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The inclusion of fresh forage in the lactating buffalo diet affects fatty acid and sensory profile of mozzarella cheese

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ABSTRACT

Aim of this study was to determine the effect of inclusion of fresh forage in diet for lactating buffalo on properties of mozzarella cheese under intensive farming conditions. Thirty-two buffalo cows were equally allotted into 2 groups fed diets with (fresh group, FRS) or without (control group, CTL) fresh sorghum. The study consisted of 2 trials. In the first one, animals from group FRS were fed a diet containing 10 kg of fresh sorghum (10-FRS diet) that was doubled to 20 kg (20-FRS diet) in the second trial. All diets were isonitrogenous and isoenergetic, and fresh forage accounted for 13.4 and 26.5 of dietary dry matter, respectively, for the 10-FRS and 20-FRS diet. In each trial, milk from the 2 groups was used to produce 3 batches/diet of Mozzarella di Bufala Campana Protected Designation of Origin cheese. Milk yield and composition were not influenced by dietary treatment. The use of 10-FRS diet did not affect any properties of mozzarella. As the inclusion rate of fresh sorghum doubled to 20 kg, an increment of unsaturated fatty acid percentages and a lowering of short-chain and saturated fatty acids were observed. Moreover, the sensory characteristics of mozzarella were modified, although no effects were observed on consumer acceptance. We conclude that the use of green fodder can represent a low-cost feeding strategy to improve the healthiness of buffalo mozzarella under intensive farming conditions with no detrimental effect on consumer blind acceptance.

Key words: fresh forage, buffalo mozzarella cheese, fatty acid composition, sensory properties

INTRODUCTION

Dairy water buffalo (*Bubalus bubalis*) farming is a traditional Italian enterprise that in recent years has been involved in intensification of rearing techniques (Napolitano et al., 2004). Buffalo milk is almost exclusively used for cheese-making mozzarella (Masucci et al., 2016), a typical fresh and stringy-textured cheese, that has been endowed (EC 103/2008) with Protected Designation of Origin (**PDO**) Mozzarella di Bufala Campana. In the last few years, an increasingly number of buffalo farms have spread outside the PDO area to take advantage of the high price paid for buffalo milk and to differentiate dairy products (Cecchinato et al., 2012). In such increasingly competitive market, buffalo dairy farmers producing mozzarella-PDO are forced to pursue competitive strategies focusing on product quality. The increasing consumer interest in nutritional and health properties of foods could create new market opportunities (Jones and Jew, 2007; Siró et al., 2008; Annunziata and Vecchio, 2011).

Dietary recommendations for human health indicate a reduction of SFA and *trans* fatty acids to reduce incidence of cardiovascular disease (Kliem and Shingfield, 2016). Depending on breed, diet, and stage of lactation, fat of milk and dairy products has SFA content over 60%, but it contains the health-promoting rumenic acid (*cis*-9, *trans*-11 C18:2, commonly referred as CLA), a naturally occurring anticarcinogen (Jensen, 2002). Therefore, interest is growing in the development of dairy products naturally enriched in PUFA and CLA. Several feeding strategies are known to be able to provide higher nutritional characteristics to milk fat (Chilliard and Ferlay, 2004; Elgersma et al., 2006). In particular, the use of fresh forage may represent a low-cost approach in comparison with diet supplementation with oilseeds or fats and does not result in significant increases in *trans* 18:1 isomers other than *trans*-11 18:1 (Dewhurst et al., 2006). In addition, the consumers commonly prefer "green image" products obtained

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from grazing animals or, at least, fed without the use of preserved fodders (Kalač, 2011).

However, feeding management and fat characteristics may also affect the sensory quality of the dairy products (Coulon et al., 2004; Dewhurst et al., 2006), whereas any perceived reduction of typical characteristics of a traditional food might be not accepted by regular consumers (Vecchio et al., 2016).

Total mixed rations based on maize and grass silages, hays, and concentrates are commonly used in buffalo farming throughout the year. The hypothesis is that fresh-cut forage inclusion in the diet for lactating buffaloes would be able to improve the healthy characteristics of milk fat under intensive farming conditions. We used sorghum, a forage crop that is spreading in intensive dairy farming, due to its higher flexibility (compared with maize silage, it can be used both fresh and ensiled), and lower environmental impact (compared with maize silage it needs lower inputs of water and nitrogen fertilizer; Lemaire et al., 1996; Farré and Faci, 2006). Therefore, this study aimed to evaluate fatty acid profile, sensory properties, color, and consumer liking of Mozzarella di Bufala Campana PDO cheese produced under the dietary use of fresh sorghum.

