



Effect of feeding hydroponics maize fodder on digestibility of nutrients and milk production in lactating cows

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Received: 23 July 2013; Accepted: 5 March 2014

ABSTRACT

Hydroponics maize fodder of 7 days growth was fed to 6 dairy cows divided into two equal groups (BW 442 kg; avg. milk yield 6.0 kg). Animals were offered 5 kg concentrate mixture and *ad lib.* jowar straw along with either 15 kg fresh hydroponics maize fodder (T-HF) or conventional napier bajra hybrid (NBH) green fodder (T-CF) for 68 days. The hydroponics maize fodder (HMF) had higher CP (13.30 vs 11.14, %), EE (3.27 vs 2.20, %), NFE (75.32 vs 53.54, %) and lower CF (6.37 vs 22.25, %), TA (1.75 vs 9.84, %) and AIA (0.57 vs 1.03, %) than NBH. HMF intake was low (0.59 kg DM/d) than NBH (1.19 kg DM/d) by the cows. However, the DMI (2.05 and 2.17 %) was similar in both the groups. Digestibility of CP (72.46 vs 68.86, %) and CF (59.21 vs 53.25, %) was higher ($P < 0.05$) for cows fed HMF. The DCP content (9.65 vs 8.61, %) of the ration increased significantly ($P < 0.05$) due to feeding of HMF; however, the increase ($P > 0.05$) in the CP (13.29 vs 12.48, %) and TDN (68.52 vs 64, %) content was non-significant. There was 13.7% increase in the milk yield of T-HF (4.64, kg/d) than the T-CF group (4.08 kg/d). The feed conversion ratio of DM (2.12 vs 2.37), CP (0.29 vs 0.30) and TDN (1.45 vs 1.52) to produce a kg milk was better in the T-HF than the T-CF group. There was higher net profit of Rs. 12.67/- per cow/d on feeding HMF. It can be concluded that feeding of HMF to lactating cows increased the digestibility of nutrients and milk production leading to increase in net profit.

Key words: Cows, Digestibility, Feeding, Fodder, Hydroponics, Lactating, Maize, Milk, Nutrients

Green fodder is an essential component of the dairy ration, otherwise the productive and reproductive performance of the dairy animals is adversely affected. Therefore, for a sustainable dairy farming, quality green fodder should be fed regularly to the dairy animals (Naik *et al.* 2012a). However, the major constraints in production of green fodder by dairy farmers are unavailability of land for fodder cultivation due to small land holding size, scarcity of water or saline water, labour required for cultivation (sowing, earthing up, weeding, harvesting etc.), requirement of manure and fertilizer, more growth time (approx. 45–60 days), fencing to prevent fodder crops from wild animals and natural calamities etc. Further, the non-availability of quality fodders round the year aggravates the constraints of the sustainable dairy farming (Naik *et al.* 2013a). Due to the above constraints in the conventional method of fodder cultivation, hydroponics technology is coming up as an

alternative to grow fodder for farm animals (Sneath and McIntosh 2003, Naik *et al.* 2011a, Naik *et al.* 2012b, Naik *et al.* 2013b). However, only a few reports are available on the feeding value of the hydroponics green fodder to dairy animals in India (Reddy *et al.* 1988, Pandey and Pathak 1991). Therefore, an experiment was conducted to find out the effect of feeding hydroponics maize fodder on digestibility of nutrients and milk production in lactating cows.

MATERIALS AND METHODS

Production of hydroponics maize fodder: Hydroponics fodder maize was produced in a hydroponics chamber measuring about 25 ft × 10 ft × 10 ft with a daily production potential of 600 kg fresh hydroponics maize fodder and equipped with automatic sprayer irrigation of tap water. Clean seeds of maize (*Zea mays*) were soaked in tap water for 4 h and were then distributed in the greenhouse trays with a seed rate of 7.6 kg/ m². On first day, the trays containing the soaked seeds are put on the top most rows of the rack and then every day these are shifted to their respective below rows till they reach the down last row on seventh day. Inside the green house, the plants are allowed to grow for 7 days and then on eighth day, these are harvested and fed to the dairy animals.

