NUTRITIONAL EVALUATION AND EFFECT OF FEEDING HYDROPONIC FODDER MAIZE ON THE HAEMATO-BIOCHEMICAL PARAMETERS IN CROSS BRED CALVES

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Abstract

The study was undertaken to assess the nutrient changes occurring during the growth of hydroponic fodder maize (HFM) and effect of feeding HFM on blood biochemical and haematological parameters in cross bred calves. Representative samples of HFM were taken on each day of germination and were oven dried and subjected to chemical analysis. Results showed that crude protein (CP), total ash (TA), ether extract (EE), crude fiber(CF) and acid insoluble ash increased whereas nitrogen free extract(NFE) decreased ($p<0.05$) in the HFM when compared with the original grain. For animal experimentation fifteen healthy crossbred calves of three months age were selected and divided into three groups of five each based on age, sex and body weight and allotted randomly to three experimental treatments T_1 (control), T_2 (50% of calf starter replaced by HFM on dry matter basis), T_3 (75% of calf starter replaced by HFM on dry matter basis). All the experimental animals were fed with calf starter containing 24% CP and 70% TDN and were fed as per ICAR standard (2013). Feeding trial was conducted for a period of 90 days. The haemato- biochemical parameters such as plasma protein, plasma glucose, serum calcium, serum phosphorus, blood urea nitrogen, serum cholesterol and triglycerides did not show any significant difference ($P>0.05$) among the groups.

It can be concluded that HFM is more nutritious than conventional fodder maize and calf starter can be replaced with HFM on dry matter basis at 75 percent level without any adverse effect on the haemato-biochemical parameters in cross bred calves.

Key words: *Hydroponic fodder, Crossbred calves, Nutrient, Blood*

India has the largest cattle population in the world and a large gap exist in between demand and availability of feeds and fodder. (Gebremedhin *et al.,* 2015 and Ata, 2016). The

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diminishing pasture availability and increasing use of grazing lands for crop production has necessitated changes in the feeding systems. Hydroponic fodder is a promising area in this regard (Naik *et al.,* 2014). The method of growing plants without soil using 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 concept of hydroponic fodder production include using one kilogram of grain in a hydroponic system and producing four to eight kilograms of fresh green sprouts, independent of weather and seasons. Within eight to nine days, hydroponic fodder can reach 25-28 cm height and roots will be formed like a mat. (Rajkumar, 2016). Development of this system has enabled the production of fresh forage from maize, oats, barley, wheat and other grains. Additionally, compared to conventional field cropping, hydroponics fodder requires only five per cent of space and two to three per cent of water (Al-Karaki and Al-Hashimi, 2012). During sprouting process there will be breakdown of complex compounds into a simpler form (protein, starch and lipid) by hydrolytic enzymes. Due to this enzymatic action, total protein, fat, certain essential amino acids, total sugar, B- complex vitamins of the sprouts will be enhanced (Dung *et al*., 2010). Research to evaluate the nutritive changes of the ydroponic fodder maize (HFM) and feeding trials as a partial replacement for calf starter in cross bred calves are very limited. Hence this research work was done to evaluate the nutritive changes of the HFM and to study the performance of calves fed on HFM.

Materials and Methods

Hydroponics maize fodder production: Two hydroponics fodder making devices used in the present study were installed in a room of 16 × 13 ft 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 hrs for a period of 60 seconds with the use of 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* L.) were procured from Haritha Agro Tech Ltd. Thrissur. After 6 hours soaking, clean maize seeds were transferred to gunny bag and kept for 12 hours. Two kg of these seeds were loaded on a plastic tray of 4 ft × 2 ft. inside the green house and hydroponics fodder was allowed to grow for 8 days and was fed to the calves on ninth day.

Representative samples were taken on each day of germination and were oven dried to estimate the dry matter content. The samples then analysed for nutrient content *viz*., Crude Protein (CP), Crude Fiber (CF), Ether Extract (EE), and Total Ash (TA) as per AOAC (2016).

Fifteen healthy weaned crossbred 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 calf starter replaced by HFM on dry matter basis), T_3 (75% of calf starter replaced by HFM on dry matter 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 *ad libitum*. The calves were housed individually in well ventilated, clean and dry shed with facilities for feeding and watering. Weighed quantity of calf starter and hydroponics fodder maize was given in the forenoon and fresh green grass was fed in the afternoon to the calves throughout the experimental period. Individual data on quantities of calf starter, hydroponic fodder maize and green grass offered daily were recorded. Body weights of all calves were recorded at fortnightly intervals. Based on the body weight, feed and fodder allowances were reviewed fortnightly. Calves were fed as per ICAR (2013) for a period of three months.

Blood samples were collected from all animals at the end of the experiment.

Haematological parameters were studied immediately in fresh blood samples using haematological analyzer (Mythic 18 vet). Plasma total protein, glucose, blood urea nitrogen, calcium, phosphorus, cholesterol and triglycerides were determined using the blood analyzer (Mispa plus, SEAC radim group) using kits supplied by Agappe diagnostics, Ernakulam, India.Data were analyzed statistically as per Analysis of Variance (Snedecor and Cochran, 1994).

