METHANE PRODUCTION FROM LACTATING BHADAWARI AND MURRAH BREEDS OF BUFFALO FED WHEAT STRAW-CONCENTRATE DIET

Sultan Singh[1,*], B.P. Kushwaha[2], M. Mohini[3], A.K. Mishra[1], S.K. Nag[1] and A. Singh[1]

ABSTRACT

To determine the buffalo breed difference in methane emission, six animals three each of lactating Bhadari and Murrah buffalo with mean body weight of 441.87±7.95 kg and 515.40±2.54 kg were used to estimate the nutrients digestibility and methane production. Animals of both breeds were fed wheat straw-concentrate for one month and a digestion trial was conducted for 6 days. During this period gas expired by animals was collected from each animal in canisters for 24 h following SF_6 technique. Gas samples (4 to 5) were collected from each animal to estimate the CH_4 production. Dry matter intake of Murrah bufflo (12.26) was significantly (P<0.05) higher than Bhadawari (8.96 kg/d). The dry matter and organic matter digestibility of wheat straw-concentrate diet was similar between both Bhadawari and Murrah buffalo breeds. Crude protein digestibility tended to be higher in Bhadawari (62.27) than Murrah buffalo (57.49%). The ADF and cellulose digestibility was relatively less in Bhadawari (41.45 and 58.81) than Murrah buffaloes (45.67 and 62.44%), while NDF and hemi-cellulose digestibility was at par between both buffalo breeds. Methane production g/kg DDMI was lower (P<0.05) in Bhadwari (21.49 and 34.96) than Murrah breed buffaloes (23.26 and 41.88) on wheat straw-concentrate diet. Methane production (g/kg milk) was lower (P<0.05) for Bhadawari breed (42.78) than Murrah buffloes (49.96). It is evident from study that Bhadawari breed animal produced less methane per kg of feed intake and per kg of milk yield than Murrah breed animals.

Keywords: Bhadawari buffalo, breed, methane emission, Murrah buffalo

INTRODUCTION

Livestock is the main contributor of methane emission (10.06 Tg) of Indian Agricultural sector (14.08 Tg MOEF, 2012). Buffaloes contribute about 45% of total livestock methane emission in India. Methane production of ruminants is influenced by several factors such as animal species and size, animal physiological stage, feed dry matter intake, digestibility, diet composition etc. Thus animal type and diet play an important role in methane production (Johnson and Johnson, 1995; Shibata and Terada, 2010). Studies have shown that methane emission differ between ruminant species on same diet at the same time (Swaingon *et al*., 2008; Nielson *et al.*, 2014). *In*

[1]Plant Animal Relationship Division, Indian Grassland and Fodder Research Institute, Uttar Pradesh, India, *E-mail: singh.sultan@rediffmail.com

[2]Central Institute for Research on Buffaloes, Haryana, India

[3]Dairy Cattle Nutrition Division, National Dairy Research Institute, Haryana, India

vitro methane production with buffalo inoculums was lower than cattle inoculums both on degraded organic matter and % of total gas on corn silage, grass silage and wheat straw diets (Calabro *et al*., 2013). To improve the GHG inventories continuous efforts are being made to precise the country's GHG emissions through the research input. In India there are 13 recognized buffalo breeds of different size and yield potential originated in different parts of country. There is need to use the specific methane emission factors for a particular breed to improve the livestock inventory. With this background the present study was carried out to determine the methane production from two buffalo breeds namely Bhadwari and Murrah on a standard wheat straw-concentrate diet.