Experimental animals, feeding and management: Six

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dairy cows (avg. BW 442 kg; avg. milk yield 6.0 kg) were divided into 2 equal groups on basis of their body weight (mean BW 449.12 kg and 435.48 kg) and daily milk yield 5.92 kg and 6.08 kg). All the animals were kept in well ventilated, clean cement floored shed. A standard conventional concentrate mixture (CM) containing maize grain 35, rice polish 25, soybean meal 15, cotton seed cake 22, mineral mixture 2 and common salt 1 parts by weight was prepared. All the animals were offered daily 5 kg CM along with *ad lib.* jowar straw and 15 kg hydroponics maize fodder (T-HF) or conventional green fodder (napier bajra hybrid, CO-3) fodder (T-CF) harvested on 45 days of growth, to meet their nutrient requirements (Ranjhan 1998) for a period of 68 days. The daily ration was offered twice daily in equally divided doses, while clean drinking water was made available *ad lib.* throughout the experiment. Milking of the animals was performed twice daily at 6.00 am and 3.00 pm by machine milking.

Digestion trial: At the end of the feeding period, a 6-d digestion trial was conducted on all experimental animals. During the digestion trial, the feeding schedule of the animals remained the same as earlier. The feed residues after 24 h consumption of each animal were weighed to determine the daily feed intake. Faeces were collected quantitatively from the animals immediately after defecation.

Recording of data and analytical procedures: The feed offered and residues left were recorded daily. The body weight changes of the experimental animals were recorded at fortnight intervals. The daily (morning and evening) milk yield of the animals was recorded and the feed conversion ratio was calculated as 'kg intake per kg milk production per day'. The feeds and fodder offered were analyzed for proximate principles (AOAC 2000). The data were analyzed statistically for the test of significance (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

Chemical compositions of feeds and fodder: The nutrient contents of the concentrate mixture is as per the BIS specifications of the compounded cattle feed (Table 1). The compositions of the conventional NBH (CO-3) green fodder and jowar straw were within the normal range and similar to the reports of the earlier workers (Naik *et al.* 2013c).

The HMF looked like a mat of 20–30cm height consisting of germinated seeds embedded in their white roots and green shoots (Naik *et al.* 2011a, Naik *et al.* 2013b). The increase in weight of the hydroponics maize fodder than the seed weight on fresh basis was 5.5 folds. The DM content (on fresh basis) of the hydroponics maize fodder was slightly higher than the conventional CO-3 green fodder and the hydroponics barley fodder reported by Reddy *et al.* (1988). However, Dung *et al.* (2010b) observed 3.7 times increase in the fresh weight of the 7-d hydroponics barley fodder with DM% of 19.7%. According to Sneath and McIntosh (2003), various commercial hydroponics fodder producers claims yields of 6–10 times with DM% from 6.4–20; while trial yields range from 5–8 folds. Naik and Singh (2013) reported that yields of 5–6 folds on fresh basis (1 kg seed produces 5–6 kg HMF) and DM content of 11–14% are common for HMF; however, sometimes the DM content up to 18.3% was observed as in the present study. The hydroponics maize fodder had higher CP, EE, NFE and lower CF, TA and AIA percentage than the napier bajra hybrid (CO-3) green fodder. Earlier, Naik *et al.* (2012b) also reported higher CP, EE and NFE; and lower CF, TA and AIA percentage in hydroponics maize fodder than the conventional maize fodder. In hydroponically produced barley fodder, CP content of 16.3% (Snow *et al.* 2008) and 14% (AI-Ajmi *et al.* 2009) were reported by the earlier workers. Sneath and McIntosh (2003) reviewed the composition of sprouted barley and reported that the CP ranged from 11.38 to 24.9%. As per Pandey and Pathak (1991), the artificially grown barley fodder had 14.69% CP, 3.18% EE and 78.55% total carbohydrate. Similarly, Reddy *et al.* (1988) observed 13.72% CP, 16.33% CF, 3.72% EE, 62.12% NFE and 0.17% Ca and 0.48% P in the artificially grown barley fodder and concluded that it was superior to certain common non-leguminous fodders, but comparable to leguminous fodders.

