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Quality of buffalo milk as affected by dietary protein level and flaxseed supplementation

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ABSTRACT

The aim of the present research was to evaluate the effects of protein level and flaxseed supplementation on the yield and quality of buffalo milk. In particular, the fatty acid profile of milk from buffalo cows subjected to different diets has been investigated. A 2 × 3 factorial design was tested with buffalo cows receiving 2 dietary crude protein (CP) and 3 flaxseed (FS) supplementation levels. Treatments were (1) low dietary CP level [12% of dry matter (DM)] and no flaxseed supplementation (LP); (2) low dietary CP level (12% of DM) and low flaxseed supplementation (500 g/d) (LPFS500); (3) low dietary CP level (12% of DM) and moderate flaxseed supplementation (1,000 g/d) (LPFS1000); (4) moderate dietary CP level (15% of DM) and no flaxseed supplementation (MP); (5) moderate dietary CP level (15% of DM) and low flaxseed supplementation (500 g/d) (MPFS500); and (6) moderate dietary CP level (15% of DM) and moderate flaxseed supplementation (1,000 g/d) (MPFS1000). Milk protein and casein were affected by flaxseed supplementation being higher in MP, intermediate in LP, and lower in flaxseed-supplemented diets. However, the results from the present study highlighted that low protein diets sustained milk yield, protein, and casein synthesis in milk when whole flaxseed was administered. Short-chain fatty acids, in particular C8:0 and C10:0, were the lowest in milk from buffalo cows fed the highest level of flaxseed supplementation. Medium-chain fatty acids were the lowest in FS1000, intermediate in FS500, and the highest in the HP and LP groups. Long-chain fatty acids were the highest in FS1000, intermediate in FS500 groups, and the lowest in milk from buffalo receiving no flaxseed supplementation. Protein level of the diet influenced the percentage of C18:0, which was higher in MP than LP groups. Total conjugated linoleic acid content evidenced the same trend of long-chain fatty acids, with an increase of about 7% in FL500 and of 22% in FL1000 than the control. Apart from protein level of the diet, atherogenic index, thrombogenic index, and n-6/n-3 were the lowest in FS1000 groups; thrombogenic index and n-6/n-3 were intermediate in milk from animals receiving FS500. Nutritional value of the acidic profile in buffalo milk is influenced by flaxseed supplementation, and its improvement reflects the level of dietary flaxseed supplementation.
Key words: buffalo cow, flaxseed, dietary protein, fatty acids, conjugated linoleic acid

INTRODUCTION

Water buffalo account for the second most widely available milk source in countries around the world; within European countries, Italy accounts for 95% of all water buffalo. Lactating buffalo in Italy accounted for 214,164 heads (FAOSTAT, 2016) that were mainly reared in central and southern regions of Lazio, Campania, and Puglia (Borghese et al., 2000). The milk of this species accounts for over 50% of drinking milk in countries such as India, Pakistan, Egypt, and Nepal, whereas in Italy buffalo milk is used almost exclusively for mozzarella cheese production (Zicarelli, 2004).

Several authors reported that the protein concentration used in lactating buffalo diets can be equal to or below 12% DM, as these concentrations have little influence on the quality and quantity of milk yield (Verna et al., 1992; Campanile et al., 1998). However, Tweatia and Bathia (1996) stated that the ideal protein content was between 11 and 14% DM in the diet to stimulate ruminal microflora. The incorporation of PUFA in the diets has been carried out in several lactating species with the aim of improving the acidic profile of milk for direct human consumption or for dairy products. Among lipid sources, flaxseed has been successfully supplemented to cow (Caroprese et al., 2010; Cattani et al., 2014; Santillo et al., 2016), sheep (Zhang et al., 2006; Caroprese et al., 2011), and goat (Nudda et al., 2006, Luna et al., 2008; Caroprese et al., 2016), leading to a better n-3 PUFA profile in milk. Sunflower oil has been identified as a dietary fat supplement capable of reducing rumen protozoa for the duration of its utiliza-

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tion (Ivan et al., 2001). Defaunation has been proved to increase protein utilization by rumen microorganisms that might result in increased intestinal availability of AA (Veira et al., 1983; Tufarelli et al., 2009). Moreover, reduced fauna has been found to increase milk production in dairy cattle (Moate, 1989).

