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Milk quality of Jersey cows kept on winter pasture supplemented or not with concentrate

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ABSTRACT - This study was carried out to evaluate the effect of the use of supplementation in pasture cultivated with *Avena strigosa* (black oats), *Lolium multiflorum* (ryegrass) and *Vicia sativa* L. (common vetch) on the composition and somatic cells count (SCC) of Jersey cow milk. Eight cows of the Jersey breed were separated by milk production, lactation period and live weight and were randomly blocked into two homogeneous groups (one with supplementation and other only on pasture), in a randomized complete design. Both groups were allowed to pasture for about 7 hours per day in a rotational grazing system in strips, with a one-day occupation period. The supplemented group was fed daily with 8 kg of supplement made of soy bean meal, soy shells, calcium limestone and mineral salt. The results showed significant differences between the two groups, because the percentage of total solids, protein and milk fat were higher in the supplemented cows. The lactose percentage was not influenced by the supplement intake. The somatic cell count, although there was a lower statistical difference for the group on pasture, showed small numerical oscillation between the groups and therefore should not be considered an effect of supplementation. The supplement supply to Jersey cows during lactation caused an increase in the total milk solid percentage, because it raised the fat and protein concentration.

Key Words: milk composition, pasture, somatic cells count

Qualidade do leite de vacas Jersey mantidas em pastagem cultivada de inverno e suplementadas ou não com concentrado

RESUMO - Este trabalho foi realizado com o objetivo de avaliar o efeito do uso de suplementação em pastagem cultivada constituída por *Avena strigosa* (aveia-preta), *Lolium multiflorum* (azévem-anual) e *Vicia sativa* L. (ervilhaca) sobre a composição e a contagem de células somáticas (CCS) do leite de vacas Jersey. Foram utilizadas oito vacas da raça Jersey, distribuídas ao acaso, após estratificação por produção de leite, período de lactação e peso corporal, em dois grupos homogêneos (um com suplementação e outro apenas em pastagem), em delineamento experimental completamente casualizado. Os dois grupos foram mantidos na pastagem por aproximadamente 7 horas por dia em um sistema de pastejo rotativo em faixas, com período de ocupação de um dia. O grupo sob suplementação recebeu diariamente 8 kg de suplemento constituído de farelo de soja, casca de soja, calcário calcítico e sal mineral. Os resultados evidenciaram diferenças significativas entre os dois grupos, uma vez que os percentuais de sólidos totais, proteína e gordura do leite foram maiores nas vacas sob suplementação. O percentual de lactose não foi influenciado pelo consumo de suplemento. A contagem de células somáticas, embora com diferença estatística menor para o grupo em pastagem, apresentou pequena oscilação numérica entre os grupos, a qual não pode ser considerada efeito da suplementação. O fornecimento de suplemento a vacas Jersey em lactação promove aumento do percentual de sólidos totais do leite, uma vez que eleva suas concentrações de gordura e proteína.

Palavras-chave: composição do leite, contagem de células somáticas, pastagem

Introduction

Once the quantity produced was guaranteed quality became the main issue in the Brazilian productive chain; consumers are seeking information about what they are eating and, day after day, this information is more accessible. Furthermore, the quality criteria established by the foreign market are rising each day, obliging the Brazilian legislation to propose steps to improve milk production. Following the market tendency, consumers have been searching for safer

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and healthier products, made by production systems that respect the environment and animal welfare (Martins, 2005).

Therefore, to continue in this industry, producers will have to adopt technological models that warrant economic efficiency and also environmental and social sustainability (Vilela & Resende, 2003). In this context, it is necessary to better comprehend factors related to milk composition and sanitary quality, to adopt steps that contribute to reducing fat content, raising the content of products such as protein and unsaturated fatty acids, which increase the industrial yield and nutraceutic characteristics of milk (Santin, 2004). In addition, it has become more important to have an adequate milking hygiene management to obtain a better herd health, which results in a reduced somatic cell count (SCC) and higher quality and durability of the final product (Páez et al., 2006).

The increase in milk composition could be reached by choosing animals with higher solids production and a balanced diet (Micguire et al., 1996). However, the SCC is influenced by milking conditions, climate and seasons and the sanitary management of the animals (Gonzalez et al., 2004).

Therefore, the knowledge of factors that interact and interfere in the composition and sanitary quality of milk is important in the search for a product that aggregates value to the producer, provides better industrial yield and that meets consumer needs. There are few studies with the Jersey breed on pasture, although these animals are capable of producing in temperate climate areas and have a favorable solid composition on their milk.