Ingredient composition of calf starter and chemical composition of calf starter and Hybrid Napier grass (CO-3) are presented in Tables 1and 2.

Results and Discussion

The nutrient content of calf starter is as per BIS specification and chemical composition of CO-3 was within the normal range and are comparable to the values of earlier research workers. (Naik *et al*., 2013, Naik *et al*., 2014 and Naik *et al*., 2017).

Table 1. Ingredient composition of calf starter (%)

Ingredient composition	Percentage composition of calf starter
Maize	22.50
Black gram bran	25.00
Soya bean meal	25.00
Corn gluten fibre	20.00
Gingilly oil cake	5.00
Mineral mixture	2.00
Salt	0.50

Chemical composition of fodder maize on different days of sprouting under hydroponics system, % (DM basis) is presented in Table 3. Crude protein (CP) content of the hydroponics maize fodder was 13.81 per cent on ninth day of sprouting. There was significant (P<0.01) increase in CP content from first to ninth day of cultivation. Naik *et al*. (2012) and Gebremedhin (2015) also found an increased CP content during sprouting of HFM. The increase in CP content was mainly due to decrease in DM content (Sneath and McIntosh, 2003). Crude fibre (CF) content of hydroponics maize fodder was 10.04 per cent. Similar results were also observed by Gebremedhin (2015) and Gunasekaran *et al*. (2016). Increase in CF (P<0.01) observed at different stages of growth was mainly due to the synthesis of structural carbohydrates like cellulose and hemicelluloses (Chung *et al,* 1989 and Naik *et al*. (2012). Ether extract (EE) content of the hydroponics maize fodder was 3.57 was significantly (P<0.01) different at different stages of growth. The present results were correlated with findings of Naik *et al*. (2012) and Gunasekaran *et al*. (2016). The total ash (TA) content observed in nine day grown hydroponics maize fodder was 3.36 per cent and values were increasing significantly (P<0.01) at different days of growth. Comparable values were also reported by Gebremedhin (2015). The nitrogen free extract **(**NFE) content of hydroponics maize fodder was 68.82 per cent and NFE content decreased significantly (P<0.01) at different days of

Table 2. Chemical composition of calf starter, and green grass (CO-3) fed to experimental calves as per cent (DM basis)

Parameters	Calf Starter	Hybrid Napier
Dry matter	91.93	19.78
Crude Protein	24.34	11.24
Ether extract	4.23	2.98
Crude fibre	5.36	25.14
Total Ash	6.67	10.88
Nitrogen free extract	59.4	49.76
Acid insoluble ash	2.34	3.12
Calcium	2.04	0.49
Phosphorus	1.05	0.32

sprouting. The present result is comparable with the findings of Gebremedhin (2015). The acid insoluble ash (AIA) content of maize seed increased to 0.55 at ninth day of sprouting. In agreement with the present results, Naik *et al*. (2012) and Gebremedhin (2015) also found comparable results for HFM.

The values of various haematological parameters, (haemoglobin, MCV, MCHC, RBC count, WBC count, granulocytes, lymphocytes, and monocytes) were similar in both groups indicating that dietary incorporation of HFM did not affect these parameters to any significant effect(Table 4). The average plasma protein concentrations at the end of the experiment for group T_1, T_2 and T_3 were 6.38, 6.56 and 6.46 g/dL, respectively. The average serum Ca and P values in experimental animals were 11.27, 6.59, 11.29, 6.42 and 11.30, 6.49 mg/dL for group T_1, T_2 and T_3, respectively. The concentration of glucose and BUN was 60.97, 10.58, 61.04, 10.76 and 61.06, 11.12 mg/dL, in group T_1, T_2 and T_3 respectively The average serum cholesterol and triglyceride values were 95.33, 32.82 ,92.88, 28.45 and 90.86, 29.58mg/ dL, respectively for group T_1, $T_2$and T_3. There was no significant difference in any of the blood biochemical parameters between the three groups (Table 5).

Table 3. Chemical composition of fodder maize[1] on different days of sprouting under hydroponics system, % (DM basis)

