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Chemical Composition, *In situ* Digestion Kinetics and Feeding Value of Oat Grass (*Avena sativa*) Ensiled with Molasses for *Nili-Ravi* Buffaloes

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ABSTRACT : This study examined the effect of cane molasses and fermentation time on chemical composition and characteristics of oat grass silage (OGS) and its *in situ* digestion kinetics, intake, digestibility, milk yield and composition in buffaloes (*Bubalus bubalis*). Oat grass (OG) harvested at 50-days of age was ensiled in laboratory silos with cane molasses at the rate of 0, 2, 4 and 6% of OG dry matter (DM) for 30, 35 and 40 days. Silage pH was decreased while lactic acid content increased with increasing level of cane molasses and fermentation time. Dry matter (DM), crude protein (CP) and true protein (TP) content of OGS were ($p<0.05$) significantly higher with higher cane molasses levels. However, they were not affected by the fermentation time. Similar trends were observed for neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, acid detergent lignin and ash content of OGS. The OG ensiled for 30-days with 2% molasses was screened from laboratory study and used to determine comparative *in situ* DM and NDF digestion kinetics of OG and its silage. *In situ* DM and NDF digestibilities of OG were significantly ($p<0.05$) higher than OGS. Ruminal DM and NDF lag time, rate and extent of digestion of OG and its silage were similar. Two experimental diets of OG and OGS were formulated using 75:25 forage to concentrate ratio on a DM basis. Dry matter and CP intakes were similar in lactating buffaloes fed either OG- or OGS-based diets. However, NDF intake was higher in buffaloes fed the OG- compared with OGS-based diet. Apparent DM, CP and NDF digestibilities were similar in lactating buffaloes fed either OG- or OGS-based diets. Milk yield (4% FCM) was similar in buffaloes fed either OG-(10.3 kg/d) or OGS-(9.95 kg/d) based diets. Milk fat, total solids and true protein content were higher with OG compared with the OGS diet. Solids not fat and CP content were similar in milk of buffalo fed either OG or OGS. The results of this study indicate that OG ensiled with 2% molasses could safely replace 75% DM of green oat fodder in the diets of lactating buffaloes without negatively affecting intake, digestibility, milk yield and composition. (**Key Words :** Grass Silage, Fermentable Carbohydrate, Digestibility, Milk Yield)

INTRODUCTION

Irregular and inadequate supply of quality forage is the most critical constraint impeding livestock productivity in developing countries (Sarwar et al., 2006). In south Asia, rapidly growing human need for food (cereal grains) has limited the area under fodder cultivation (Masters et al., 2005) Low per acre fodder yield coupled with fodder scarcity periods (extremes of summer and winter) further deteriorated fodder availability (Sarwar et al., 2002; Khan et al., 2006a). Ensiling of multi-cut high yielding fodders during fodder availability period could bridge the escalating gap between supply and demand of fodder for ruminants in the region.

Preservation of fodder is achieved by acid production leading to steady decline in pH under anaerobic condition. Fermentable carbohydrates, nitrogen (N), dry matter (DM) content, type and amount of bacterial population at ensiling time were important factors that affect silage buffering capacity (related to the amount of acid needed to change the pH) and its quality (Khorasani et al., 1993; Maruyama et al., 2005).

The most preferred crop for ensiling is maize (Bolsen et al., 1996; Evitayani et al., 2005); however, oat, sorghum, barley, millet, mott and jambo grasses can also be ensiled. Oat (*Avena sativa* L.) is a tall annual cereal, widely grown as a fodder in temperate, sub-tropical, and tropical regions. However, oat grass (OG) has low concentration of soluble

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Table 1. Chemical composition of oat grass harvested at 25 (OGE), 50 (OGM) and 75 (OGL) days of maturity (% DM)