In this context, this study was carried out to evaluate the effect of the use of supplementation on winter cultivated pasture on the composition and somatic cell count (SCC) of Jersey cow milk

Material and Methods

The experiment was undertaken on a private farm in Pelotas, South of Rio Grande do Sul State, (5^{th} district-Cascata), which represents the milk production system of the region. The soil is classified as Hydromorphy Planosoil, Eutrophic Solodic (Streck et al., 2002). The climate is temperate humid of the Cfa type, according to the Köeppen-Geiger classification (Mota, 1953). The pluviometric precipitation registered throughout this experiment was 465.5 mm and, throughout the year 2006, 1.303 mm. The average temperature varied from 11.2°C to 29.8°C and the relative humidity was from 50.8% to 90.5% during the days of evaluation.

Eight cows of the Jersey breed were separated according to milk production, lactation period and live weight and were randomly blocked in two homogeneous groups, in a randomized complete design, considering factors the treatments (n=2) and observation periods (n=9) with averages repeated in time. The variables analyzed were: milk fat percentage (n=36), protein (n=36), lactose (n=36), total solids (n=36) and somatic cell count (n=36). On average, at the beginning of the experiment the animals age was 59 ± 3.5 months old, 2.5 ± 0 lactations, 2.8 ± 0 body score, 407 ± 13.95 kg live weight, 134 ± 2.47 days of lactation and 17.4 ± 1.2 kg milk per cow/day. Data was collected during nine periods from August to November of 2006, with an interval of about 15 days, in a total of 120 days of experiment.

The cows were kept on winter cultivated pasture, consisting of *Avena strigosa* (black oats), *Lolium multiflorum* (ryegrass) and *Vicia sativa* L. (common vetch), half receiving a daily supplementation of 8 kg of the concentrate, according to the farm management.

The concentrate consisted of 87.5% pelleted soy shells and 12.5% soy bean meal until the 4^{th} period of observation. After that, the supplement consisted of 68.75% pelleted soy shells and 31.25% soy bean meal. Throughout the whole experimental period, 250 g calcium limestone and 150 g mineral salt were added to the concentrate and offered to the cows during mechanical milking at 5 a.m. and 5 p.m. On average, the concentrate contained, in the first four experimental periods, 23% CP, determined by the Kjeldahl (N × 6,25) method, according to a technique described by AOAC (1996); 49% NDFa (neutral detergent fiber corrected for ashes), according to the method described by Van Soest et al. (1970) and modified as in Silva & Queiroz (2002); and 86% OM digestibility, according to Tilley & Terry (1963). In the rest of the experimental periods, the concentrate contained 28% PB, 42% NDFa and 84% OM digestibility. This modification was made to compensate the bromatological changes in the pasture throughout the periods (Table 1), correcting the protein deficit in the diet to obtain the total expression of the cow's production. In the diurnal interval between milkings, the cows were kept on pasture (total access of 7h/day) and, in the nocturnal period, they stayed indoors with water, but without access to food. This management was adopted because equipment to monitor cows at night was not available and to avoid errors in the estimation of dry matter intake. However, it is possible that this action limited the cows´ intake and damaged milk production.

The pasture was established from March to June 2006, in an scheduled way, with an interval of about 15 days per

Table 1 - Percentage of dry matter (MS), neutral detergent fiber corrected for ashes (NDFa), crude protein (CP) and digestibility *in vitro* of organic matter (DIVOM) of the forage in the period from August to November 2006

Period	Pasture				Supplementation			
	DM	NDFa	CP	DIVOM	DM	NDFa	CP	DIVOM
1	15.66	39.75	25.53	74.75	17.04	47.59	25.30	73.75
2	9.96	48.47	25.00	67.43	13.02	48.56	22.02	67.56
3	13.63	39.65	20.29	77.08	14.32	39.79	16.88	78.02
4	15.00	38.74	25.68	74.97	15.43	38.98	26.51	75.98
5	18.39	47.45	15.39	75.92	17.07	47.72	15.84	76.77
6	21.59	63.25	10.80	63.87	21.97	64.00	11.29	63.51
7	27.25	67.60	9.47	55.65	27.73	68.09	9.54	55.66
8	31.47	64.05	14.55	59.06	33.27	62.51	13.90	58.60
9	32.07	67.06	12.66	48.79	31.94	62.67	16.12	55.98
Mean	20.55	52.89	17.71	66.39	21.31	53.32	17.48	67.31

area. The objective was an offer of a pasture of better quality with a higher percentage of leaf blades for a longer period. Fertilizer was applied using the NPK 5-20-20 formula (200 kg/ha) at sowing and nitrogen (50 kg/ha, applied as covering as urea, fractioned after grazing). This procedure was adopted in the whole area (7.5 ha) which was divided into 2,000 m^2 strips, with an electrified fence, in a total of 33 strips used in a one-day occupation period. The pasture showed an average forage offer of 966 kg DM/ha, estimated by the double sample method, cut 5 cm above soil level using a graduated disc of forage measurements, as described by Santillan et al. (1979).