Parameters	Maize seed	Days of sprouting under hydroponics system								
		1	2	3	4	5	6	7	8	9
Dry matter	90.73 ± 0.04^{j}	60.82 ±0.15^{i}	50.48 ±0.29^{h}	35.76 ±0.19^{g}	32.71 ±0.29^{f}	27.07 ±0.24^{e}	22.08 ±0.22^{d}	20.58 ±0.12^{c}	18.48 ±0.15^{b}	17.50 ±0.16^{a}
Crude protein	8.50 ±0.09^{a}	8.92 ±0.02^{b}	9.4 ±0.09^{c}	9.85 ±0.04^{d}	10.74 ±0.04^{e}	11.77 ±0.04^{f}	11.85 ±0.02^{g}	12.42 ±0.03^{h}	12.89 ±0.03^{i}	13.81 ±0.07^{l}
Ether extract	2.14 ±0.01^{a}	2.24 ±0.02^{b}	2.56 ±0.01^{c}	2.74 ±0.01^{d}	2.85 ±0.01^{d}	3.08 ±0.02^{e}	3.15± 0.01^{f}	3.26 ±0.02^{g}	3.47 ±0.02^{h}	3.57 ±0.01^{i}
Crude fibre	2.32 ±0.02^{a}	2.57 ±0.01^{b}	3.18 ±0.02^{c}	4.79 ±0.03^{d}	5.16 ±0.02^{e}	5.58± 0.15^{f}	6.2± 0.02^{g}	8.22 ±0.04^{h}	9.31 ±0.04^{i}	10.04 ±0.01^{j}
Total Ash	1.13 ±0.00^{a}	1.24 ±0.01^{b}	1.35 ±0.01^{c}	1.52 ±0.01^{d}	1.56 ±0.01^{d}	1.64± 0.01^{e}	1.75± 0.01^{f}	2.27 ±0.02^{g}	2.79 ±0.02^{h}	3.36 ±0.03^{i}
Nitrogen free extract	85.91 ±0.13^{i}	85.03 ±0.03^{i}	83.52 ±0.09^{h}	81.09 ±0.05^{g}	79.65 ±0.05^{f}	78.34± 0.10^{e}	77.0± 0.04^{d}	73.82 ±0.06^{c}	71.54 ±0.05^{b}	68.82 ±0.05^{a}
Acid insoluble ash	0.02 ±0.00^{a}	0.02 ±0.00^{a}	0.06 ±0.00^{b}	0.07 ±0.00^{c}	0.08 ±0.00^{d}	0.18± 0.00^{e}	0.21± 0.00^{f}	0.33± 0.01^{g}	0.48 ±0.00^{h}	0.55 ±0.00^{i}

Means bearing different superscripts within same rows differ significantly (P<0.01)

[1] Average of six values with SE

Table 4. Haematological parameters of experimental calves

Parameters	**T_1**	**T_2**	**T_3**
Haemoglobin (mg/dl)	12.18 ± 0.14	12.17 ± 0.15	12.15 ± 0.32
MCV (fL)	38.16 ± 0.18	38.79 ± 1.44	38.21 ± 1.24
MCH (pg)	12.60 ± 0.46	12.75 ± 0.19	12.16 ± 0.33
MCHC (g/dl)	32.12 ± 0.19	32.08 ± 0.79	31.78 ± 0.51
RBC count (x 10^6/µl)	8.04 ± 0.55	8.08 ± 0.07	8.26 ± 0.35
WBC count (x10^3/µl)	10.58 ± 0.84	10.57 ± 0.22	10.98 ± 0.72
Granulocyte (%)	36.78 ± 0.78	36.42 ± 0.69	36.42 ± 0.69
Lymphocyte(%)	59.72 ± 1.26	59.78 ± 1.02	59.22 ± 1.13
Monocyte(%)	3.13 ± 0.33	3.56 ± 0.16	3.86 ± 0.23

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

Table 5. Blood biochemical parameters of experimental calves

Parameter	T_1	T_2	T_3
Total protein, (g/dl)	6.38 ± 0.06	6.56 ± 0.07	6.46 ± 0.10
Calcium, (mg/dl)	11.27 ± 0.8	11.29 ± 0.16	11.30 ± 0.09
Phosphorus, (mg/dl)	6.59 ± 0.13	6.42 ± 0.10	6.49 ± 0.07
Glucose, (mg/dl)	60.97 ± 0 .33	61.04 ± 0.29	61.06 ± 0.16
BUN,(mg/dl)	10.58 ± 0.58	10.76 ± 0.63	11.12 ± 0.52
Cholesterol,(mg/dl)	95.33 ± 2.62	92.88 ±1.43	90.86 ± 2.48
Triglyceride,(mg/dl)	32.82 ± 2.82	28.45 ± 1.80	29.58 ± 2.52

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

Values recorded in the present study falls in the normal range reported for the species. (Rani *et al.,* 2011, Vinu, 2012, Jini, 2014, Kumar *et al.,* 2016 and Rani *et al.*, 2016). Present results are in agreement with Verma *et al*. (2015) and Rajkumar (2016) who reported that incorporation of hydroponics fodder maize in the ration of calves showed no significant difference between treatments on haematological and blood biochemical parameters.

Critical evaluation of the results obtained in the present study revealed that HFM is more nutritious than conventional fodder maize grain and inclusion of HFM in the ration of calves had similar effect on haematological and biochemical parameters. On summarizing the overall results of the study, it could be inferred that calf starter can be replaced with hydroponic maize fodder on dry matter basis at 75 percent level cross bred calves without any adverse effect on their haemato-biochemical parameters and health.

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