleico e acido stearico.*

KEY WORDS: fatty acid; CLA; cow milk; stearoyl-CoA desaturase.

INTRODUCTION – Conjugated linoleic acid (CLA) refers to a mixture of positional and geometrical isomers of fatty acids with 18 carbon atoms and 2 conjugated double bounds. Some isomers are assumed to play an important role in human health (Pariza *et al.*, 2001). The *cis*9, *trans*11 CLA isomer (rumenic acid; RA) is the major CLA isomer in dairy products and it origins partly (more than 70%) from mammary desaturation of *trans*11 C18:1 (vaccenic acid; VA) and partly from rumen biohydrogenation of linoleic acid (Corl *et al.*, 2001). The enzyme involved in the mammary RA desaturation is stearoyl-CoA desaturase (SCD), that is able to desaturate several other fatty acids found in milk fat. Diet seems to be the major factor of variation of milk CLA content, but also species, breed and individual have been showed as important sources of variation when cows were fed the same diet (Jahreis *et al.*, 1999; Lawless *et al.*, 1999). The aim of this study was to determine the effects of breed, parity and stage of lactation on the levels of CLA and other fatty acids in milk of Italian Friesian and Reggiana cows, maintained on the same commercial dairy farm.

MATERIAL AND METHODS – Milk of 22 Italian Friesian cows and 24 Reggiana cows (belonging to different parity) was monthly sampled during the period between calving and the 7th month of lactation. All the calvings occurred during the spring season; cows were maintained on the same dairy farm during the whole experimental period and subjected to a typical dietary regimen of the Parmigiano Reggiano disciplinary. Fat of milk samples was extracted and trans-methylated, then methyl esters of fatty acids were analysed with a chromatograph fitted with a FID detector and equipped with a 100 m fused silica capillary column. The analysis involved a programmed run with temperature ramps. Nonadecanoic acid methyl ester was used as the internal standard. Desaturase Index (DI) was calculated according to Malau-Aduli *et al.* (1997) formula:

DI = 100 x $((C_{14:1} + C_{16:1} + C_{18:1})/(C_{14:1} + C_{16:1} + C_{18:1} + C_{14:0} + C_{16:0} + C_{18:0}))$.

Data were subjected to the following mixed linear model (Cappio-Borlino *et al.*, 2000):

$$Y_{ijkpq} = m + B_i + P_j + DIM_k + DIM(B) + L_p + E_{ijkpq};$$

where Y is the test day measure q (CLA and other fatty acids content, desaturase index) of lactation p; m the overall mean, B the fixed effect of the breed (i= 1, 2); P the fixed effect of the parity (j= 1 for first parity and 2 for second or greater), DIM the fixed effect of the days in milking interval (k = 1, 2, ….7), L is the random effect of each individual lactation (genetic and permanent environmental effect associated with each animal) and E the residual error.

RESULTS AND CONCLUSIONS – Milk fatty acid composition of the two breeds differed in 14:0; 14:1 and 16:0 acids content (Table 1), which are completely (first two acids) or in part (16:0) synthesised in mammary gland.

Table 1. Effect of breed and parity on selected fatty acid composition of milk fat (g/100 g lipid extract) and on desaturation index (DI).

	Breed		Parity	
	Italian Friesian	Reggiana	1	2
14:0	10.32±0.19 A	9.65±0.18 B	10.12±0.26	9.90±0.21
14:1	0.84±0.04 a	0.75±0.03 b	0.81±0.05	0.78±0.04
16:0	25.27±0.46 a	24.12±0.44 b	24.99±0.63	24.55±0.52
16:1	1.29±0.05	1.28±0.04	1.24±0.06	1.30±0.05
18:0	9.97±0.27	10.12±0.26	10.26±0.37	9.90±0.28
18:1 *cis*9	10.69±0.40	10.67±0.39	18.91±0.55	18.56±0.44
18:1 *trans*11	1.32±0.05	1.34±0.05	1.41±0.07	1.29±0.05
18:2 *cis*9, *trans*11	0.77±0.02	0.77±0.02	0.80±0.03	0.75±0.02
18:2 *cis*9, *cis*12	2.99±0.08	3.09±0.08	2.85±0.11	3.1±0.42
DI	31.46±0.57	31.93±0.55	31.72±0.78	31.10±0.76

A, B: P<0.01; a,b: P<0.05.

Average content of long chain fatty acids did not differ between milk fat of the two breeds. Regarding milk rumenic acid (RA) content, previous studies (Lawless *et al.*, 1999; White *et al.*, 2001) reported differences between milk fat of Holstein and Jersey cows or Holstein and Montbeliard or Normand cows, but in our trial no differences were found between milk fats of Italian Friesian and Reggiana cows. Also DI, that includes ratios for the fatty acid pairs that are proxies for SCD enzyme, remained essentially stable. Parity effect was never significant (Table 1). During the first period of lactation, when cows are often in negative energetic balance, milk fat contained more fatty acid with 18 carbon atoms and less 14:0; 14:1 and 16:0 acids (Table 2). In this period, in fact, long chain fatty acids are mobilized from body lipids and they may inhibit fatty acid elongation in mammary gland. Milk fat RA content raised during lactation and increased more than 50% at 7th sampling (Table 2). This result did not agree with Peterson *et al.* (2002) who observed that average RA content of milk fat for Holstein cows fed the same diet was relatively constant over a 12 weeks experimental period. On the contrary, DI, that represents a estimation of SCD activity, was higher during early lactation. Interestingly, in our study *cis*9, *cis*12 18:2 acid and VA, that are respectively the ruminal and the mammary precursors of RA, did not vary during lactation (Table 2), as consequence of little variation of dietary lipid source. In conclusion, breed and parity did not affect RA content in milk fat, while stage of lactation did. The higher value of DI did not correspond to the higher value of milk RA content, therefore, since the major part of RA origins from mammary synthesis by means of SCD activity, more studies are needed to completely explain the relationship between DI and RA content in milk fat.

Table 2. Effect of DIM interval on selected fatty acid composition of milk fat (g/100 g lipid extract) and on desaturation index (DI).

	Days in milking interval (DIM)						
	1	2	3	4	5	6	7
14:0	7.73A	9.89B	10.49C	10.77C	10.55C	10.43C	10.03BC
14:1	0.48A	0.66B	0.79C	0.91C	0.94C	0.91C	0.86C
16:0	23.27A	25.12B	24.87B	25.89B	25.37B	24.38B	23.97A
16:1	1.46A	1.25B	1.23B	1.32B	1.29B	1.27B	1.33B
18:0	11.25A	10.64AB	9.79B	9.33B	9.83B	9.65B	9.85B
18:1 *c*9	21.47A	18.5B	17.26BC	17.76B	18.18B	18.68B	18.96B
18:1 *t*11	1.31	1.34	1.37	1.36	1.35	1.32	1.38
18:2 *c*9,*t*11	0.59A	0.69B	0.78B	0.82C	0.82C	0.83C	0.89C
18:2 *c*9, *c*12	2.99	3.02	3.03	2.95	3.09	3.04	3.12
DI	35.61A	30.91B	29.96B	30.35B	30.65B	32.02C	32.38C

A, B, C: P<0.01

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Milk fat globules in different dairy cattle breeds Part I: morphometric analysis

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RIASSUNTO – Il globulo di grasso in diverse razze di bovini da latte. Nota I: Analisi morfometrica – *In questo studio vengono valutate le caratteristiche morfometriche del globulo di grasso del latte bovino di tre diversi tipi genetici: Frisona Italiana, Frisona Tedesca e Jersey. Il latte della Frisona è caratterizzato da un numero medio di globuli di grasso/ml tendenzialmente superiore ($4{,}33x10^9$ nella Frisona Italiana e $4{,}19x10^9$ per la Frisona Tedesca, $3{,}55x10^9$ razza Jersey) e da un diametro medio significativamente minore (4,93 Frisona Italiana, 4,97 Frisona Tedesca* vs *5,30 Jersey: P≤0,01). La percentuale dei globuli di dimensioni maggiori (>6μm) è superiore nella razza Jersey (P≤0,01), mentre minore (P≤0,01) è quella relativa ai globuli medi (3-6 μm).*

KEY WORDS: milk fat globules, morphometric analysis, milk quality, cattle.

INTRODUCTION – The study of the morphometric parameters of milk fat globules can aid in increasing our knowledge of the relationship between the number and dimensions of globules and the chemical, nutritional and technological characteristics of milk and its by-products. It is well-known that the fat globules secreted from the mammary cell are of heterogeneous dimensions, and at present the process of their synthesis in the cell is not yet entirely clear (Keenan, 2001). The few studies previously carried out on livestock mainly concern dairy cattle; results show a certain variability which is probably related to the different breeds, to physiological factors (Simonin *et al.*, 1984; Martini *et al.*, 2002), to the different diet plans adopted as well as to the different methods of evaluation employed (Walstra, 1969). For several years our interest has focused on studying the causes of this variability in the physical and chemical characteristics of milk fat globules; in this paper we have attempted to evaluate the influence of genotype on their morphometric characteristics.

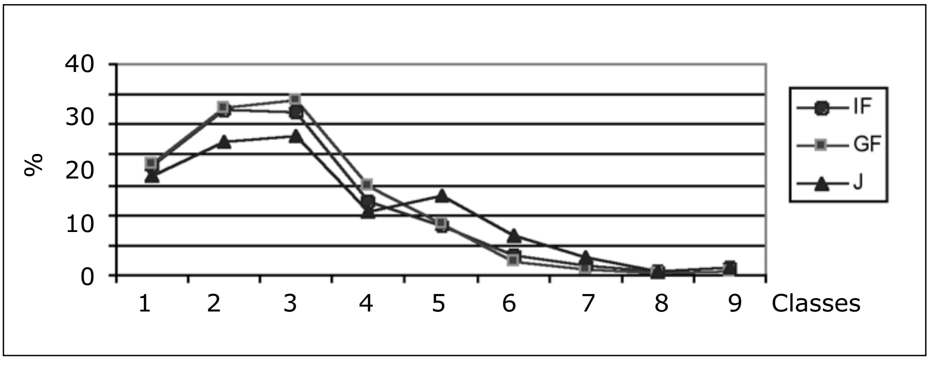
MATERIAL AND METHODS – The trial was carried out on 68 cows of different breeds (34 Italian Friesian, 25 German Friesian and 9 Jersey); to reduce the possible influence of differing environmental conditions, all animals came from one herd in the province of Pisa, and they all fed the same diet. The milk samples for quantitative/qualitative analysis were taken over a time period of 1 year; only one sample from each animal was taken from the morning milking. Morphometric analysis of the measured fat globules was carried out following the method of Scolozzi *et al.* (2000). The diameter of the fat globules was divided according to size into nine classes of 1.5-μm class widths (from 1.5 μm to >13.5 μm) and were then further classified into small (1.5-3 μm), medium (3-6 μm) and large (>6 μm). The following procedures were carried out on every sample of fresh milk: standard chemical analysis, SCC (somatic cell count), TBC (total bacterial count), titratable acidity and pH; rheological parameters (r, k_{20}, a_{30} and a_{45}) were also measured (ASPA 1995). The difference between breeds was tested using the following model:

$$y_{ijkl} = \mu + TG_i + O_j + E_k + b_1X_1 + e_{ijkl}$$

where y_{ijkl} = considered parameters; μ = overall mean; TG_i = fixed effect of the i^{th} genotype (i = 1,..,3); O_j = fixed effect of the j^{th} parity (j = 1,..,4); E_k = fixed effect of the k^{th} season sample (k = 1,..,4); b_1= regression coefficient on the time elapsed since calving (X_1); e_{ijkl} = residual error. The experimental data obtained were analyzed by JMP software version 3.1.6.2 of SAS Inst. (1996).

RESULTS AND CONCLUSIONS – Milk production of the Italian and German Friesians was higher by about 30% than that of the Jerseys (P≤0.01); the latter breed presented a higher percentage of dry matter, non-fat dry matter, protein and fat (P≤0.01), a lower content of SCC (P≤0.05) and a higher titratable acidity (P≤0.01); the clotting aptitude was also best, with the rennet clotting time and the rate of curd firming time lower and the curd firmness higher at 30 and 45 minutes (P≤0.01). The number of fat globules/ml of milk was higher in the Friesian ($4.33x10^9$ in the Italian Friesians and $4.19x10^9$ in the German Friesians) and lower in the Jersey breed ($3.55x10^9$). The average diameter of the fat globules was statistically greater (P≤0.01) in the Jerseys, compared to the Friesians (5.31 *vs* 4.93 and 4.97); our results are slightly higher than previously described averages (Timmen and Patton, 1988; Jensen, 1991; Mehaia, 1995; Mather and Keenan, 1998). Figure 1 shows the percentage of fat globules measured and distributed in nine size classes according to diameter; in each breeds the percentage of fat globules presents an increasing trend up to the 3^{rd} class (4.5-6μm), and the percentage then decreases progressively until the last class. In the 2^{nd} and 3^{rd} class (3-6μm) the percentage of the number of the fat globules is significantly greater (P≤0.05) in the Friesian, compared to the Jersey breed, while from the 5^{th} to the 7^{th} class (6-12 μm) the opposite trend occurs, with a greater statistical percentage of globules (P≤0.01) found in the Jersey breed. Jerseys (Table 1) appeared to have a lower percentage of small fat globules (1.5-3 μm), and a statistically (P≤0.05) lower percentage of medium fat globules (3-6 μm) than Friesian; on the other hand, this breed presented a higher percentage of large fat globules (>6 μm; P≤0.01). This suggests a relationship between the dimensions of fat globules secreted from the mammary gland and the breeds: fat globules/ml in the milk of the Jerseys compared to that of Friesians, are fewer but are larger in size. According to other Authors (Timmen and Patton, 1988; Beaulieu and Palmquist, 1995), it would seem that the mammary secretion of the fat depends on the different mechanisms of lipid synthesis in the various genotypes, suggesting the possibility for a differentiated commercial destination of the milk.

Figure 1. Distribution of fat globules in nine classes.



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Milk fat globules in different dairy cattle breeds Part II: relationship to fatty acid composition

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RIASSUNTO – Il globulo di grasso in diverse razze di bovini da latte. Nota II: relazioni con il profilo acidico del latte – *Vengono valutate le relazioni tra le caratteristiche morfometriche dei globuli di grasso del latte di tre diversi tipi genetici (Frisona Italiana, Frisona Tedesca e Jersey) ed il profilo acidico del rispettivo latte. La razza Jersey presenta un contenuto in acidi grassi saturi a corta catena superiore, rispetto alla Frisona (P≤0,01) ed un minore contenuto di acido oleico (P≤0,01). Il diametro dei globuli di grasso è correlato positivamente al contenuto di acidi grassi a corta e media catena e a quelli saturi, viceversa, negativamente con gli acidi grassi a lunga catena, mono e polinsaturi e al rapporto acidi grassi insaturi/saturi.*

KEY WORDS: milk fat globules, fatty acids, milk quality, cattle.

