

METHANE PRODUCTION ON MAIZE FODDER BASED RATIONS IN BUFFALO CALVES

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ABSTRACT

Two experiments were conducted on growing buffalo calves. In first experiment the animals of 1-1.5 Yr. age were divided in two groups of female (gp.I) and male (gp.II) calves and fed concentrate mixture and maize fodder. The concentrate mixture was consumed by all the animals. DM intake (kg/d) through green maize fodder was 4.99 ± 0.11 and 5.1 ± 0.13 in female and male animals. Average total DMI per 100 kg body weight was 1.90 ± 0.10 and 2.23 ± 0.06 kg which was higher in case of male animals. DMD was 59.93 ± 1.92 and 57.7 ± 2.50 in the two groups, hence total digestible nutrients intake was 3.04 ± 30.09 and 2.99 ± 0.14 kg/day in the two groups which corresponds to 9.93 ± 0.30 and 9.77 ± 0.47 M Cal of metabolisable energy consumption by the animals. Total methane produced (g/d) was 79.99 ± 6.75 and 93.22 ± 4.58 in the two groups, when expressed on the basis of per kg body weight of the animal the values were 306.00 ± 34.25 and 409.00 ± 35.14 mg. One kg dry matter intake resulted in 15.9 ± 1.26 g of methane in female calves and 18.34 ± 1.31 g in male calves while one kg of digestible dry matter intake produced 26.70 ± 2.03 and 32.17 ± 3.22 g by the two groups. However, when expressed in terms of metabolisable energy intake the values were 8.08 ± 0.71 and 9.15 ± 1.09 g/M Cal which did not differ in two groups.

In second experiment all male calves were divided into group I (138.0 ± 3.85) and group II (107.33 ± 1.11) by taking two levels of bodyweights. DM intake was higher in group I, however, these were not different when expressed as $\text{g/kg W}^{0.75}$. Digestibility of the nutrients though did not differ statistically yet it was on higher side in group II which resulted in lower methane production per kg DMI (33.63 ± 5.68 , 27.13 ± 1.54). However, each kg of DDMI and DOMI resulted in similar amount of methane production in the two groups. Methane production per day was 76.50g on an average on maize silage fed calves.

Key words: Methane, Buffalo calves, Maize, maize silage

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Ruminants are one of the important methane sources which produce about 15-20 % of global methane (Lashof and Tirpak, 1990) along with rice fields, coal mines and land fills etc. Though methane's contribution is less than 2% of all the factors leading to global warming (Johnson and Johnson, 1995) it plays an important role because it is 21 times more effective than carbondioxide. Its importance further increases due to the fact that it also contributes to the ozone depletion in the atmosphere (Crutzen, 1995) which increases amount of UV rays coming on the earth. These rays are the cause of many diseases not only of human's but for all living beings. On the other hand methane is a natural byproduct of ruminant digestion process acting as hydrogen sink and it amounts to 8-12% of gross energy (Blaxter, 1967) in general in cattle. Methane production also depends upon quality and quantity of feed digested by the animals (Madhu Mohini and Singh , 2001; Khan et. al, 1988) . As buffaloes are known to digest crude fiber in better way therefore, this study was taken up to measure methane by buffalo calves on feeding green forage (maize) and maize in the form of silage.

Material and Methods

Experiment 1:

Twelve buffalo calves of 1-1.5 yrs of age were taken from NDRI herd and divided in two groups (female and male) of 6 each (210-280 kg b.wt.). The animals were fed green maize ad lib. and one kg of concentrate mixture (CP 19.50% and TDN 65%).

Experiment 2:

Twelve buffalo male calves of 9-12 months of age were taken from NDRI herd and divided in two groups according to their body weight. The average body weight in group 1 was 138.00 ± 3.85 and in group II was 107.33 ± 1.11 . The animals were fed maize silage ad.lib. and one kg of concentrate mixture (CP 18.36 and TDN 65%).

