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The effect of feeding hydroponics maize fodder on growth performance and nutrient digestibility in cross bred calves

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Abstract
A study was undertaken to assess the effect of feeding hydroponic fodder maize on growth performance in cross-bred calves. Fifteen healthy cross-bred calves of three months age were selected and were divided into three groups of five each based on their age, sex and body weight. They were allotted randomly to three experimental treatments T_1 (control), T_2 (50% of the calf starter was replaced by hydroponic maize fodder on dry matter (DM) basis), T_3 (75% of the calf starter was replaced by hydroponic maize fodder on DM basis). All the experimental animals were fed with calf starter containing 24% CP and 70% TDN and the feeding trial was conducted for a period of 90 days. The results of the experiment showed that calf starter can be replaced with hydroponic maize fodder on DM basis at 75% level without any adverse effect on the growth performance and nutrient digestibility in cross-bred calves.

Keywords: Hydroponic fodder, cross-bred calves, growth, digestibility

Introduction
The decreasing pasture availability and increasing use of grazing lands for crop production has necessitated the improvement of feeding systems. Feeding systems based on improved feeding practices will help to maintain the body conditions of animals, increase their resistance to diseases and nutrition-related problems and thus to increase animal productivity and rural income opportunities. Hydroponic fodder is an emerging area in this regard. (Naik 2014) [10]. The method of growing plants without soil using bare a minimum quantity of water is known as hydroponics, and it is easier to harvest and hence need less labour. Hydroponics is a Greek word, which means "water working" ("Hydro" means "water" and "Ponic" means "working"). The idea of hydroponic fodder production include putting one kilogram of grain into a hydroponic system and producing four to eight kilograms of fresh green sprouts, independent of weather and seasons. Hydroponic fodder can reach 25-28 cm height and roots will be formed like a mat within eight to nine days. (Rajkumar *et al*., 2018) [12]. Development of this system has enabled the production of fresh forage from maize, oats, barley, wheat and other grains. Hydroponics fodder requires only 5% of space and 2 to 3% of water when compared to conventional field cropping. In the process of germination there will be breakdown of complex compounds into a simpler form and nutrients of the grains are breakdown by hydrolytic enzymes. Due to this enzymatic action, total protein, fat, certain essential amino acids, total sugar, B- complex vitamins of the sprouts will get enhanced. Researches to evaluate the nutritive value of the hydroponic fodder as a partial replacement for feed/fodder are very scanty. Hence this research work is planned to evaluate the growth performance of calves fed on hydroponic fodder maize.

Materials and Methods
Fifteen healthy weaned cross-bred calves of three to four months of age, selected from University Livestock Farm and Fodder Research Development Scheme (ULF&FRDS), Mannuthy formed the experimental subjects for the study. The calves were allotted randomly to three experimental treatments T_1 (control), T_2 (50% of the calf starter was replaced by hydroponic maize fodder on the dry matter (DM) basis), T_3 (75% of calf starter was replaced by hydroponic maize fodder on the DM basis) as uniformly as possible with regard to age, sex and body weight. All the experimental animals were fed with calf starter containing 24% CP

and 70% TDN and good quality green grass was offered to all the treatment groups at *adlibitum*. Calves were fed as per ICAR standard (2013) [5]. The calves were housed individually in well ventilated, clean and dry pen with facilities for feeding and watering.

Hydroponics maize fodder production: Two hydroponics fodder making devices used in the present study were installed in a room of 16×13 feet size. The room was enclosed using a green house net. Water was stored in a tank having 300 litre capacity. Water fogging was done in every two hours for a period of 60 seconds with the use of an automatic electronic controller circuit. The two chambers of hydroponics maize fodder producing unit, each measured about 14 ft× 5 ft × 6 ft, was built using stainless steel. Each unit had a daily production capacity of 25 kg hydroponics fodder. Dry, sound and clean seeds of maize (*Zea mays*) were procured from Haritha Agro Tech Ltd., Thrissur. After 6 hours of soaking, clean maize seeds were transferred in to a gunny bag and kept for 12 hours and 2 kg of these seeds were loaded on a plastic tray of 4 ft × 2 ft for germination. Hydroponic fodder was allowed to grow for a period of 8 days and was fed to the calves on ninth day.

All the calves were fed as per ICAR standards (ICAR, 2013) [5]. Weighed quantity of calf starter, hydroponic fodder maize and good quality green grass were offered to all the experimental animals during the forenoon and afternoon periods and data on quantities of calf starter, hydroponic fodder maize and green grass offered daily were recorded. The data on daily dry matter intake from calf starter, hydroponic fodder maize and green grass with respect to each calf were maintained throughout the experimental period. Body weights of all the calves were recorded at fortnightly intervals. Based on the body weight, feed and fodder allowances were revised fortnightly. Clean drinking water was made available to all calves throughout the experiment. The experiment was done for a period of three months.