MATERIALS AND METHODS

Experimental Design, Animals, Diets, and Cheese Production

The study consists of 2 trials, 17 d each, and took place in September 2014 in a buffalo dairy farm (40°31′N 14°57′E, Campania region, southern Italy) producing PDO mozzarella cheese. Thirty-two lactating buffaloes were blocked by milk yield and DIM and randomly allocated into 2 groups fed diets with (fresh group, **FRS**) or without (control group, **CTL**) daily cut fresh sorghum. Two inclusion rates of fresh sorghum (10 and 20 kg as fed) were tested. The lower rate was chosen in order not to markedly change the daily feeding routine and also to extend the period of fresh forage availability. However, this lower rate was unable to significantly change mozzarella fatty acid profile; therefore, it was doubled. The cows were housed into 2 adjacent freestall barns with access to the outdoors and were milked twice daily (0500 and 1700 h).

In the first trial, the CTL group was fed the standard diet used by the farmer, whereas the FRS group was fed a TMR containing 10 kg of fresh sorghum (**10-FRS** diet). Fresh forage accounted for about 13.4% of TMR on a DM basis. The CTL and 10-FRS diets were formulated to be isonitrogenous and isoenergetic and were based on the same ingredients except for inclusion of fresh forage (Table 1). Sorghum [*Sorghum bicolor* (L.) Moench × *Sorghum sudanense* (Piper) Stapf.; commercial hybrid Nicol, Pioneer Hi-Bred International, Johnston, IA] was sown on the farm in July 2014 and at start of the trial was at the early milk stage [i.e., growth stage 5 to 6 according to the scale of Vanderlip and Reeves (1972)]. Sorghum was cut daily about 3 cm long and was mixed into the TMR with the other ingredients. The rations were fed once daily (0800 h) for ad libitum intake (approximately 10% orts) and were re-approached twice daily to ensure unlimited access to feed. The experimental period consist of 14 d of adaptation to diet and 3 d of cheese manufacturing. In each of them, daily (sum of pm and am milkings) bulk milk of each group was collected along with sampling of fresh sorghum, TMR, and milk of each cow. Group milk was transported to the dairy in refrigerated stainless-steel tanks and used for separately manufacturing mozzarella cheese according to the traditional procedure. Briefly, raw water buffalo milk was gently heated (37–38°C) and added with natural whey starter culture from the previous day manufacture and liquid rennet (Caglificio Clerici S.p.a., Codrago, Como, Italy). At curd formation, the coagulum was reduced to particles of 2 to 3 cm and held under whey until pH 4.85, a value suitable for manual stretching into hot water (90–95°C). Thereafter, the stretched curd was mechanically formed into 50-g small balls that were placed in brine (2% NaCl) and sent to the laboratory. A total of 3 batches/diet were produced, about 20 kg each. Over the 3 d of cheese manufacturing, yield (%) of mozzarella was 27.2 ± 0.21 and 27.1 ± 0.26, and DMI (kg/d) was 18.2 ± 1.15 and 17.9 ± 0.65 for CTL and 10-FRS groups, respectively.

The second trial started immediately after the end of the first one. Other 32 animals were used and randomly allocated to the CTL and FRS-20 groups. The TMR for control group was kept constant, whereas group FRS was fed a diet in which the fresh sorghum content was doubled to 20 kg (**20-FRS** diet) and accounted for about 26.5% of DM. The 20-FRS diet was kept isonitrogenous and isoenergetic with respect to CTL (Table 1). Fresh sorghum was at the soft dough stage [i.e., growth stage 7 (Vanderlip and Reeves, 1972)]. The same experimental design and sampling procedure reported above for the first trial were used. Average percent mozzarella yields were 28.6 ± 0.59 and 28.6 ± 0.80, whereas DMI (kg/d) were 19.1 ± 0.8 and 18.9 ± 0.9 for groups CTL and 20-FRS, respectively.

Chemical Analyses of Milk, Feeds, and Cheese, and Instrumental Measures of Color and Texture of Cheese

The samples of fresh sorghum and TMR collected over the 3 d of mozzarella manufacturing were pooled