To the best of our knowledge no studies have reported the role of both protein level and fat supplementation of the diet in lactating buffalo cows. It would be useful to gain information on the effect of fat supplementation on the efficiency of utilization of dietary protein in terms of production and composition of buffalo milk. Therefore, the aim of the present research was to evaluate the effects of dietary protein level and flaxseed supplementation on the yield and quality of buffalo milk. In particular, the fatty acid profile of milk from buffalo cows subjected to different diets was investigated.

MATERIALS AND METHODS

Experimental Design

The experiment was conducted in a dairy farm located in Foggia (Apulia region, Italy). The experiment included 48 Mediterranean buffalo cows during mid lactation (175 ± 22 DIM; ±SD); animals were homogeneous for age (52 ± 6 mo), BW (561 ± 15 kg), parity (2.08 ± 0.28), milk production (8.9 ± 0.80 kg/day), milk fat (8.56 ± 0.9%), protein (4.73 ± 0.4%) content, and for fatty acids composition grouped as SFA, MUFA, PUFA, and CLA. A 2 × 3 factorial design was tested with buffalo cows receiving 2 dietary CP and 3 flaxseed (**FS**) supplementation levels. Treatments were: (1) low dietary CP level (12% of DM) and no flaxseed supplementation (**LP**); (2) low dietary CP level (12% of DM) and low flaxseed supplementation (500 g/d; **LPFS500**); (3) low dietary CP level (12% of DM) and moderate flaxseed supplementation (1,000 g/d; **LPFS1000**); (4) moderate dietary CP level (15% of DM) and no flaxseed supplementation (**MP**); 5) moderate dietary CP level (15% of DM) and low flaxseed supplementation (500 g/d; **MPFS500**); and (6) moderate dietary CP level (15% of DM) and moderate flaxseed supplementation (1,000 g/d; **MPFS1000**).

Animals were assigned randomly to 1 of the 6 groups subjected to the different diets and received a diet based on concentrate mainly constituted by corn silage, wheat middlings, corn and soy flour, vetch and oat hay, and straw; the corn and soy flour were used to modulate the protein content of the MP and LP diets. Chemical composition and milk forage units of the experimental diets are reported in Table 1. The chemical composition of diets was determined with standard procedures (AOAC, 1990). The flaxseed groups received the same diets of MP and LP in which 500 (FS500) and 1,000 g/d (FS1000) of concentrate was substituted with the same amount of whole flaxseed (Lin Tech, Tecnozoo srl, Torreselle di Piombino Dese, Italy).

The experiment lasted 7 wk; the first 2 wk were considered an adaptation period and the measurements were made during the last 5 wk. Buffalo cows were housed in cement paddocks with free access to water

Table 1. Ingredients, chemical composition, and milk forage unit (MFU) of the experimental diets (% on DM basis)

	Diet[1]					
Item	MP	LP	MPFL500	LPFL500	MPFL1000	LPFL1000
Ingredient						
Corn silage	35.06	36.40	34.63	35.66	33.23	35.59
Wheat middlings	10.40	10.80	9.86	10.89	7.61	8.77
Straw	13.40	13.81	13.29	13.93	13.50	13.62
Vetch and oat hay	15.43	16.02	15.42	16.10	15.51	15.79
Soy	15.61	11.04	15.36	8.73	14.19	8.02
Corn	10.41	14.34	8.62	11.70	10.44	12.40
Flaxseed	—	—	2.77	2.91	5.45	5.69
Chemical composition						
Ether extract	2.69	2.79	3.84	3.86	4.90	4.93
CP	14.89	12.35	14.93	12.24	14.95	12.36
NSC	33.03	34.50	31.89	33.10	32.45	33.53
ADF	25.53	25.93	25.83	26.04	25.92	26.29
NDF	45.61	44.90	44.12	44.79	44.20	45.04
ADL	3.95	4.06	4.16	4.28	4.37	4.50
MFU	0.87	0.86	0.89	0.88	0.88	0.87

[1]LP = low dietary CP level (12% of DM) and no flaxseed supplementation; LPFS500 = low dietary CP level (12% of DM) and low flaxseed supplementation (500 g); LPFS1000 = low dietary CP level (12% of DM) and moderate flaxseed supplementation (1,000 g); MP = moderate dietary CP level (15% of DM) and no flaxseed supplementation; MPFS500 = moderate dietary CP level (15% of DM) and low flaxseed supplementation (500 g); MPFS1000 = moderate dietary CP level (15% of DM) and moderate flaxseed supplementation (1,000 g).