MATERIALS AND METHODS

Animal feeding, digestibility trial and gas collection

In the present study 6 lactating animals 3 of each Bhadwari and Murrah breed with mean body weight of 441.87±7.95 kg and 515.40±2.54 kg were used for nutrients utilization and methane production. Animals of both breeds were fed wheat straw-concentrate mixture (consisted of maize grain 30%, mustard seed cake 33%, wheat bran 34%, mineral mixture 2% and common salt 1%, respectively) kept in metabolic sheds. After one month of feeding a digestion trial was conducted for 6 days and feces of individual animal was collected for 24 h and pooled in plastic buckets covered with lid. Representative samples of faeces for dry matter (100 g) and nitrogen (10 g preserved in 20% H_2SO_4) estimation were collected for individual animal during the trial. Representative samples of feed offered (wheat straw and concentrate mixture) and orts were collected daily and were kept for DM estimation. Dried samples of feces, feed offered and refusals were ground through one mm sieve using an electrically operated grinding mill. Ground samples were stored in plastic containers and used for further chemical and biochemical estimations. Milk yield was also recorded during the digestion trial.

Methane was measured by sulfur hexafluoride tracer technique (Johnson *et al*., 1994). A permeation tube containing sulfur hexafluoride (SF_6) was inserted in the rumen of each of the experimental animal. The release rate of SF_6 from the permeation tube was determined prior to inserting in the rumen. A halter fitted with a capillary tube was placed on the animal's head and connected to an evacuated sampling canister. Animals were acclimatized to wearing the halter and canister before the actual gas sampling. The breath samples of all the experimental animals were collected daily for six consecutive days in canisters and thus 4 to 5 samples were collected from each animal. Three canisters were kept in background to collect the air sample in the shed to serve as blank.

Analytical methods

The DM, ash, EE and CP of feeds offered, refusals and faeces samples were estimated as per AOAC (1990). Cell wall fractions (NDF, ADF, lignin and cellulose) were determined sequentially using method of Goering and Van Soest (1970) modified by Van Soest *et al.* (1991). Analysis of collected gas samples for methane and SF_6 estimation was done at Animal Nutrition Division of NDRI, Karnal using gas chromatograph fitted with flame ionization detector (FID) and electron capture detector (ECD). Emission rate of methane was calculated from CH_4 to SF_6 ratio as described by Johnson *et al*. (1994) in samples and

known release rate of SF_6. Methane collected in background canister used as blank was subtracted from methane concentration of collected samples (canisters). Data on intake, nutrients digestibility and methane production was statistically analyzed as per Snedecor and Cochran (1989) (Table 1).

RESULTS AND DISCUSSION

Intake and nutrients digestibility

Dry matter intake was significantly (P<0.05) higher of Murrah (12.26 and 113.31) than Bhadawari breed buffaloes (8.96 kg/d and 93.00 g/kg w0.75 Table 2). The differences in dry matter intake may be attributed to breeds body weight and their nutrients maintenance requirement. The dry matter and organic matter digestibility of wheat straw-concentrate diet was similar between both Bhadawari and Murrah buffalo breeds. Crude protein digestibility tended to be higher in Bhadawari (62.27) than Murrah buffalo (57.49%). On the other hand the digestibility of ADF and cellulose was relatively lower in Bhadawari (41.45 and 58.81) than Murrah breed buffaloes (45.67 and 62.44%), while NDF and hemi-cellulose digestibility was at par between both buffalo breeds.

Methane production

Methane production (g/d) was significantly higher (P<0.05) of Murrah (301.80) than Bhadawari buffalo (183.42 Table 3) on wheat straw-concentrate diet. The more methane production of Murrah buffalo is due to higher dry matter intake of this breed. Singhal and Madhu Mohini (2003) reported 162.67 to 259.74 g/d methane emission from buffaloes fed on balanced diet. Kannan *et al*. (2010) recorded methane emission of 214.7 g/day in buffaloes fed diet consisting of roughage: concentrate (52:48) yielding 5.25 kg milk. Methane production (g/kg DMI. g/kg DDM and g/kg milk) was significantly higher (P<0.05) of Murrah (24.75, 41.88 and 49.96) than Bhadawari breed animals (21.50, 34.95 and 42.78), respectively. Methane production of 40.70 g/kg DMI and 54.03 g/kg DDMI in lactating Murah buffaloes fed wheat straw-beseem-concentrate diet recorded by Zafarian and Manafi (2013) substantiates our results. On roughage-concentrate diet Murrah buffaloes produced methane 20.97 g/kg DMI (Kanannan *et al*., 2010) also supports our results. Our methane production results on per kg intake and milk yield lies within the methane production range of 23.58 to 27.30 g/kg DMI and 42.71 to 45.35 g/kg milk in buffaloes fed green-concentrate and wheat straw-green-concentrate (Singhal and Mohini, 2002).