Parameters	OGE	OGM	OGL	SE
Dry matter	21.4[c]	28.2[b]	34.5[a]	2.1
Crude protein	12.1[a]	10.0[b]	7.0[c]	0.8
Neutral detergent fiber	63.0[c]	70.1[b]	76.1[a]	2.8
Acid detergent fiber	30.2[c]	38.5[b]	42.5[a]	2.6
Acid detergent lignin	3.20[c]	4.30[b]	6.10[a]	0.6
Ash	11.2	11.3	12.5	0.5

Means in the same row bearing different superscript are significantly different at ($p<0.05$). SE: Standard error among means.
OGE: Oat grass at early maturity.
OGM: Oat grass at medium maturity.
OGL: Oat grass at late maturity.

carbohydrates (Bolsen et al., 1996; Shaoa et al., 2005) thus its ensilation with fermentable carbohydrates is prerequisite for better fermentation and preservation. The scientific evidence regarding the influence of fermentable carbohydrates on chemical composition, silage characteristics and feeding value of OG in buffaloes is limited. Therefore, the present study examined the influence of cane molasses and fermentation time on chemical composition and characteristics of oat grass silage (OGS) and its influence on feed intake, *in situ* digestion kinetics, nutrients digestibility, milk yield and its composition in lactating *Nili-Ravi* buffaloes (*Bubalus bubalis*).

MATERIALS AND METHODS

Oat grass

The oat seeds were sown in the field adjacent to the Animal Nutrition Research Center, University of Agriculture, Faisalabad, Pakistan. The OG was harvested at different maturities (25, 50 and 75 days) and five random samples at each stage of maturity were analyzed for nutrient concentration. The OG was chopped in a locally manufactured chopper. Samples were dried at 55°C and ground to particle size of 2-mm through a Wiley mill. The DM of OG samples was determined by drying them at 135°C for 4 h followed by equilibration in a desiccator (AOAC, 1999; ID 930.5), and organic matter (OM) was calculated as weight loss upon ignition at 600°C. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents were determined with the ANKOM fiber analyzer using reagents described by Van Soest et al. (1991). The N contents were determined by a Kjeldahl method (AOAC 1999; ID 984.13). Chemical analysis of OG harvested at 25, 50 and 75 is presented in Table 1. OG harvested after 50-days was used in subsequent trials in this study.

Table 2. Chemical composition of cane molasses (% DM)

Parameters	Cane molasses
Dry matter	68.0
Crude protein	4.70
Ash	11.1
Dextrose	1.2
Sucrose	35.6
Fructose	4

Laboratory ensiling study

The OG chopped with a locally manufactured chopper was ensiled in laboratory silos (transparent thick polyethylene bags of 10-kg capacity having dimensions (80×40 cm) using cane molasses (Chemical composition of molasses is given in Table 2) at the rate of 0, 2, 4 and 6% of

Table 3. Characteristics and chemical composition of oat grass[1] silage (% DM)