INTRODUCTION – Several studies have pointed out that even under similar environmental conditions, fatty acid composition in milk from dairy cattle of different breeds may be not homogeneous (Beaulieu and Palmquist, 2000; Palmquist *et al.*, 1993; Bitman *et al.*, 1995). The higher percentage of polyunsaturated fatty acids in Friesian milk, compared to that of Jerseys, may be related to the physical characteristics of fat globules (Timmen and Patton, 1988; Jensen *et al.*, 1991; Scolozzi, 2002). Milk fat globules of heterogeneous dimensions have been described for many years (Walstra, 1969), but it is still uncertain whether a link exists between the morphometric characteristics of fat globules and their chemical composition (Polidori *et al.*, 1995). In this study we proposed to investigate the relationship between milk fatty acid composition and the morphometric characteristics of fat globules.

MATERIAL AND METHODS – The study was carried out on 68 cows of different breeds (34 Italian Friesian, 25 German Friesian and 9 Jersey); to reduce the possible influence of differing environmental conditions, all the animals came from a single herd in the province of Pisa and all fed the same diet. The milk samples were taken for qualitative/quantitative analysis during a one year period and a single sample from each animal was taken from the morning milking. Morphometric analysis of the fat globules was carried out following the method of Scolozzi *et al.* (2000). Fat globules were divided into nine size classes of 1.5-μm class widths (from 1.5 μm to >13.5 μm) and were further classified into small (1.5-3 μm), medium (3-6 μm) and large (>6 μm). The fatty acids of milk fat were analyzed by gas chromatography as the methyl ester derivates after trans-esterification with sodium methoxide (Christie, 1982); the gas chromatographic apparatus Perkin Elmer Auto System was equipped with a FID detector and a capillary column (OMEGAVAX 320), with helium as carrier gas; peak areas of individual fatty acids were quantified as percent of total fatty acids. Three-way analysis of variance (breeds, parity and season sample) with the covariate on the time elapsed since calving was used to test the effect of the breeds on the variables examined. The relationship between the morphometric parameters and milk fatty acid composition was tested by single pair correlations. The experimental data obtained were analysed by JMP software version 3.1.6.2. of SAS Institute (1996).

RESULTS AND CONCLUSIONS – Results showed that Jersey milk fat contained a statistically higher proportion of saturated fatty acids of mammary origin C4:0, C6:0, C8:0, C10:0 e C11:0 and lower C18:1 than did Friesian milk fat (P≤0.01); these results were comparable with those obtained by other Authors (Morales *et al.*, 2000; Beaulieu and Palmquist, 2001; White *et al.*, 2001). The grouping of the milk fatty acids of Friesians and Jerseys is reported in Table 1, where we observe a higher content of short- chain fatty acids (P≤0.01), to the detriment of that of long- chain (P≤0.05) and a significantly lower ratio of unsaturated/saturated fatty acids in the milk of the Jerseys compared to that of the Friesians (P≤0.01). The correlations between the grouping of the fatty acids and the dimension of the milk fat globules, subdivided into small, medium and large, are reported in Table 2: in the Friesian milk, the value of the number of the globules/ml was negatively correlated (P≤0.01) with the saturated fatty acids, but correlated positively (P≤0.01) with both monounsaturated and the ratio of unsaturated/saturated fatty acids. Diameters of fat globules, in turn correlated with the number of globules/ml of milk (Martini *et al.*, 2002), presented positive correlations (P≤0.01) with short and medium chain fatty acids and with saturated fatty acids, but negative correlations (P≤0.01) with long-chain fatty acids, with mono and polyunsaturated and with the ratio of unsaturated/saturated fatty acids. In particular, the higher percentage of small globules was related to a smaller amount of short and medium-chain and of saturated fatty acids (P≤0.01), as well as to a higher proportion of long-chain and monounsaturated fatty acids (P≤0.01). The milk fatty acid composition was significantly modified and contrary to the increase in the percentage of the larger sized globules. In Jerseys the number of significant correlations is lower, but the trend is similar to that observed for the Friesians. In the light of our results we can conclude that the morphometric characteristics of milk fat globules may be related to the acidic composition of the fat and in particular, that a higher number of small fat globules in milk implies a greater abundance in these of unsaturated and long chain fatty acids.

Table 1. Milk fatty acid groups (% of total fatty acids).

	Italian Friesian		German Friesian		Jersey	
%	average	s.e	average	s.e.	average	s.e.
SCFA	7.99 B	0.191	7.98 B	0.220	9.79 A	0.325
MCFA	45.97	1.648	44.83	1.619	47.95	1.057
LCFA	45.94 a	2.799	47.19 ab	2.825	42.16 b	2.230
SFA	68.54 B	1.796	67.97 B	1.454	73.70 A	2.073
MUFA	26.57 A	1.649	28.39 A	2.254	22.51 B	1.903
PUFA	4.89	0.973	3.64	1.330	3.79	1.123
UFA/SFA	0.46 A	0.040	0.47 A	0.054	0.36 B	0.046

A,B: P≤0.01; a,b: P≤0.05

Table 2. Correlation between morphometrical parameters and fatty acid groups.

			Italian and German Friesian			Jersey	
%	N°globules	Diameter	Small	Medium	Large	Small	Medium
SCFA	-0.252	0.305**	-0.430**	-0.455**	0.527**	-0.896*	0.191
MCFA	-0.128	0.331**	-0.437**	0.264	0.331*	-0.735	0.996**
LCFA	0.177	-0.357**	0.485**	0.296	-0.407**	0.837*	-0.968**
SFA	-0.388**	0.571**	-0.569**	-0.497**	0.5614**	-0.103	0.822*
MUFA	0.350**	-0.506**	0.593**	0.360*	-0.536**	0.104	-0.870*
PUFA	0.218	-0.337**	0.216	0.409**	-0.426**	0.028	-0.821*
UFA/SFA	0.384**	-0.548**	0.242	0.481**	-0.580**	0.067	-0.052

***: P≤0.01; *: P≤0.05*

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Factors affecting the shape of the lactation curve in Reggiana cattle

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RIASSUNTO – Fattori che influenzano la curva di lattazione in bovine di razza Reggiana – *E' stata analizzata la produzione (kg) di latte, di latte FCM, di grasso e di proteine di 541 bovine di razza Reggiana, adattandola al modello di Wood; i coefficienti ottenuti sono stati elaborati attraverso ANOVA (effetti fissi: allevamento, ordine e stagione di parto, effetto casuale: toro). Le primipare hanno messo in luce una produzione di latte, FCM e proteine inferiore rispetto alle pluripare, sia all'inizio che al picco, ed una maggiore persistenza (P<0,05). Le bovine con parto autunnale hanno prodotto più FCM, grasso e proteine (P<0,05).*

KEY WORDS: lactation curve, Wood model, Reggiana, milk.

INTRODUCTION – Reggiana is a local breed of cattle, reared in Northern Italy, with a low population size (916 milk recorded cows during 2001). The breed is appreciated because of milk composition characteristics for transformation, particularly for colloidal Ca and P content, rheological properties and k-CASB gene frequency (Mariani *et al.*, 1998). Mean productive levels are 5401 kg milk, 3.51% fat, 3.38% protein (AIA, 2001). The breed is selected mainly for protein yield (kg), but literature about lactation curve is not available. Objectives of the research are to describe the lactation curve of Reggiana cattle by applying the Wood model and to evaluate some factors affecting its shape.

MATERIAL AND METHODS – 541 Reggiana cows from 102 sires and 82 herds were monthly controlled for milk yield; individual records were submitted to non linear regression analysis (SPSS, ver. 10.0.06, 1999) to fit the Wood model [$y_n=A*n^Be^{(-Cn)}$] (1967), where y_n is the production at week n, and A, B, C are the equation coefficients (initial yield and slope during the ascendant and the descendent phase of the curve, resp.). Negative coefficients, if present, were erased because atypical. Only cows with more than 5 records were used (4611 observations). Milk, 4% fat corrected milk (FCM), fat and protein yield (kg) coefficients were calculated and used to obtain some parameters (Wood, 1967; Cappio-Borlino *et al.*, 1989), i.e., week at peak (WP)=B/C; peak yield (PY)=$A*(B/C)^Be^{-B}$; persistency (PER)=$C^{-(B+1)}$. Coefficients and parameters for each cow were then submitted to ANOVA, using a mixed model (fixed factors: herd, parity, season of calving; random factor: sire).

RESULTS AND CONCLUSIONS – Factors in the model accounted for 36.2% to 61.9% of total variability (milk yield), 32.2% to 61.3% (FCM), 23.6% to 55.9% (fat) and 35.7% to 63.1% (protein). Herd significantly affected initial and peak yield of milk, FCM and protein (P<0.001), as it wasn't significant for fat (P>0.05).

Sire significantly affected the initial yield of FCM, protein (P<0.01), fat (P<0.05) and milk (P<0.10). The calculated coefficients and parameters of the lactation curves are reported in Table 1; 1^{st} parity cows have shown lower initial and peak milk yield than pluriparous (P<0.05), lower slope in the descending phase and, as a consequence, higher persistency; week at peak was slightly delayed too, and the slope during the ascendant phase was lower, but differences were low (P>0.05). Susmel *et al.* (1993) and Macciotta *et al.* (2002) noted in Italian Simmental cows higher values of persistency and lower produc-

Table 1. Coefficients and parameters for milk, FCM, fat and protein yield.

			A (kg)	B	C	WP	PY (kg)	PER (d)
Milk yield	Parity	1st	20.26 a	0.190	0.0255 a	6.36	22.17 a	72.90 b
		2nd	25.50 b	0.230	0.0366 b	5.25	26.75 b	57.58 a
		3rd	26.47 b	0.224	0.0335 ab	5.22	27.15 bc	58.52 a
		4th	24.49 b	0.251	0.0381 b	5.46	27.91 bc	59.10 a
		≥5th	26.46 b	0.238	0.0406 b	5.20	28.72 c	56.04 a
	Season	Jan-Mar	23.80	0.237	0.0380 b	5.71	26.96 bc	62.15 b
		Apr-Jun	25.07	0.229	0.0380 b	5.18	27.79 c	53.23 a
		Jul–Sep	25.35	0.216	0.0356 ab	5.53	25.78 ab	60.16 ab
		Oct–Dec	24.32	0.225	0.0278 a	5.57	25.63 a	67.78 b
FCM yield	Parity	1st	20.18 a	0.189	0.0233 a	6.70 b	19.95 a	81.09 b
		2nd	26.06 b	0.164	0.0312 ab	4.85 a	24.75 bc	60.47 a
		3rd	24.79 b	0.203	0.0315 ab	5.17 ab	24.02 b	59.79 a
		4th	24.89 b	0.242	0.0338 ab	5.92 ab	26.47 c	59.16 a
		≥5th	24.91 b	0.230	0.0406 b	5.37 ab	25.33 bc	61.87 a
	Season	Jan-Mar	24.48 bc	0.209	0.0333	5.66	24.57 b	64.30
		Apr-Jun	23.78 ab	0.222	0.0330	5.42	25.00 b	57.88
		Jul–Sep	21.70 a	0.198	0.0379	6.14	22.79 a	67.56
		Oct–Dec	26.72 c	0.193	0.0241	5.19	24.07 ab	68.17
Fat yield	Parity	1st	0.771 a	0.236	0.0216	8.31 b	0.750 a	82.76 b
		2nd	1.138 c	0.290	0.0294	6.71 ab	0.919 b	69.09 a
		3rd	1.084 bc	0.317	0.0297	6.02 a	0.887 b	66.94 a
		4th	0.975 abc	0.297	0.0277	6.06 a	1.033 c	58.13 a
		≥5th	0.940 ab	0.333	0.0534	5.99 a	0.968 bc	64.32 a
	Season	Jan-Mar	1.049 bc	0.266	0.0338	6.43	0.936	68.47
		Apr-Jun	0.904 ab	0.309	0.0295	6.04	0.936	63.65
		Jul–Sep	0.846 a	0.400	0.0454	7.81	0.863	74.43
		Oct–Dec	1.126 c	0.204	0.0206	6.19	0.910	66.44
Protein yield	Parity	1st	0.768 a	0.167	0.0191 a	7.49 b	0.696 a	87.94 b
		2nd	0.887 b	0.214	0.0267 ab	5.83 ab	0.839 b	70.10 a
		3rd	0.916 b	0.216	0.0261 ab	5.81 ab	0.866 b	66.59 a
		4th	0.905 b	0.265	0.0271 ab	6.94 ab	0.879 b	74.13 a
		≥5th	0.939 b	0.260	0.0318 b	5.60 a	0.886 b	66.99 a
	Season	Jan-Mar	0.867 a	0.209	0.0264	6.12	0.853	76.33
		Apr-Jun	0.876 a	0.207	0.0269	5.73	0.861	68.61
		Jul–Sep	0.828 a	0.235	0.0294	6.26	0.807	70.81
		Oct–Dec	0.961 b	0.246	0.0219	7.23	0.812	76.86

a, b, c: *$P<0.05$.*

tion levels in 1st parity cows. According to Wood (1969) cows calving in April-June have shown higher peak yield than those calving from July to December, and lower persistency ($P<0.05$). Initial and peak FCM yield parameters were similar to those for milk production, with reference to differences between 1st parity cows and pluriparous. Calving season effect was, on the contrary, quite different. In fact initial yield was higher in cows calving in October-December than in other seasons ($P<0.05$), that means an higher fat content in autumn milk. First calving cows have shown lower initial and peak fat and protein yields than pluriparous ($P<0.05$); similarly, the highest values of protein and fat persistency of yields were observed for 1st parity cows ($P<0.05$). Initial fat and protein yield values were higher than peak yields at almost all parities, as described by Schutz *et al.* (1990) for Guernsey, Holstein and Jersey cattle. Protein yield curve, compared to fat, was slower to rise and to fall, except for autumn calving cows. Moreover protein peak yield was earlier, when compared to fat, and persistency was higher. Season of parity significantly ($P<0.05$) affected the initial yield of fat (lowest values for cows calving in April-September than in autumn) and protein (highest values for cows calving in autumn than in other seasons). In conclusion, the Wood model can describe the lactation curve of milk, fat and protein for Reggiana cattle too, with an acceptable goodness of fit ($R^2=0.377$; $P<0.001$); because several environmental and genetic factors were shown to affect lactation curve coefficients and parameters, a better knowledge of those factors for Reggiana cows is useful, because this local breed is often reared in the same herd with other breeds, so to improve bulk milk composition. That will allow to better estimate nutrient requirements in different physiological phases and to support the genetic improvement.