Garg *et al.* (2013) reported methane production ranging between 154.5-232.0 g/d and 25.3 to 40.9 g/kg milk yield, respectively in buffaloes fed diets comprising locally available fodder and feeds resources in three states of India. Methane emission in crossbred cows was 258.7 and 221.0 g/d on balanced and unbalanced rations, respectively (Sherasia *et al*., 2016). These workers further reported methane production of 15.8 and 16.0 g/kg DMI and 19.9 and1 6.3 g/kg milk yield, respectively in crossbred cows fed unbalanced and balanced rations, respectively. Mohini and Singh (2010) also reported lower CH_4 emission (197.4 and 29.9 g/kg milk) in cows on balanced diet than conventional diet (223.4 g/d and 40.0 g/kg milk yield), respectively.

CONCLUSION

Results revealed that methane production

Table 1. Chemical composition of whet straw and concentrate mixture (%DM).

Parameters	Wheat straw	Concentrate mixture
CP	4.01	18.01
OM	91.02	90.9
EE	1.49	4.4
NDF	78.7	43.8
ADF	50.8	15.7
Cellulose	38.9	9.79
Hemi cellulose	27.9	28.1
Lignin	7.37	4.81

Table 2. Feed intake, nutrients digestibility and milk yield of Bhadawari and Murrah buffaloes.

Parameters	Bhadawari	Murrah	Pooled SEM
Body weight (kg)	441.87	515.40	18.55
Milk yield (kg)	4.36	6.12	0.51
Wheat straw intake	5.14	8.13	0.80
Concentrate mixture intake	3.84	4.12	0.06
Net intake (kg)	8.96[a]	12.26[b]	0.96
% body wt	2.03	2.38	0.15
g/kg w 0.75	93.00[a]	113.31[b]	7.44
Nutrients digestibility (%)			
Dry matter	56.67	57.75	1.14
Organic matter	59.97	61.11	1.05
Crude protein	62.27	57.49	0.86
Neutral detergent fiber	52.96	55.74	1.37
Acid detergent fiber	41.45	45.67	2.18
Cellulose	58.81	62.44	1.53
Hemi cellulose	72.38	70.38	0.66

[a,b]Values within row differed significantly at P<0.05 level.

Table 3. Methane production of Bhadawari and Murrah buffaloes fed wheat straw-concentrate diet.

Methane production	Bhadawari	Murrah	Pooled SEM
CH_4 g /d	183.42[a]	301.80[b]	22.38
CH_4 g/kg DMI	21.50	24.75	2.01
CH_4 g/kg DDMI	34.97[a]	41.88[b]	1.21
CH_4 g/kg milk	42.78[a]	49.96[b]	1.08

[a,b]Values within row differed significantly at P<0.05 level.

(g/kg DDMI and g/kg milk) was lower (P<0.05) in Bhadawari buffaloes than Murrah. This indicates that methane emission factors should be determined for individual breed of ruminant species to improve the national livestock inventories. Present study was carried out with limited animals, there is need to carry methane production studies on different ruminant breeds with large animals.

REFERENCES

AOAC, 2007. Association of Official Analytical Chemists. *Official Methods of Analysis of AOAC International*, 18th ed. Washington DC, USA.