Digestion trial involving a total collection period of five days was carried out towards the end of the feeding experiment to assess the digestibility coefficient of nutrients. The representative samples of calf starter, hydroponic fodder maize and green grass offered were taken daily during the digestion trial for chemical analysis. The balance of feed, hydroponic fodder maize and grass samples were collected from individual animals and their moisture content was determined. At the end of the collection period feed samples collected daily were pooled and subjected to chemical analysis. The dung was collected manually as and when it was voided. All precautions were taken to collect the dung quantitatively, uncontaminated with urine, feed residue or dirt. The dung collected each day was weighed accurately and were kept in double lined air tight plastic bags and stored in a deep freezer during the entire collection period. At the end of the collection period, stored samples from each animal were pooled and used for chemical analysis.

The calf starter, fodder and dung samples were analyzed for proximate principles. (AOAC, 2016) [1]. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined using the method described by Van Soest *et al.*, (1991) [16].

The data obtained on different parameters during the course of the experiment were subjected to statistical analysis using Analysis of Variance (ANOVA) (Snedecor and Cochran, 1994) [15].

Results and Discussion

The ingredient composition of calf starter is presented in Table 1. The chemical compositions of calf starter, Hydroponic fodder maize and Hybrid Napier grass (CO-3) are presented in Table 2. The nutrient content of calf starter is as per BIS specification [2] and chemical composition of CO-3 and Hydroponic fodder maize was within the normal range and were comparable to the values of earlier researchers. (Naik *et al.*, 2013, Naik *et al.*, 2014, Naik *et al.*, 2017 and Rajkumar *et al.*, 2018) [9-12].

Table 1: The ingredient composition of the calf starter

Ingredient composition	Percentage composition of calf starter
Maize	23
Black gram bran	25
Soya bean meal	25
Corn gluten fibre	20
Gingilly oil cake	5
Mineral mixture	2
Salt	1
Total	100

Table 2: The chemical composition of calf starter, hydroponics maize fodder and green grass fed to experimental calves% (DM basis)

Parameters	Calf Starter	Hydroponic Maize Fodder	Hybrid Napier
Dry matter	91.93	18.48	19.78
Crude Protein	24.34	12.88	11.24
Ether extract	4.23	3.47	2.98
Crude fibre	5.36	9.31	25.14
Total Ash	6.67	2.79	10.88
Nitrogen free extract	59.4	71.55	49.76
Acid insoluble ash	2.34	0.48	3.12
Calcium	2.04	0.78	0.49
Phosphorus	1.05	0.53	0.32

Body weight gain

The data on fortnightly body weight of calves have been presented in the Table 3. The average initial body weight of the calves in treatments T_1, T_2 and T_3 were 54.72, 54.80 and 54.84 kg, respectively. The average body weight of calves were recorded at fortnight intervals and the final body weight was 79.98, 84.38 and 82.06 kg, respectively for T_1, T_2 and T_3 at the end of experiment. There was no significant difference ($P>0.05$) in body weight among the three dietary treatments. Total weight gain and the average daily gain of the calves were similar among the dietary treatments and presented in Table 3. These results were in agreement with Fazaeli *et al.* (2011) [3]. A higher body weight gain were reported by Verma *et al.* (2015) [17] and Rajkumar *et al.* (2018) [12] in calves fed hydroponics barley fodder and hydroponic maize fodder, respectively.

Table 3: The fortnightly average body weight (kg) of experimental calves

Fort night	Treatments		
	T_1	T_2	T_3
0	54.72 ± 1.72	54.80 ± 1.33	54.84 ± 1.73
1	57.48 ± 2.18	58.08 ± 1.69	58.06 ± 2.27
2	60.96 ± 2.13	60.97 ± 1.82	61.78 ± 2.89
3	63.36 ± 1.97	64.60± 2.16	64.06 ± 3.25
4	68.44 ± 2.91	70.10± 2.41	68.90 ± 3.55
5	72.86 ± 2.37	74.48± 2.81	74.92± 4.07
6	79.98 ± 2.33	84.38 ± 3.08	82.06 ± 4.22
Parameters			
Initial body weight (kg)	54.72 ± 1.72	54.80 ± 1.33	54.84 ± 1.73
Final body weight (kg)	79.98 ± 2.33	84.38 ± 3.08	82.06 ± 4.22
Total weight gain (kg)	25.26 ± 0.97	29.58 ± 1.86	27.22 ± 2.86
Average daily gain (g)	300.80± 0.01	352.20 ± 0.02	324.00± 0.03
Total DM intake (kg/animal)	166.26 ± 4.88	169.40 ± 3.43	168.80 ± 9.06
Average daily DM consumed(kg/animal)	1.85 ± 0.07	1.88 ± 0.02	1.87 ± 0.04
FCR	6.61 ± 0.27	5.79 ± 0.28	6.32 ± 0.34

T_1, T_2 and T3- mean of five values. (P>0.05).

