Indian Journal of Animal Sciences **87** (8): 1046–1048, August 2017/Short communication

Effect of feeding compressed complete feed block with or without deoiled mahua seed cake on methane production and energy utilization in crossbred calves

A K PATIL[1], V B CHATURVEDI[2], PUTAN SINGH[3], A K VERMA[4] and ASIT DAS[5]

ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

Received: 9 January 2017; Accepted: 1 March 2017

Key words: Compressed complete feed block, Crossbred calves, Methane, Saponin

Methanogenesis is a normal phenomenon that enable ruminant to maintain a reduced rumen environment essential for anaerobic fermentation, however, enteric methane emission by ruminants is one of the factors that contributes to global warming (UNFCC 2006). Methane produced during ruminal fermentation represents a loss of 2–12% of gross energy intake that hampers the potential conversion of food energy to metabolisable energy (Johnson and Johnson 1995). This has encouraged many researchers to find alternatives to reduce enteric methane emission by ruminants (Bodas *et al.* 2008). Researchers have suggested mitigation strategies with success rate ranging from 7.1 (Santoso *et al.* 2004) to 96% (Agarwal *et al.* 2006). However, most of those studies were conducted *in vitro* and response varied largely (7–96%). Plants containing bioactive products such as essential oils, saponins and tannins with antimicrobial activites can be exploited in ruminant production system to reduce enteric methane emission (Wallace *et al.* 2002). However, in majority of the studies conducted so far, extracts of the plant parts were used in *in-vitro* system (Agarwal *et al.* 2006, Bodas *et al.* 2008) with very few *in vivo* trials (Santoso *et al*. 2004). But in field conditions, it is not feasible to use extracts of the plants for the feeding of the animals because it is less cost effective and the organic solvents used for the preparation of extracts might affect the animals adversely. Often feed ingredients those are naturally having chemical substances to reduce methane production in ruminants can be the best. Deoiled mahua seed cake (DMSC) is the by-product after extraction of oil from mahua (*Bassia latifolia*) seeds, a good and inexpensive source of protein. The DMSC contain 5–10% saponin and 5.1% tannins (Ojha 2010). It is believed that the saponin and tannin containing plant extracts suppress methane emission by reducing protozoal counts and by altering the rumen fermentation pattern (Wallace *et al.* 2002). However, the reponse of saponins on protozoal count depends largely on it’s source (Jayanegara 2014). Research conducted earlier have demonstrated that saponins from DMSC have potential to significantly decrease the protozoal count and reduce methane production by 22.41% (Inamdar *et al.* 2013). Considering that saponins may decrease methanogen populations through a reduction of protozoa numbers (Lila *et al.* 2003), we hypothesized that feeding of CCFB containing 5% DMSC would reduce *in vivo* methane production in cattle. The specific objective of this experiment was to study the effect of feeding CCFB containing deoiled mahua seed cake on the methane production and energy utilization in crossbred calves.

Growing crossbred male calves (12; 6–10 months old, BW 141 kg) were randomly distributed into 2 groups of 6 each. Animals of the control group (T_0) were fed compressed complete feed block (CCFB) without deoiled mahua seed cake (DMSC), while those in treatment group (T_1) were fed CCFB containing 5% DMSC (Table 1). Both the diets were made iso-nitrogenous and iso-caloric, and were formulated to meet the requirement to support average daily gain (ADG) of 600 g/d. The feeding was done at 9.00 AM. All the animals were dewormed and vaccinated 1 month prior to the onset of the experiment. After 30 days of experimental feeding, a respiration chamber study was conducted for *in-vivo* methane estimation.

Estimation of methane production: Estimation of methane production in crossbred calves was done in an open circuit respiration chamber maintained at 25°C and 65% relative humidity. The animals were shifted to the chamber

Table 1. Chemical composition of CCFB offered to crossbred calves

Attribute (%)	CCFB (T_0)	CCFB (T_1)
Organic matter	91.5	91.7
Crude protein	13.1	12.9
Ether extract	1.31	1.56
Neutral detergent fibre	52.5	53.2
Acid detergent fibre	33.3	33.8
Hemicellulose	19.2	17.3
Total carbohydrates	77.1	77.3
Calcium	0.99	0.97
Phosphorus	0.72	0.70
Total ash	8.49	8.32

Present address: [1]Ph.D. Scholar (ashokdrpatil@gmail.com), [2,3,4,5]Principal Scientist (chaturvedivb@gmail.com, putan60@gmail.com, vermaak62@gmail.com, drasitdas@rediffmail.com), Division of Animal Nutrition.

