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Effect of feeding hydroponics maize fodder replacing maize of concentrate mixture partially on digestibility of nutrients and milk production in lactating cows

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ABSTRACT

An experiment was conducted to find out the effect of feeding hydroponics maize fodder by replacing maize of concentrate mixture partially on digestibility of nutrients and milk production in lactating cows. Lactating cows (6) (avg. BW 437 kg, avg. milk yield 8.57 kg) were divided into 2 equal groups i.e. Maize Grain Group (MGG) and Hydroponics Maize Fodder Group (HMFG) based on their body weight and milk yield. Two types of concentrate mixture ($CM_{maize\ 100}$ or $CM_{maize\ 50}$) were prepared. $CM_{maize\ 100}$ contained maize grain 35, rice polish 35, soybean meal 27, mineral mixture 2 and common salt 1 parts by weight. In $CM_{maize\ 50}$, 50% of the maize of $CM_{maize\ 100}$ was replaced partially and it contained maize grain 17.5, rice polish 54, soybean meal 25.5, mineral mixture 2 and common salt 1 parts by weight. Randomly, animals of MGG and HMFG were offered 6 kg $CM_{maize\ 100}$ and $CM_{maize\ 50}$, respectively along with 10 kg fresh conventional green fodder (napier bajra hybrid, CO-3) and *ad lib.* jowar straw. Besides, animals of the HMFG were offered five kg fresh HMF, sprouted from approximately one kg maize, which has been withdrawn from 6 kg concentrate mixture. The experiment was conducted for a period of 45 days. The fresh yield of the HMF from one kg maize seed was 5–6 kg with 12.39% DM content. Feeding of HMF by replacing the maize grain of the concentrate mixture had not altered the DM intake (11.20 vs 11.52 kg/day) and roughage:concentrate ratio (51:49 vs 52:48) of the animals. There was nonsignificant increase in the digestibility of nutrients, nutritive value, milk yield (7.97 vs 8.59 kg/day), 4.0% FCM (8.25 vs 9.31 kg/day), and fat (%) (4.20 vs 4.50) in HMFG than the MGG. The feed conversion ratio (FCR) in terms of DM (1.51 vs 1.40), CP (0.19 vs 0.18) and TDN (1.03 vs 0.96) was better in the HMFG than the MGG. It can be concluded that hydroponics maize fodder can be fed to the lactating cows by replacing maize of the concentrate mixture partially with improvement in the performance of the animals.

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

For a sustainable and viable dairy farming, feeding of quality green fodder regularly to dairy animals is highly essential (Naik *et al*. 2012a, 2013a). However, due to various constraints in the production of green fodder conventionally, hydroponics technology is coming up as an alternative to grow fodder for farm animals (Naik *et al.* 2015). In India, maize has been the preferred crop for hydroponics fodder production due to many reasons (Naik and Singh 2014). However, very often question comes in the mind of farmers that if hydroponics maize fodder (HMF) would be fed to dairy animals; the maize requirement of the farm would be increased; as it would be required as an ingredient for concentrate mixture and sprouting of maize to produce HMF. Therefore, an experiment was conducted to find out the effect of feeding HMF replacing maize of concentrate mixture partially on digestibility of nutrients and milk production in lactating cows.

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MATERIALS AND METHODS

Production of hydroponics maize fodder: Fresh HMF was produced in a hydroponics chamber measuring about 25 ft length × 10 ft width × 10 ft height, equipped with automatic sprayer irrigation of tap water. Clean seeds of maize (*Zea mays L.*) were soaked in tap water for 4 h and then were distributed in the green house trays with a seed rate of 7.6 kg/m^2 (Naik *et al.* 2016a). Inside the green house, the plants were allowed to sprout for 7 days and then on 8th day, they were fed to the animals.

