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Effect of Supplementing *Syzygium cumini* (Jamun) Fruit Shreds to Total Mixed Ration on the Performance of Lactating Crossbred Cows

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ABSTRACT

This study was taken up to assess the effect of supplementing *Syzygium cumini* (Jamun) fruit shreds on nutrient utilization, enteric methane (CH_4) emission and performance of the lactating crossbred cows (CBCs). Twelve lactating CBCs were allocated into two groups (n=6) and were fed a total mixed ration (TMR) containing concentrate mixture, green Berseem fodder (*Trifolium alexandrium*) and wheat straw in 40: 42: 18 ratio on DM basis supplemented with or without *S. cumini* @ 2% for 180 days. A 14 days digestion trial was conducted by indicator method using chromic oxide green as an external marker, before the termination of feeding trial. The enteric CH_4 production was assessed by sulfur hexafluoride (SF_6) tracer technique. *S. Cumini* fruit shreds are rich source of phenolics (21.78%), antioxidants (4.95%) and saponins (4.35%). Supplementation of diet with *S. cumini* fruit shreds did not affect intake and digestibility of nutrients. The CH_4 emission was mitigated ($P<0.05$) by 29% in CBCs fed on TMR supplemented with *S. cumini* fruit shreds. Supplementation of diet with *S. cumini* fruit shreds did not show any adverse effect on milk yield. It was concluded that CH_4 emission can be mitigated in lactating CBCs fed TMR supplemented with *S. cumini* fruit shreds without any adverse effect on the performance of lactating CBCs.

Keywords: Lactating crossbred cows, Methane, Milk yield, Nutrient utilization, *Syzygium cumini* fruit shreds

INTRODUCTION

India has the largest population of livestock in the world. Amongst the various livestock species, cattle population in India is 190.90 million and it contributes to around 37.28% of the total livestock population in the country (Anonymous, 2012). Being the highest milk producing nation, India contributes to 18.5% milk produced in the world (GOI, 2016). Despite the production potential of livestock, it also contributes directly or indirectly to climate change through the emissions of greenhouse gases such as carbon dioxide, CH_4 and nitrous oxide. Amongst various GHGs, CH_4 emission from enteric fermentation in ruminants contributes up to 63% (Herrero *et al.,* 2009). The enteric CH_4 production can be reduced considerably by improving the efficiency of nutrient utilization and the energy lost as gaseous products of digestion can be diverted to improve the productivity of the animals.

Various strategies can be used to mitigate CH_4 production which includes: i) Dietary inclusion of feed additives like organic acids, prebiotics, nitrates and sulphates, ii) Biological means by using yeast culture, bacteriocins and by enhancing acetogenesis, iii) Other strategies include animal breeding and selection and modification of rumen microbes genetically (Ingale *et al.,* 2013). Number of studies have revealed that the *in vitro* CH_4 production can be reduced significantly by supplementing the ration with plant secondary metabolites (PSM) like essential oils (Hundal *et al.,* 2016a), tannins (Hundal *et al.,* 2016b) or with herbal feed additives (HFAs) containing saponins (Wadhwa *et al.,* 2018; Singh *et al.,* 2018a). Further, supplementing the ration with HFAs containing saponins improved performance of growing cattle (Singh *et al.,* 2018b). Management strategies like genetic selection of efficient feed utilizers or high producing animals along with manipulation of diet (Bakshi and Wadhwa, 2009) can help in mitigating CH_4 emissions which would further help in increasing the efficiency in which animals use nutrients to produce milk or meat.

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We hypothesized that supplementation of *S. cumini* in lactating CBCs would improve their performance by reducing enteric CH_4 production. Hence, this study was conducted to assess the effect of supplementing Syzygium cumini (Jamun) fruit shreds on nutrient utilization, enteric methane (CH4) emission and performance of the lactating crossbred cows.

MATERIALS AND METHODS

The present study was conducted in the Department of Animal Nutrition and Livestock Dairy Farm, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, India. All experimental protocols were approved (GADVASU/2018/IAEC/14/09) and compliant with the guidelines established by Institutional Animal Ethics Committee constituted (IAEC) under Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), New Delhi.