There was no difference ($P>0.05$) in the DM intake of concentrate mixture and jowar straw between the groups (Table 2). Although nonsignificant, there was reduced intake of hydroponics maize fodder than the CO-3 green fodder by the animals, which lead to lower ($P<0.05$) total roughage and DM intake in T-HF group than the T-CF group. However, the DM intake per 100 kg BW was similar ($P>0.05$) in both the groups. The roughage: concentrate ratio

Table 1. Chemical composition (on % DM basis) of feeds and fodder

Parameters	Concentrate mixture	Conventional napier bajra hybrid green fodder (CO-3)	Jowar straw	Hydroponics maize fodder
Dry matter (on fresh basis)	92.40	15.12	89.84	18.30
Crude protein	21.68	11.14	3.40	13.30
Ether extract	4.83	2.20	0.84	3.27
Crude fiber	8.39	22.25	34.19	6.37
Nitrogen free extract	58.27	53.54	52.43	75.32
Total ash	6.83	9.84	9.14	1.75
Acid insoluble ash	1.16	1.03	5.32	0.57

Table 2. Effect on dry matter intake and digestibility of nutrients and nutritive value

Parameters	T-HF	T-CF
Mean BW	435.48±40.83	449.12±23.58
<i>Dry matter intake (kg/day)</i>		
Concentrate mixture	4.62	4.62
Green fodder	0.59±0.08	1.19±0.43
Jowar straw	3.64±0.39	3.89±0.49
Total roughage*	4.23±0.43	5.08±0.57
Total DM*	8.85±0.43	9.70±0.57
DM intake/ 100 kg BW	2.05±0.10	2.17±0.17
Roughage: concentrate ratio*	48: 52±2.69	52: 48±2.97
<i>Digestibility (%)</i>		
Dry matter	65.39±1.54	61.15±0.38
Organic matter	68.47±1.37	64.19±0.66
Crude protein*	72.46±0.84	68.86±1.13
Ether extract	87.69±1.35	82.05±0.64
Crude fiber*	59.21±0.41	53.25±0.73
Nitrogen free extract	70.47±2.44	67.37±1.02
<i>Nutritive value (%)</i>		
CP	13.29±0.53	12.48±0.54
DCP*	9.65±0.49	8.61±0.52
TDN	68.52±1.03	64.00±0.78

*Significantly different (P<0.05).

in T-HF group (48: 52) was lower (P<0.05) than the T-CF group (52: 48). Pandey and Pathak (1991) reported voluntary intake of 50.38 kg fresh hydroponics green fodder/ d, which supplied 7.13 kg DM and concluded that DM intake is a limiting factor on sole feeding of hydroponics green fodder. Lower DM intake associated with the feeding of hydroponics green fodder has also been reported by the earlier workers, which may be due the high water content of the hydroponics green fodder that might have made it bulky leading to limited DM intake by the animals (Fazaeli *et al.* 2011). Reddy *et al.* (1988) used artificially grown barley fodder vs NB-21 (10 kg/d) as a constituent of the ration of the milch cows and observed similar DM intake (2.74 vs 2.84, kg/100 kg BW) and roughage: concentrate ratio (65: 35 vs 63: 37) in both the groups. It was observed that sometimes, the animals took the leafy parts of the hydroponics green fodder and the roots portions are left (Reddy *et al.* 1988), which can be avoided by mixing the hydroponics green fodder with the other roughage components (chopped straw or conventional green fodder) of the ration.

There was increase (P<0.05) in the digestibility of CP and CF of the cows due to feeding of hydroponics maize fodder; however, the increase (P>0.05) in the digestibility of DM, OM, EE and NFE was nonsignificant (Table 2). Reddy *et al.* (1988) also observed significant increase in the digestibility (%) of DM, OM, CP, CF, EE and NFE and concluded that the increase in the digestibility of the nutrients may be due to the tenderness of the fodder due to its lower age. According to Shipard (2005), sprouts are the most enzyme rich food on the planet and the period of greatest enzyme activity in sprouts is generally between