The average bromatological composition of the forage sampled was 17.6% CP and 53.1% NDFa, according to Silva & Queiroz (2002), with 67% OM digestibility, according to Tilley & Terry (1963) (Table 1).

Milk production was measured by individual milk control, using scales and a bucket, always 48 hours after animal grazing, on two consecutive days, in a total of four milkings per period (measurements repeated in time). The milk production data were corrected to 4% fat [(0.4) × (milk production) + 15 (milk production × %fat/100)]. The samples were taken after adequate homogenization, followed by refrigeration to be sent to the Milk Analyses Laboratory of EETB, Embrapa Temperate Climate, where the protein, fat, lactose and total solids contents were determined by infrared spectrophotometry using the Bentley 2000® equipment (Fonseca & Santos, 2000), and the SCC by flux cytometry (Somacount 300, Bentley Instruments, Inc.).

The live weight, body condition score and the hematocrit were monitored in all periods to ensure the maintenance of the cows´ production potential.

An ANOVA was done for all variables tested using the randomized test to estimate the level of significance (P<0.05) of the difference between the means from the two treatments and repeated in time, with the use of the statistical package Multiv (Pillar, 1999).

The statistical model adopted is shown below:

$$Yijk= m + Ti + A(T)i(j) + Pk + TPik + Eijkl$$

where: Y_{ijk} = observation resulting from each period k, in treatment i, on animal j; m = general mean of the experiment; T_i = treatment effect (GL=1); $A(T)_{i(j)}$ = animal effect within treatment (GL=3); P_k = period effect (GL=8); TP_{ik} = effect of the treatment and period interaction; (GL=17); E_{ijkl} = experimental error.

Results and Discussion

The percentage of lactose in milk (Table 2) did not differ significantly (P>0.66035) between the supplemented group and the group only on pasture. The average lactose content in the nine evaluation periods was 4.28 and 4.26% for the groups on pasture and with supplementation, respectively (Table 2).

No interaction effect was found (P>0.05) on the period × treatment interaction on lactose percentage. Lactose is the milk component which suffers less percentage variation and is positively correlated to milk production (Gonzalez et al., 2004). It is related to the osmotic pressure regulation of the mammary gland, therefore a greater lactose concentration in the mammary gland determines a higher passage of water to the alveolar lumen, promoting higher productions (Peres, 2001).

The averages found for lactose in this study were lower than those reported by Noro et al. (2006), in the North of Rio Grande do Sul State (4.52 %). These authors worked with 259 herds from 1998 to 2003 and registered an average production of 19 kg milk/ cow.day using individual samples. Zanela et al. (2006) also found higher averages (4.43%) in a study in Capão do Leão with Jersey cows producing 13 kg milk/cow.day in 162 days of lactation, fed corn silage *ad libitum* and concentrate at the quantity of 6 kg/cow.day.

The fat content showed a significant difference between the averages of both groups with supplementation and on

Table 2 - Milk composition from supplemented cows and cows on only pasture in different experimental periods

	Composition/Treatment[1]							
	% Lactose		% Fat		% Protein		% Total solids	
Period	SUPL	PAST	SUPL	PAST	SUPL	PAST	SUPL	PAST
1	4.30	4.25	4.68	4.48	3.61	3.65	13.61	13.44
2	4.25	4.30	5.06	4.50	3.74	3.59	14.25	13.78
3	4.34	4.45	4.81	4.50	3.65	3.45	13.94	13.51
4	4.31	4.42	4.95	4.46	3.76	3.43	14.18	13.42
5	4.31	4.36	4.68	4.51	3.56	3.44	13.85	13.21
6	4.35	4.14	4.53	4.53	3.58	3.41	13.51	13.53
7	4.24	4.16	4.92	4.86	3.82	3.50	14.10	13.61
8	4.20	4.07	4.47	4.37	3.67	3,50	13.36	12.96
9	4.21	4.16	4.82	3.97	3.67	3,50	13.76	12.68
Mean	4.28a	4.26a	4.77a	4.46b	3.67a	3,49b	13.84a	13.35b

[1] Means followed by the same letter are not different statistically (P>0.05) for the randomized test.
Means of two consecutive days of individual milk control.