Molasses level (%)	Ensiling time (Days)	pH	Lactic acid	DM[2]	CP[3]	TP[4]	NDF[5]	ADF[6]	Cellulose	ADL[7]	Ash
0	30	3.96[a]	4.00[f]	25.5[b]	8.52[b]	6.72[b]	66.1[b]	39.6[a]	36.2[a]	6.2[a]	15.7[a]
	35	3.88[b]	4.14[e]	24.4[c]	8.18[b]	6.65[b]	66.2[b]	39.9[a]	36.3[a]	6.5[a]	15.6[a]
	40	3.85[b]	4.15[e]	23.1[d]	8.12[b]	6.62[b]	65.8[b]	39.7[a]	37.0[a]	6.3[a]	15.9[a]
2	30	3.66[c]	4.29[d]	26.9[a]	9.64[a]	7.20[a]	68.0[a]	38.3[b]	33.0[b]	5.1[b]	14.1[b]
	35	3.69[c]	4.26[bc]	26.3[a]	9.66[a]	7.15[a]	67.5[a]	38.1[b]	33.2[b]	5.0[b]	14.5[b]
	40	3.63[d]	4.43[b]	26.0[a]	9.55[a]	7.12[a]	67.4[a]	38.4[b]	33.4[b]	4.9[b]	14.3[b]
4	30	3.65[d]	4.32[c]	27.0[a]	9.81[a]	7.05[a]	68.1[a]	38.3[b]	33.3[b]	5.2[b]	14.4[b]
	35	3.60[e]	4.40[b]	26.8[a]	9.70[a]	7.08[a]	68.3[a]	37.9[b]	34.0[b]	5.1[b]	14.8[b]
	40	3.57[ef]	4.45[b]	26.9[a]	9.54[a]	7.11[a]	67.9[a]	38.2[b]	34.3[b]	5.0[b]	14.7[b]
6	30	3.61[e]	4.41[b]	27.2[a]	9.83[a]	7.10[a]	68.5[a]	38.4[b]	34.3[b]	4.9[b]	14.8[b]
	35	3.55[f]	4.52[a]	27.0[a]	9.66[a]	7.03[a]	68.6[a]	38.0[b]	33.8[b]	5.1[b]	15.0[b]
	40	3.52[gf]	4.54[a]	26.8[a]	9.20[a]	6.99[a]	68.4[a]	37.8[b]	33.9[b]	5.2[b]	15.1[b]
P values											
Molasses level (M)		0.04	0.03	0.04	0.03	0.02	0.01	0.04	0.01	0.03	0.04
Ensiling period (P)		0.03	0.02	0.06	0.20	0.21	0.22	0.21	0.14	0.21	0.24
M×P		0.02	0.025	0.21	0.17	0.21	0.14	0.16	0.15	0.19	0.18

[1] Harvested at 50-day age and was ensiled in laboratory silos; [2] DM: Dry matter; [3] CP: Crude protein.
[4] TP: True protein; [5] NDF: Neutral detergent fiber; [6] ADF: Acid detergent fiber; [7] ADL: Acid detergent lignin.

Table 4. Mean (±standard deviation) chemical composition of oat grass and its silage[1] (% DM) used for nylon bag study and performance trial

Parameters	Oat grass	Oat grass silage
Dry matter	28.4±1.6	25.8±1.2
Crude protein	10.1±0.9	9.54±0.6
Neutral detergent fibre	70.1±2.2	66.7±1.5
Acid detergent fiber	38.5±1.4	36.0±1.0
Acid detergent lignin	4.30±0.5	5.22±1.4
Ash	12.3±1.0	14.7±1.1

[1] Harvested at 50-day age and was ensiled with 2% cane molasses in trench silos.

forage DM levels for 30, 35 and 40 days. Four silos per treatment were prepared and placed at the room temperature (25°C). After opening these silos, silage pH was recorded using a pH-mV meter (HM-21P, TOA Corporation, Tokyo, Japan). Lactic acid in OGS samples was determined in aqueous extracts by means of a GLC with a semi-capillary FFAP (nitroterephthalic acid-modified polyethylene glycol) column (Hewlet-Packard, Wardbronn, Germany), over a temperature range of 45 to 230°C. True protein (TP) was estimated by multiplying TCA insoluble-N×6.25. The OGS samples were analyzed for DM, N, NDF, ADF, cellulose, ADL, and total ash using method described above. Chemical composition of OGS ensiled with cane molasses for different ensiling times is given in Table 3.

Statistical analysis

The data thus generated during laboratory trial was subjected to analysis of variance technique according to factorial arrangement of treatments (4×3) i.e. four cane molasses levels (0, 2, 4, and 6%) and three fermentation periods (30, 35 and 40 days) to determine best combination of additive level and fermentation period. In case there was significant ($p<0.05$) difference among treatment means, the Duncan's Multiple Range test was applied (Steel and Torrie, 1984).

