Indian J. Anim. Nutr. 2019. 36 (4): 347-352
doi: 10.5958/2231-6744.2019.00057.4
Indian Journal of Animal Nutrition

Comparative Evaluation of Oat Hay and Silage Based Rations on Nutrient Utilization and Methane Emissions in Murrah Buffaloes

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ABSTRACT

In the present study oat hay and silage were compared for their methane (CH_4) production and nutrient utilization potential in Murrah buffaloes. Sixteen dry buffaloes (566.5± 12.5 kg live weight) were selected from Livestock Research Centre of the National Dairy Research Institute, Karnal. Animals were distributed randomly into two groups (T_1 and T_2) based on body weight. Animals in group T_1 and T_2 were offered oat hay and oat silage, respectively along with supplementation of mineral mixture and salt. After feeding for a duration of 60 days, a digestibility trial was conducted followed by methane emission measurement by SF_6 tracer technique. Average daily DM intake was similar in both the groups, whereas, fibre (NDF, ADF) intake was significantly ($P<0.05$) higher in hay fed group. Digestibility of nutrients (DM, OM, EE, NDF and ADF) except CP was not affected by hay or silage; CP digestibility was higher (60.59%) on silage feeding as compared to hay (58.28%) feeding. Feeding of hay resulted in more ($P<0.05$) enteric CH_4 emissions (341.35 l/d) than silage feeding (317.86 l/d). Total CH_4 production was reduced by 6.86% on oat silage than hay. Higher ($P<0.05$) percent of ME was lost in methane in group T_1 (16.41) as compared to T_2 (13.97). Thus, Oat could be stored as silage than hay for lowering methane emission from Murrah buffaloes.

Key words: Hay, Murrah buffaloes, Methane emission, Oat silage

INTRODUCTION

Scarcity of feed and fodder is the common problem faced by livestock owners of India. The problem is aggravated further by non-uniform availability of fodder throughout the year, as growing fodder availability is chiefly dependent upon the climate. There is surplus availability of green fodder during flush season, whereas, during extreme seasons majority of Indian farmers get less or even no green fodder. The excess fodder produced, stored either as hay or silage, fed to animals during scarcity period. The previous one is dehydrated product, whereas the latter one is an anaerobically fermented high moisture product. The above aspect may affect the rate of utilization of either of the stored forages in the rumen. The rate of utilization of the fodder can be best estimated from their intake level and nutrient digestibility. Utilizable crude protein (Zhao and Lebzien 2000) gives the idea of the protein entering the duodenum for digestion. Methane is a major greenhouse gas produced especially from fodder digestion in ruminant livestock which not only contribute to environmental pollution, but also results in substantial loss (2-12%) of gross energy intake which could have been otherwise utilized for productive purposes. Buffalo and cattle contribute about 39 and 53.1% of total livestock methane production in India (Singhal *et al.,* 2005). Considering the fact that environmental issues can no longer be ignored while designing feeding regimes for large ruminants, it was hypothesized that comparative nutritive value and methane mitigating potential would vary according to methods of conservation of forage. The specific objective of this experiment was to compare nutrient utilization and methane emissions in Murrah buffaloes fed either oat hay or silage diets.

MATERIAL AND METHODS

The fodders were evaluated for their chemical composition and *in vitro* utilizable crude protein (Zhao

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and Lebzien 2000) content before start of the animal experiment. The experiment was conducted in the experimental shed of the National Dairy Research Institute, Karnal, India (latitude 29.43°N & longitude 77.2°E). Environmental temperature during the study ranged from 27 to 31 °C, and humidity ranged from 16 to 18 %. All the experimental procedures were approved by Institutional Animal Ethics Committee of NDRI (IAEC/21/14 dated 04.01.2014).