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Effect of space availability at feed bunk and rest area on metabolic conditions and productive responses in dairy cows

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RIASSUNTO – Influenza della disponibilità di spazio in mangiatoia e nella zona di riposo sulle condizioni metaboliche e produttive di bovine da latte – *La ricerca è stata condotta su 32 bovine Frisone suddivise in due gruppi ed allevate in due distinti box: gruppo C con 16 posti in mangiatoia e 16 cuccette (C); gruppo S con 13 posti in mangiatoia e 12 cuccette (S). E' stato utilizzato il quadrato latino 2x2 come disegno sperimentale con 2 periodi di 3 settimane ciascuno. I controlli hanno riguardato: ingestione, attività degli animali, condizioni metaboliche e quantità e qualità del latte. Il minore spazio in mangiatoia e nella zona di riposo ha influenzato il comportamento alimentare, ha aumentato la presenza di animali nella zona di alimentazione con una riduzione del tempo dedicato al riposo. Le primipare del gruppo S hanno mostrato valori più alti di NEFA e creatinina nel plasma e di grasso nel latte. Le condizioni sperimentali (breve durata, gruppi piccoli, fase intermedia di lattazione) hanno mitigato gli effetti sugli animali.*

KEY WORDS: dairy cows, rest area, feeding area, metabolic conditions

INTRODUCTION – It has been estimated that dairy cows spend 3 to 5 h/d eating, consuming 9 to 14 meals per day. In addition, they ruminate 7 to 10 h/d, spend approximately 30 min/d drinking, 2 to 3 h/d being milked, and require approximately 10 h/d for lying time (Grant and Albright, 2000). Management decisions on dairy must not interfere with the cow's ability to perform these activities which comprises her daily routines. It is well known that feed bunk space modifies eating behaviour, while the amount and characteristics of rest area modify resting activity of the cows. The traditional recommendation of 0.6 linear meter of bunk space per cow is the minimal amount of space needed for all cows to eat at one time (Grant and Albright, 2001). The optimal or critical feed bunk space needed is probably not a constant number and will depend on competition between cows, the total number of cows having access to feed space, and the availability of feed over a 24-hour period (NRC, 2001). Aim of this trial was to contribute to a better knowledge on the effect of feed bunk space and of rest area availability on behavioural, metabolic and productive responses of lactating cows.

MATERIAL AND METHODS – The trial was carried out on 32 Italian Friesian cows in mid lactation (ranging between 100 and 160 DIM at the start of the trial), raised in an experimental free barn (two rows freestall barn). The animals were fed corn silage (22 kg), alfalfa hay (4.1 kg) and concentrate (12.8 kg); the ration was delivered as TMR at 07.00 h. The cows were subdivided in two homogeneous groups (according to parity, DIM and milk yield) and raised in two pens: the 1st one (11.2x11.5 m), used as control, with 16 cubicles and 16 gates at feed bunk (C); the 2nd one (9.1x11.5 m) with 12 cubicles and 13 gates at feed bunk (S). It was used a 2x2 Latin-square change-over design with two periods of three weeks and an intermediate period of two weeks. During the trial controls were carried out on: 1) DMI of each group weighting the feed delivered and the orts; 2) time spent eating, standing and lying by the cows during the day (form 08.30 h to 17.00 h). The activities were recorded using video camera and recording 1 second every minute. 10 animals per group (4 primiparous and 6 multiparous), at -1, 3, 7, 14 and 21 days from start of each period, were checked for: 1) metabolic conditions, analysing the parameters of Piacenza Metabolic Profile as well as tryglicerides, NEFA, BHBA, creatinine and LDH (Bertoni *et al.*, 1998) on blood collected at 07.00 h; 2) milk yield and some milk traits. Milk was sampled from afternoon milking (the day before blood sampling) and analysed for fat, protein, lactose, somatic cell count (SCC), pH, titratable acidity and clotting parameters (Bertoni *et al.*, 1992). The data were processed with a factorial model using treatment (C *vs* S), period (2 levels), parity (2 levels), day from start (4 levels), cows and the interactions between treatment x day and treatment x parity x day.

RESULTS AND CONCLUSIONS – The different availability of feed bunk space modified the pattern of feed bunk presence, but the visits and the total time spent eating by each cows during the day was unaffected. Only the primiparous (PR) reduced the visits to the feed bunk, increasing the time spent in each visit. Dry matter intake (DMI) was not affected (21.9 *vs* 22.0 kg/head/d in C and S group respectively). The technique used to deliver the feeds and the carefulness to have a little amount of orts (1.5-2.0 kg as fed/head) before the new TMR delivery could have contributed to maintain an uniform intake during the day. In S group, as soon as 1-1.5 h after feed delivery, there were free gates at the feed bunk; this indicates a reduced competition, also in S group, to reach feed bunk. Nevertheless, in the morning the cows of S group spent more time standing around feed bunk, reducing time spent lying in the cubicles, even though cubicles were available. Energy and protein metabolism were influenced by space availability in PR cows only (Table 1). Significant higher values of cholesterol, NEFA and creatinine were observed in S group *vs* C group.

Table 1. Lsmeans of some blood parameters in primiparous cows of control group (C) and of group with a reduced space at feed bunk and rest area (S).

Days from start		3		7		14		21		
Parameter		C	S	C	S	C	S	C	S	MSE
Cholesterol	mmol/l	5.56	5.69	5.54	5.65	5.62	5.74	5.47 *	5.72	0.0677
NEFA	mmol/l	0.10	0.14	0.16	0.13	0.08**	0.15	0.07	0.10	0.0023
Urea	mmol/l	4.64	4.24	5.18	5.53	5.07	5.26	5.38	5.40	0.3455
Creatinine	mcmol/l	73.1 *	80.8	79.8	79.0	73.1	76.5	71.7 *	79.9	71.862
ALP	U/l	62.6	59.4	65.8 *	58.7	66.6 *	60.2	66.8 *	61.0	37.514

**: P<0.05; **: P<0.01*

These differences could indicate a slight stress condition in PR of S group, leading hormonal changes to affect blood parameters. Higher NEFA and cholesterol in S group could indicate an hormonal condition favourable to lipolysis. This response could be due to psychological stressors and to the consequences on eating behaviour observed in PR of S group. A more uniform feed intake during the day, indeed, reduces NEFA and BHBA plasma levels in lactating cows (Bertoni *et al.*, 1994). Creatinine is used as index of muscle protein mass but a fast protein mobilisation, also stimulated by some type of stressors, leads to an increase in creatinine and urea. The lower values of ALP (P<0.05) observed in PR of S *vs* C group and the relathionship between ALP and Zn in primiparous (r=0.45; P<0.001) could indicate an indirect effect of potential stress factors on ALP. Milk yield was not significantly affected by treatment, probably in relation to the short duration of the trial. Higher fat content in S (Table 2) could have been affected by the physiological variations, as NEFA increased. Milk protein content slightly decreased in PR of S group and this could have contributed to the slight decrease of titratable acidity and to the slight worsening of clotting features.

From our results it can be concluded that the reduction of space (-18.5%) at feed bunk affects eating behaviour and increases the time spent standing by the cows around feed bunk. This suggests that, in these situations, quality and size of rest area becomes much more important. Our metabolic and productive results indicate that only the primiparous were slightly affected, but we consider that our trial conditions (small group, mid-lactation phase and short experimental period) have minimized the negative effects of reduced space availability but, in other conditions (i.e. transition phase), the negative impact could be higher.

Table 2. Lsmeans of milk yield and of some milk traits in primiparous cows of control (C) and of group with a reduced space at feed bunk and rest area (S).

Days from start		3		7		14		21		
Parameter		C	S	C	S	C	S	C	S	MSE
Milk yield	kg/d	27.5	27.8	28.8	29.2	27.7	27.3	29.4	28.2	3.2473
Fat	%	3.53	3.58	3.43*	3.73	3.75	3.90	3.66	3.58	0.1370
Protein	%	3.58	3.64	3.57	3.63	3.67	3.64	3.73	3.65	0.0078
Titrat. acid.	°SH/50ml	3.95	3.88	3.86	3.79	4.00**	3.77	3.74	3.70	0.0197
Curd firm.	mm	20.5	21.2	16.1	16.6	19.7	19.4	16.8	15.6	38.262

**: P<0.05; **: P<0.01*

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Coagulation properties and *Nostrano di Primiero* cheese yield of milk from Brown grazing cows of different k-casein genotype

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RIASSUNTO – Proprietà di coagulazione e resa in *Nostrano di Primiero* del latte di vacche Brune al pascolo con differente genotipo per la k-caseina – *Il latte prodotto in alpeggio da 16 bovine di razza Bruna Italiana con diverso genotipo per la k-caseina, 8 AA e 8 BB, è stato analizzato per composizione e caratteristiche reologiche. Lo stesso latte è stato trasformato in formaggio del tipo* Nostrano di Primiero. *La composizione del latte e il tempo di coagulazione (r) sono risultati simili tra i due tipi genetici, così come la composizione del siero e la resa in formaggio. Il tempo di rassodamento del coagulo (k_{20}) e la sua consistenza (a_{30}) sono risultati invece migliori per il tipo genetico BB rispetto all'AA (4,2 min* vs *7,9 min e 32,9 mm* vs *25,2 mm).*

KEY WORDS: milk coagulation properties, Italian Brown cows, k-casein genotype, pasture.

INTRODUCTION – Genetic variants of milk proteins affect composition, technological characteristics and, as a consequence, cheesemaking properties of milk (Jakob and Puhan, 1992; Mariani and Summer, 1999). The effects of α_{S1}, β and k-caseins variants, on milk coagulation properties are well known (Grosclaude, 1988). Cheesemaking involving many cheese varieties showed shorter clotting and curd firming times, higher curd firmness and cheese yields with the k-casein BB variant (Van Den Berg *et al.*, 1992; Walsh *et al.*, 1998). During an experiment concerning the performances of Italian Brown cows grazing on alpine pasture, the effect of k-casein AA and BB genetic variants on rennet coagulation properties of milk and on typical local cheese yield was investigate.

MATERIAL AND METHODS – Eight Brown cows with k-casein AA genotype and 8 with BB genotype were chosen, from a herd of 150 animals on alpine pasture, according to: milk production, genetic merit (EVM), stage and number of lactation, body condition score (BCS; Edmonson *et al.*, 1989), and somatic cells count (SCC). Individual milk was weighted and analysed for its composition in fat, protein, lactose (infrared Milk-o-scan apparatus), for titratable acidity and rheological traits: rennet clotting time (r), curd firming time (k_{20}), and gel firmness (a_{30}; McMahon and Brown, 1982). Milk was processed, separately for each genetic type, in three consecutive days, for the production of *Nostrano di Primiero* cheese (from raw milk, lightly skimmed, with medium-long ripening). The whey obtained from each vats of cheese was analysed for its composition in fat, protein, and total solids (infrared Dairylab apparatus). Each whole cheese was weighted 24 hrs after production and, subsequently, at 1 and 4 months of ripening. Both animal and cheesemaking data were processed by one way ANOVA.

RESULTS AND CONCLUSIONS – All the animals were in the final stage of lactation (Table 1); the BB group had an EVM and a milk production higher than AA group, although differences were not statistically significative.

Table 1. Characteristics of experimental animals.

	Genetic variant		SE	Sign.
	AA	BB		
Milk production (kg)	12.8	13.6	1.31	ns
Genetic merit (EVM, kg)	6131	6745	751.5	ns
Lactation number	2.4	2.1	0.55	ns
Days of lactation	262	268	36.9	ns
Body Condition Score (BCS, p.ts)	2.65	2.89	0.21	ns
Somatic Cell Count (.000/ml)	278	296	191.5	ns

The composition of individual milk (Table 2) and the titratable acidity were similar between the two genetic types. Concerning the rheological properties, r was statistically the same between AA and BB type, while k_{20} e a_{30} were significantly different between the two experimental thesis; similarly to other Authors (Mariani and Battistotti, 1999), milk from k-casein BB genetic type gave firmer curds (32.9 mm *vs* 25.2 mm) and shorter firming time (4.2 min *vs* 7.9 min) in comparison with the AA type.

Table 2. Composition and coagulation properties of individual milk.

	Genetic variant		SE	Sign.
	AA	BB		
Fat (%)	4.15	4.03	0.33	ns
Protein (%)	3.64	3.71	0.19	ns
Lactose (%)	4.94	4.82	0.14	ns
Titratable acidity (°SH/50ml)	3.54	3.49	0.24	ns
Rennet clotting time (r, min)	17.0	14.8	2.25	ns
Curd firming time (k_{20}, min)	7.9	4.2	1.55	**
Curd firmness (a_{30}, mm)	25.2	32.9	3.37	**

***: P< 0.01.*

In particular, the value of k_{20} for the BB type was very low in comparison with known values for Brown breed (Mariani *et al.*, 1997). Whey composition (Table 3) was equivalent between the two variants. Cheese yield, in the different moments of ripening, was always higher for the BB type, according to what is known for other cheese varieties (Russo *et al.*, 1985), but with no statistical difference.

Table 3. Whey composition and cheese yield (means of three replicate cheesemaking trials).

	Genetic variant		SE	Sign.
	AA	BB		
Whey composition (%):				
Fat	0.89	0.87	0.0711	ns
Protein	0.94	0.91	0.0376	ns
Total solids	7.11	6.94	0.2475	ns
Cheese yield (%):				
24 hours	12.0	12.5	0.33	ns
1 month	11.3	11.7	0.36	ns
4 months	10.9	11.2	0.35	ns

Generally speaking, also in our operative conditions the k-casein BB variant confirmed better rheological properties and cheese yield, although statistical differences were observed only for k_{20} and a_{30} parameters. Due to the small animal number and data variability the differences between groups did not reach the threshold of significance. Moreover, in late lactation, milk has not the best characteristics for cheesemaking (Lucey and Kelly, 1994), and this might have produced the flattening of the data.

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Relationship between pasture and nutritional aspects of Fontina cheese manufactured in alpine farms

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RIASSUNTO – Relazioni tra caratteristiche del pascolo e proprietà nutrizionali del formaggio Fontina prodotto in malga – *In 3 malghe collocate a 3 diverse altitudini (PA=1600 m, T1=2300 m e T2=2500 m S.L.M.) e che hanno ospitato in successione stagionale le stesse bovine, sono stati prelevati campioni di formaggio Fontina ed è stata determinata la composizione floristica del pascolo prelevando campioni delle essenze foraggere più rappresentative (11 in PA, 5 in T1 e 8 in T2). Su formaggi e singole essenze foraggere sono stati determinati il profilo degli acidi grassi ed il contenuto di alcuni metalli pesanti ed è stato stimato l'apporto di ciascun analita da parte della dieta utilizzando l'incidenza relativa e l'appetibilità di ciascuna specie foraggera nel pascolo. L'aumento dell'altitudine ha determinato un incremento del contenuto di CLA nel Fontina (1,67% in PA, 1,90% in T1 e 2,14% degli AG in T2; P<0,01). Sono inoltre state osservate relazioni negative tra contenuto di CLA nel formaggio e di ac. linoleico nel pascolo e positive relazioni sono emerse tra alcuni metalli pesanti (es. Cr), presenti nella Fontina e nelle erbe del pascolo.*

KEY WORDS: Fontina cheese, alpine pasture, CLA, heavy metals

INTRODUCTION – In recent years consumers have markedly increased their attention to the quality of foods, as a results of an amplified requirement of safety in all agricultural products, including those of animal origin. As a consequence, there has been a growing interest for the so called functional foods, for foods from the organic agriculture and for the DOP (Protected Origin Denomination) brand products. Fontina cheese is one of the Italian cheeses qualified as DOP, and it is produced exclusively in Valle d'Aosta with raw and whole milk from Valdostana cows. During the summer the cheese is directly manufactured in Alpine farms located in different valleys, and where cows are grazed and moved progressively to higher altitudes. This study has been address to investigate a possible relationship between pasture of the same cows at increasing altitudes and nutritional aspects of the Fontina cheese produced in the alpine farm.