Experimental animals, feeding and management: Six

lactating cows (avg. BW 437 kg, avg. milk yield 8.57 kg) were divided into two equal groups i.e. Maize Grain Group (MGG) and Hydroponics Maize Fodder Group (HMFG) based on their body weight (mean BW 430 kg and 444 kg) and daily milk yield (8.77 and 8.38 kg). All the animals were kept in well ventilated, clean cement floored shed. Two types of concentrate mixture ($CM_{maize\ 100}$ and $CM_{maize\ 50}$) were prepared. $CM_{maize100}$ contained maize grain 35, rice polish 35, soybean meal 27, mineral mixture 2 and common salt 1 parts by weight. In $CM_{maize\ 50}$, 50% of the maize of $CM_{maize\ 100}$ was replaced partially and it contained maize grain 17.5, rice polish 54, soybean meal 25.5, mineral mixture 2 and common salt 1 parts by weight. Randomly, animals of MGG and HMFG were offered 6 kg $CM_{maize\ 100}$ and $CM_{maize\ 50}$, respectively along with 10 kg fresh conventional green fodder (napier bajra hybrid, CO-3) and *ad lib.* jowar straw. Besides, animals of the HMFG were offered five kg fresh HMF, sprouted from approximately one kg maize, which has been withdrawn from 6 kg concentrate mixture. The nutrient requirements of the experimental animals were fulfilled (Ranjhan 1998) and the experiment was conducted for a period of 45 days. The daily ration was offered twice daily in equally divided doses except the HMF, which was offered once in the morning. Clean drinking water was made available *ad lib*. throughout the experiment period. Milking of the cows 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 the experimental animals. During the digestion trial, feeding schedule of the animals remained 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, residues left, faeces voided and milk yield were recorded by a digital weighing balance. The body weights of the animals were recorded as per Shaeffer's formula (1998). The milk samples were analysed for fat and solid not fat (SNF) by milk analyser. The 4% fat corrected milk yield (FCMY) was calculated (NRC 1989) using the formula: FCMY (kg) = (0.4×kg of milk) + (15×kg of fat). The feed conversion ratio (FCR) was calculated as 'kg feed intake per 4% FCM kg milk yield per day'. The feed and faecal samples 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 was as per the BIS specifications of the compounded cattle feed (Table 1). The fresh yield of the HMF from one kg maize seed was 5–6 kg with 12.39% DM content. The HMF looked like a mat of 20–30 cm height consisting of germinated seeds, roots and leaves (Naik *et al.*, 2016b). Naik and Singh (2014) reported that fresh yields of 3.5–6.0 folds with DM content of 11–14% are common for HMF; however, sometimes DM content up to 18.3% has also been observed (Naik *et al.* 2015). The nutrient content (13.37% CP, 3.39% EE, 9.92% CF, 72.15% NFE and 1.82% TA) of the HMF observed in this experiment was parallel to the reports (13.30–13.57% CP, 2.46–3.49% EE, 6.37–14.07% CF, 66.72–75.32% NFE, 1.56–3.84% TA and 0–0.57% AIA) of the earlier works (Naik *et al.* 2012b, 2014, 2016c). Napier bajra hybrid and jowar straw were predominantly used as the source of green fodder and roughage for the dairy animals. The nutrient content (%) of the napier bajra hybrid (CO-3) green fodder and jowar straw was within the range and similar to the reports of the earlier works (Naik *et al.* 2013a).

Feeding of HMF by replacing the maize grain of the concentrate mixture partially had not altered (P>0.05) the

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

Parameter	Concentrate mixture		Green fodder		Jowar straw
	$Maize_{100}$	$Maize_{50}$	Hydroponics maize	Napier bajra hybrid (CO-3)	
Dry matter	91.37	91.87	12.39	18.36	90.12
Crude protein	20.50	20.63	13.37	10.14	3.18
Ether extract	3.50	3.85	3.39	2.99	0.62
Crude fibre	11.33	11.41	9.92	25.41	35.51
Nitrogen free extract	58.60	57.64	72.15	52.93	51.17
Total ash	5.72	5.92	1.82	9.93	9.31
Acid insoluble ash	0.44	0.45	0.30	1.48	5.32

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

Parameter	MGG	HMFG
Mean BW	434.61±20.31	430.45±15.13
Dry matter intake (kg/day)		
Concentrate mixture	5.48±0.00	5.51±0.00
Hydroponics maize fodder	0.00±0.00	0.62±0.00
Green fodder	1.04±0.08	0.94±0.27
Jowar straw	4.69±0.21	4.45±0.17
Total roughage	5.72±0.19	6.01±0.10
Total DM	11.20±0.19	11.52±0.10
DM intake/100 kg BW	2.59±0.12	2.69±0.12
Roughage:concentrate ratio	51: 49±0.83	52:48±0.43
Digestibility (%)		
Dry matter	68.85±0.84	68.14±1.42
Organic matter	71.41±0.73	70.80±1.32
Crude protein	72.35±0.81	73.45±2.30
Ether extract	81.33±0.33	82.30±0.75
Crude fiber	58.64±1.49	59.41±1.63
Nitrogen free extract	75.38±0.57	73.98±1.42
Nutritive value (%)		
CP	12.56±0.18	12.92±0.04
DCP	9.08±0.12	9.45±0.17
TDN	68.08±0.54	68.29±1.30

