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Methane Reduction Potential of Hydroponic Fodders and Combination of Hydroponic Fodder Bajra with Anionic Salts in Increasing Serum Calcium Level of Transition Cows

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ABSTRACT

Background: The study reported in this research is to assess the methane reduction potential of hydroponic fodders and its novel combination with anionic salts on the serum calcium level in transition cows, the period cows are prone to metabolic disorders.

Methods: A growth trial of hydroponic fodders to assess the biomass yield and an *in vitro* gas production study was conducted to assess the methane production on inclusion of different hydroponic fodders with that of conventionally cultivated fodders along with paddy straw and concentrate feed. A feeding trial was also conducted in 16 transition cows (farm and field conditions) to assess the serum calcium level through feeding anionic salts *viz*., calcium sulphide and magnesium chloride along with hydroponic fodder bajra.

Result: Significantly (P<0.05) lowest methane production was observed in paddy straw, hydroponic fodder bajra, concentrate feed group compared to other treatment groups. Anionic salts supplementation for three weeks prior to calving resulted in significant (P<0.05) increase in the serum calcium levels. In post supplementation, average increase in serum calcium level is 0.93 mg/dl, an increase by 10.80 per cent. Further, feeding cost of anionic salts (Calcium sulphide and magnesium chloride) for three weeks (21 days) is only INR 55.65/-.

Key words: Anionic salts, Hydroponic fodder, Serum calcium, Supplementation, Transition cows.

INTRODUCTION

Tamil Nadu contributes more than 5% of total milk production in the country and ranked 10th among high milk producing states in India (Policy note, 2022). Healthy cows are highly essential to augment milk yield. High yielding cows are prone for metabolic disorders in the transition period. The time period from 3 weeks before calving to 3 weeks after calving is defined as the transition period. During transition period, managing right nutrition improves milk production and reproductive performance. Milk fever is the one of transition period diseases which is most common in mature dairy cows around 5-10 years of age occurs due to the deficiency of calcium (Neville, 2010). Older animals are more susceptible and the incidence of milk fever increases to above 10% from 3rd to 7th calving (Radostits *et al*., 2000). The economic importance of milk fever is reduction in quantity of milk yield which is around 142 kg per lactation (Bar and Ezra, 2005). Prevalence of milk fever in cattle is 13.67% and for buffalo it is 11.99%. Death arises in dairy cows if not treated in time. The treatment is expensive for recovery of animals. Total economic losses of the farmer due to milk fever is INR 1068/- per affected animal (Thirunavukkarasu *et al*., 2010).

MATERIALS AND METHODS

A growth trial was carried out to ascertain the biomass yield of hydroponic fodder maize, hydroponic fodder bajra, hydroponic fodder horse gram and hydroponic fodder sunhemp. Hydroponic fodders were produced in a locally fabricated hydroponic unit in plastic trays at Institute of

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Animal Nutrition, Kattupakkam during the year 2022. Irrigation to the fodder was done by automatic sprinklers at 3 hourly intervals for 15 seconds. Maize seeds were soaked in water for 12 hours and the soaked seeds were allowed to sprout in gunny bags for 24 hours before being loaded onto plastic trays for fodder production in the fabricated hydroponic unit. The seeds of horse gram, bajra and sun hemp were soaked in water for 12 hours and allowed to sprout in gunny bags for 4 hours. Fodder biomass yield was recorded on 9th day for hydroponic fodder maize, 6th day for hydroponic fodder bajra, hydroponic fodder horse gram and hydroponic fodder sunhemp. The fodder biomass yield was documented on fresh matter basis by weighing the trays of hydroponic fodder maize, hydroponic fodder bajra, hydroponic fodder horse gram and hydroponic fodder sunhemp and subtracting the respective weights from respective empty tray weights. In the above experiments for the optimum growth of hydroponic maize and horse gram, standardized conditions were followed (Gunasekaran *et al*., 2018; Gunasekaran *et al*., 2020; Gunasekaran *et al*., 2022). Standardized growth conditions were followed for hydroponic bajra and sun hemp (Rachel *et al*., 2018). Representative samples of hydroponic fodder maize, hydroponic fodder bajra, hydroponic fodder horse gram and hydroponic fodder sun hemp were collected and analysed for mineral content (Sodium, Potassium, Chloride and Sulphur) to calculate the Dietary Cationic Anionic Difference status of hydroponic fodders (AOAC, 2015). The dietary cationic and anionic difference was calculated:

$$\text{DCAD mEq/100g DM} = (Na + K) - (Cl + S)$$

An *in vitro* gas production technique Hoheneim gas production (Menke and Steingass, 1988) was conducted to study methane production potential of hydroponic fodders in combination with conventionally cultivated fodders along with paddy straw and concentrate feed. Diets were prepared by mixing roughage and concentrate feed in 75: 25 ratio. In the roughage portion, paddy straw and hydroponic fodders/ conventional fodders were mixed in 65:35 ratio. The inclusion ratio (2:1) for cereal hydroponic fodders and leguminous hydroponic fodders was followed in this trial. In this study, 200 mg of sample and 30 ml rumen buffer volume was taken per 100 ml glass syringe. Fresh rumen liquour was collected from cattle through stomach tube. The syringes were incubated for 24 hours in a orbital shaking incubator at 39°C. Total gas production was recorded at 24 hours. The total gas was partitioned as carbon dioxide and methane using saturated potassium hydroxide solution. *In vitro* true digestibility of dry matter (IVTDDM) and methane per 100 mg true digestibility of dry matter (TDDM) was also determined.

Table 1: Fresh biomass yield (Kg/Kg seed) of hydroponic fodders produced in the hydroponic fodder production unit (Mean*±SE).

Hydroponic fodders	Biomass yield (kg/kg seed)
Fodder maize	4.01±0.13
Fodder bajra	3.93±0.15
Fodder horse gram	6.28±0.27
Fodder Sunhemp	5.36±0.50

*Mean of six samples

For conducting a feeding trial with supplementation anionic salts, seven pregnant cows in farm and nine pregnant cows in field conditions approximately three weeks before calving were selected. The selected cows were supplemented with anionic salts along with concentrate feed / bran and oil cakes during the last three weeks before parturition. DCAD value of the ration to be fed to experimental cows in transition period was adjusted to -15 to -10 mEq/100 g dry matter by feeding anionic salts *viz*., calcium sulphide and magnesium chloride along with hydroponic fodder bajra to achieve the urine pH around 6.0-6.5.

RESULTS AND DISCUSSION

The fresh biomass yield (Kg/Kg seed) of hydroponic fodders produced in the hydroponic fodder production unit is presented in Table 1.

In hydroponic cereal fodders, biomass yield is found to be higher for hydroponic fodder maize compared to hydroponic fodder bajra whereas among the leguminous hydroponic fodders horse gram is found to be higher compared to sunhemp.

The sodium, potassium, chloride and sulphur contents (% DMB) and DCAD value of hydroponic fodders is presented in Table 2.

DCAD value of hydroponic fodder maize, hydroponic fodder bajra, hydroponic fodder horse gram and hydroponic fodder sunhemp was -0.34, -5.45, 14.40 and -3.00 m Eq/ 100 g DM respectively.

Feeding with paddy straw, hydroponic fodders and concentrate feed decrease the methanogenesis compared to paddy straw, conventional green fodder and concentrate feed group. Significantly ($P<0.05$) lowest methane production was observed in paddy straw, hydroponic fodder bajra, concentrate feed group compared to other treatment group. Per cent of methane in total gas production was lowest in paddy straw, hydroponic fodder maize, hydroponic horse gram and concentrate feed group compared to other group (Table 3).

Decreased methanogenesis in hydroponic fodders is due to shifting of fermentation towards propionogenesis. In an *in vitro* study, increased proportion of concentrate feeding has shown to reduce methane output by reducing the protozoal population (Iqbal *et al*., 2008). This could be the reason for reduced methane production in hydroponic fodder treatment groups normally harvested in 6-8 days.

Table 2: Sodium, potassium, chloride and sulphur content (% DMB) and DCAD value of hydroponic fodders (Mean*±SE).

Hydroponic fodders	Sodium (%)	Potassium (%)	Chloride (%)	Sulphur (%)	DCAD valuem Eq/100 g DM
Hydroponic fodder maize	0.118±0.01	0.487±0.01	0.305±0.01	0.147±0.01	-0.34
Hydroponic fodder bajra	0.164±0.01	0.518±0.01	0.530±0.01	0.175±0.01	-5.45
Hydroponic fodder horse gram	0.209±0.02	1.490±0.06	0.480±0.01	0.310±0.01	14.40
Hydroponic fodder sun hemp	0.112±0.01	0.892±0.01	0.197±0.01	0.403±0.02	-3.00

*Mean of six samples.

Table 3: *In vitro* total gas, carbon dioxide and methane production of hydroponic fodder based complete feed and conventional fodder based complete feed at 24 hours.