The *S. cumini* (Jamun) fruit shreds (JFS) were procured from the Unati Cooperative Marketing-cum-Processing Society Ltd. Talwara, Hoshiarpur, Punjab and screened in triplicate for phenolics (Makkar *et al.,* 1993), flavonoids (Balbaa *et al.,* 1974) and saponins (Baccou *et al.,* 1977).Twelve lactating CBCs were randomly divided into two groups of six animals each. In control group, cows were fed on basal TMR. In the experimental groups, the control TMR were supplemented with *S. cumini* fruit @ 2.0% of DM intake. Milk samples were collected at monthly interval. Impact of HFAs on the nutrient digestion were assessed by conducting a 14 days digestion trial by using chromic oxide green as an external marker @ 0.2% of daily DM intake. Faecal samples were collected from the rectum by grab method. Spot urine samples were also collected individually and was preserved in glass bottles, which were kept in refrigerator till analysed for nitrogen content (AOAC, 2007). The amount of chromic oxide (mg %) in faeces was also calculated (Hill and Anderson, 1958). The faeces, urine and orts were weighed daily at 9.00 a.m. before feeding.

The dried and finely grounded feed, JFS, orts and faecal samples were analysed for DM, total ash, ether extract and nitrogen concentration (AOAC, 2000). Cell wall constituents were analysed by using methodology of Robertson *et al.* (1991). SF_6 trial was conducted in the 2nd and 5th month of feeding trial. CH_4 and SF_6 concentrations were determined by using gas chromatography. CH_4 emission rate was calculated as the product of the permeation tube emission rate and the ratio of CH_4 to SF_6 concentration in the sample. Samples were analyzed in duplicate. The gas chromatograph was fitted with a 3.3 m molecular sieve 5A column with inner diameter of 0.32 mm for SF_6 and a 1.5 m Porapak Q stainless steel column with inner diameter of 2 mm for CH_4. The injector, detector and oven temperature was maintained at 40, 220 and 50°C for SF_6 and 40, 100 and 52°C for CH_4 estimation, respectively. Nitrogen was used as a carrier gas, with flow rate of 30 ml/min both for SF_6 and CH_4 estimation. Prepared standards were used to standardize the gas chromatograph for SF_6 (39.2 ppt and 101.7 ppt) and CH_4 (10.4 ppm and 101.9 ppm, Scott-Marrin Inc., Riverside, CA, USA). Background CH_4 [(CH_4) b] was subtracted from CH_4 concentration in the canister [(CH_4) y]. The concentration of CH_4 was then calculated by using the equation of Johnson *et al.* (1994). Enteric CH_4 emission rate was calculated by using following equation:

$$QCH_4=QSF_6\,(CH_4)\text{ y- }(CH_4)\text{ b / }(SF_6)$$

Where, QCH_4 is the CH_4 emission rate (g/min), QSF_6 is the known release rate of SF_6 from permeation tube (g/min), (CH_4) b is the background CH_4, (CH_4) y is the CH_4 in sample in canister (g/m^3) and SF_6 is the SF_6 concentration of collected sample in canister (g/m^3).

Data were analyzed by using one way ANOVA and factorial design (Snedecor and Cochran 1994), by using SPSS (2009) version 16 and the significant differences in means were tested by Tukey's test.

Table 1. Chemical composition of TMR and *S. cumini* shreds (% DM basis)

Parameter	Ash	OM	CP	EE	NDF	ADF	Cellulose	ADL
TMR	7.60	92.40	14.82	3.10	47.20	27.00	10.85	5.30
S. cumini shreds	13.20	86.80	9.20	1.15	51.50	30.90	8.90	13.60

RESULTS AND DISCUSSION

The chemical composition of TMR and *S. cumini* shreds used during the experimental period is presented in Table 1. The active components present in *S. cumini* fruit shreds are presented in Table 2. Jamun seed contains various polyphenols such as ellagitannins, gallic acid, ellagic acid, *etc.*, and phytosterol such as β-sitosterol. Being rich in phytochemicals, it is a potential source of phenolics, flavonids, tannins *etc.*

Supplementation of *S. cumini* shreds in the diet did not affect the daily DM intake and digestibility of nutrients (Table 3). No information is available regarding the effect of Jamun supplementation on the performance of animals. Similar to the findings of the present study, supplementation of pomegranate peel extract (PPE) upto 800 ml/cow/day to dairy cows did not exert any effect on the intake of DM and apparent nutrients digestibility (Abarghuei *et al.,* 2013). Foiklang *et al.* (2016) studied the effect of grape pomace powder (GPP), mangosteen peel powder (MPP) and monensin on feed intake and nutrients digestibility in rumen fistulated steers. Results showed that GPP supplemented group had significantly higher (P<0.05) UTRS intake than those in other groups in terms of % BW and g/kg $BW^{0.75}$. However, total DM intake was not significantly different among treatments (P>0.05).