DM intake (11.20 vs 11.52, kg/ day) and roughage: concentrate ratio (51:49 vs 52:48) of the animals. Similar to this study, Reddy *et al.* (1988) observed DM intake (2.74 vs 2.84, kg/100 kg BW) and roughage:concentrate ratio (65:35 vs 63:37) in milch cattle fed rations containing artificially grown barley fodder vs NB-21 fodder (10 kg/ d). It was reported that HMF is palatable and the germinated seeds embedded in the roots are also consumed along with the leaves of the fodder plants without any wastage. There was fresh HMF intake of 21 kg daily in heifers fed limited concentrate mixture (2 kg) and jowar straw (3 kg) (Naik *et al.* 2016c). However, decrease (8.85 vs 9.70, kg/ day) in DM intake in cows fed HMF (3.2 kg/day) had also been reported in earlier works (Naik *et al.* 2014). Pandey and Pathak (1991) concluded that DM intake is a limiting factor on sole feeding of hydroponics green fodder, which might be due the high water content of the hydroponics green fodder.

The increase in digestibility of the nutrients and nutritive values of the ration in HMFG than the MGG was non-significant (Table 2). However, earlier workers observed significant increase in digestibility of nutrients and nutritive values in cows fed hydroponics fodder (Reddy *et al.* 1988, Naik *et al.* 2014). The improvement in digestibilities of the nutrients in cows fed hydroponics fodder might be attributed to the tenderness of the fodder due to its lower age. Pandey and Pathak (1991) reported that digestibility of the different nutrients of artificially grown barley fodder was comparable with highly digestible legumes like berseem and other clovers and were optimum to meet the production requirement of the lactating cows. The digestibility of the various nutrients and nutritive values in HMFG, observed in this study were within the range of the respective digestibility of the nutrients (65.35–65.62% DM, 65.08–68.47% OM, 67.74–72.46% CP, 72.81–87.69% EE, 51.73–59.71% CF, 68.23–70.47% NFE) and nutritive values (12.02–13.29% CP, 8.17–9.65% DCP, 63.20–68.71% TDN) in animals fed HMF (Naik *et al.* 2014, 2016a, 2016b). There was non-significant increase in the milk yield (7.97 vs 8.59, kg/day), 4.0% FCM (8.25 vs 9.31, kg/day), fat (%) (4.20 vs 4.50) and SNF (%) (9.08 vs 8.29) between the groups due to feeding of HMF by partially replacing the maize of the concentrate mixture (Table 3). Increase (13.7%) in milk yield (4.64 vs 4.08 kg/d) due to feeding of hydroponics fodder had been reported by the earlier workers, which was attributed to the higher DCP and TDN content of the ration (Reddy *et al.* 1988, Naik *et al.* 2014). The feed conversion ratio (FCR) in terms of DM (1.51 vs 1.40), CP (0.19 vs 0.18) and TDN (1.03 vs 0.96) was better in the HMFG than the MGG; which was similar to the observations of Naik *et al.* (2014) in cows fed HMF. Hydroponics 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 ration containing artificially grown fodder (Reddy *et al.* 1988). Reduction in the requirement of concentrate mixture along with increase in the milk production in cows had been observed in field condition by the famers due to feeding of hydroponics fodder (Anonymous 2012, 2013; Naik *et al.* 2013b).

Table 3. Effect on milk yield and feed conversion ratio

Parameter	MGG	HMFG
Milk yield		
Milk yield (kg/day)	7.97±1.46	8.59±1.92
4.0% Fat corrected milk (kg/day)	8.25±1.79	9.31±2.31
Milk composition		
Fat (%)	4.20±0.44	4.50±0.22
SNF (%)	9.08±0.09	8.92±0.07
Feed conversion ratio (*kg feed/ 4% FCM kg milk yield*)		
DM	1.51±0.36	1.40±0.34
CP	0.19±0.04	0.18±0.04
DCP	0.14±0.03	0.13±0.03
TDN*	1.03±0.25^{b}	0.96±0.25^{a}

*Means bearing different superscripts in a row differ significantly (P<0.05).

It can be concluded that hydroponics maize fodder can be fed to the lactating cows by replacing maize of the concentrate mixture partially with improvement in the performance of the animals.

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