MATERIAL AND METHODS – Samples of single forages and Fontina cheese were collected in Rhêmes valley (Valle d'Aosta) during the summer 2001 in three different sites located at increasing altitudes: PA, 1600 m from Sea Level (SL), pasture during June, T1, 2300 m from SL, pasture in July, and T2, 2500 m from SL, pasture in August. The three sites reflected changes in altitude, season and composition of pasture, but the grazing cows and the cheese-maker remained the same. Fontina cheese was sampled (about 1 kg) from each site after 90 d of seasoning, and a total of 28 weekly samples (9 from PA, 9 from T1, and 10 from T2 altitudes) were collected and used in the study. In each site, samples of the main representative forage species were also collected at the beginning of the grazing period (11 from PA, 5 from T1, and 8 from T2), together with the registration of the phenological stage and the botanical composition of the pasture A relative incidence of each species in the pasture was then determined on the basis of the presence and the palatability of each forage species (Delpech, 1981). All samples were analysed for DM and lipids content (Martillotti *et al.*, 1987). The fatty acid profile in extracted fat was performed by gas chromatographic method (Christie, 1982), and the minerals content was determined using ICP/AES spectrophotometer in previously mineralized samples by microwaves. All data were statistically analysed by SAS (1996), and the mean ingestion of each chemical compound analysed was estimate for PA, T1 and T2 using analytical data and the relative incidence of each forage species in pasture.

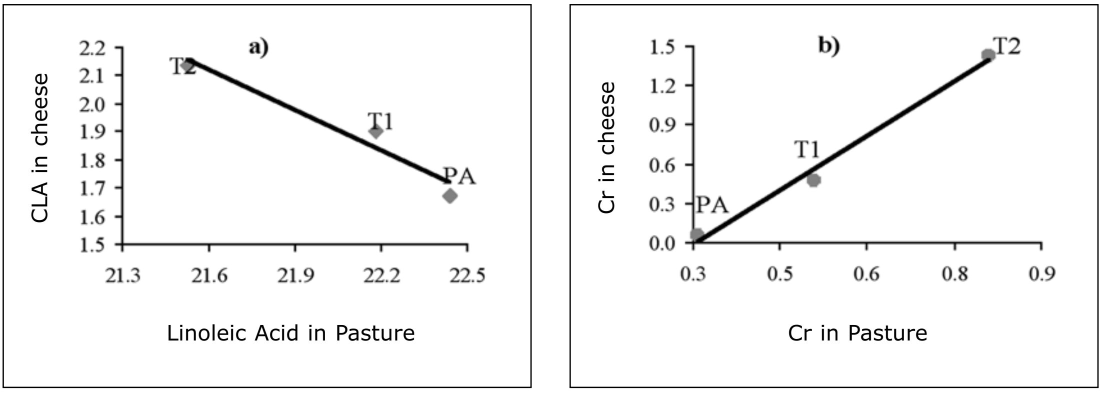
RESULTS AND CONCLUSIONS – The DM content of the ingested pasture resulted quite different between T2 and the other two sites of pasture (18.2 *vs* 27.0%; Table 1), probably due to the altitude. Moreover, the content of lipids in the grass was influenced by altitude (1.7% *vs* 2.7% of DM for T2 and PA+T1, respectively). On the other hand, the fatty acids profile showed small variation among pastures.

Table 1. Dry matter (%), total lipids (% DM), fatty acids profile (% total FA), and minerals (ppm) in pasture (estimated) and Fontina cheese

Item	Pasture			Fontina cheese			P Value
	PA	T1	T2	PA	T1	T2	
DM	27.1	27.0	18.2	58.9^{B}	56.2^{A}	58.4^{B}	<0.01
Lipids	2.9	2.4	1.7	51.7^{B}	47.0^{A}	47.7^{A}	<0.01
SFA	21.4	19.7	19.3	64.5^{B}	64.4^{B}	62.4^{A}	<0.01
MUFA	4.5	6.4	6.6	29.5^{A}	29.8^{A}	31.3^{B}	0.01
PUFA	74.1	73.9	74.1	6.0A^{B}	5.8^{A}	6.3^{B}	<0.01
Sat./Uns.	0.27	0.25	0.24	1.82^{B}	1.81^{B}	1.66^{A}	<0.01
ω3	51.52	51.50	52.38	1.64^{a}	1.58^{a}	1.80^{b}	<0.01
ω6	22.56	22.27	21.62	2.68^{B}	2.30^{A}	2.35^{A}	<0.01
ω6/ω3	0.44	0.43	0.41	1.64^{C}	1.46^{B}	1.31^{A}	<0.01
CLA	0.06	0.10	0.10	1.67^{A}	1.90^{B}	2.14^{C}	<0.01
Al	58.87	133.19	95.65	2.72^{B}	0.27^{A}	0.28^{A}	<0.01
Cr	0.31	0.51	0.81	0.05^{a}	0.47^{ab}	1.42^{b}	0.06
Ni	3.17	11.95	8.00	0.25^{b}	0.12^{ab}	0.02^{a}	0.08
Cu	10.80	17.19	16.71	7.13^{a}	8.85^{b}	8.68^{ab}	0.09

The content of heavy metals analysed increased moving from the lower to the higher site of pasture. Fontina cheese produced at different altitudes showed always significant variations for all variable analysed. As in a previous study (Mantovani *et al.*, 2001), the higher pasture (T2) showed a significant change in the fatty acids profile of cheese, with a reduction in the % of SFA ($P<0.01$) and a consequent increase in the % of MUFA and PUFA ($P<0.01$). These results are also in agreement with data reported for milk by Collomb *et al.* (2002). The content of ω3 fatty acids increased significantly at the higher altitude ($P<0.05$), while the ω6 fraction shown an opposite pattern ($P<0.01$); therefore, the ω6/ω3 was significantly reduced by the altitude (1.64, 1.46, and 1.31 for PA, T1, and T2, respectively; $P<0.01$). Similarly, the CLA content increased with the altitude (1.67%, 1.90%, and 2.14% of FA for PA, T1, and T2, respectively; $P<0.01$), as previously indicated by Collomb *et al.*, 2002. The content of heavy metals in cheese was affected by altitude; indeed, the contents of Cr and Cu in Fontina were enhanced by increasing the altitude ($P<0.05$; Table 1). However, Al and Ni showed an opposite pattern, decreasing from PA to T2 ($P<0.05$; Table 1). A negative relationship was found between linoleic acid content in pasture and CLA content in cheese (Figure 1a); in vitro studies have found, on the contrary, a positive relationship between dietary linoleic acid and CLA content in milk and derivates, suggesting this fatty acid as the main precursor of CLA (Bauman *et al.*, 2001). On the other hand, the positive relationship between the content of Cr in pasture and in cheese (Figure 1b), could indicate a direct transfer of this element from ingested forages to milk and, therefore, to Fontina cheese. In conclusion, further studies on the relationship between the composition of pasture and the cheese seem necessary to confirm some direct transfer processes from feed to milk, aiming to enhance the nutritional characteristics of milk derivates.

Figure 1. Relationships between (a) linoleic acid and CLA (% of total FA) and between (b) Cr (ppm) in pasture and in cheese.



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First investigation on economic sustainability of dairy cattle breeding in Apulia

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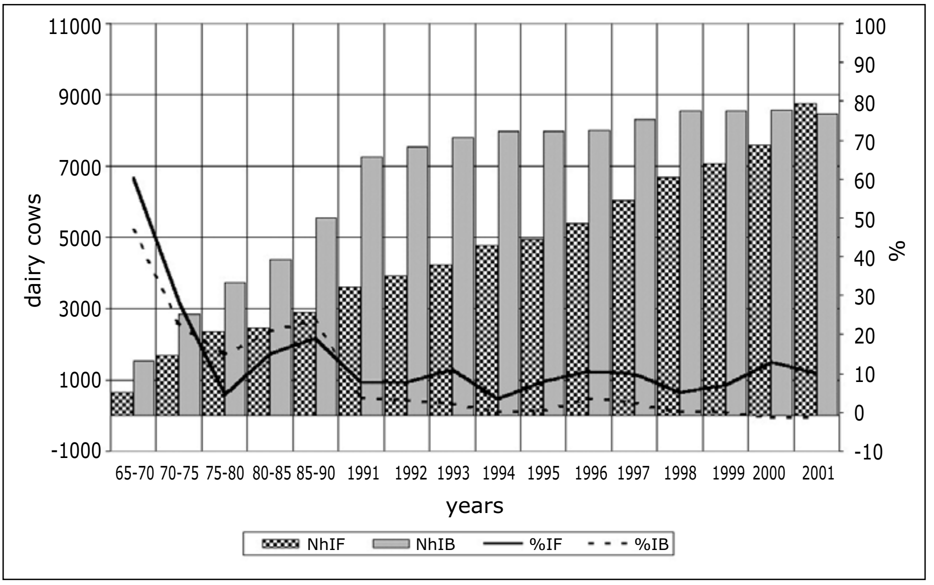
RIASSUNTO – Sostenibilità economica degli allevamenti di bovini da latte in Puglia – *Nel comparto zootecnico bovino da latte italiano esistono realtà produttive eterogenee, tra le quali la zootecnia da latte della Murgia Barese-Tarantina della cui sostenibilità economica questo lavoro tenta una prima valutazione anche in termini di confronto tra le due razze bovine maggiormente allevate. I risultati ottenuti mostrano una differenza tra le due razze ed inducono a riflettere sulle possibili evoluzioni del settore, in Puglia, nei possibili futuri scenari normativi.*

KEY WORDS: Apulia, milk, quotas, regime, genotype

INTRODUCTION – Traditionally the dairy cattle breeding in Apulia is mostly concentrated in the *"Murgia barese-tarantina"*. The most represented breeds in the Apulian dairy cattle population are Italian Brown (IB) and Italian Friesian (IF). The figures plotted in Fig. 1 show the general upward trend of the two breeds recorded for the period 1965–2001 in Taranto's province, representing more than 50% of the above husbandry area. Even though during the last ten years the IB upward slope have stopped with an almost steady-state, the total number of cows in the herds now stands at 17213. Notwithstanding milk quotas regime since 1984, during the last twenty years dairy farms increased both herd size and milk yields. The situation appears rather complex for both singularly and together the two breeds taken. The high quality IB milk is traditionally bound to the typical "Fior di latte" cheese-making, thus giving a reason for the increase even after 1984, but for the IF increase, it seems that farmers may have had a more positive view of the future relied on the higher milk production. This work wants to be a first approach to the cost analysis of dairy farms with different breeding system in a semi-arid land where such livestock activity is hardly sustainable on the economic standpoint when compared to environmentally more competitive areas.

MATERIAL AND METHODS – The farms investigated belong to a representative sample, located in one area of Apulia (Murgia barese tarantina) highly specialised in milk production according to the concentration of dairy farms and cows (POM. Quolatte, 2001). Within this sample we examined two farms environmentally very close and similar for structure and management; they differed only for the genotype bred which was the IF in one case and the IB in the other. We used the traditional method for the milk production cost determination (De Benedictis and Cosentino, 1979) recently used by Osservatorio Latte-ISMEA.

Figure 1. Number of heads (Nh) and rate of variations (%) of Italian Brown (IB) and Italian Friesian (IF) registered from 1964 to 2001 in the Taranto province.



RESULTS AND CONCLUSIONS - The results obtained analysing the amount and percentage incidence of the cost factors involved with dairy farm business are reported in Table1. The following points are noteworthy: i) the differences between the two breeds as to the heaviest cost factors namely, the feeding costs and overheads for IF and work, allowances and capital interests for IB; ii) the cost difference of 0.145 € between the two breeds. The reason for such differences in the financial profits of the two farms may be found in the characteristics of the two breeds, which are mainly due to health attitude, feeding needs and milk production. The IB is more rustic than IF and produces an undoubted good milk (Pecorari *et al.*, 1987) with an high protein and fat content; but these positive characteristics are not sufficient to allow the IB to compete with the better quantitative performances of IF. In fact even though, for both breeds the prime cost obtained is lower than 0.388 € (weighted mean of the regional prices for 2002\2003-Osservatorio latte ISMEA, 2002) there is almost no profit for IB milk production. This key fact, emerging from the results of the cost analysis, justify the upward trend with a rate of about 8% shown by IF in the last years. It may be also forecast that, at this juncture, IB is going to be progressively abandoned until completely substituted by IF. In addition, in the light of some comments about Agenda 2000, published by the EU Commission, things may go even worse owing to the possible removal of quotas system which would cause an increase of milk stock with a consequent market price fall of about 0.100-0.150 € (Sorrentino and Branca, 2001). On the other hand the diversity of dairy farms requires business tools that are tailored to the different needs. Whether the future direction of IB business wants to be forecast, the strong linkage between the production and transformation segment must not to be neglected, owing to the high cheese yield of IB milk. Moreover, there are a series of factors that should concur to slow down the substituting process of IB by IF. First of all, farmers are often resistant to changes, especially small holder farmers, who are the most closely linked to their traditional way of breeding IB cattle both for cultural and sentimental reasons. Secondly, living a curtailment system, the milk production level of IF breed negatively affect profitability; in fact, the cash target being achieved with a small margin of income per litre, the farmers should tend to expand production, thus exceeding the limit fixed by possessed quota; the over-production results in a fine which could definitively cut the profit of the IF dairy farm business. In quotas regime, all the above points had needed to be considered, thus the last decade's increase in IF population provides evidence that some mechanism has been gearing up for the evasion of the quotas rules, favouring the black market for raw milk. Paradoxically, the operators of this market are the same ones acting in lawful system. Besides, milk is not paid on the basis of compositional quality because, nowadays, cheese-makers collect all the breed milks to match high demand for Apulian traditional dairy products. Conclusively, in the analysed areas, the dairy cattle breeding appears in all its financial fragility. At present the economical sustainability of IF dairy business seems to rely mainly on the neglect of rules, while the IB dairy business is hardly sustainable, the survival hope being reliant on the possibility to generate additional income such as a brand mark for *fior di latte* and/or a money reward system promoted by public institutions and bound to milk quality aiming to protect products that nowadays have large market shares.

Table 1 – Production cost of a litre of milk (€).

Costs	Italian Brown		Italian Friesian	
	€	%	€	%
Work	0.050	12.9	0.020	8.3
Feeding	0.195	50.4	0.148	61.5
Straw	0.028	7.4	0.019	7.7
Allowances	0.025	6.5	0.011	4.6
Overheads	0.032	8.3	0.028	11.7
capital interests	0.055	14.2	0.014	5.9
land benefit	0.001	0.3	0.001	0.3
Total	0.386	100.0	0.241	100.0

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Management and productive aspects of a dairy herd in a Valle d'Aosta alpine pasture

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RIASSUNTO – Aspetti gestionali e produttivi di una mandria da latte in un alpeggio della valle d'Aosta – *Il contributo riporta i risultati relativi all'analisi della gestione di un alpeggio con bovine da latte in Valle d'Aosta. Tra le principali informazioni viene evidenziata una ridotta disponibilità di tempo giornaliera per il pascolamento: ciò determina una modesta produttività lattea legata a deficit nutrizionali. Sono stati anche osservati elevati valori in cellule somatiche spiegabili con fenomeni di difficoltà nell'adattamento al pascolo d'alta quota. Un'auspicabile variazione gestionale dovrebbe consentire un miglior adattamento all'ambiente alpino prevedendo anche il prolungamento della fase di pascolamento al fine di aumentare il consumo di erba da parte delle bovine.*

KEY WORDS: dairy cow, milk, typical cheese, grazing systems.