pasture (P<0.0031); the higher values were obtained by the groups without supplementation (Table 2) and in the periods 2 and 9 of the experiment. The average fat percentage throughout the evaluation period were 4.77 and 4.46% for groups under supplementation and on pasture, respectively. Normally, because of the concentration of solid components, higher fat percentages are expected as milk production lowers. This did not happen in this experiment, where supplemented cows showed higher milk production (20 kg/day), and also a higher percentage of milk fat (4.77 %) compared to the ones on pasture (17 kg/day and 4.46%, respectively). This result was explained by a greater NDF intake in supplemented cows, which were fed 8.0 kg/day concentrate consisting of soy shells. Soy shells are rich in fiber which could have provided a bigger production of volatile fatty acids (VFA) inside the rumen, resulting in more adequate amounts of acetic acid and raising mammary gland fat production. Furthermore, the concentrated supplement supply allowed an adequate amount of energy for the demand of the mammary gland to produce fat (Bauman & Griinari, 2003), which could have helped to increase this component in the milk.

The milk protein content was significantly different between the supplemented cows and cows on pasture (P<0.00005). Means obtained over the nine evaluation periods were 3.67 and 3.49% and the highest protein content was observed in the supplemented group (Table 2) and in periods 4, 7 and 8. This was probably due to a higher amount of aminoacids available in the diets of the supplemented cows. When interpreting these differences it should be taken into account that greater crude protein values (CP) do not determine the specific quantity of milk casein, which is a fundamental component for its industrial transformation, especially in cheese production. However, in the current legislation, the requirements refer only to the CP content, as happens in industries which pay bonuses for milk protein content. Thus, it is possible to evaluate a product by its serum protein composition (albumin and immunoglobulin), that are usually more concentrated in milk with a higher somatic cell count that does not favor the use and quality of the available raw material.

As a consequence of the protein and fat percentages obtained, the total solids content varied significantly between the groups (P<0.0002) with means of the nine evaluations of 13.84 and 13.35% for the supplemented group and the group on pasture, respectively, and in period 9 (Table 2). This indicated a higher energetic and protein supply in the diet with supplement, that was sufficient for the synthesis demands of these milk components.

The total solids composition, represented by the sum of solids present on milk, is a marker of milk quality requested by dairy industries, since they represent the components responsible for the yield of products made with milk. Furthermore, some dairy industries pay their producers based on total solids content, mainly protein and fat.

However, this marker does not always express the specific quality of casein and conjugated fatty acids, both important components in industry and for heath. As mentioned above, higher values of total solids on milk do not necessarily indicate a higher industrial yield and nutritional quality of the processed milk. Thus, it could be convenient to evaluate components such as casein and fatty acids specifically when giving bonuses to producers.

The total solids values were superior to the average shown in the majority of Brazilian studies working with herds of different breeds or with animals of the Holstein (Suñé & Mühlbach, 1998; Machado et al., 2000; Melo et al., 2003; Gonzalez et al., 2004; Noro et al., 2006), yet they were similar or lower than those obtained by herds of the Jersey breed (Nörnberg, 2003; Zanela et al., 2006) in the South of Sul do Rio Grande do Sul.

In the current study, a significant difference was detected in the somatic cell count between the groups ((P<0.00105) (Table 3). The mean SCC values found for all treatments (Table 3) were below the maximum limit reported in the literature (400.000 cel/mL) to ensure that milk components do not alter due to infections in the mammary gland (Machado et al., 2000).

Many factors could cause a predisposition to an infection and the increase in SCC contents in milk, including a weakening of the immune system caused by metabolic disturbances and physiological damage caused by milk production peaks. In the case of the supplemented group, it contributed to raise the SCC (Table 3).

When we work with alternatives for equilibrium in nutritional quality and animal welfare, we expect a better health in the animals involved. This was observed throughout the experiment, where the use of *pre dipping* milking management- drying the mammary glands with individual paper towels, complete milking and *pos dipping*, cleaning milking devices after milkings, frequently changing the rubbers of these devices, verifying pulsations and vacuum pumps (Fonseca & Santos, 2000)- resulted in significantly smaller SCC values in the supplemented groups (Table 3).

Thus, it can be said that animals kept only on winter pasture showed better mammary gland health and that supplementation in this type of pasture promotes a higher concentration of milk solids but the costs and final milk profits should be evaluated to compensate the investment.

Table 3 - Somatic cell count (SCC) of milk from Jersey cows on winter cultivated pasture with or without supplementation

	SCC × 1000[1] Period									
Treatment	1	2	3	4	5	6	7	8	9	Mean
Supplementation	307	397	524	432	340	382	362	359	313	380a
Pasture	388	338	332	331	228	195	299	310	292	301b

Means followed by the same letter are not different statistically (P<0.00105).
[1] Means of two consecutive days of individual milk control.

Conclusions

The supply of concentrate to Jersey cows on winter pasture favored higher fat, protein and total solids contents in milk production, although with a higher somatic cell count compared to the management only on pasture.

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