Effects of adsorbents in dairy cow diet on milk quality and cheese-making properties

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ABSTRACT: The use of adsorbents (clinoptilolite+sepiolite) in the diet of cows was evaluated in two trials. A total of 52 Italian Friesian cows were assigned to one of two dietary treatments, control and adsorbent (CON vs. ADS). Individual and bulk milk samples were collected. On individual data, no significant difference was found between treatments in milk yield, milk fat, protein, and lactose concentrations, milk protein yield, pH, and titratable acidity, both in summer and spring. In spring only, there was a trend (P = 0.07) for a higher milk fat yield and a lower somatic cell number in ADS than in CON group. In summer only, milk clotting time was higher in ADS than in CON group (P < 0.05). On bulk milk, no significant differences in components and technological features were found between the CON and ADS groups. The bulk milk contents in total and soluble Ca were 1100 vs. 1108 mg/kg and 378 vs. 369 mg/kg for CON and ADS respectively, proving to be unaffected by treatment and suggesting a lack of interference by ADS on milk Ca availability for cheese-making process. We concluded that, for a period of 12 weeks, the addition of 1% on DM of the diet for lactating cows of non-nutritional adsorbents does not negatively affect milk yield, milk composition, and cheese-making features.

Key words: Adsorbents, Dairy cow, Milk quality, Cheese-making.

INTRODUCTION – Aflatoxin (AF) B₁, a mycotoxin produced by Aspergillus flavus and A. parasiticus, causes aflatoxicosis in livestock and its metabolite AF M₁ is excreted in milk, resulting in a possible risk for human health (D’Mello, 2000). The European Community has fixed at 50 ng/kg the limit for AF M₁ in milk and 5 µg/kg the limit for AF B₁ in concentrate. In 2003, in Italy, significant problems arose with colonization and contamination of maize destined for animal feed with Aspergillus flavus and aflatoxin; this resulted in milk and derived products being contaminated with AF M₁ at levels above the statutory limit. In bovine animals, acute AF B₁ decreased rumen motility, reduced cellulose breakdown and production of VFA and ammonia, decreased feed conversions, breeding efficiency and milk production, and increased health problems (Coulombe, 1993). A possible approach to the problem of contamination of agricultural products by AF B₁ is to add non-nutritional adsorbents to animal diets in order to sequester ingested AF. Different adsorbents were tested for their binding capacity for AF B₁ in ruminal fluid, resulting in about 80% for clinoptilolite and 100% for sepiolite (Spotti et al., 2005). One of the major concerns that arise from the use of natural zeolites in ruminant nutrition is their potential adsorbent and binding effect on some essential nutrients, such as β-carotene, vitamins A and E or other components that affect their metabolism and absorption (Katsoulos et al., 2005). Additionally, when its cation selectivity is taken into account, possible interactions of its use with K, Na, Ca, Fe, and Mg must be considered (Mumpton, 1999). In dairy cow metabolism, a possible role of zeolite (the clay family of clinoptilolite) on the availability of some minerals was considered (Jørgensen et al., 2001; Bosi et al., 2002). On the base of the mentioned results, a long term treatment with high levels of non-nutritional adsorbents during lactation may cheese-making properties caused by a reduced availability of some minerals in milk. Therefore, an experimental study was carried out with the aim of verifying, regardless of the presence of an actual contamination, the results on milk features when high levels of non-nutritional adsorbents lasts for a 3-months period.

MATERIAL AND METHODS – The use of adsorbents in the diet of cows was evaluated in two trials (one in summer and one in spring) at the experimental farm of the CRA - Istituto Sperimentale per la Zootecnia. The first trial
was conducted between June and September 2005, the second between March and June 2006. In the first trial, 28 Italian Friesian cows (14 at an early stage of lactation and 14 in mid lactation) were randomly assigned to one of two dietary treatments, control and adsorbent (CON vs. ADS), considering their parity, DIM, and previous milk yield for the assignment. In the second trial, 24 Italian Friesian cows (12 at an early stage of lactation and 12 in mid lactation) were randomly assigned with the same criteria as the previous trial. The diet of the control group was formulated as follows (on DM basis): corn silage (30%), alfalfa hay (13%), fescue hay (8%), protein supplement at 40% CP (15%), mix of corn flaked and corn meal (18%), cotton-seed (6%), mineral-vitamin (2%), concentrate in the robot self feeder (8%). The diet was formulated to meet the nutrient requirements for a production of 28 kg of milk, and distributed ad libitum. The ADS group was fed the same diet, supplemented with 160 g/d per cow of adsorbents (80% clinoptilolite + 20% sepiolite). The adsorbents were added in the TMR and were fed once daily by a total mix wagon. The experimental periods lasted 84 days for each trial. Cows were milked in an automatic milking system that allowed for daily milk yield recording, and availability for voluntary access for 22 hours, thirty minutes per day. Individual and bulk milk samples were collected before the trial start and at 2, 4, 6, 8, 10, and 12 weeks of trial. During the trial, controls were carried out on: milk yield, milking frequency; fat, protein, and lactose contents; somatic cell; pH, titratable acidity (°SH 100 mL⁻¹), clotting time, and (only on bulk samples) ionic and total Ca. Statistical analysis of data from individual cows was performed by a randomised block design, separately for each trial, with adsorbent supplementation (CON vs. ADS), milk yield level (high vs. low), and week of trial as main factors, with cow repeated in time. Data from bulk milk were analyzed by ANOVA, with adsorbent supplementation (CON vs. ADS) as the main factor.