Effect of supplementation of diet with *S. cumini* shreds on enteric CH_4 emission was assessed by SF_6 tracer technique. The results of the present study revealed that CH_4 emission (g/d, g/DMI, g/kg DOMI) in *S. cumini* fruit shred supplemented group was decreased (P<0.05) by 27% (Table 4). The findings of the present study was in accordance with the results of Hundal *et al.* (2019), who observed that enteric CH_4 emission (g/kg DMI) was reduced (P<0.05) by 25.3% with supplementation of diet with PPE and by 27.7% when diet was supplemented with *T. undulata* extract in comparison to the animals fed control diet. CH_4 emission per liter of milk showed a decreasing trend but due to less number of observations, the effect was non-significant. The gross energy (GE) intake was same in animals fed control diet or diet supplemented with *S. cumini*. However, the loss of energy (MJ/d) from animals was less (P<0.05) by 27%, while loss of energy as percent of GE was less (P<0.05) by 28% in animals fed diet supplemented with *S. cumini*. CH_4 emission (g/d) was observed to be higher when assessed after 5 months of feeding, however, CH_4 emission per liter of milk remained same during the experiment period. GE intake and loss of energy (MJ/d) was observed to be higher when estimated at the end of the experiment period (5 month), however loss of CH_4 % GE remained similar at 1 or 5 month of feeding trial.

Supplementation of diet with *S. cumini* shreds did not affect the milk yield of CBCs, irrespective of duration of feeding (Table 5). However, Anantasook *et al.* (2014) found that supplementation with RPM and RPO to diets of cows increased milk yield.

CONCLUSIONS

From the results it can be concluded that supplementation of *S. cumini* fruit shred reduced enteric CH_4 emission without impairing nutrient utilization and performance of lactating CBCs.

Table 2. Active components in *S. cumini* shreds

Active component	% DM basis
Total phenolics	21.78
Leucocyanidin (CT)	0.32
Saponins	4.35
Vitamin C	2.65
DPPH	2.00
Flavonoids	0.30

Table 3. Effect of *S. cumini* fruit shred supplementation on feed intake and nutrient digestibility

Parameters	Group		SEM	P-Value
	Control	*S. cumini*		
Dry matter intake, kg/d	14.83	14.88	0.113	0.134
Digestibility of nutrients, %				
Dry matter	66.08	71.66	1.514	0.660
Organic matter	70.98	71.99	1.408	0.547
Crude protein	78.98	78.76	1.065	0.601
Ether extract	73.86	72.12	1.351	0.326
Neutral detergent fibre	63.92	64.73	1.763	0.691
Acid detergent fibre	56.59	58.19	2.095	0.625
Cellulose	64.96	66.19	1.700	0.543

Table 4. Effect of supplementing *S. cumini* fruit shred on enteric CH_4 production

Parameter	Group		SEM	P-Value	Period, months		SEM	P-Value
	Control	*S. cumini*			1	5		
CH_4, g/d	272.17^b	197.97^a	13.44	0.008	215.29^a	254.86^b	9.126	0.023
CH_4, g/kg DMI	21.21^b	15.54^a	0.473	0.002	18.88	17.88	0.853	0.324
CH_4,g/kg DOMI	32.68^b	23.68^a	0.727	0.003	28.95	27.41	1.314	0.324
CH_4,g/l milk	21.79	16.41	2.735	0.214	14.79	23.41	1.485	0.100
GE intake, MJ/d	208.33	209.66	19.305	0.950	185.54^a	232.45^b	6.597	0.006
Loss of energy, MJ/d	15.19^b	11.04^a	0.165	0.010	12.02^a	14.22^b	0.509	0.023
% Loss of GE	7.33^b	5.26^a	0.75	0.003	6.47	6.12	0.294	0.324

$^{a, b}$Mean with different superscripts in a row differ significantly (P<0.05)

Table 5. Effect of *S. cumini* fruit shred on milk yield

Parameters	Group		SEM	Period, month					SEM
	Control	*S. cumini*		1	2	3	4	5	
Milk yield, kg/d	14.04	14.09	0.18	14.16^c	12.97^b	16.22^e	15.41^d	11.58^a	0.28

^{a,b,c,d}Mean with different superscripts in a row differ significantly (P<0.01)

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