Sixteen dry Murrah buffaloes (566.5 ± 12.5 kg body weight) were selected from Livestock Research Centre of National Dairy Research Institute, Karnal and distributed randomly into two groups based on body weight. Animals were housed in Dairy Cattle Nutrition experimental shed and given an acclimatization period of 10 days. Animals in group 1 were given hay and those of group 2 were fed silage for 60 days. In both the groups mineral mixture and salt were supplemented. A digestibility trial of 7 days duration was conducted to evaluate the nutrient digestibility. Methane emission was measured by SF_6 tracer technique (Johnson *et al.*, 1994). A permeation tube containing SF_6, standardised for steady release rate (0.0035 g/day) over a period of 6 weeks, was placed in the rumen 2 days prior to the experiment. The animals were fitted with halter with capillary tubing (SS Capillary tubing 0.0635" X 0.004") in such a way that the gas collection inlet was close to nose. The eructed gas from nose and mouth was collected in an evacuated canister. Five collections each of 24-h duration were made for each animal. Methane and SF_6 concentrations in the collected sample were quantified using a gas chromatograph (Nucon-5700) fitted with flame ionization and electron capture detectors (FID and ECD), respectively. The data obtained were subjected to the statistical analysis as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Detailed chemical composition of oat silage and oat hay is presented in Table1. A relatively higher content of CP was observed in oat silage (11.97%) as compared to oat hay (9.20. The NDF (56.17 vs 43.16%) and ADF (47.40 vs 32.35%) content in oat hay were higher than the oat silage.

Average daily dry matter intake (DMI kg/day)

Table 1. Chemical composition of oat hay and oat silage fed to buffaloes

Parameter	Oat hay	Oat silage
DM (%)	87.00±0.72	26.72±0.80
	% DM	
OM	91.10±0.15	90.79±0.12
CP	9.21±0.22	11.97±0.09
EE	1.82±0.02	1.97±0.01
NDF	56.17±0.41	47.40±0.52
ADF	43.16±0.27	32.35±0.31
Ash	8.90±0.19	9.21±0.29
NDICP	1.3±0.07	2.1±0.09
ADICP	0.6±0.03	1.0±0.06
Hemicellulose	13.02±0.69	15.05±0.43
Cellulose	40.53±0.23	41.11±0.31
ADL	8.29±0.65	6.01±0.39
TDN %	54.61±0.61	56.83±0.72
DE (MJ/kg)	10.07±0.03	10.48±0.12
ME (MJ/kg)	8.29±0.05	8.71±0.01
uCP	10.01±0.49	10.32±0.97

Table 2. Effect of feeding oat hay or oat silage on intake and digestibility of nutrients in dry buffaloes

Parameter	Oat hay group (T_1)	Oat silage group (T_2)
BW, kg	566±21.29	567±29.65
DM intake, kg	8.30±0.19	8.34±0.20
DMI intake, (kg/100kg BW)	1.46±0.01	1.47±0.01
DMI intake, $W^{0.75}$	71.07±0.66	71.55±0.67
CP intake, kg	0.82^{b}±0.04	1.06^{a}±0.07
CP intake, g/kg$W^{0.75}$	6.54^{b}±0.06	8.73^{a}±0.08
EE intake, kg/d	0.15±0.03	0.16±0.01
NDF intake, kg/d	4.66^{a}±0.04	3.95^{b}±0.21
ADF intake, kg/d	3.58^{a}±0.03	2.70^{b}±0.02
Digestibility coefficient (%)		
DM	68.87±2.19	69.09±1.76
OM	70.44±3.33	69.51±1.88
CP	58.28^{b}±1.78	60.59^{a}±2.72
EE	80.18±2.92	82.99±3.11
NDF	64.50±2.22	67.99±1.89
ADF	61.31±1.41	61.46±1.12

[a,b]Means bearing different superscripts in a row differ significantly ($^{*}P<0.05$)

was similar (P>0.05) in both the groups (T_1,8.30 and T_2, 8.34 kg/d). Neutral detergent fibre and acid detergent fiber intake was significantly (P<0.05) higher in T_1 than T_2, while the CP intake was significantly (P<0.05) higher in T_2 than T_1 group. Wallsten *et al.* (2009) reported increasing intake of oat silage DM with increasing plant maturity when fed to heifers. The increase was from 1.6 kg/100 kg LW at early milk stage to 2.0 kg/100 kg LW at dough stage. In the present study silage DMI averaged 1.47 kg/100 kg BW for buffaloes.