Chemical composition of the feeds is given in table 1. Animals were housed in clean, dry and airy byres having an arrangement for individual feeding. Concentrate mixture was fed at 10.00 am and silage was offered twice at 12.00 am and 4.30 pm. Clean drinking water was provided 3 times a day in experiment 1 (June-July) and two times in experiment 2 (Dec-Jan).

After preliminary feeding of 21 days, 7 days digestibility trial was conducted to access the digestibility of nutrients. Daily records of feed offered, residue left and faeces voided was kept. The samples of feed, residue and faeces were analysed for proximate principles (AOAC, 1984).

Methane production by the animals was measured by SF₆ (Sulphur hexafluoride) tracer technique (Johnson et al, 1994) details are given by Madhu Mohini & Singh (2001). Gross energy and digestibility energy of feed was calculated from the values of various ingredients given by Mc Donald et al. (1983). The data was analysed statistically as per Snedecor and Coheharan (1968) for comparing the two groups and for determining the correlations between methane production and other parameters.

RESULTS AND DISCUSSION

Experiment-1:

Though body weight of the animals was higher in female animals (262.63±7.6) as compared to males (229.15±6.83), total DMI was higher in males (5.11±0.13) than in group I (4.99±0.11). However, the difference was not significant statistically. Dry matter intake per 100 kg body weight and per kg^{0.75} b.wt. was 1.90±0.10, 76.66±3.30 and 2.23±0.06, 86.66±1.63 in the two groups, respectively (table-1). Digestibility of the ration's proximate principles (table-2) were 59.93±1.92, 57.72±2.50, 56.98±2.71, 60.10±0.92, 63.08±3.08 in the two groups for DM, OM, CP and CF. Though the differences between two groups was not significant the digestible nutrients intake kg/d (table-3) was almost similar in the two groups. Overall average gross energy and digestibility energy intake was 22.03±0.46 and 12.46±0.46.

Average methane production (g/day) was 79.99±6.75 and 93.22±4.58 in the two groups with an overall average of 86.60±4.69. Apparently the value was higher in male animals as compared to female animals. In terms of mg per kg body weight and g per kg nutrients intake the values were 307.20±33.93, 397.50±26.62; 15.97±1.26, 18.34±1.31 per kg DMI, 17.78±1.41, 20.41±1.44 per kg OMI, 70.92±5.62, 78.84±5.89 per kg CFI, 3.62, 4.12 g/Mcal GE (Av. 3.87) and 7.91, 9.30 g/Mcal ME (Av. 8.60). Male calves also reported higher values on feeding of Jowar (Madhu Mohini and Singh, 2001) and Shibata et. al. (1993) reported 12.13 g methane/kg DMI. However when expressed per kg DDM the values ranged from 20.69 to 42.98g while invitro experiments had shown 32.6 to 41.3

lt/kg DDM with various levels of green maize (Singh and Madhu Mohini, 1999). Energy lost as methane gas was 1067.13 ± 90.09 and 1243.55 ± 60.56 with an average of 1155.34 Kcal/day (table-5). This amounted to 5.17% of GE, 9.34% of DE and 11.60% of ME on taking average of the two groups (Mc Donald et.al, 1983). However it was quite low (3.23% of GE and 5.34 % of DE) when the animals were fed Jowar as green fodder (Madhu Mohini and Singh, 2001).

Experiment 2:

Chemical composition consisting proximate principles of maize silage (table-1) is not different then that of maize green fodder. However, the ash content is higher thereby decreasing OM content of the silage was comparable to that of green fodder in male animals (group II), 2.45 ± 0.06 kg /100 kg b.wt. as compared to group group I (2.13 ± 0.05) (table-2). However, the difference was not significant statistically. Average DMI kg/100 kg b.wt. was 2.38. Average digestibility of nutrients like DM, OM , CP & CF depicted in table –3, was 52.16, 56.82, 56.01 and 72.50, respectively with no significant difference among the groups. Hence, digestible nutrients intake was also less in group II with an average of 1.41, 1.40, 410.2, 198.2 and 1.38 for DM, OM, CF, protein and total digestible nutrients. Gross energy intake (Mcal) was 12.44 ± 0.13 and 9.56 ± 0.52 with average of 11.00 Mcal.