Calabro, S., F. Infascelli, R. Tudisco, N. Musco, M. Grossi, G. Monastra and M.I. Cutrignelli. 2013. Estimation of *in vitro* methane production in buffalo and cow. *Buffalo Bull.*, **32**(Special Issue 2): 924-927.

Ellis, J.L., E. Kebreab, N.E. Odongo, B.W. McBride, E.K. Okine and J. France. 2007. Prediction of methane production from dairy and beef cattle. *J. Dairy Sci*., **90**: 3456-3467.

Garg, M.R., P.L. Sherasia, B.T. Phondba and S.A. Hossain. 2014. Effect of feeding a balanced ration on milk production, microbial nitrogen supply and methane emissions in field animals. *Anim. Prod. Sci*., **54**: 1657-1661.

Garg, M.R., P.L. Sherasia, B.M. Bhanderi, B.T. Phondba, S.K. Shelke and H.P.S. Makkar. 2013. Effects of feeding nutritionally balanced rations on animal productivity, feed conversion efficiency, feed nitrogen use efficiency, rumen microbial protein supply, parasitic load, immunity and enteric methane emissions of milking animals under field conditions. *Anim. Feed Sci. Tech*., **179**: 24-35.

Johnson, K.A., M.T. Huyler, H.H. Westberg, B.K. Lamb and B. Zimmerman. 1994. Measurement of methane emission from ruminant livestock usingusing SF_6 tracer technique. *Environmental Science and Technology*, **28**(2): 259-362.

Johnson, K. A. and D.E. Johnson. 1995. Methane emissions from cattle. *J. Anim. Sci.*, **73**: 2483-2492.

Kannan, A., M.R. Garg and P. Singh. 2010. Effect of ration balancing on methane emission and milk production in lactating animals under field conditions in Raebareli District of Uttar Pradesh. *Indian J. Anim. Nutr*., **27**(2): 103-108.

MOEF. 2012. India Second National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Forests, GOI, New Delhi, India. p. 58-62.

Mohini, M. and G.P. Singh.2010. Effect of supplementation of urea molasses mineral block (UMMB) on the milk yield and methane production in lactating cattle on different plane of nutrition. *Indian J. Anim. Nutr.,* **27**: 96-102.

Neilson, M.O., A. Kiani, E. Tejada, A. Chwalibog and L. Alstrup. 2014. Energy metabolism and methane production in llamas, sheep and goats fed high- and low-quality grass-based diets. *Arch. Anim. Nutr*., **68**(3): 171-185.

Sherasia, P.L., B.T. Phondba, S.A. Hossain, B.P. Patel and M.R. Garg. 2016. Impact of feeding balanced rations on milk production, methane emission, metabolites and feed conversion efficiency in lactating cows. *Indian J. Anim. Res*., **50**(4): 505-511.

Shibata, M. and M. Terada. 2010. Factors affecting methane production and mitigation in

ruminants. *Anim. Sci. J.*, **81**: 2-10.

Singhal, K.K. and M. Mohini. 2002. *Uncertainty reduction in methane and nitrous oxide gases emission from livestock in India*. Project report, Dairy Cattle Nutrition Division, National Dairy Research Institute, Karnal, India, 62p.

Snendecor, G.W. and W.G. Cochran. 1989. *Statistical Methods*, 8th ed. Iowa State University Press, Ames, Iowa, USA.

Swainson, N.M., S.O. Hoskin, H. Clark, C.S. Pinares-Patino and I.M. Brookes. 2008. Comparative methane emissions from cattle, red deer and sheep. *In Proceedings of the New Zealand Society of Animal Production*, **68**: 59-62.

Van, S.P.J., J.B. Robertson and B.A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci*., **74**: 3583-3597.

Zafarian, R. and M. Manafi. 2013. Effect of garlic powder on methane production, rumen fermentation and milk production of buffaloes. *Annual Research and Review in Biology*, **3**(4): 1013-1019.