Nylon bag study

The OG ensiled for 30-days with 2% molasses was screened from laboratory study and used to determine comparative *in situ* DM and NDF digestion kinetics of OG and OGS. Four ruminally cannulated buffalo bulls were used in this study. The buffalo bulls were housed on the concrete floor in separate pens. Ten days were given as adaptation period to the diet at the start of experiment followed by 4-days of incubation period for the *in situ* nylon bags. Ruminally cannulated buffalo bulls were fed oat grass and its silage (50:50) to avoid the effects of diet on the ruminal fermentation pattern (Clark and David, 1990). Nylon bags measuring 13×21 cm, with an average pore size of 50 μm, were used to study *in situ* digestion kinetics. For each time point, 10 g DM of each sample (OG and/or OGS) was weighed into bags, in triplicate. Two bags were used to determine DM and NDF disappearance and the third bag served as a blank (having no sample). The bags were closed and tied with nylon fishing line and were exposed to ruminal fermentation for 1, 2, 4, 6, 10, 16, 24, 36, 48, 72, and 96 h. After removal from the rumen, bags were washed in running tap water (15 minutes) until the rinse was clear. Bags were then dried in oven at 55°C for 48 h. After equilibration with air for 8 h, the bags were weighed and the residues were transferred to 100 ml cups and analysed for DM and NDF as described above. Ruminal DM and NDF digestion, rate of digestion and lag time, were determined for each incubation time, individually. Degradation rates were determined by subtracting the indigestible residue, i.e. the 96 h of ruminal incubation, from the amount in the bag at each time point and then regressing the natural logarithm of that value against time (Sarwar et al., 2004) after correcting for lag time (Mertens, 1977). The lag time was calculated according to Mertens and Loften (1980).

Feeding trial

Oat grass (chemical composition given in Table 4) was chopped in a locally manufactured chopper and was ensiled with 2% molasses in three trench silos of similar (3×10× 2 m) capacity. The silos were filled with chopped OG and were pressed properly using tractor to remove air for good anaerobiasis. Each pit was covered with a 10-cm-thick layer of rice straw, followed by a plastic film covering, which was plastered with a blend of wheat straw and mud to avoid any cracking on drying. It was presumed that plastic sheet and mud plastering provided anaerobic conditions for proper silage making. Plastic sheet was removed to take the silage for feeding, starting the removal of silage through the upper layer and working downwards to the lower layers. An amount of silage just sufficient for one day's feeding was taken out. After removing silage from the pit the plastic sheet was put back to keep the pit sealed. The OGS was analyzed for its pH, lactic acid contents, DM, N, NDF, ADF, cellulose, ADL and total ash using methods described previously.

Twenty early lactating multiparous (3-4 parity) *Nili-Ravi* buffaloes, ten animals in each group with similar body weight (469±21 kg) and milk production (7.74±0.21 kg/day) were selected. The groups and diets were allotted to animals at random. Each animal was housed on a concrete floor in a separate pen. Fresh and clean water was made available round the clock in the pens for whole experimental period.

Two experimental diets were formulated using 75:25 forage to concentrate ratio on DM basis. The OG and OGS diets had 75% OG and 75% OGS DM, respectively as forage component. Chemical composition of OG and OGS (ensiled in bulk in trench silo with 2% cane molasses) is

Table 5. Comparative *in situ* digestion kinetics of oat grass and its silage

Parameters	Oat grass	Oat grass silage	SE
Dry matter			
Digestibility (%)	61.2[a]	58.9[b]	0.31
Lag time (h)	1.41	1.46	0.13
Rate disappearance (%/h)	3.69	3.63	0.05
Extent of digestion (%)[1]	70.5	70.3	0.11
Neutral detergent fibre			
Digestibility (%)	58.6[a]	55.1[b]	0.33
Lag time (h)	1.86	1.88	0.12
Rate of disappearance (%/h)	3.44	3.39	0.04
Extent of digestion (%)[1]	67.6	67.7	0.05

[1] Extent of DM and NDF digestion was calculated at 96 h after rumen incubation.