RESULTS AND CONCLUSIONS – The utilized feedstuffs always had AF B₁ contents below the limit fixed by the European Union; thus, no relevant interference of AF B₁ absorption with the adsorbents was expected. The results concerning individual milk production, milk composition, and technological features are given in Table 1. No significant difference was found between CON and ADS groups in milk yield, milk fat, protein, and lactose concentrations, milk protein yield, pH, and titratable acidity, both in summer and spring. In spring only, there was a trend \((P = 0.07)\) for a higher milk fat yield and a lower somatic cell number in ADS than in CON group. During summer, milk clotting time was higher in ADS than in CON group \((P < 0.05)\). The milking frequency was significantly higher in ADS group than in CON group during summer. On bulk milk, no significant differences in components and technological features were found between the CON and ADS groups. The bulk milk contents in total and soluble Ca were 1100 vs. 1108 mg/kg and 378 vs. 369 mg/kg for CON and ADS respectively, proving to be unaffected by treatment and suggesting a lack of interference by ADS on milk Ca availability for cheese-making process.

| Item                              | Summer               | Spring               |
|-----------------------------------|----------------------|----------------------|
|                                   | CON¹ ADS¹ SE         | CON¹ ADS¹ SE         |
| Milk yield kg cow⁻¹ d⁻¹            | 22.7 25.9 1.18       | 22.7 25.4 1.77       |
| Milking frequency milkings d⁻¹     | 2.49b 2.85ᵃ 0.08     | 2.14 2.27 0.11       |
| Fat yield kg d⁻¹                   | 0.89 0.93 0.06       | 0.81ᵈ 1.02ᶜ 0.08     |
| Protein yield kg d⁻¹               | 0.76 0.80 0.03       | 0.79 0.82 0.05       |
| Fat content % w/w                  | 4.02 3.73 0.15       | 3.81 4.13 0.18       |
| Protein content % w/w              | 3.36 3.23 0.06       | 3.43 3.37 0.07       |
| Lactose content % w/w              | 4.92 5.01 0.05       | 4.79 4.85 0.04       |
| Total solids % w/w                 | 13.06 12.71 0.17     | 12.45 12.85 0.23     |
| Somatic cell count ln (k mL⁻¹)     | 5.05 4.80 0.28       | 5.12ᶜ 4.39ᵈ 0.28     |
| Milk pH                            | 6.68 6.69 0.015      | 6.70 6.71 0.017      |
| Titratable acidity °SH 100 mL⁻¹    | 6.70 6.85 0.085      | 6.87 6.79 0.182      |
| Clotting time min                  | 27.1ᵇ 33.4ᵃ 2.14     | 22.61 23.74 1.25     |

¹CON = control; ADS = adsorbent
ᵃᵇ = \(P < 0.05\); \(cᵈ = P < 0.10\)
Our results on milk yield and milk components agree with those reported by Bosi et al. (2002). On the other hand, our results on milk fat and protein yields do not agree with those of Johnson et al. (1988), who obtained a significant reduction in these parameters using zeolite at 2% on DM. The possible explanation of this difference could be seen in the lower percentage of adsorbent use in our trials, which was approximately of 1% on DM, more similar to that reported by Bosi et al. (2002). The higher clotting time of ADS individual samples during summer is difficult to explain; however, in that season, both groups showed clotting time values that seem very critical for a good cheese-making process. Additionally, regarding both results on individual spring samples and on bulk milk samples overall, the trials were good, showing no differences in clotting time between treatments. Both ionic and total Ca in our bulk milk samples can be considered in a normal range for cheese-making process, when compared with the values reported by Formaggioni et al. (2004).

We concluded that, for a period of 12 weeks, the addition of 1% on DM of the diet for lactating cows of non-nutritional adsorbents does not negatively affect milk yield, milk composition, and cheese-making properties.

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