Treatments	Total gas (ml/0.2 g)	Methane (ml/0.2 g)	Per cent of methane in total gas production	IVTDDM %	Methane (ml)/ 100 mg of TDDM
Paddy straw+Hydroponic fodder maize+ Hydroponic sunhemp+Concentrate feed	18.75±5.97	5.22^{ab}±2.39	25.00^{a}±5.00	77.88^{ab}±5.14	6.38±2.73
Paddy straw+Hydroponic fodder maize+ Hydroponic horse gram +Concentrate feed	17.25±1.60	3.45^{ab}±0.32	20.00^{a}±0.00	77.30^{ab}±3.23	3.75±0.16
Paddy straw+Hydroponic fodder bajra+ Hydroponic sunhemp+Concentrate feed	10.25±3.40	2.87^{ab}±0.55	35.00^{ab}±8.66	75.79^{ab}±5.05	3.64±0.15
Paddy straw+Hydroponic fodder bajra+ Hydroponic horse gram+Concentrate feed	14.50±2.38	5.80^{ab}±0.95	40.00^{ab}±0.00	76.79^{ab}±1.07	8.11±2.00
Paddy straw+Hydroponic fodder maize+Concentrate feed	12.16±6.69	4.56^{ab}±2.86	33.33^{ab}±6.67	76.39^{ab}±5.30	6.33±1.31
Paddy straw+Hydroponic fodder bajra+Concentrate feed	9.75±3.35	2.45^{a}±0.50	30.00^{a}±7.07	84.46^{b}±2.25	2.88±0.54
Paddy straw+Fodder bajra napier hybrid grass+Concentrate feed	17.00±2.84	7.05^{ab} ±2.45	38.75^{ab}±10.87	73.49^{ab} ±2.05	10.90±5.38
Paddy straw+Fodder sorghum+ Concentrate feed	19.50±2.19	7.45^{b}±0.47	40.00^{ab}±5.77	72.49^{a}±1.74	7.90±2.47

*Mean of six samples.

^{ab}Means values within a column bearing different superscripts differ significantly (P<0.05).

Table 4: Effect of anionic salts on serum calcium level (mg/dl) in transition cows.

Selected transition cows	Pre supplementation calcium level (mg/dl)	Post supplementation calcium level (mg/dl)
Institutional farms*	9.17^{a}±0.39	9.94^{b}±0.42
Farmers field**	8.80^{a}±0.58	9.85^{b}±0.61
Overall mean	8.96^{a}±0.36	9.90^{b}±0.38

*Mean of 7 samples, **Mean of 9 samples.

^{a,b} Means bearing different superscripts within row differ significantly (P<0.05).

Based on the feeding practices of the affected animals with milk fever, DCAD value was found to be positive (2035.64±144.58 mEq in Kg DM feed). This could be the reason for the animals to be affected by milk fever. For close up cows, DCAD value in feeds should be negative for higher serum calcium levels. For DCAD to have an effect on blood pH and hence milk fever, it must be at 0 mEq/100 g DM or below (Roche *et al*., 2003).

Anionic salts supplementation (calcium sulphide and magnesium chloride) for three weeks prior to calving resulted in significant (P<0.05) increase in the serum calcium level. The details are provided in Table 4.

In post supplementation, average increase in the serum calcium level is 0.93 mg/dl (Table 4). Anionic salt supplementation resulted in increased serum calcium level by 10.80 per cent. Anionic salts activates calcium metabolism through bone resorption and increased calcium absorption in goats (Liesegang, 2006). The DCAD value contributed by feeding hydroponic fodder bajra (9 kg/animal/day) to transition cows is -6.13 mEq/100g DM, the cost of cultivation hydroponic fodder bajra will be higher, however the similar DCAD level could be obtained by additionally feeding 0.26 grams of calcium sulphide at the cost of INR 0.49 paise only to make it more farmer friendly. Supplementation of anionic salts (calcium sulphide and magnesium chloride) in the existing feeding practices is essential in improving serum calcium level of dairy cows in transition period thereby the incidence of milk fever can be reduced.

CONCLUSION

From the *in vitro* studies lowest methane production was observed in paddy straw, hydroponic fodder bajra, concentrate feed group compared to other treatment groups. From the feeding trials conducted in transition cows, anionic salts supplementation increased the serum calcium level (10.80%) and can reduced the incidence of milk fever in transition cows. Further, the feeding cost of anionic salts (Calcium sulphide and magnesium chloride) for three weeks (21 days) prior to calving is only INR 55.65/- thereby the farmers' money can be saved towards the treatment cost.

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Conflict of interest: None.

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