Table 3. Effect on milk yield, feed conversion ratio and economics of feeding

Parameters	T-HF	T-CF
Milk yield (kg/day)	4.64±1.21	4.08±0.11
<i>Feed conversion ratio (kg feed/ kg milk yield)</i>		
DM	2.12±0.40	2.37±0.08
CP	0.29±0.06	0.30±0.00
DCP	0.21±0.05	0.20±0.01
TDN	1.45±0.27	1.52±0.05
<i>Economics of feeding</i>		
Cost of feed	144.88±4.55	137.51±5.02
Feed cost/kg milk production	34.98±7.14	33.69±0.53
Cost of milk (@ ₹ 36/kg)	166.92±43.73	146.88±3.85
Net profit/animal/day	22.04±40.98	9.37±2.08

*Significantly different (P<0.05).

germination and 7 days of age (Chavan and Kadam 1989). Another reason of the increase in the digestibility of the nutrients due to feeding of hydroponics maize fodder may be its high enzyme activities. Pandey and Pathak (1991) reported that the digestibilities of the nutrients of the hydroponics green fodder are comparable to the highly digestible legumes like berseem and other clovers. The DCP content of the ration increased significantly (P<0.05) due to feeding of hydroponics maize fodder; however, the increase (P>0.05) in the CP and TDN content was nonsignificant. The improvement in the nutritive values (CP, DCP and TDN, %) in T-HF may be attributed to the high digestibility of the nutrients of the ration. Reddy *et al.* (1988) observed higher (P<0.05) DCP% and TDN% in the artificially grown barley fodder based ration than the NB-21 based ration and suggested that the former ration is optimum to meet the production requirement of the lactating cows.

There was 13.7% increase in the milk yield of T-HF group than the T-CF group due to feeding of hydroponics maize fodder, which may be due to the higher DCP and TDN content of the ration (Table 3). Similar to this experiment, an increase of 7.8% in milk production was observed in cows fed ration containing hydroponics barley fodder (Reddy *et al.* 1988). The feed conversion ratio (FCR) in terms of DM, CP and TDN was better in the T-HF group than the T-CF group. It is reported that the hydroponic sprouts are rich source of nutrients and contain a grass juice factor that improves the performance of livestock (Finney 1982). The DM required per kg milk production also reduced by 11.6% on the ration containing artificially grown fodder (Reddy *et al.* 1988). Pandey and Pathak (1991) fed artificially grown barley fodder *ad lib.* to lactating crossbred cows and concluded that the mean daily intake of CP, DCP and TDN are higher than the maintenance requirement, but lower than the total requirement for maintenance and milk production; therefore, for maintenance, hydroponics barley fodder should be fed; but for high yielding cows, supplementation of adequate quantity of concentrate is necessary. The cost of the feed/d (P<0.05) and feed cost

per kg milk production ($P>0.05$) was higher in the T-HF group (₹ 144.88 and Rs. 34.98) than the T-CF group (₹ 137.51 and ₹ 33.69). The higher cost of the hydroponics maize fodder (₹ 4/kg) than the conventional green fodder (₹ 1.50/kg) might be the reason for the higher cost of the feed in the T-HF group than the T-CF group (Naik *et al.* 2012c). The cost of milk increased non-significantly ($P>0.05$) in the T-HF group (₹ 166.92) vs than the T-CF (₹ 146.88) group, which led to the higher net profit of ₹ 12.67/ cow per day due to feeding of hydroponics maize fodder. Reddy *et al.* (1988) also reported that the cost of feed per kg milk production increased by 20% on the ration containing artificially grown fodder; but in spite of the cost variations, it was concluded that being superior fodder than NB-21, it could be a good feed component of high yielding cows stationed in hilly areas. A farmer at Mandrem village in Pernem Taluka of Goa also observed that on daily feeding of 10 kg hydroponics fodder maize per cow, 1.0 kg concentrate mixture per cow per day was saved and experienced enhancement of approximately 1.0 litre (from 8 litres to 9 litres) milk per cow per day, earning additional net profit of ₹ 10/ cow/ day (Anonymous 2012).

It can be concluded that feeding of hydroponics maize fodder increased the digestibility of nutrients, milk production and net profit in lactating cows.

ACKNOWLEDGEMENTS

The authors are thankful to Indian Council of Agricultural Research (ICAR), New Delhi; Rashtriya Krishi Vikas Yojana (RKVY), Govt. of India and Goa State Co-operative Milk Producer's Union Limited, Curti, Ponda, Goa for providing financial support to conduct the study.

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