Average methane production (g/d) in the two groups vary significantly being higher in group I (88.21 ± 6.42) as compared to group II (64.78 ± 3.47) with overall average of 76.50 g/day (table-4). It was also lower in group II when expressed as per kg body weight and per kg dry matter intake (608.22, 27.13) as compared to group I ($628.40 \pm 33.63 \pm 5.68$) however when compared to fresh maize fed group in experiment I the values were significantly ($P < 0.05$) higher.

Though the DM and CP digestibility was lower in maize silage fed groups (Expt. 2) as compared to green maize fed groups (Expt. 1) the fibre digestibility was higher which may have led to higher methane production in expt. II. When it was expressed as nutrients intake the values were 33.63 ± 5.68 and 27.13 ± 1.54 g per kg DMI, 51.10 ± 6.34 & 51.82 ± 3.59 g per kg DDMI and 7.09 ± 1.08 , 6.77 ± 1.12 g per Mcal GE intake. No difference was observed when expressed as per kg DDMI and DOMI. Energy lost

through methane was 9.56 % of GE and 22.74 % of ME (Table-5) on feeding silage based rations. Though McDonald et.al (1983) reported 8 % GE loss as methane at maintenance level, Johnson et al (1993) and Kujawa (1994) reported 2-12 % of GE loss depending upon the type of feed. Soluble sugars were reported to be more methanogenic at low level of intake (Torrent et. al 1994) which could have resulted in higher values in these groups. In the earlier experiment only 2 % GE was lost when buffalo calves were fed on Jowar as green fodder (Madhu Mohini & Singh, 2001) and the value was 5.89 g per kg DMI as compared to 15.97-18.34 g on maize green feeding.

Hence, the methane values vary with the type of feed and for quantification at national level, feed should be considered as an important factor.

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Table I Chemical composition of feed (% DM basis)

Parameters	Maize Green	Concentrate mixture	Maize Silage
Organic matter	89.34	92.05	86.62
Crude protein	8.20	19.50	8.55
Ether extract	1.78	4.28	3.65
Crude fiber	28.87	6.07	27.14
Ash	10.66	7.95	13.38
Nitrogen free extract	50.49	62.2	47.28

Table 2. Body weight and intake of various nutrients in two groups

Parameters	Experiment-1		Experiment-2	
	I	II	I	II
Body weight	262.63 ± 7.6	229.15 ± 6.82	138.00 ± 3.85	107.33 ± 1.11
DM INTAKE (kg/d)				
Green Maize	4.09 ± 0.11	4.21 ± 0.12		
Maize Silage			2.29 ± 0.14	1.73 ± 0.09
Concentrate mixture	0.90	0.90	0.90	0.90
Total	4.99 ± 0.11	5.11 ± 0.13	3.19 ± 0.14	2.63 ± 0.09
Kg/100 kg B.wt	1.90 ± 0.10	2.23 ± 0.06	2.31 ± 0.05	2.45 ± 0.06
G/kg W ^{0.75}	76.66 ± 3.30	86.66 ± 1.63	79.22 ± 2.34	73.88 ± 1.72
OMI	4.49 ± 0.09	4.60 ± 0.44	2.67 ± 0.15	2.30 ± 0.08
CFI	1.06 ± 0.03	1.19 ± 0.03	0.622 ± 0.04	0.509 ± 0.03
CPI (mg)	0.52 ± 0.01	0.53 ± 0.01	0.373 ± 13.40	0.330 ± 5.57
GEI	22.11 ± 0.46	22.64 ± 0.52	12.44 ± 0.13	9.56 ± 0.52
DIGESTIBLE NUTRIENT INTAKE (kg/d)				
DM	2.99 ± 0.13	2.96 ± 0.19	1.51 ± 0.14	1.32 ± 0.07
OM	2.78 ± 0.15	2.81 ± 0.18	1.49 ± 0.10	1.31 ± 0.05
CF	0.78 ± 0.03	0.76 ± 0.05	4.46 ± 0.64	3.73 ± 0.24
CP	0.31 ± 0.01	0.32 ± 0.01	2.07 ± 0.12	1.89 ± 0.5
TDN	2.79 ± 0.13	2.77 ± 0.19	1.48 ± 0.12	1.28 ± 0.04
ME (M Cal)	10.10 ± 0.13	10.02 ± 0.19	5.36 ± 0.12	4.63 ± 0.04