INTRODUCTION – In Western Italia Alps pasture areas utilization ratio is sensibly getting lower both as to surfaces and to mountain livestock resources. Recent researches show that in the valley bottom areas transhumance is progressively being abandoned for a permanent and intensive livestock breeding often made up with non local breeds and anyway no more fit to high altitude grazing (Battaglini *et al.*,2001). This trend is leading to lose local pastures (referred as to exploitable surfaces and fertility) and livestock resources. But the situation in Valle d'Aosta is different if compared to the other alpine areas, so much so that we assist to a growth more or less evident of the livestock resources and a substantial maintenance of pasture surfaces (Cavallero *et al.*,1997). This situation is due to the local livestock production trend, aimed almost exclusively to Fontina PDO cheese's production that has allowed to put the agricultural sector into value. Some initiatives have locally been taken on aimed to characterize livestock systems particularly with regard to alpine pasture period which involves a strong link between productions, feeding and management (Coulon *et al.*,1997; Bassignana and Chatel, 2001; Mantovani *et al.*, 2001).

Aim of this research is to give some management and productive indications which depend on relationships between livestock activity and mountain environment by characterizing a Val d'Aosta alpine pasture system.

MATERIAL AND METHODS – The study has been carried out during a summer season in an alpine pasture (Avise, Aosta) taking into consideration some productive parameters of a dairy cows herd. The alpine pasture was located in two subsequent grazing altitudes, a lower one (Maisonnettes Neuves at 1900 m a.s.l. of 52 ha with two utilisations: 21/6-19/7 [MN I] and 30/8-13/9 [MN II] and a higher one (Bettex at 2200 m a.s.l. of 70 ha: 26/7-23/8 [B]). The herd was formed by 87 dairy cows (mainly Aosta Red Pied with Aosta Chestnut and Aosta Black Pied). The daily grazing management considered pasture system on two different areas after milking (two periods: morning, 6.30-10.00 and afternoon, 18.30-21.00). The herd grazing organisation included, according to local traditions, the exploitation during morning hours of the less productive areas, more distant from the shelter, while during the afternoon pasture more fertile swards, due to the fertirrigation with liquid manure. In addition to the grass intake, feeding provided the daily supplementation of about 1 kg of concentrate (25% CP, 1.00 Milk FU kg DM-1) given in the morning, back from pasture. Observations have concerned: the bulk milk daily yield, the quality through the analysis of bulk milk samples collected weekly (fat, proteins, lactose, somatic cells count [SCC] and bacterial count [BC]); the weight controls of daily cheese and the relevant cheese yield [CY] determination. Data relevant to milk have been analysed through the following statistical model:

$$y_{ijk} = \mu + A_i + M_j + bx_{ij} + \varepsilon_{ijk}$$

where: y_{ijk}: milk yield, fat, protein, lactose, SCC, BC, CY; μ = general mean; A_i= pasture phase (MN I, B, MN II); M_j= milking time (morning, evening); b = regression coefficient; x_{ij} = days in milk covariate; ε_{ijk} = error. To add information on the pasture management, grass intake has been weekly estimated on the basis of the grass quota daily offered and refused in homogeneous areas, before and after the two daily grazing periods (Frame, 1981). These data and the relevant nutritive characteristics allowed to verify the fulfilment of feeding requirements in the three pasture phases.

RESULTS AND CONCLUSIONS - The individual daily yield varied on average from 12 kg at the beginning of the season to 6 kg at the end. There were no significant differences in milk production and quality between milking times.

Table 1. Milk yield and qualitative characteristics in the three pasture phases

		MN I	B	MN II	Levels of significance	
					Period	Covariance
Herd milk	kg d^{-1}	735	657	704	n.s.	P <0.01
Fat	%	4.07 b	4.08 b	4.42 a	P <0.05	n.s.
Protein	%	3.60	3.60	3.70	n.s.	P <0.05
Lactose	%	4.95 ab	4.92 b	5.00 a	P <0.05	P <0.01
Somatic cells	no. 1000 ml^{-1}	575 a	414 b	402 b	P <0.05	P <0.01
Bacterial count	no. 1000 ml^{-1}	93	40	11	n.s.	n.s.
Cheese yield	%	10.1 b	10.3 b	11.2 a	P <0.05	P<0.01

Herd milk productivity was negatively, even if not significantly, influenced by the pasture height getting lower (- 11%) in the period at the higher pasture and recovering (+ 7%) in the second utilisation of end season, back in the lower pasture (Table 1). Milk chemical composition parameters were not subject to significant variations, except in correspondence of the last alpine pasture phase. Somatic cells values were generally high in all the three periods: nevertheless the lower pasture first utilisation, as already similarly observed in other researches (Bianchi *et al.*, 1993), was higher due to animal adaptation difficulties (prompt passage from stabled to grazing regime) and hierarchical ones (especially influenced by Aosta Chestnut cows combativeness). Milk's bacterial charge has particularly good values (lower than 100000 BC ml^{-1}). Cheese yields, expressed on real daily productive data, sensibly increased at about the end of pasture period in concomitance with the increase of fat and protein percentages (Table 1). Nevertheless a significantly low CY value was observed in correspondence with the somatic cells higher value (at about 600000 SCC ml^{-1}). As to feeding balance, it was observed that in the first two utilizations [MN I and B] the grass showed better nutritive values but lower intakes connected with the short grazing activity at pasture, determining negative energetic balances: this confirms that pasture lengths were not sufficient to guarantee an adequate grass intake (Table 2).

Table 2. Pasture diet characteristics and nutritive balances.

		MN I	B	MN II	Signif.
Estimated intake	kg d^{-1}	11.6 b	12.7 ab	13.3 a	P <0.05
DM	%	21.1 Bc	24.4 ABb	27.4 Aa	P <0.01
Ash	% DM	8.4 b	8.4 b	9.0 a	P <0.05
Crude Protein	% DM	13.9 a	12.5 b	12.3 b	P <0.05
NDF	% DM	54.7	49.7	60.4	n.s.
Milk FU	no. kg DM^{-1}	0.77 ab	0.81 a	0.72 b	P <0.05
DM balance	%	- 11.4	- 3.8	+ 1.3	
CP balance	%	+13.2	+14.1	+ 9.0	
Energetic balance	%	- 23.2	-13.1	-20.4	

From the global analysis of these results it can be deduced that the answer to the feeding deficit is negative and shows itself not only by a contraction of productions, but also, on animal welfare state. In order to improve the present situation, it is necessary to make some changes in the herd management. These conditions can be substantially expressed by a more prolonged pasture period in order to reduce the distance covered and movement activity, to guarantee to animals pasture cadences which do respect the rumen physiology, thus optimising the exploitation of fodder resources and the animal well-being.

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Kinetics of fat and protein secretion in dairy cattle, sheep, goats and buffaloes

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RIASSUNTO – Cinetiche di secrezione di grasso e di proteine in vacche, pecore, capre e bufali – *I dati derivanti da 3 controlli funzionali (iniziale, intermedio e finale) di vacche Frisone e Pezzate Rosse, di pecore Sarde e Valle del Belice, di capre Sarde e Saanen e di bufale hanno mostrato un buon adattamento al modello* $y=ax^b$ *in cui* y *è la produzione giornaliera di grasso o di proteine (in g),* x *è la produzione giornaliera di latte (in kg) e* a,b *sono dei parametri dei quali solo il primo é stato significativamente influenzato dalla specie e, entro ciascuna specie, dalla razza.*

KEY WORDS: secretion kinetics, fat, protein, dairy ruminants.

INTRODUCTION – The negative correlations of fat and protein concentrations and milk yield, existing in all ruminants dairy species (Oftedal, 1984; Mepham, 1987), reflect a deep mechanism regulating the respective kinetics of secretion of carrier (mainly lactose which is the major responsible for the water drawn to the milk) and of fat and protein. Whereas the correlation coefficients are low (from –0.2 to – 0.4), fat and protein daily yield and milk production are positively and strongly linked (r = 0.8÷0.9). It means that more productive animals have higher fat and protein yield, but their milk has lower concentration of these components.

The aim of this work is to investigate the relationships between milk, fat and protein yield in all main ruminant dairy species by using a simple mathematical model.

MATERIAL AND METHODS – Data analysed consisted of 100 cows (50 Frisona Italiana and 50 Pezzata Rossa Italiana breeds), 117 ewes (67 Sarda and 50 Valle del Belice breeds), 82 goats (44 Sarda and 38 Saanen breeds) and 50 buffaloes cows sampled from official dairy records collected by the Italian Breeders Association within national genetic programs. In order to evaluate the effect of lactation stage on secretion kinetics, from each lactation were considered the first, the intermediate and the last monthly test day (TD) records. TD data of each breed were analysed with the simple model $y = ax^b$ where: y = daily fat or protein yield (in g); x = daily milk yield (in kg); a and b are parameters. First derivative of equation $y' = abx^{(b-1)}$ shows the concentration equation i.e. the pattern with which fat and protein content decreases as milk production increase.

The 39 a and b estimated parameters were checked for normality distribution, then they where analysed by two factors (species S and lactation stage LS) ANOVA. Breed effects was checked excluding buffaloes data and nesting this factor into the species. Last, general regression was obtained for fat and protein pooling the arithmetic means production of all animals.

RESULTS AND CONCLUSIONS – Fat and protein kinetics are in good agreement with the model, but the fitting of the former was lower (average $R^2 = 0.7443$ *vs* 0.8979). The coefficient b was always < 1, as expected: this value justifies the opposite signs of correlation between concentrations or yields of fat and protein and milk production. Interactions was never significant.

Table 1. ANOVA for the parameters of equation $y = ax^b$.

Paramet.	Species (S)				Lactation stage (LS)			SEM	Signific.	
	cattle	sheep	goats	buff.	first	inter	final		S	LS
Fat										
a	57.82	73.35	41.02	100.7	49.06	83.28	72.32	21.84	**	§
b	0.875	0.876	0.934	0.945	0.989	0.811	0.923	0.1500	ns	ns
R^2	0.643	0.757	0.839	0.730	0.710	0.695	0.821	#	#	#
Prot										
a	40.50	58.17	35.90	53.0	41.40	49.29	50.00	6.33	**	§
b	0.946	0.904	0.928	0.947	0.969	0.894	0.929	0.0780	ns	ns
R^2	0.896	0.895	0.935	0.832	0.889	0.868	0.912	#	#	#

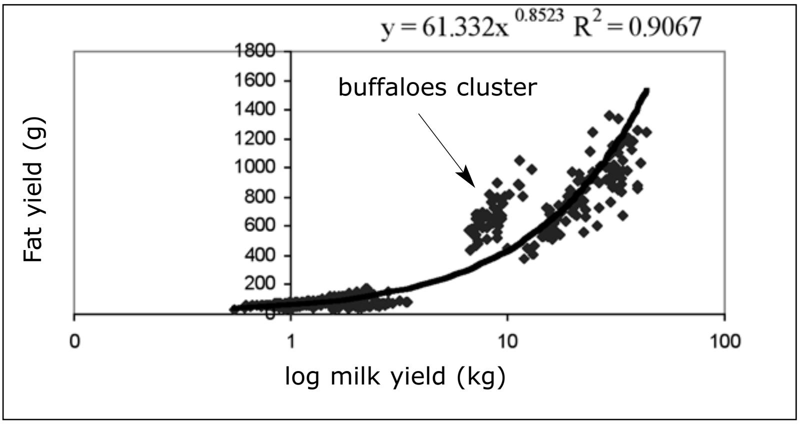
*** P<0.01; § P<0.1; # not performed because of its non-normal distribution.*

In fact, the first derivative, which describe the concentration pattern, shows a negative (and small) exponent of the x, therefore its trend decreases slightly. Kinetics are different among species for a values only; no effect of species and of lactation stages was found for b parameter and interactions between the two factors resulted always non significant (Table 1). This result indicates that the *curvature* of all equations is the same and they differed just for the relative efficiency in fat or protein to carrier secretion rates. Breed nested into species significantly affects a parameters both for fat and protein equations, but a linkage with the production level of each breed was not evident. Figure 1 shows, in log-scale, the uniformity of secretion kinetics among species. Notwithstanding with the difference among a coefficients, probably due to the difference in genetic levels of the different breeds, it seems that the general mechanism regulating the relative rate of synthesis of fat or protein and lactose is the same for all ruminant species, apart from buffaloes that seem to have a different behaviour, especially for fat synthesis.

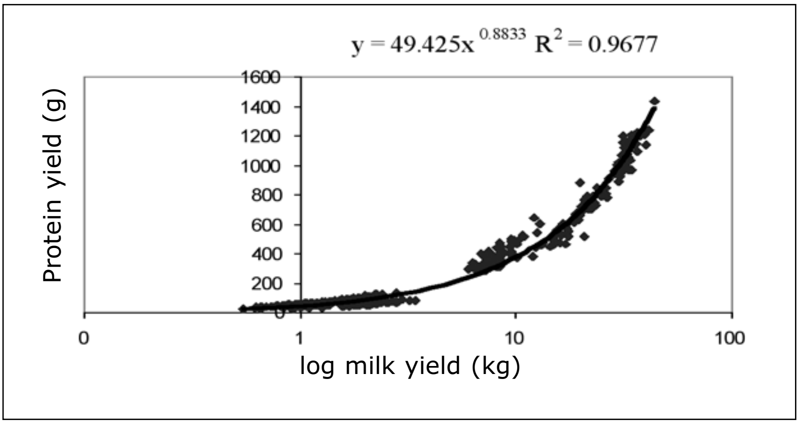
In conclusion, the model proposed seems able to describe the pattern of fat or protein yield compared to the milk production in all ruminant dairy species. Since the parameters a and b compress all the available information, they can be used as first steep for a deeper understanding of the kinetics mechanism relating milk fat and protein production.

Figure 1. Kinetics for fat (a) and protein (b) secretion in relation to milk yield (log kg) for dairy cattle, dairy sheep, goats and buffaloes.