Dry matter intake

The total dry matter intake during the experimental period was 166.26, 169.40 and 168.80 kg respectively for T_1, T_2 and T_3. (Table 3). Similar observations were made by Naik *et al*., (2014) [10] in calves which were fed with hydroponics fodder maize and conventional fodder. Fazaeli *et al*., (2011) [3] reported a lower DM intake in calves fed with hydroponics barley fodder where as Verma *et al*., (2015) [17] and Rajkumar *et al*., (2018) [12] reported a higher DM intake in calves fed with hydroponics barley fodder and hydroponic maize fodder, respectively. The feed conversion ratio (FCR) observed in the present study was 6.61, 5.79 and 6.32 respectively for T_1, T_2 and T_3. Fazaeli *et al*., (2011) [3] also reported similar FCR in calves fed with either hydroponics barley fodder or control diet. Rajkumar *et al*., (2018) [12] observed improved FCR in calves fed hydroponics maize fodder than those fed with control diet.

Digestibility of nutrients

The digestibility of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) observed in the present study were 74.66, 76.18 and 76.66, 76.83, 79.14 and 78.91, 50.49, 51.90 and 51.24, 82.22, 82.88 and 86.47, 81.15, 82.71 and 82.07,60.02,61.56 and 60.60, 47.01,50.01 and 49.17% in the 3 dietary treatments T_1, T_2 and T_3, respectively. The statistical analysis revealed a significant difference among the groups in their digestibility of CP and EE; whereas the digestibility of DM, CF, NFE, ADF and NDF were found similar among the treatment groups. (Table 4). Khanna *et al*., (2016) [6] observed similar DM digestibility in buffaloes fed with hydroponics maize fodder. Verma *et al*., (2015) [17] reported higher DM digestibility in calves fed with hydroponics barley fodder and Limba (2015) [8] reported improved DM digestibility in cows fed with hydroponic maize fodder than those fed control diet.

The digestibility of CP and EE were significantly higher in treatment group (P < 0.05). Naik *et al*., (2014) [10] and Verma *et al*., (2015)[16] also observed increased digestibility of CP in cows and in calves respectively, fed with hydroponics maize fodder. The increase in digestibility of nutrients may be due to high enzyme activities in the sprouts. Helal and Hassan (2013) [4] reported lower CP digestibility in goats fed hydroponics barley sprouts compared to alfalfa fed control groups. Khanna *et al*., (2016) [6] found significant improvement in digestibility of EE in Murrah buffaloes fed hydroponics maize fodder than those fed conventional fodder diet. Naik *et al*., (2014) [10] in lactating cows, Verma *et al*., (2015) [17] in Hariana male calves and Rajkumar *et al*., (2018) [12] in cross-bred calves found similar digestibility of EE in control and hydroponic fodder maize fed groups. The CF digestibility obtained in the present study was in accordance with previous observation by Naik *et al*., (2014) [10], Verma *et al*., (2015) [17] and Rajkumar *et al*., (2018) [12]. Khanna *et al*., (2016) [6] recorded improved CF digestibility in buffaloes fed with hydroponics maize fodder than those fed conventional fodder.

Naik *et al*., (2014) [10] and Sharma *et al*., (2016) [14] reported similar NFE digestibility in dairy cows and in goats respectively, fed with either hydroponics fodder or conventional fodder, whereas Khanna *et al*., (2016) [6] reported lower digestibility of NFE in Murrah buffaloes fed with hydroponics maize fodder than those fed with the basal diet. The digestibility of NDF and ADF were not affected by the addition of the hydroponic maize fodder to the ration of calves and was within the normal range reported to the species. Rani *et al*., (2016) [13] and Kumar *et al*., (2017) [7] also reported similar NDF and ADF digestibility in cross-bred calves. Khanna *et al*., (2015) [6] reported an increase in digestibility of NDF in lactating buffaloes and Limba (2015) [8] reported increased digestibility of ADF in Rathi cows fed with hydroponic fodder maize.

Table 4: The digestibility coefficient of nutrients* in calves maintained on three dietary treatments%

Parameter	T_1	T_2	T_3
Dry matter	74.66 ± 0.40	76.18 ± 0.44	76.66 ± 0.52
Crude protein	76.83 ± 0.45^a	79.14 ± 0.42^b	78.91 ± 0.44^b
Crude fibre	50.49 ± 0.57	51.90 ± 0.23	51.24 ± 0.89
Ether extract	82.22 ± 0.28^a	82.88 ± 0.19^b	82.47 ± 0.44^b
Nitrogen free extract	81.15 ± 0.30	82.71 ± 0.28	82.07 ± 0.42
NDF	60.02 ± 0.47	61.56 ± 0.32	60.68 ± 0.28
ADF	47.01 ± 0.15	50.01 ± 0.18	49.17 ± 0.23

*T_1 T_2 and T_3 - mean of five values a, b - Means with different superscripts within the same row differ significantly (P<0.05)

Conclusion

The results of the present study revealed that calf starter can be replaced with hydroponic maize fodder on DM basis at 75% level in crossbred calves without any adverse effect on their growth performance and nutrient utilization. Improvement in nutrient utilisation may be due to the high quantity of bioactive enzymes in the sprouts. Further research should be needed to know the long term effect of feeding hydroponic maize fodder.

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