Data pertaining to the nutrient digestibility of buffaloes fed on oat hay or silage are presented in Table 2. The CP digestibility (%) was significantly (P<0.05) higher in T_2 than T_1, whereas digestibility coefficients of all other nutrients were similar between the groups. The DM and CP digestibility coefficients were 68.87 and 69.09; 58.28 and 60.59% in T_1 and T_2, respectively. Silage protein usually serve as rumen degradable protein (RDP) as most of the proteins are broken down during fermentation to non-protein

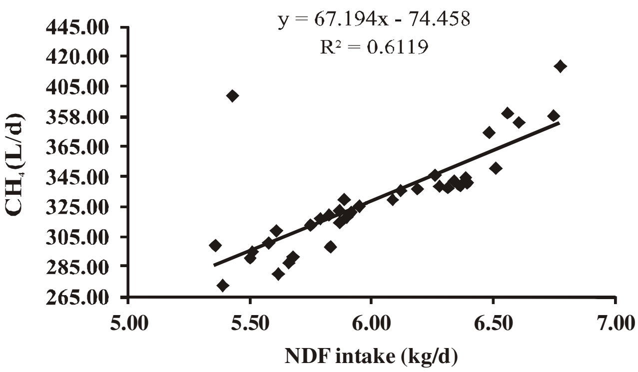

Fig 1. Relationship between neutral detergent fibre intake (NDFI) and methane emissions in buffaloes

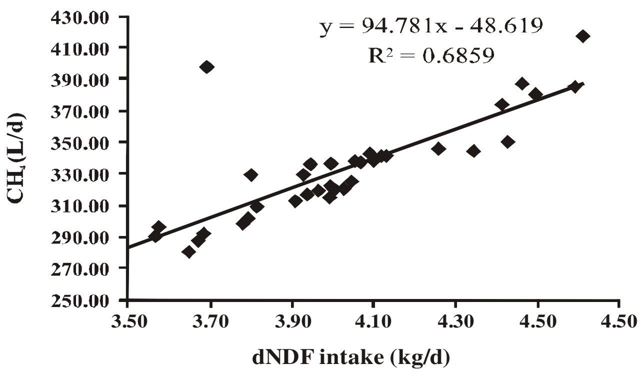

Fig 2. Relationship between digestible neutral detergent fibre intake (dNDFI) and methane emissions in buffaloes

nitrogen, like ammonia nitrogen, (Papadopoulos and Mckersie, 1983; Wilkinson, 2005). In the present study *In vitro* utilizable CP were found to be similar in both the groups.

The energy intake and loss of energy in the form of methane from buffaloes fed on oat hay or silage is presented in Table 3. The energy intake in terms of gross energy (GE) and digestible energy (DE) was similar between the groups. The overall methane production was significantly lower (P<0.05) in oat silage fed group than oat hay fed group. The higher methane emission (g/kg DM, MJ/kg DM and g/kg NDF intake) was in T_1 (24.36, 1.36 and 35.68) as compared to T_2 (21.79, 1.21 and 34.52). Percentage of DE and ME lost in methane was 13.51, 16.41% and 11.61, 13.97% in T_1 and T_2, respectively. The difference in energy loss was analysed to be significant (P<0.05). Methane loss (MJ/d) was 6.86% lower in dry buffaloes fed on oat silage instead of oat hay-based diets. Methane release in buffalo in relation to NDF intake and digestible NDF intake is depicted in fig. 1 and 2, respectively. Significant correlation was observed between methane emissions and NDF intake (R^2 = 0.61, P<0.05). Sundstol (1981) observed a reduction in loss of gross energy in the form of methane when forages were ensiled than when dried. This could be due to reduced rate of carbohydrate fermentation in the rumen with silage as extensive fermentation already occurred during ensiling. Similar findings to present study were reported on comparison of alfalfa hay and silage (Benchaar *et al.,* 2001). They used a mechanistic model approach to assess a 33% depression in total CH_4 production (Mcal/d) on alfalfa silage rather than alfalfa hay. Kirkpatrick and Steen (1999) observed no differences in gross energy loss (%) as methane when forages were conserved either as silage or by freezing directly after harvesting. Silage based diets when fed to Merino lambs recorded reduced loss of energy via methane, urine and faeces (Beukes, 2013). Martin *et al.* (2008) observed less methane production on DM intake basis on corn silage based diet as compared to hay diet in two successive experiments. Martin *et al.* (2010) reviewed methane mitigation strategies to uncover that methane production tend to be lowered when forages were ensiled than when they were dried. Many studies suggest that methane yield in cattle respond in a quadratic manner when pasture forage was substituted with maize silage (Blaxter and Wainman 1964; Arndt *et al.,* 2010). Blaxter and Clapperton (1965) found that both feed intake and digestibility were important factors affecting CH_4 yield