Oat grass was harvested at 50-day age and was ensiled with 2% cane molasses in a trench silo. Means in the same row bearing different superscript are significantly different at ($p<0.05$). SE: Standard error between means.

given in Table 4. All the diets were formulated to be iso-nitrogenous and iso-energetic using NRC (2001) standards for energy and protein (Table 6). Diets were mixed daily and fed twice (06:00 and 18:00) a day at *ad libitum* intakes. The trial lasted for 120-days with first 20-days for dietary adaptation and 100-days for sample collection. Daily feed intake and milk production were recorded and averaged over 100-days.

Buffaloes were milked twice daily, and individual milk yields were recorded. Milk samples were collected at two consecutive milking (pm and am) fortnightly with 12 h interval and preserved in 2-bromo-2-nitro-propane-1-3-diol and kept refrigerated (6°C) until analysis (Johnson et al., 1999). Total-N in milk was estimated by Kjeldhal method (920.105; AOAC, 1990). Milk CP contents were calculated by multiplying % N with 6.38. Milk TS were determined by heating milk sample on steam bath (10-15 minutes), followed by heating at 98-100°C for 3 h in a hot air oven (925.23; AOAC, 1990). Milk fat was determined by using fat extraction tubes following the method of Roese Gottlieb (905.02; AOAC, 1990). Solids-not-fat was calculated by the difference of TS and milk fat. Fat corrected milk (FCM; 4% fat) was calculated as described by Tyrrell and Reid (1965) using equation; 4% FCM = milk (kg/d)×(44.01×milk fat% +163.56)/339.60. Total milk ash was determined by incineration at 550°C (945.46; AOAC, 1990). Milk samples were deproteinized with sulfosalicylic acid and stored at -20°C and analyzed for urea (Broderick, 1986).

During the last week of the study, a digestibility trial was conducted as described by Khan et al. (2004). Fecal grab samples were taken twice daily such that a sample was obtained for every 3 h interval of 24 h period (8 samples) between morning and evening feedings (Sarwar et al., 1991).

Table 6. Ingredients and chemical composition of experimental diets (% DM)

Ingredients (%)	Diets	
	OG	OGS
Oat grass	75.0	-
Oat grass silage	-	75.0
Rice polishing	3.60	3.70
Wheat bran	5.00	5.00
Maize gluten feed 30%	6.40	6.0
Maize oil cake	2.50	2.50
Canola meal	2.50	2.50
Cane molasses	4.00	4.00
Mineral mixture	1.00	1.00
Urea	-	0.30
Chemical composition (%)		
Dry matter	35.0	34.2
Crude protein	12.7	12.7
Neutral detergent fiber	62.5	54.0
Acid detergent fiber	32.4	31.5
Hemicellulose	30.4	18.4
Cellulose	27.5	24.4
Acid detergent lignin	3.43	4.71
Ash	8.88	10.8
NE_L (MJ/kg)[1]	5.20	5.20

OG and OGS diets contain 75% dry matter from oat grass fodder and oat grass silage (ensiled with 2% molasses), respectively.

[1] NE_L was calculated using equation given in NRC (2001).

The acid insoluble ash was used as digestibility marker (Van Keulen and Young, 1977). Feed offered and orts were sampled daily and composited by animal for analysis. Feed, orts, and fecal samples were also analyzed for DM, N, ash contents NDF, ADF and ADL by methods described above.

Statistical analysis

The data on *in situ* digestion kinetics parameters, feed intake, digestibility, milk yield and its composition were analyzed by t-test using SAS (1988).

RESULTS

Dry matter, NDF, ADF and ADL concentrations in OG were increased ($p<0.05$) and CP contents decreased with its maturity (Table 1). The OG harvested at 50 days of age was selected for ensiling.

