Influence of replacing corn silage with barley silage in the diets of buffalo cows on milk yield and quality

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Abstract A 150-day trial was carried out on 40 Italian Mediterranean buffalo cows that, immediately after calving, were equally divided into two homogeneous groups (M and O) based on the number of calving events and previous milk yield. The animals were fed (16 kg dry matter (DM)/head) two isoenergy/isoprotein diets (NEI: 6.39 MJ/kg DM; 15.4 CP% DM), composed of corn (diet M) or barley silage (diet O) concentrate, alfalfa hay, and a vitamin-mineral supplement. The fermentation characteristics of both silage diets were evaluated by an *in vitro* gas production technique, and their nutritional values were calculated as follows: $NEI \text{ (MJ/kg DM)} = 0.54 + 0.0959 \text{ GP} + 0.0038 \text{ CP} + 0.0001733 \text{ CP}^2$, where GP is the gas production after 24 h of incubation (ml/200 mg DM) and CP is the protein content of silage (g/kg DM). The nutritional values of the silages were slightly different (4.16 vs. 4.14 MJ/kg DM for M and O, respectively) likely due to the high content of hemicellulose in the O diet (22.0 vs. 16.9%). Average milk yield did not differ between the groups; instead, milk fat (8.39 vs. 9.06%; $P < 0.01$) and protein (4.41 vs. 4.60%; $P < 0.01$) levels were significantly higher in the O group. The results elicit great interest in southern Italy where corn cultivation is adversely affected by the high cost of irrigation.

Keywords Buffalo cow · Barley · Silage

Abbreviations

DM dry matter
CP crude protein
NDF neutral detergent fiber
ADF acid detergent fiber
ADL acid detergent lignin
NEI net energy for lactation

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Table 1 Chemical composition (DM%) and nutritional value (NEI, MJ/kg DM) of corn and barley silage

	DM (%)	CP	NDF	ADF	ADL	NEI
Corn	28.2	8.2	53.1	36.2	4.3	4.16
Barley	27.7	9	62.2	40.2	4.2	4.14

Introduction

In southern Italy, whole-crop barley (*Hordeum vulgare* L.) harvested at a milky-waxy maturation of grain [32–34% dry matter (DM)] yields 10.5–12.5 t DM/hectare (Francia et al. 2006). In addition, it shows a constant energy value due to the trade-off of seed components and fibrous fractions of plants and a good ensiling suitability (Delogu et al. 2002). Finally, harvesting the whole crop allows a maximal yield per unit of area via double-cropping (winter cereal plus corn or sorghum). This productive system is of increasingly interest, allowing the optimization of, in particular, water resources (Manninen et al. 2005). Due to the high costs of irrigation, replacing corn silage with barley silage for animal feeding is of great interest in southern Italy. Therefore, the aim of the present study was to evaluate the influence of this substitution in the diets of lactating buffalo cows on milk yield and quality.

Material and methods

The 150-day trial was carried out on a farm in Cassino, in the province of Frosinone, where 40 Italian Mediterranean buffalo cows, immediately after calving, were equally divided into two homogeneous groups (M and O) based on the number of calving events and previous milk yields. The animals were fed (16 kg DM/head) two isoenergy and isoprotein diets [net energy for lactation (NEI): 6.39 MJ/kg DM; 15.4 crude protein (CP)% DM], composed of corn (diet M) or barley silage (diet O) concentrate, alfalfa hay and a vitamin/mineral supplement. Feeds were analyzed for chemical composition (AOAC 2000; Van Soest et al. 1991) monthly. The fermentation characteristics of both silages were evaluated by the *in vitro* gas production technique (Theodorou et al. 1994), and their nutritional values were calculated as follows (Menke and Steingass 1988): $NEI \text{ (MJ/kg DM)} = 0.54 + 0.0959 \text{ GP} + 0.0038 \text{ CP} + 0.0001733 \text{ CP}^2$ where GP is the gas production after 24 h of incubation (mL/200 mg DM) and CP is the protein content of the silage (g/kg DM). Individual milk

Fig. 1 Mean milk fat (left panel) and protein (right panel) percentage per sample

yield was recorded daily, and samples of milk were analyzed monthly for fat, protein, and lactose using an infrared method. Data for milk yield and quality were statistically assessed using the GLM procedure (SAS/STAT 2000).

Results

The chemical composition of corn silage (Table 1) was consistent with that obtained in our previous research performed in the same area (Calabrò et al. 2007; Infascelli et al. 2007). The barley silage showed DM and CP levels similar to those of corn silage but higher values of fiber. However, the nutritional values of the silages were slightly different, probably due to the higher content of hemicellulose in barley silage (22.0 vs. 16.9%).

Average milk yield did not differ between the groups (7.94 vs. 8.09 kg/day, for groups M and O, respectively) nor did lactose (5.01 vs. 5.0%); instead milk fat (8.39 vs. 9.06%; $P < 0.01$) and protein (4.41 vs. 4.60%; $P < 0.01$) levels were significantly higher in the group fed barley silage. However, as depicted in Fig. 1, the differences were significant in the fourth and fifth fat samples and in the third protein sample.

Discussion

Replacing corn silage with whole-crop barley silage in the diets of lactating buffalo cows gave encouraging results. Indeed, while milk yield was unaffected by the diet, milk fat and protein levels were significantly higher in the group fed barley silage. These results are of great interest, particularly for the dairy processing of buffalo milk. The higher milk fat percentage was probably due to the higher digestibility of neutral detergent fiber (NDF) in barley silage, which had a higher level of hemicellulose. This hypothesis has been suggested by other authors (Miron et al. 2007) who observed higher NDF digestibility in sorghum silage than in corn silage with the same content of lignin, probably due to the inhibitory action of corn grain on the activity of rumen cellulolytic bacteria. In conclusion, despite few available data, the results obtained are of great interest in areas where the high costs of irrigation affect corn cultivation.

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