Table 3. Methane emissions and energy loss in buffaloes fed oat hay or oat silage

Parameter	Oat hay group (T_1)	Oat silage group (T_2)
DMI, kg/d	9.00±0.26	9.37±0.19
GEI, MJ/d	162.00±1.68	168.66±2.79
DEI, MJ/d	90.63±1.57	98.20±4.85
MEI, MJ/d	74.61^{b}±1.31	81.61^{a}±1.57
CH_4, l/d	341.35^{a}±3.44	317.86^{b}±6.28
CH_4, g/d	219.27^{a}±2.21	204.18^{b}±4.03
CH_4, g/kg DMI	24.36^{a}±0.88	21.79^{b}±0.82
CH_4, g/kg NDFI	35.68^{a}±0.22	34.52^{b}±0.37
CH_4, MJ/d	12.24^{a}±0.12	11.40^{b}±0.23
CH_4, MJ/kg DM	1.36^{a}±0.05	1.21^{b}±0.02
CH_4, MJ/kg DDM	1.77^{a}±0.13	1.65^{b}±0.03
CH_4 loss as %GE	7.56^{a}±0.05	6.76^{b}±0.08
CH_4 loss as % DE	13.51^{a}±0.07	11.61^{b}±0.14
CH_4 loss as %ME	16.41^{a}±0.10	13.97^{b}±0.19

[a,b]Means bearing different superscripts in a row differ significantly (*P<0.05)

(% of GEI) and that at the maintenance level of feeding CH_4 yield increased with higher digestibility of the diet. McCaughey *et al.* (1997, 1999) reported that feed intake rather than digestibility was the major determinant of CH_4 production. In the present study, where buffaloes were fed close to maintenance, neither feed intake nor feed digestibility was related to CH_4 yield (% of GEI), whereas, CH_4 production (g/d) was directly related to NDF intake and digestible NDF intake. A similar relationship was found in small ruminants (sheep and alpaca) fed forages ad libitum indoors or grazed (Pinares-Patiño *et al.,* 2003). Moe and Tyrrell (1980) also advocated the concept of CH_4 production as a function of the amount of cell walls digested in the rumen. Singh *et al.* (2011) attributed the variation in CH_4 production from dry roughages to significant difference in the NDF, ADF, carbohydrate and protein fractions. Woodward *et al.* (2001) found CH_4 production of 26.9 and 35.1 g/kg DMI in lactating dairy cows fed on silages made from *Lotus corniculatus* and pasture, respectively.

CONCLUSIONS

Enteric CH_4 emissions (l/d) was significantly higher (P<0.05) in oat hay fed group (341.35) than oat silage fed group (317.86). Total CH_4 production was reduced by 6.86% in dry buffaloes fed on oat silage instead of oat hay, whilst nutrient intake and digestibility values remained unaltered. Thus, oat fodder could be better preserved as silage than hay for lowering methane emission from Murrah buffaloes.

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Received on 19-09-2019 and accepted on 26-09-2019