(a)



(b)



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Buffalo milk: proteins electrophoretic profile and somatic cell count

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RIASSUNTO – Latte di bufala: profilo elettroforetico e contenuto in cellule somatiche – *L'analisi elettroforetica SDS-PAGE al 14% è stata eseguita su campioni di latte bufalino appartenenti a 3 classi distinte per contenuto in cellule somatiche (SCC): alto (>1.500.000), medio (±211.000) e basso (13.000). I campioni, sia individuali che seguiti nell'intera lattazione, erano stati scelti da un data-set di 416 records completo dei relativi parametri quanti-qualitativi. I campioni con basse SCC presentano una ripartizione percentuale delle lattoproteine molto simile a quella del latte vaccino intero "alta qualità". Durante la lattazione, il latte di bufale con basse SCC (<13.000) ha presentato maggiore quantità di caseina, bassa variabilità di questa e minore percentuale di sieroproteine, dimostrandosi quindi qualitativamente più idoneo alla trasformazione in termini di resa casearia.*

KEY WORDS: milk proteins, somatic cell count, buffalo

INTRODUCTION – Water buffalo milk differs from the cow's milk for greater fat and protein content, very important features in cheese making. Proteins, casein and whey-proteins in particular, are the most important factors determining cheese yield. Several previous research discussed the rule of SCC in cow milk production (Varisco, 1999) and the close relationship existing between cow's milk cheese yield and somatic cell count (Barbano, 2000). In particular the inverse correlation between cheese yields and somatic cells'content have been demonstrated. In Italy the regulation in force DPR 54/97 acknowledges what expressed in EEC 46/92 Directive (Tripodi, 1999) without fixing the limit threshold of somatic cells for buffalo's milk. Therefore in Italy the buffalo's milk for cheese manufacturing is used without any concern for somatic cell content. Controlling buffalo's milk somatic cell content could help, like in cow's productive system, to produce high quality milk with hygienic parameters more suitable for cheese manufacturing. The aim of this research was to investigate the relationships existing between somatic cell content and different percentage distribution of casein and whey-protein fractions in buffalo milk.

MATERIAL AND METHODS – 416 milk samples, produced by 59 buffaloes females from 2^{nd} up to 7^{th} lactation, reared in a farm of the Marche region, were collected together with the monthly functional controls of the local breeders association (APA). The samples were divided in three classes characterised by a different somatic cell number: high (>1,500,000/ml), middle (±211,000/ml) and low (<13,000/ml). 5 samples of each class and individual milk samples of the whole lactation belonging to buffaloes of the first and third class were analysed using SDS-PAGE 14% electrophoresis technique. Gels were subjected to Image Analysis (*claritySC*™ by Genomix Corporation) to evaluate protein band molecular weights and their optical density expressed as relative percentage on the total reading in each lane. After molecular weight estimation, bands were grouped in two main classes: casein (including bands within 35-55 kDa) and whey-proteins (including bands within 56-130 kDa and below 35 kDa). Hierarchic ANOVA was applied to evaluate the effect of parity and month of lactation, nested within parity, on quanti-qualitative parameters. Pearson coefficients between somatic cells content, casein and whey-protein fractions were estimated too (JMP, 1995).

RESULTS AND CONCLUSIONS – ANOVA did not show differences for parity on all parameters except acidity; month within parity affected all parameters except somatic cell count. Protein content throughout whole lactation followed the regular productive trend. Protein content ranged between 4.68 and 4.98% after delivery, it decreased in the middle of lactation (4.29-4.92%) and then it reached by the end of lactation values between 4.91 and 5.77%. The highest fat content was reached in the middle of lactation. The content of somatic cells was always below the limit threshold expressed by the EEC Dir. 46/92 except in the fifth lactation, which was characterised by an anomalous trend for all parameters. The results of electrophoretic study by SCC classes showed an evident increase of casein content as the level of SCC decreased (Table 1). Moreover milk samples with the lowest SCC (class 3) showed also low intra-class variability as expressed by the standard deviation values.

Table 1. Distribution (%) of milk proteins (x±sd) by SCC classes.

	Class 1 (>1,500,000 SCC)			Class 2 (±211,000 SCC)			Class 3 (<13,000 SCC)		
Ig	0.44	±	0.20	0.47	±	0.36	0.04	±	0.06
SA	0.74	±	0.15	1.35	±	0.85	0.34	±	0.09
Cn	69.51	±	5.29	70.16	±	9.01	76.48	±	2.13
β-lg	16.31	±	2.47	14.88	±	4.42	12.41	±	1.10
α-lac	8.65	±	2.33	9.56	±	3.79	7.05	±	1.91

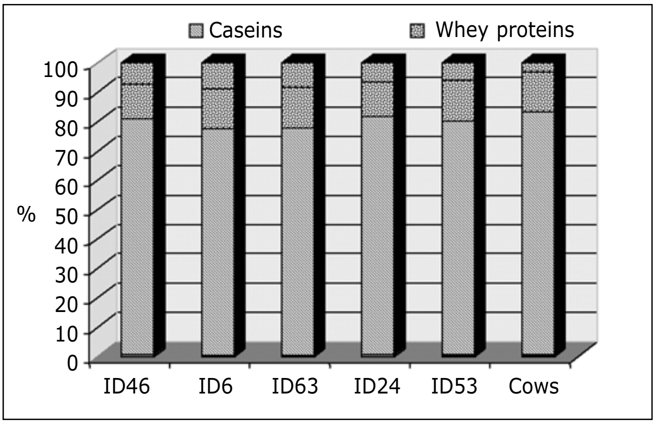
Ig=Immunoglobulins; SA=Serum Albumin; Cn=Casein; β-lg=β-lactoglobulin; α-lac=α-lactalbumin

In particular Figure 1 shows that the casein content among class 3 animals was always higher then 74% and close to the cow casein value. The analysis of milk constituents throughout all months of lactation in class 1 and 3 are summarised in Table 2. During lactation all samples in class 3 always showed casein content higher than 70%; as a consequence the level of whey proteins, which do not directly take part in cheese yield, was always at a lower level than that of the class with the highest SCC. The correlation matrix among milk quantitative parameters and distribution of casein and whey proteins highlighted, with significant Pearson's coefficients (P<0.001), the correlation between milk proteins content and somatic cell levels. In particular r=-0.946 between casein and whey proteins, r=-0.343 between SCC and casein, r=+0.375 between SCC and whey proteins confirmed the influence of SCC on milk quality and hygiene as already widely reported in the literature for cow milk.

Table 2. Milk proteins % distribution (x±sd) during lactation in class 1 and 3.

Month	Class 1(>1,500,000 SCC)						Class 3 (<13,000 SCC)					
	Casein			Whey Proteins			Casein			Whey Proteins		
1	68.93	±	3.93	28.14	±	4.87	72.23	±	1.16	23.78	±	1.47
2	70.04	±	5.48	26.67	±	3.54	73.69	±	5.32	23.18	±	5.73
3	70.63	±	2.14	25.97	±	1.66	73.12	±	3.28	23.79	±	3.40
4	68.60	±	1.24	27.39	±	0.94	73.57	±	5.52	22.85	±	4.35
5	69.43	±	3.22	27.18	±	3.26	72.08	±	2.21	25.44	±	2.00
6	73.00	±	8.28	22.51	±	7.56	74.75	±	4.55	21.89	±	3.83
7	69.78	±	8.05	27.86	±	6.77	70.85	±	3.88	25.79	±	2.90
8	71.30	±	5.37	24.90	±	6.91	72.35	±	3.73	23.88	±	2.29

Figure 1. % Distribution of proteins in low SCC buffalo milk.



This research verified that somatic cell content affects the distribution of casein and whey proteins in buffalo's milk. In particular it was pointed out how a low number of SCC implies a higher quantity of casein, which could increase cheese yield during milk transformation. More caution in farm management could help buffaloes breeders to contain milk cellular charge and then produce high quality milk more suitable for cheese industry. Finally an updating of the DPR 54/97 including the limit threshold for somatic cell count, in conformity with the EEC 46/92 Directive that regulate the collection of produced buffaloes' milk, would be hoped as already suggested by Sala *et al.* in 1988. This restriction will not be a limit for farmers but should be interpreted as a tool to improve quality of milk, quantitative cheese production and then buffalo farmers' profits.

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Excretion pattern of aflatoxins in buffalo milk and carry-over in mozzarella cheese

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RIASSUNTO – Presenza di aflatossine(AF) nel latte di bufala e passaggio nella mozzarella – *Due bufale sono state alimentate per 5 d con mangime naturalmente contaminato da AF. Nel latte è stata rilevata la presenza non solo di AFM_1, ma anche di AFM_2, AFB_1 e AFB_2. Le percentuali di escrezione nel latte, rispetto alle quantità ingerite, sono risultate molto basse per AFM_1 (0,2%), AFB_1 (0,05%) e AFB_2 (0,2%), mentre notevolmente più alta è stata quella per AFM_2 (2%). Partendo da latte contaminato, sono state prodotte alcune mozzarelle con la tradizionale tecnica di caseificazione, al fine di valutare il passaggio delle AF nel formaggio. Contrariamente a quel che avviene per i formaggi vaccini, non è stato rilevato alcun aumento della concentrazione di AF nella mozzarella; per AFM_1 e AFB_1 il livello è risultato analogo a quello del latte, mentre per AFM_2 e AFB_2 è risultato inferiore.*

KEY WORDS: aflatoxins, buffalo, milk, cheese.

INTRODUCTION – Some raw materials, used in animal feeding, can be contaminated by aflatoxins (AF). All the mammals that ingest AFB_1, excrete small amounts of the hydroxylated metabolite aflatoxin M1 (AFM_1) in their milk (Wood 1991). In the case of cow's milk, the percentage excreted is 1-3% of that ingested (Veldman *et al.* 1992). AFM_1 has been categorised as a class 2B, possible human carcinogen. AFM_1 is associated with the protein fraction of milk and hence it is carried-over to cheese and to other milk products (Brackett and Marth, 1982). In Italy, buffalo milk is mainly used for the production of the typical mozzarella cheese. A survey of AFM_1 in buffalo milk and dairy products, carried out in Southern Italy (Minervini et al, 1997), has shown that the contamination is generally low; other papers have signalled the occurrence in buffalo milk of AFB_1 in addition to AFM_1 (Rashda *et al.*, 1993, Dhand *et al.*, 1998). In this work we have investigated the excretion pattern of AF in milk obtained from two buffalo cows fed a contaminated ration. Mozzarella was produced from contaminated milk, in order to study the AF carry-over into cheese.

MATERIAL AND METHODS – Two buffalo cows were fed for 5 days a basal ration to which 2 kg of a peanut meal naturally contaminated with AF were added, one kg in the morning and one in the evening. Daily morning and evening milk samples (250 ml) were collected from each buffalo and stored at -20°C before analysis. Nine kg of contaminated milk were used to manufacture mozzarella in a cheese factory, by the traditional technology; milk, whey, water for washing and mozzarella were weighed. Extraction and clean-up of AF from peanut meal, feeds and forages were carried out according to Stroka *et al.* (1999). AF in milk were extracted by immunoaffinity column according to Mortimer *et al.*(1987). AF in mozzarella cheese was extracted with chloroform and the extract was evaporated to dryness using rotary evaporation at 35°C. The residue was re-dissolved with methanol and water, de-fatted and purified by an immunoaffinity column (Pietri *et al.*, 1997). AF were determined by HPLC with fluorimetric detection, AFB_1 after derivatization of the purified extract with trifluoroacetic acid.

RESULTS AND CONCLUSIONS – Recoveries for the above described methods fell within the acceptable range of 91-102%, and all results were not corrected for recovery. The detection limits in feed, cheese and milk were respectively: 50, 2 and 0.5 ng/kg for AFB_1; 100, 5 and 1 ng/kg for AFB_2; in cheese and milk they were respectively: 5 and 1 ng/kg for both AFM_1 and AFM_2. The peanut meal contained 104 and 9 µg/kg of AFB_1 and AFB_2 respectively, while the rest of the ration contained no AF. Milk samples showed the presence of AFM_1 and AFM_2, but also of AFB_1 and AFB_2 (Fig. 1). Total amounts of the individual AF ingested and excreted into milk during the whole experimental period were considered; the carry-over rates were calculated from AFB_1 intake for AFB_1 and AFM_1; from AFB_2 intake for AFB_2 and AFM_2. In spite of a high AFB_1 ingestion (208 µg/day), carry-over as AFM_1 was rather low (Table 1) in comparison with bovine; however, a very low excretion of unmetabolised AFB_1 (and AFB_2) was also noticed. For AFB_2, the excretion percentage as AFM_2 was clearly higher (about 2%).

The low carry-over rate of AFB_1 as AFM_1 observed in buffalo could be related to the low milk production; some authors reported that AFM_1 excretion decreases in low-producing dairy cows (Galvano *et al.*, 1996). AFB_1 excretion in buffalo could be due to higher milk fat (7-8%) compared with cow milk, as AFB_1 is less polar than AFM_1; or to a lower metabolisation efficiency. After cheese-making, milk, whey, mozzarella and water for washing were analysed for AF (Table 2). AFM_1 and AFB_1 concentrations were not different between milk and mozzarella; moreover, AFM_2 and AFB_2 concentrations decreased in cheese, probably because of a lower interaction AF-casein. Thanks to the curd washing phase of the mozzarella-making technology, no AF enrichment from milk to cheese was observed, while this does not happen with other cheeses (Brackett and Marth, 1982, Van Egmond 1989).

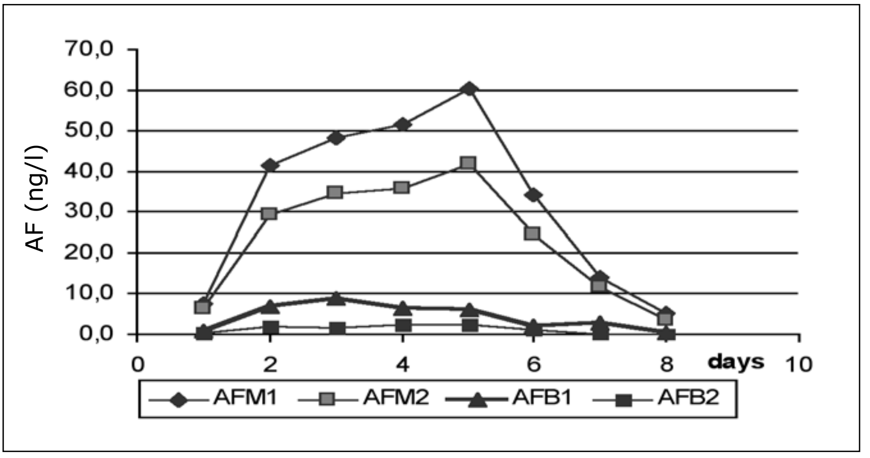
Table 1. Excretion percentages of aflatoxins in buffalo milk.

	AFM_1, %	AFM_2, %	AFB_1, %	AFB_2, %
1st buffalo cow	0.22	1.82	0.03	0.09
2nd buffalo cow	0.17	2.31	0.06	0.20

Table 2. Aflatoxin concentrations (ng/kg), percent distribution (%) and carry-over factor in mozzarella production.

	AFM_1	AFM_2	AFB_1	AFB_2
Milk	43.4±1.9 (100%)	48.5±4.0 (100%)	14.8±1.6 (100%)	4.4±0.4 (100%)
Whey	24.5±0.8 (50%)	37.1±1.2 (68%)	7.5±0.8 (45%)	2.0±0.4 (42%)
Washing water	7.5±1.1 (37%)	7.3±1.0 (31%)	3.0±0.7 (43%)	1.0±0.3 (46%)
Mozzarella	45.6±1.6 (11%)	18.2±1.3 (4%)	15.6±1.1 (11%)	2.7±0.2 (7%)
Carry-over factor	1.05	0.38	1.05	0.61

Figure 1. Aflatoxin excretion into milk of a buffalo cow fed a contaminated ration.