Table 3. Digestibility coefficients of various nutrients (%)

Parameters	Experiment-1		Experiment-2	
	I	II	I	II
DM	59.93 ± 1.92	57.72 ± 2.50	50.46 ± 1.27	53.96 ± 1.24
OM	57.55 ± 2.62	56.98 ± 2.71	56.16 ± 1.08	57.28 ± 1.16
CP	59.99 ± 0.41	60.10 ± 0.92	54.93 ± 2.48	57.27 ± 2.05
EE	72.26 ± 1.71	69.89 ± 0.67	69.09 ± 2.34	69.34 ± 2.28
CF	66.96 ± 1.82	63.08 ± 3.08	71.66 ± 3.62	71.66 ± 3.18
NFE	58.48 ± 1.12	59.61 ± 1.43	54.61 ± 2.91	56.78 ± 2.64

Table 4. Methane production and its relation with nutrients

Parameters	Experiment-1		Experiment-2	
	I	II	I	II
Methane	79.99 ± 6.75	93.22 ± 4.58	88.21 ± 6.42	64.78 ± 3.47
Mg/Kg B.wt	307.20 ± 33.93	397.50 ± 26.62	628.40 ± 52.68	608.22 ± 36.55
PER KG NUTRIENTS INTAKE (g)				
DM	15.97 ± 1.26	18.34 ± 1.31	33.63 ± 5.68	27.13 ± 1.54
OM	17.78 ± 1.41	20.41 ± 1.44	30.15 ± 3.06	27.13 ± 2.21
CF	70.92 ± 5.62	78.84 ± 5.89	127.27 ± 13.92	136.05 ± 19.76
CP	1.54.48 ± 12.20	178.05 ± 11.60	237.29 ± 68.00	198.96 ± 11.09
ME (M Cal)	7.91 ± 1.16	9.30 ± 1.21	16.45 ± 2.10	13.99 ± 2.51
GE (M Cal)	3.62 ± 0.64	4.12 ± 0.68	7.09 ± 1.08	6.77 ± 1.12
PER KG DIGESTIBLE NUTRIENT INTAKE (g)				
DM	26.70 ± 2.30	32.17 ± 3.22	51.10 ± 6.34	51.82 ± 3.59
OM	28.76 ± 2.18	33.90 ± 3.12	56.84 ± 6.87	56.11 ± 2.03
CF	102.49 ± 7.71	126.02 ± 12.35	140.32 ± 36.56	174.45 ± 15.19
CP	243.03 ± 9.26	296.74 ± 20.18	385.10 ± 16.8	354.15 ± 18.90

Table 5. Energy intake (M Cal) and its loss as methane (per day)

Parameters	Experiment-1		Experiment-2	
	I	II	I	II
Gross energy	22.11 ± 0.46	22.64 ± 0.52	12.44 ± 0.13	9.56 ± 0.52
Digestible	11.91 ± 0.28	13.03 ± 0.68	9.12 ± 0.22	7.16 ± 0.39
ME	9.93 ± 0.30	9.77 ± 0.47	5.50 ± 0.29	3.64 ± 0.22
Methane (g/d)	79.99 ± 6.75	93.22 ± 4.58	88.21 ± 0.42	64.78 ± 3.47
Methane energy (k cal)	1067.13 ± 90.09	1243.55 ± 60.56	1176.81 ± 8.64	864.25 ± 46.29
Energy loss as methane (%)				
GE	4.82 ± 0.38	5.53 ± 0.39	9.72 ± 0.90	9.41 ± 0.70
DE	8.94 ± 0.70	9.74 ± 0.95	12.95 ± 1.26	12.13 ± 0.08
ME	10.35 ± 0.86	12.85 ± 0.95	21.55 ± 2.19	23.92 ± 2.03