Silage characteristics and chemical composition

Silage pH was decreased while lactic acid contents were increased with the increasing level of cane molasses and fermentation time (Table 3). The interaction between cane molasses and ensiling time was significant for these parameters. Dry matter, CP and TP contents of OGS were significantly higher with the inclusion of cane molasses levels (Table 3) but, they were not affected by the fermentation time. Similar trend was observed for NDF, ADF, cellulose, ADL and ash contents of OGS.

Table 7. Nutrient intakes and their digestion by buffaloes fed OG and OGS diets

Items	Diets		SE
	OG	OGS	
DM[2] intake (kg/day)	13.3	13.2	0.07
DM intake (%/body weight)	2.86	2.97	0.18
Apparent DM digestibility (%)	56.7	56.7	0.41
CP[3] intake (kg/day)	1.74	1.70	0.01
Apparent CP digestibility (%)	71.3	71.1	0.76
NDF[4] intake (kg/day)	8.35[a]	7.16[b]	0.03
NDF intake (%/body weight)	1.79[a]	1.28[b]	0.07
NDF digestibility (%)	48.5	50.1	2.67
Digestible nutrient intake (kg/day)			
DM	7.54	7.45	0.14
CP	1.24	1.21	0.02
NDF	4.04[a]	3.56[b]	0.18

OG and OGS diets contain 75% dry matter from oat grass fodder and oat grass silage (ensiled with 2% molasses), respectively.
[2] DM: Dry matter; [3] CP: Crude protein; [4] NDF: Neutral detergent fiber.
Means in the same row bearing different superscript are significantly different at ($p<0.05$). SE: Standard error between means.

Table 8. Milk yield and composition by buffaloes fed OG and OGS diets

Items	Diets[1]		SE
	OG	OGS	
Milk yield (kg/ day)	7.51	7.95	0.27
Milk yield 4% FCM[1] (kg/ day)	10.3	9.95	0.20
Milk fat (%)	6.87[a]	5.95[b]	0.14
Solids not fat (%)	9.17	9.19	0.08
Total solids (%)	16.0[a]	15.1[b]	0.20
Crude protein (%)	3.57	3.57	0.09
True protein (%)	3.35a	2.92[b]	0.06
Non-protein nitrogen (%)	0.22[b]	0.65[a]	0.12

OG and OGS diets contain 75% dry matter from oat grass fodder and oat grass silage (ensiled with 2% molasses), respectively.
[1] Fat corrected milk was calculated as described by Tyrrell and Reid (1965) using equation; 4% FCM = milk (kg/d)×(44.01×milk fat% +163.56)/339.60.
Means in the same row bearing different superscript are significantly different at ($p<0.05$). SE: Standard error between means.

***In situ* DM and NDF digestion kinetics**

In situ DM and NDF digestibilities of OG were significantly higher than OGS at 48 h of incubation (Table 5). Ruminal DM and NDF lag time, rate and extent of digestion of OG and its silage were similar.

Feed intake and digestibility

Dry matter and CP intakes were similar in lactating buffaloes fed either OG or OGS based diets (Table 7). However, NDF intake was significantly higher in buffaloes fed the OG based diet than those fed the OGS based diet. Apparent DM, CP and NDF digestibilities were similar in lactating buffaloes fed either OG or OGS based diets (Table 7).

Milk yield and composition

Milk yield (4% FCM) was similar in buffaloes fed either OG (10.3 kg/d) or OGS (9.95 kg/d) diets (Table 8). Fat, total solids and true protein contents in buffalo milk were higher with OG diet compared with OGS diet. Solid-not-fat, crude protein and non-protein N contents were similar in buffalo milk fed either OG or OGS based diets (Table 8).