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Characterisation of milk production in some Alpine valleys of Piemonte

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RIASSUNTO – Caratterizzazione della produzione di latte in alcune vallate piemontesi – *Il presente contributo, attraverso l'esame di alcuni allevamenti con bovini da latte del territorio montano piemontesi, evidenzia lo stretto rapporto che intercorre tra ambiente, razze allevate e produzione di latte da destinare alla trasformazione in formaggi tipici. In particolare, razze molto specializzate come la Bruna consentono produzioni quantitativamente superiori mentre razze locali, quali la Valdostana Pezza Rossa e la Pezzata Rossa d'Oropa, attraverso sistemi di alimentazione basati su foraggi prodotti localmente, permetterebbero di giungere ad una più corretta tipicizzazione dei prodotti.*

KEY WORDS: dairy cow, milk, breed, livestock farming systems

INTRODUCTION – Alpine breeding systems are an example of sustainable integration between land management and productive processes; forage exploitation has characterized and modified landscape and environment (Brunschwing *et al.*,1998; Coulon *et al.*, 1997). On the Alps, intensive lowlands-typical breeding methods are generally inapplicable; moreover, the presence of autochthonous breeds characterized by high resistance and adaptation to local environment and fodders has determined the production of typical dairy products, often different from valley to valley. In spite of deep changes that have characterised the social and economic structure of Alpine regions – particularly the breeding activities – mountain farming is still important for keeping a steady equilibrium of breeding systems because it allows the presence of animals during the summer season on alpine pastures.

Aim of this work was to emphasize the peculiarities of cow's milk in some Alpine sites of Piemonte (N-W Italy). Data on main qualitative characteristics of milk are presented; the different nutritional properties of milk from Alpine pastures or lowland, as underlined by some authors (Ferlay *et al.*, 2002; White *et al.*, 2001) are shown too.

MATERIAL AND METHODS – Analysis of milk production and quality from 3 experimental trials (Battaglini *et al.*, 2001; Bianchi *et al.*, 2002) conducted in some alpine valleys of Piemonte are reported. Trial 1: two years of observations on Brown Swiss (B) cows bred in alpine pastures (summer) and indoor (winter) in the Ossola valley (OV). Trial 2: one year of observations on Aosta Red Pied (ARP) cows bred in alpine pastures (summer) and indoor (winter) in the Sacra valley (SAV). Trial 3: one year of observations on Brown Swiss and Oropa Red Pied (ORP) cows bred in alpine pastures (summer) in the Sesia valley (SEV). Results were obtained on individual milk samples collected monthly from multiparous subjects; data include milk production and quality (fat, fatty acid composition, protein and lactose, somatic cells count [SCC]). The descriptive parameters were environment, breed and season-system (Table 1). Animals were fed only grass during summer pasture; in winter, the diets were different among valleys (hay, silage and concentrate in OV; hay and concentrate in SAV). Milk production and quality from animals fed indoor and in mountain pastures of OV (trial 1) and SAV (trial 2) were compared. Statistical analysis has been made separately in the different trials using ANOVA. They included the season-systems for B in OV and ARP in SAV (with days in milk as covariate) and the breeds, B *vs* ORP, in SEV for summer pasture.

Table 1. General information of breeding systems in the three valleys.

location	Ossola (OV)	Sacra (SAV)	Sesia (SEV)
Years	2000-2001	2001	1999
Breeds	B	ARP	B - ORP
Farms no.	2	1	1
Cows no.	10-12	10	10/10
Season-system	*winter-indoor* *summer-pasture*	*winter-indoor* *summer-pasture*	*winter-indoor* *summer-pasture*
Pasture height m a.s.l.	1800÷2200	1200	1250÷1750
Grazing period days	62÷92	150	113

RESULTS AND CONCLUSIONS – The summer grazing influenced positively some milk parameters such as fat and protein, as well as the acidic profile of fatty acids. Unsaturated fatty acids (UFA) increased significantly and UFA/SFA decreased (Table 2).This variation was particularly significant in OV, characterized intensive feeding system (silages and concentrates) in the valley barns during winter, and extensive feeding system (grazing only) in Alpine pastures during summer. The variation, due to the high amount of linoleic and linolenic fatty acids in the grass, positively influenced the acidic composition of milk.

Table 2. Results from trials 1 and 2: milk yield and quality in winter and summer.

location			OV			SAV	
breed			B			ARP	
season system		winter indoor	summer pasture	Signif.	winter indoor	summer pasture	Signif.
Milk yield	kg $h^{-1}d^{-1}$	23.2	11.1	P<0.01	12.4	11.1	n.s.
Fat	%	3.40	4.16	P<0.01	3.38	3.33	n.s.
Protein	%	3.38	3.40	n.s.	3.38	3.29	n.s.
SCC	no. 1000 ml^{-1}	389	778	P<0.01	195	278	P<0.01
ω 3	%	2.41	4.56	P<0.01	1.21	1.41	n.s.
ω 6	%	2.99	3.04	n.s.	2.15	1.99	n.s.
ω 3/ω 6		0.81	1.50	P<0.01	0.56	0.71	P<0.01
SFA/UFA		1.73	1.24	P<0.01	2.07	1.86	P<0.01

The somatic cell count of milk samples collected in the summer season was always higher than in winter samples; data are more evident in OV, and they are probably due to the presence of a specialized breed (B) associated to some management difficulties in the passage from indoor to outdoor breeding.

A similar behaviour was observed in SAV, even though the differences were less significant due the characteristic of the local breed (ARP), less specialized than B. Therefore the breed seems to be relevant, as confirmed in Table 3. In the same environment (SEV), significant differences were observed in the acidic composition of milk samples collected from two breeds (B and ORP), as well as in the average somatic cell count.

This result is less favourable to B than ORP, and it is confirmed from the data obtained in OV. As to ARP bred in SAV, the results show good amounts of milk fat and protein and a high milk yield; as to UFA/SFA ratio, the results indicate a good attitude of the breed even though the high somatic cell count could be related to some difficulties in the management.

Table 3. Results from trial 3: milk yield and quality from two breeds (SEV)

breed		B	ORP	Signif.
Milk yield	kg h^{-1} d^{-1}	10.9	10.4	n.s.
Fat	%	4.14	3.56	P<0.01
Protein	%	3.20	3.21	n.s.
SCC	no. 1000 ml^{-1}	1281	467	P=0.06
ω 3	%	1.69	2.16	P<0.01
ω 6	%	2.44	3.15	P<0.05
ω 3/ω 6		0.69	0.69	n.s.
SFA/UFA		1.69	1.61	P<0.05

The trials showed that there are still management problems in the alpine pastures which need to be solved. Local breeds proved to be well adapted in some environments and may help to obtain better milk productions.

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Effects of the availability of an external area on dairy cows welfare during summer period

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RIASSUNTO – Effetto della disponibilità di recinti esterni sulle condizioni di benessere di vacche da latte nel periodo estivo – *La ricerca è stata condotta nel periodo estivo in una stalla sperimentale su 20 bovine Frisone suddivise in due gruppi ed allevate in due distinti box: uno con accesso al paddock in terra battuta (CP) ed uno senza accesso (SP). Entrambi i box erano equipaggiati con ventilatori e nebulizzatori. I controlli hanno riguardato l'attività degli animali, le condizioni metaboliche, la produzione e le caratteristiche del latte. In SP si sono riscontrati, nel mese di agosto, valori più alti di aptoglobina e globuline e più bassi di zinco e, al termine dell'estate, si è osservata una maggiore frequenza di ulcere soleari. In SP l'acidità titolabile del latte è risultata più bassa ed i parametri reologici, specialmente nel periodo più caldo, sono risultati peggiori. L'assenza di paddock può accentuare le conseguenze negative del caldo; occorre quindi, soprattutto in queste situazioni, ottimizzare le condizioni all'interno del ricovero.*

KEY WORDS: dairy cows, heat stress, paddock

INTRODUCTION – Problems of environmental pollution, as well as the need to ensure the cleanliness of the milking cows, do not suggest the use of external paddock. On the contrary, for the production of organic milk, the access to the paddock or pasture is compulsory, as the presence of the paddock could improve animal welfare, particularly in hot summer conditions. The negative effects of heat stress are not simply restricted to a lower milk yield but also lead to a worsening of milk composition (Bernabucci and Calamari, 1998) and cheesemaking properties (Calamari and Mariani, 1998). Moreover, a decrease of fertility and a greater susceptibility of the animals to disease due to the lowering of their immune defences have been observed (Bertoni, 1998). The presence of the paddock gives to the cows the possibility to find more favourable microclimatic conditions outdoor during late afternoon and night. Aim of this trial was to evaluate the effect of accessibility to the paddock in hot season on activities, metabolic and productive responses of dairy cows.

MATERIAL AND METHODS – The trial was carried out in summer season on 20 Italian Friesian cows (6 primiparous and 14 multiparous) in mid lactation (124±45 DIM, ranging between 80 and 170 d, at the beginning of the trial), raised in an experimental free barn (two rows freestall barn). The largest side of the barn was completely open to an unshaded hard court paddock, while the other was half closed by a masonry wall. The animals were fed corn silage (20 kg/d), alfalfa and grass hay (5 kg) and concentrate (13.8 kg); the ration was delivered as TMR at 07.00 h. The cows were subdivided in two homogeneous groups, considering parity, lactation phase and milk yield, and raised in two pens: one of them without the access to the paddock (SP) and in the other using it (CP). Each pen was equipped with 2 axial flow fans (switched on at 23° C). Two misters, activated at 23° C (60" of misting every 3'), were placed in front of each fan. During the trial (100 days length) controls were carried out on: 1) microclimatic conditions indoor and outdoor (temperature, humidity and air speed) with electronic probes. Data were used to compute the Temperature Humidity Index (THI); 2) time spent eating, standing and lying by the cows (from 08.00 h to 20.00 h). The activities were recorded one day per week using video camera and recording 1 second every minute; 3) blood parameters (Bertoni *et al.*, 1998), on samples collected before TMR delivery, every two weeks (weekly in hotter period); 4) milk yield and some milk traits the day before blood sampling. A representative milk sample was collected on the afternoon milking (14.00 h) and analyzed for fat, protein, lactose, somatic cell count (SCC), pH, titratable acidity and clotting parameters (Bertoni *et al.* 1992); 5) foot diseases, observed during hoof trimming at the end of the trial. The data were processed with a factorial model using treatment (with or without paddock), day of sampling and the interaction.

RESULTS AND CONCLUSIONS – The daily *maximum* THI indicated that dairy cows were exposed to potential heat stress conditions for 82 days of the 100-d study. Based on index values suggested by Armstrong (1994) the potential existed to suffer high heat stress only for 15 d, in particular in mid of July and begin of August. Higher presence of cows lying in freestalls and lower presence of cows standing in rest area, particularly in late afternoon and evening, was found in SP group. These results indicate that the cows raised in the pen with paddock preferred to lye down in the paddock in late afternoon and during the night, where microclimatic conditions were more favourable. During hours of the day with high temperature, when climatic conditions in the paddock were unfavourable, they preferred standing in rest area, where the wind speed and mist were higher, inside the building. The variation of blood parameters indicated that heat stress was slight in both groups, as consequence of the positive effects of the conditioning system used in the barn. In fact cholesterol, that decreases in high heat stress (Ronchi *et al.*, 1997), did not decrease in hotter periods in any group.

Table 1. Blood parameters of cows in pen with (CP) or without paddock (SP).

Parameter	day	25-6	06-7	14-7	23-7	03-8	11-8	25-8	08-9	22-9	MSE
Daily max. THI		73.2	78.5	78.1	79.1	78.5	80.7	75.9	75.6	71.8	
Haptoglobin	CP	0.23	0.26	0.37	0.22	0.21	0.21	0.23[a]	0.22	0.24	0.022
(g/l)	SP	0.25	0.31	0.28	0.30	0.26	0.27	0.39[b]	0.24	0.25	
Globulin	CP	42.1	43.2	43.9	44.5	42.4[a]	42.4	40.6[A]	39.8[A]	41.9	18.05
(g/l)	SP	42.5	44.0	44.8	46.3	46.6[b]	44.7	48.0[B]	46.7[B]	43.2	
Zn	CP	10.9	11.6	12.2	11.1	11.6[b]	12.3	12.6	11.7	11.7	2.214
(mcmol/l)	SP	10.8	10.7	11.5	10.9	9.5[a]	11.3	11.7	11.1	10.6	
ALP	CP	36.2	37.9	40.2	35.6	36.4	39.5	40.9	37.7	39.7	0.0423
(U/l)	SP	36.0	38.5	37.3	37.2	34.2	38.6	37.6	37.7	39.7	

a, b: P<0.05; A, B: P<0.001

The alkaline phosphatase (ALP), another parameter that decreases in heat stress (Vazhapilly *et al.*, 1992), decreased very slightly in both group during the periods with higher THI, and lower values were observed in SP *vs* CP (Table 1). A significant relationship was observed between the variations of ALP and Zn during the trial (r=0.40; P<0.001). ALP is a Zn dependent enzyme and tends to reflect changes in concentration of Zn in plasma among animals, particularly Zn deficiency will impair its activity in young (Vergnes *et al.*, 1992). In our conditions the variations of plasma Zn were slightly related to the heat stress, as observed by Ronchi *et al.* (1999), but mainly to other subclinical diseases. The cows of SP group have shown, indeed, higher values of haptglobin and globulin and lower of zinc, with significant differences in August. Moreover, at the end of the trial, a higher incidence of sole ulcer in SP was observed (4 cows in SP *vs* 1 in CP); probably due to the longer time spent standing inside the barn during the hotter period. This situation did not affect milk yield that was decreased slightly in both group during the trial. High protein content was observed in SP *vs* CP, whereas titratable acidity was lower and clotting features less favourable, in particular in hotter period (Table 2). These results could have been affected by stress related to the higher incidence of lameness in SP.

In conclusion it seems that the paddock unavailability during summer could increase the negative consequences of heat stress. In this situation the control of the indoor conditions (particularly microclimatic conditions using adequate conditioning systems and comfortable rest area) becomes much more important.

Table 2. Milk traits of cows raised in pen with (CP) or without paddock (SP).