Table 2. Methane production and energy utilization in crossbred calves±

Attribute	CCFB (T_0)	CCFB (T_1)	SEM
Nutrient utilization			
Body weight (kg)	181.32±19.78	177.73±15.89	12.12
Body weight (kg$W^{0.75}$)	49.14±4.03	48.49±3.27	2.48
DMI (g/kg $W^{0.75}$/d)	103.88±3.49	110.08±3.68	2.59
Digestibility of DM	63.80±1.22	63.64±0.80	2.41
DOMI (kg/d)	3.08±0.27	3.25±0.28	0.19
DCPI (g/kg $W^{0.75}$/d)	9.45±0.37	9.60±39	0.90
Methane production			
l/d	161.78±22.26	142.41±13.42	35.43
l/kg DMI*	29.31±1.45	24.16±0.51	3.14
l/kg DDMI*	45.97±1.96	38.34±1.19	5.07
l/kg OMI*	32.03±1.58	26.35±0.56	3.74
l/kg DOMI*	48.26±2.15	40.12±1.36	5.39
Energy utilization			
GE_i (Mcal/d)	24.8±2.87	24.7±2.86	5.33
Faecal energy (Mcal/d)	8.62±1.080	8.11±0.892	1.82
DE (Mcal/d)	16.2±1.83	16.6±2.08	3.60
Urinary energy (Mcal/d)	0.58±0.060	0.48±0.090	0.15
ME (Mcal/d)	14.1±1.59	14.6±3.69	3.20
GE lost as CH_4 (%)	6.15±0.54	5.42±0.48	0.96
HP (Mcal/d)	8.95±0.43	8.68±1.07	1.51
EB (Mcal/d)	5.93±1.23	6.79±0.66	1.97

*Significant ($P<0.05$), [#]Data in the table is based on the observations on four animals in each group. GE, Gross energy; DE, digestible energy; ME, metabolizable energy; HP, heat production; EB, energy balance..

one by one and after 2 days of acclimatization, methane was estimated for two consecutive days. The air flow rate of 250 l/min was maintained in the chamber and the amount of total volume (l/d) of air passed through the chamber was measured. Methane concentration of air flowing in and coming out was measured by automatic infrared methane analyzer (Analytical Development Co., Ltd., Hoddesdon, England, Model 300). While the animals were inside the chambers, they were fed measured amount of feed. A proper record of feces voided and urine excreted was maintained throughout the duration of the chamber study.The chamber was opened every 22 h to offer feed and to collect residues of feed and faeces. Heat production was calculated as per Brouwer equation (1965).

HP (kcal/d) = 3.866 O_2 + 1.200 CO_2 - 0.518 CH_4 – 1.431N, where, O_2, volume of oxygen (l) consumed/d; CO_2, volume of carbon dioxide (l) produced/d; CH_4, volume of methane (l) produced/d; N, amount of nitrogen excreted in urine (g/d).

Methane production: The total volume of methane produced was calculated by the following equation: CH_4 (l) = V_{STP} (M_f - M_i)/100

where, M_f, average percentage of methane in outgoing air; M_i, average percentage of methane in ingoing air.

Estimation of gross energy: For determination of energy content of feed, residue, faeces and urine, Ballistic Bomb Calorimeter (Gallenkamp, C.B.370) was used. DE intake was calculated by subtracting faecal energy from GE, whereas, ME was calculated by subtracting urinary and methane energy from DE. Energy balance was calculated as:

EB = ME intake/d – Heat production/d.

Data generated were analyzed using the SPSS (SPSS Inc., Chicago, Illinois, USA) computer package.

The results of present experiment indicated that the total methane production was reduced by 11.97% in DMSC fed group as compared to control group. Reduction of methane was also found in terms of (l/kg) DMI, DMD, OMI and OMD by 17.57%, 16.59, 17.73, and 16.86% respectively. Decreased methane production as observed in the present study (Table 2) could be attributed to presence of saponins (5–10%) and tannins (5%) in DMSC (Ojha 2010), both of which are known to reduce enteric methane emission.Our results corroborated well with those of Patra *et al.* (2006). Between 10 and 25% of methanogens are associated with ciliate protozoa and eliminating ciliate protozoa from the rumen reduces methane emission by 30 to 45% (Itabashi *et al.* 1984). Inamdar *et al.* (2013) reported that saponins from DMSC reduced the protozoal count. Thus, it would not be out of context to assume that at least part of the reduction in methane emission is due to defaunation potential of saponin present in DMSC. However, DMSC also contain tannins and other bioactive compounds having antimethanogenic activity, further elaborated study is warranted to understand the underlying mechanism of anti-methanogenic activity of DMSC.

Methane produced by domesticated ruminants represents a loss of 2–12% of the gross energy (GE) intake (Johnson and Johnson 1995). In this experiment, GE lost as methane (%) was 6.15±0.54 and 5.42±0.48 in control and treatment, respectively (Table 2). Considering that faecal and urinary energy losses and total heat production was similar, the decrease in methane energy loss in treatment group should have resulted in increased energy balance. An increase in energy balance upto the magnitude of 14.5% was observed in this experiment but failed to reach significance. Similarly, ciliate free animal produced less methane with a concomitant albeit non-significant increase in energy available to the animals (Whitelaw *et al.* 1984). From the results, it is evident that feeding of CCFB containing 5% DMSC can reduce the *in vivo* methane production in crossbred cattle without any adverse impact on energy utilization.