DISCUSSION

Silage characteristics and chemical composition

Higher lactic acid content and corresponding lower pH in OGS when ensiled with higher level of cane molasses were due to the availability of easily fermentable sugars for better growth of lactic acid producing bacteria (Bureenok et al., 2005; Sarwar et al., 2005; Khan et al., 2006b). Addition of corn starch or molasses to Mott grass (*Pennisitum purpureum*) at ensiling has improved the availability of fermentable sugars for anaerobic fermentation that lead to higher acid production and thus low silage pH (Nisa et al., 2005). Contrary to the findings of the present results, Leibensperger and Pitt (1998) reported that addition of molasses to wilted or un-wilted grasses increased fermentable carbohydrates, but did not lower the final silage pH especially in very low or very high DM silages. They explained that moisture is one of the important determinants of pH decline during ensiling. Lower moisture at ensiling retarded the growth of anaerobic bacteria and thus reduces the conversion of easily fermentable carbohydrates to organic acids and higher moisture in ensiling crops diluted the amount of acid produced and thus resists the pH decline during ensiling. Higher DM, CP, TP and fiber fractions of OGS ensiled with higher level of molasses indicated an early drop in silage pH that has not only stabilized the fermentation process, but also reduced the loss of nutrients. Further during fermentation process, there is extensive proteolytic and fibrolytic activity of microbes and plant enzymes that result in the loss of protein and fiber fractions (Kung et al., 2000). These plant and microbial enzymes are acid labile with optimum pH range between 5 to 6 and their activity become negligible as pH approached 5 (McDonald, 1981). Higher DM, protein and fiber fractions in OGS ensiled with molasses were probably because of the reduced activity of plant microbial enzymes due to more low pH and early stability of the medium compared with OGS ensiled without molasses.

***In situ* DM and NDF digestion kinetics**

The higher ruminal DM and NDF digestibility of OG than that of its silage was because of the presence of more readily degradable carbohydrate contents in the former. During ensiling process there had been loss of readily

degradable carbohydrate contents by lactic acid producing bacteria (Ruiz et al., 1992).

Feed intake and digestibility

Higher NDF intake in buffaloes with OG based diet was because of its higher NDF contents compared with OGS based diet (Table 6). Rooke (1995) reported that intake of silage was lower than that of grass due to the presence of fermentation products in the former. They explained that DM intake was negatively correlated with silage pH, concentration of acids in the silage DM and indices of fermentation quality. Moisture content of the silage based diets also affected silage intake negatively (Sarwar and Hasan, 2001; Nisa et al., 2006). In the present study, the pH of OGS was less than 4.0 indicating a good quality silage and moisture contents of both diets were almost the same, so the intake of silage based diet was not depressed. Further, it may be suggested that higher intake of NDF with OG based diet might have depressed its intake because of more pronounced gut filling compared to OGS diet and thus nullify the expected difference in intake between OG and OGS because of silage fermentation products (Khorasani et al., 1993). In contrast to the results of the present study Torotich (1992) reported that a depression in DM and NDF digestibility of silage based diets was due to lower ruminal pH, which depressed the growth of cellulolytic bacteria in the rumen. However, such affects were not observed in this study and nutrient digestibilities were similar in buffaloes fed forage or silage based diets.

Milk yield and composition

Similar milk yield by buffaloes fed either OG or OGS diets was because of similar digestible nutrient intake (Table 7) that should have provided the same amount of nutrients for the synthesis of milk (Sarwar et al., 2005). Increased NDF intake (Table 7) by buffaloes fed the OG diet might have resulted in higher ruminal acetate production, a precursor of milk fat (Sarwar et al., 1991). Production of more acetate leads to more fatty acid synthesis that might have increased percent fat and total solids in the milk (Man and Wiktorsson, 2001). Lower milk TP and higher non-protein-N contents in buffaloes fed OGS diet may be attributed to the addition of urea in the OGS diet to make both diets iso-nitrogenous.

CONCLUSIONS

The results of this study implied that OG ensiled with 2% molasses could safely replace 75% DM of green oat fodder in the diets of lactating buffaloes without any ill effect on nutrient intake, digestibility and milk yield.

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