Parameter	day	25-6	06-7	14-7	23-7	03-8	11-8	25-8	08-9	22-9	MSE
Protein	CP	3.16	3.11	3.17	3.24	3.20	3.16	3.43[b]	3.38[a]	3.46	0.020
(%)	SP	3.18	3.15	3.29	3.24	3.31	3.20	3.30[a]	3.51[b]	3.59	
Tit. Acidity	CP	3.48	3.61	3.86[b]	3.82	3.58	3.50	3.67	3.62	3.61	0.035
(°SH/50ml)	SP	3.48	3.68	3.69[a]	3.66	3.60	3.55	3.76	3.71	3.67	
Curd firm.	CP	30.3	21.8	27.2[b]	27.4	29.9	23.7	23.7	24.7	25.4	62.98
(mm)	SP	30.5	24.8	16.1[a]	24.4	25.1	22.3	27.3	22.3	32.3	

a, b: P<0.05; A, B: P<0.001

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Podolian 'caciocavallo' cheese: seasonal variations of food quality characteristics

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RIASSUNTO – Caciocavallo podolico: variazioni stagionali delle caratteristiche chimico - bromatologiche – *I caciocavalli sono stati ottenuti da latti di massa provenienti da 4 aree del Mezzogiorno continentale (province di AV, FG e PZ). L'indagine ha avuto una durata triennale. I prelievi, sono risultati più concentrati nella stagione primavera-estate. Mediamente, il prodotto con 6 mesi di stagionatura ha presentato le seguenti caratteristiche: S.S. 68,5%; proteine 44,1%; grasso 45%; minerali 7,32%, di cui 1,38% di calcio e 1,04% di fosforo; energia 3,98 kcal per grammo di prodotto tal quale. I caciocavalli ottenuti in primavera-estate hanno mostrato un più basso contenuto in grasso rispetto a quelli prodotti in autunno–inverno; un comportamento contrario si è osservato per le proteine.*

KEY WORDS: Podolian cow, caciocavallo cheese, food quality characteristics.

INTRODUCTION – Podolian breed cows, that give a milk with superb organoleptic qualities, were introduced from Ukraine in Italy during Barbarian invasions. The goodness of "Podolian Caciocavallo", whose name results from the type of ageing of the cheese tied up together "to ride" on a horizontal baton, is due to the climatic conditions and to the rearing system of Podolian cows. It comes in rounded forms with a soft, creamy white consistency and with sweet taste and delicate flavour. After three seasoning months "caciocavallo" is already excellent to eat; as time goes by the texture becomes firmer, the colour tends to yellow ochre, and the cheese reaches perfection after about two-three years. The production of this typical cheese, according to the Italian traditional system is obtained from whole milk produced from cows in outdoor rearing and it is regulated through a "Disciplinary". Nevertheless, as effect of this type of rearing quality characteristics of cheese are extremely variable. The aim of this trial is to study the effect of some environmental factors (year and season of production, and type of rearing) on quality characteristics of "caciocavallo" cheese.

MATERIAL AND METHODS – The trial was carried out on 160 caciocavallo cheese moulds obtained from morning bulk milk coming from 4 farms (rearing, in total, over 650 Podolian cows) situated in different areas of inlands of South Italy (Provinces of Avellino, Foggia, and Potenza). The study had a duration of 3 years. Samples were collected every month from cheese moulds seasoned 6 months and immediately analysed. The frequency of collection was the following: 1st period (January-February) 12 samples; 2nd period (March-April) 39 samples; 3rd period (May-June) 48 samples; 4th period (July-August) 39 samples; 5th period (September-October) 12 samples; 6th period (November-December) 12 samples. The highest collection was highest in the 2nd, in the 3rd, and in the 4th period because of the highest availability of cheese moulds in spring and in summer time. Chemical analysis was effected according to the official methods (A.S.P.A., 1995). Moreover, on every sample, the energetic content was calculated according to Carnovale and Marletta (1997). Ripening index was determined as: soluble Nx100/total N. Data, aggregated every two months, were processed using ANOVA, utilising a factorial model that considered the effect of year, of season and of rearing.

RESULTS AND CONCLUSIONS – The environmental variability, that characterise every year different floristic associations, is responsible of significant differences in milk products obtained from grazing animals. Differences are due to the milk composition utilised in cheese making and to the inset of a new microbial balance as thermo hygrometric conditions change. In the 2nd year of the trial was observed in caciocavallo cheese the lowest lipids content, while in cheese produced in the 3rd year was observed the faster ripening. Meanly, from the 2nd to the 3rd period (spring-summer) cheese showed the lowest content of fat and the highest content of protein. This result could be due to the food quality characteristics of forage in the considered periods. Cheese obtained in the 5th period showed the highest level of proteolysis and of ripening. Rearing determined significant differences for all parameters with the exception of lipids content. In conclusion, quality characteristics of product are influenced by environmental factors, particularly by grazed pasture. For this reason, quality characteristics of cheese vary during the considered periods.

Table 1 – Food quality characteristics of caciocavallo cheese [(1)].

	D.M.		Protein		Lipids		Ash		Ca		P	
Year												
1997	67.8		43.8	A	45.3	A	7.32		1.45	A	1.07	A
1998	68.5		44.8	B	44.3	B	7.35		1.43	A	1.10	A
1999	69.1		43.6	A	45.4	A	7.29		1.28	B	0.96	B
Period (twice a month)												
I	70.3	Aa	43.9	A	45.1	A	7.41	AC	1.26	a	1.05	A
II	67.7	b	44.6	Aa	44.6	A	7.15	AD	1.28		1.16	A
III	68.0		44.3	A	44.6	Aa	7.28	AD	1.43	b	1.12	A
IV	69.1		44.5	ab	44.4	Aa	7.50	C	1.42	bc	1.07	A
V	68.1	B	43.8	Ab	45.5	Ab	7.25	AD	1.37		0.93	B
VI	68.7	b	43.3	Bc	46.1	B	7.15	BD	1.32	ac	0.91	B
Rearing												
1	69.2	AC	44.3	A	44.9		7.27	A	1.36	A	1.01	A
2	67.3	AB	43.3	B	45.4		7.56	B	1.49	B	1.15	B
3	70.7	C	43.7		45.2		7.08	AC	0.96	C	0.85	A
4	60.0	D	44.6		44.0		6.69	C	1.30	AB	0.87	A

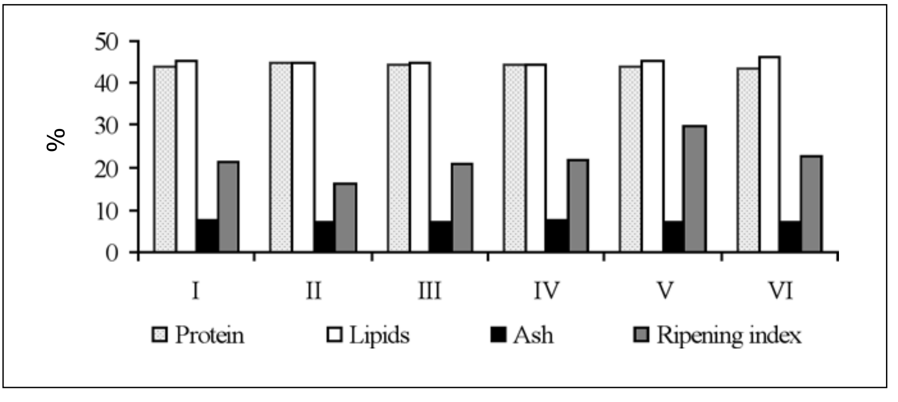
(1) A, B, C, D = P≤0.01; a, b, c = P≤0.05.

Follows Table 1. (1).

	Casein		Soluble N		NPN		Chloride		Ripening index		kcal, g	
Year												
1997	35.3	A	8.49	A	6.79	A	3.45	A	19.4	A	3.96	
1998	35.8	A	9.04	A	7.26	A	3.47	A	20.2	A	3.96	a
1999	31.8	B	11.8	B	9.55	B	3.69	B	27.1	B	4.03	b
Period (twice a month)												
I	34.5	AE	9.36	A	6.51	Aa	3.48	ac	21.3	A	4.09	ac
II	37.5	BC	7.15	BDa	5.75	Bb	3.49		16.0	Ba	3.93	b
III	35.2	AC	9.11	DAb	7.48	ABac	3.76	Ab	20.6	ABb	3.93	bc
IV	34.8	AE	9.68	A	8.03	Ac	3.54	Ba	21.8	A	3.99	
V	30.8	D	13.0	C	10.4	C	3.42	BCc	29.6	C	3.98	bd
VI	33.5	E	9.87	A	7.72	Ac	3.38	C	22.8	A	4.04	ad
Rearing												
1	33.8		10.5	A	8.37	A	3.45	A	23.8	A	4.02	A
2	34.9		8.41	B	7.08	B	3.70	Ba	19.5	B	3.92	Ba
3	33.6	a	10.2		8.53		4.00	CBb	23.1	AB	4.12	AB
4	36.6	b	7.91		5.94		4.67	Cc	17.7	AB	3.45	C

(1) *A, B, C, D = P≤0.01; a, b, c = P≤0.05.*

Figure 1. Chemical composition within periods.



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Morphological evaluation of Mediterranean buffalo bred in farms with different milk yield

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RIASSUNTO – Valutazione morfologica della bufala Mediterranea allevata in aziende con diversa produzione di latte – *Sono stati presi in considerazione i dati della valutazione morfologica (11 parametri e punteggio finale) di 1086 bufale in lattazione allevate in 19 aziende delle province di Latina e Frosinone. Le aziende, in funzione della produzione media individuale di latte per lattazione, sono state suddivise in tre tipologie: aziende con bassa produzione (< 8 kg/d), con media produzione (8 ÷ 9 kg/d), con alta produzione (> 9 kg/d). Dai risultati emerge una differenza statisticamente significativa, per quasi tutti i parametri morfologici considerati, a favore delle bufale appartenenti alle aziende con produzione di latte più elevata. Il migliore punteggio finale, 80,85, è stato ottenuto dagli animali allevati nelle aziende con alta produzione ed è statisticamente diverso (P<0,01) da quello degli altri due gruppi di bufale. Le aziende con maggiore produzione di latte allevano bufale con migliore valutazione morfologica.*

KEY WORDS: mediterranean buffalo, morphological evaluation

INTRODUCTION – Since the first steps were taken in zootechnic sciences the evaluation concerning the productive aptitude of animals has been regarded as a necessity, considering the applicative importance of such knowledge, while taking into account their particular conformation (Paci, 1949). With the purpose of explaining the variability of a productive function with variations of single morphological measurements (Cicogna *et al.*, 1994), interesting results, especially in beef cattle, were obtained through the use of mono and multivariate statistical techniques. Unlike cattle, buffaloes are subject to a slower selection due to the low rate of success in artificial insemination therefore the breeding sector, when selecting buffaloes for higher milk yield, will benefit from making the milking aptitude evident through morphological evaluation.

MATERIAL AND METHODS – The morphological evaluation data of 1086 lactating buffaloes, bred on 19 farms in the provinces of Latina and Frosinone (Lazio region, central Italy) have been taken into consideration. The farms, in function to the mean of individual milk yield, were divided into three categories: low milk yield (< 8 kg/head/d), medium yield (8 ÷ 9 kg/head/d) and a high yield (> 9 kg/head/d). In particular 5 farms (109 heads) are included in the low yield group, 8 farms (490 heads) in the medium and 6 farms (487 heads) in the high yield group. The data from the morphological characteristics (11 parameters) were elaborated and used for the inscription to the National Genealogical Register (Anon., 1996). The following parameters were evaluated, grouped according to the uniformity of their score: stature (1-3 points); head, anterior (neck and shoulders), dorsal line, foot, anterior udder and rear udder (1-4 points); back, udder ligaments, teats (1-5 points); rear limbs (1-6 points). The best evaluation is obtained from the lowest points and the total of these morphological results leads to defining a final score of 70 ÷ 100, in this case the best evaluation is given from the highest score. Using the data of the average daily energy and crude protein intake and the relative average daily milk yield, published in previous work (Bartocci *et al.*, 2002), a regression equation was calculated between the daily milk yield (Y) and the daily intake of energy and crude protein (X_1, X_2) and the final score of the animals (X_3). The differences of the considered parameters concerning the morphological evaluation, according to the farm category, and the regression equation were calculated using respectively the GLM procedure (monofactorial model) and the REG procedure (backward method), of the statistical package SAS (SAS,1993).

Table 1. Overall means and least-squares means of the eleven parameters and the final score regarding the morphological evaluation of buffaloes.

	Overall mean	Scores of buffaloes bred in farm with:			Rmse
		Low milk yield	*Medium* milk yield	High milk yield	
Stature	1.83±0.39	1.87^{A}	1.91^{A}	1.75^{B}	0.3844
Head	1.83±0.40	1.92^{a}	1.82^{b}	1.82^{b}	0.3992
Anterior	1.24±0.48	1.32^{A}	1.30^{A}	1.16^{B}	0.4707
Dorsal line	1.41±0.68	1.39	1.46	1.38	0.6834
Back	2.16±1.23	2.16	2.15	2.16	1.2336
Rear limbs	1.98±0.52	1.91^{b}	2.02^{a}	1.95^{b}	0.5171
Foot	2.88±1.16	3.06	2.89	2.82	1.1589
Anterior udder	1.90±0.35	1.92^{A}	1.92^{A}	1.86^{B}	0.3506
Rear udder	1.85±0.42	1.81^{B}	1.89^{A}	1.86^{B}	0.4136
Udder ligaments	1.26±0.52	1.28^{AB}	1.31^{A}	1.21^{B}	0.5178
Teats	1.37±0.62	1.41^{ab}	1.31^{b}	1.42^{a}	0.6210
Final score	80.58±2.01 (75 ÷ 93)	79.72^{C}	80.50^{B}	80.85^{A}	1.9858

A, B, C: P < 0.01; a, b: P < 0.05

RESULTS AND CONCLUSIONS – Table 1 shows the overall means and least-squares means, these are subdivided according to category, of the eleven parameters and the final score regarding the morphological evaluation of the animals undergoing research. Considering the overall means, the parameters with greater variability were the back (57.05%) and dorsal line (48.36%) while those with lesser variability were the anterior udder (18.55%), the stature (21.34%) the head (21.82%), and the rear udder (22.50%). All the overall means of the considered parameters, with the exception of that of the feet, fall into the lower half of the evaluation range, which appear to have the best morphological evaluation. The results concerning the feet have a value of 2.88, close to descriptive code 3 which corresponds to the description of "open claws". Taking a global view of the parameters a satisfactory morphology of the buffaloes undergoing research can be deduced. This is confirmed by the final score of 80.58, which falls into the "good +" class: the range of these scores varies from 75 (classified as "good") to 93 (classified as "excellent"). The variance analysis, between buffaloes bred within the three different farm categories, show significative differences in almost all the considered parameters, except for those of the back and dorsal line. The best evaluations proved to come from animals belonging to the high milk yield farms with the exception of the teat parameter which was obtained from animals on medium milk yield farms. The best final score 80.85, was obtained from animals bred on high milk yield farms and is statistically different (P<0.01) to those from the other two groups of buffaloes. By placing the quantity of the daily milk yield, Y (kg/d) in relation to the final morphological evaluation score (X_3), besides that concerning the quantity of the daily energy, X_1 (UFL/d) and crude protein, X_2 (g/d) intake, the following regression equation was obtained:

$$Y = 3.600542 + 0.183754\ X_1 + 0.003638\ X_2 - 0.055601\ X_3$$

(R^2=0.8836; Rmse=0.48005; $P < 0.01$)

In conclusion, from the results emerges a significative statistical difference, within all the considered parameters, favouring those buffaloes belonging to the high milk yield farms.

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