SUMMARY

This experiment was conducted to study the effect of feeding compressed complete feed block (CCFB) containing 5% de-oiled mahua seed cake (DMSC) on methane production and energy utilization in crossbred calves. Twelve male growing crossbred calves were randomly distributed into two groups of six each. The animals of control group were fed CCFB without DMSC, whereas, those in treatment group were fed CCFB containing 5% DMSC. Average daily dry matter intake (DMI) was similar between the groups. Total methane

production and relative methane production (l/kg DMI and l/kg DMD) was lower in treatment group as compared to control group. Total energy intake, energy lost in faeces, urine, methane and heat production were similar between the groups. Thus, it can be concluded that the feeding of CCFB containing 5% DMSC can reduce the *in vivo* methane production in crossbred cattle without any adverse impact on energy utilization.

ACKNOWLEDGEMENT

The authors are thankful to the Director and Head of the Division of Animal Nutrition, ICAR, Indian Veterinary Research Institute, Izatnagar, Bareilly for providing necessary facilities to carry out this work.

REFERENCES

Agarwal N, Kamra D N, Chaudhary L C and Patra A K. 2006. Effect of *Sapindus mukorossi* extracts on *in vitro* methanogenesis and fermentation characteristics in buffalo rumen liquor. *Journal of Applied Animal Research* **30**: 1–4.

Bodas R, Lopez S, Fernandez M, Garcýa-Gonzalez R, Rodrýguez A B, Wallace R J and Gonzalez J S. 2008. *In vitro* screening of the potential of numerous plant species as antimethanogenic feed additives for ruminants. *Animal Feed Science and Technology* **145**: 245–58.

Brouwer E. 1965. Report of sub-committee on constants and factors. *Energy Metabolism*. pp. 441–43. Academic Press, London, UK.

Inamdar A, Chaudhary L C, Agarwal N and Kamra D N. 2015. Effect of plant containing secondary metabolites on *in vitro* methane production and feed fermentation with buffalo rumen liquor. *Animal Nutrition and Feed Technology* **15**: 189–96.

Itabashi H, Kobayashi T and Matsumoto M. 1984. The effects of rumen ciliate protozoa on energy metabolism and some constituents in rumen fluid and blood plasma of goats. *Japanese Journal of Zootechnical Science* **55**: 248–55.

Jayanegara A, Wina E and Takahashi J. 2014. Meta-analysis on methane mitigating properties of saponin-rich sources in the rumen: influence of addition levels and plant sources. *Asian Australian Journal of Animal Science* **27**(10): 1426–35.

Johnson K A and Johnson D E. 1995. Methane emissions from cattle. *Journal of Animal Science* **73**: 2483–92.

Lila Z A, Mohammed N, Kanda S, Kamada T and Itabashi H. 2003. Effect of sarsaponin on ruminal fermentation with particular reference to methane production *in vitro*. *Journal of Dairy Science* **86**: 3330–36.

NRC. 2001. *Nutrient Requirements of Dairy Cattle*. National Academy Press, Washington, D.C.

Ojha B K. 2010. ‘Performance of crossbred calves fed on diets supplemented with deoiled mahua seed cake and guar meal as functional feed.’ M.V.Sc. Thesis, Indian Veterinary Research Institute (ICAR), Izatnagar, UP, India.

Patra A K, Kamra D N and Agarwal N. 2006. Effect of plant extracts on *in vitro* methanogenesis: enzyme activities and fermentation of feed in rumen liquor of buffalo. *Animal Feed Science and Technology* **128**: 276–91.

Santoso B, Mwenyaa B, Sara C, Gamoa Y, Kobayashia T, Morikawaa R, Kimurab K, Mizukoshib H and Takahashi J. 2004. Effects of supplementing galacto-oligosaccharides, *Yucca schidigera* or nisin on rumen methanogenesis, nitrogen and energy metabolism in sheep. *Livestock Production Science* **91**: 209–17.

UNFCC. 2008. United Nations Framework Convention on Climate Change (UNFCCC), 2006. Greenhouse Gas Inventory Data. Bonn, Germany.

Wallace R J, McEwan N R, McIntosh F M, Teferedegne B and Newbold C J. Natural products as manipulators of rumen fermentation. *Asian Australasian Journal of Animal Sciences* **15**: 1458–68.

Whitelaw F G, Eadie J M, Bruce L A and Shand W J. 1984. Methane formation in faunated and ciliate-free cattle and its relationship with rumen volatile fatty acid proportions. *British Journal of Nutrition* **52**: 261–75.