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Effect of di-calcium phosphate on calcium balance and body condition score of dairy cows fed Napier grass

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Abstract

A research work was undertaken to evaluate the feeding effects of di-calcium phosphate (DCP) on calcium balance and body condition score of dairy cows fed Napier grass. The trial was conducted in the village Alokdiar of Shajadpur upazilla under Sirajgonj district. Twenty crossbred lactating dairy cows of 320 ±15.5 kg live weight were used for the trial. Animals were equally and randomly allocated into four groups, T_0 (Napier+concentrate), T_1 (Napier+concentrate+100g DCP), T_2 (Napier+concentrate+150g DCP) and T_3 (Napier+concentrate+200g DCP). Total DMI did not differ significantly ($p>0.05$) among the groups but highly significant differences ($p<0.01$) were found in Ca intake. Ca balance; and Ca in feces, Ca in urine, Ca in milk and total Ca excretion differed significantly ($p<0.05$). No significant difference ($p>0.05$) was found in DM in feces (%), DM in feces (kg/d) and milk production (L) among the treatment groups except urine excretion. There was a linear increase of body condition score (BCS) with DCP (T_1, T_2 and T_3), but BCS was linearly declined in non DCP diet (T_0). Diets with 150g DCP may be suggested for optimizing Calcium balance and body condition score of dairy cows fed Napier grasses.

Key words: Body condition score, calcium excretion, dairy cows, di-calcium phosphate

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Introduction

The scarcity of quality fodders is one of the major problems in Bangladesh for rearing dairy cows. To mitigate this problem, Bangladesh Livestock Research Institute (BLRI) introduced Napier grass (*Pennisetum purpureum*) in the Pabna and Sirajgonj districts during 1988 to 2005, two most important milk pocket areas of Bangladesh. Despite increased daily milk production farmers complained that feeding fresh Napier grass(*Pennisetum purpureum*) resulted weakness and poor body condition (Huque et al. 2006) which is caused due to drainage of Ca in the form of calcium oxalate through the urine and feces at high rate of 25.28 g/d (Das et al. 2010). This might also be due to the presence of oxalate in the grass and feeding Napier to cows might lead to ingestion of oxalate above their dietary tolerance level (<2.0%) which might have an effect on mineral metabolism of these animals. Rahman et al. (2006) found that the oxalate content of the Napier was as high as 3.77% of the dry matter in early summer season (September - October). Since Napier grass is such an important forage species for animals throughout the tropics and sub-tropics because most of the dairy animals in our country depends on fresh grass, its soluble oxalate concentrations are of concern, being reported as relatively high (<3%) (Garcia-Rivera and Morris 1955; Lal et al. 1966; Dhillon et al. 1971), and sometimes exceeding 3.77 % of the dry matter (Rahman et al. 2006). Although plants can tolerate significant amounts of oxalate in tissues during the different stages of growth, high oxalate levels in plants have long been a significant concern for animal nutritionists, because of the negative health effects like lower body condition score associated with high intake of oxalate. Soluble oxalate can bind with calcium in the intestines and in the blood to form insoluble calcium oxalate crystals, lowering serum calcium levels. McKenzie et al. (1988) reported that 2% or more soluble oxalate can lead to acute toxicosis in ruminants. Although rumen bacteria can adapt to a high levels of soluble oxalate in the diet (Allison et al. 1977), sometimes acute toxicity occurred even in adapted ruminants fed with kikuyu grass containing relatively low oxalate (3.9–24.4 g/kg DM) concentrations (Marais 2001). While soluble oxalate is destroyed in the rumens of adapted

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animals, insoluble oxalate seems to pass through the digestive tract (Ward et al. 1979), though Libert and Franceschi (1987) reported that a substantial portion of calcium oxalate in the feed could be dissolved during digestion in ruminants. The role of insoluble oxalate in animals is not well understood. The present work was undertaken to determine the effect di-calcium phosphate (DCP) on Calcium balance and body condition score for optimizing the milk production of dairy cows fed Napier grass.

Materials and Methods

The research was conducted in the village Alokdiar, Shajadpur, Sirajgonj. The duration of the experiment was six months (November 2012 to April 2013). Twenty crossbred lactating dairy cows (of 1^{st} lactation) were selected for using in this trial. The average body weight and milk production were 320±15.5 kg/cow and 10 lit./d/cow, respectively. The animals were randomly distributed in four groups (T_0, T_1, T_2 and T_3) each having five animals. The animal grouping was done according to live weight (kg) and milk production (l/d). The animals were housed individually in loose shed. The animals were de-wormed with the LT-Zol-Vet (product of Popular Agrovet Ltd. Gazipur, Bangladesh), ear tagged and allowed for 14 days to adjust with the experimental diets and management prior to the commencement of the trial.

Four diets were prepared as: T_0 (Napier + concentrate), T_1 (Napier + concentrate + 100g DCP), T_2 (Napier + concentrate + 150g DCP) and T_3 (Napier + concentrate + 200g DCP). The concentrate part of the ration was composed of wheat bran (30%), rice polish (20%), crushed maize (10%), khesari bran (15%), soyabean meal (10%), til oil cake (12.5%) and salt (2.5%). The concentrate mixture contained 18% CP and 10.31 MJ ME/kg DM. (by proximate analysis). Fresh and clean drinking water was supplied for all the animals. In case of T_1, T_2 and T_3 groups, DCP was properly mixed with the concentrate mixture and then supplied to the animals. The daily requirement of feed was divided into two parts equally for feeding the animals in the morning at 7:00 AM and in the afternoon at 16:00 PM. Concentrate was supplied first followed by Napier grass.

Refusal of feed and Napier grass was collected every morning and weighed to determine daily intake. During the experimental period, the animals consumed all of the concentrate. Output of feces and urine were recorded daily during the last 7 days of the feeding trial period out of 159 days. The quantity of feed, refusal (Napier grass- 20kg) and feces were weighed daily and representative samples were kept for analysis. Milk was collected in every morning and evening during feeding trial. Feces and urine were collected daily which was started at every 8:00 am and weighed after every 24 hours for 7 days and sub-sample was taken every day from each animal. Samples of feces were collected in plastic bags and kept in the freezer (-20 °C) (ESCO company ltd). Urine sample was collected in a bucket containing 6N H_2SO_4 solution (purity 98% provided by Sigma Aldrich Int. Co. ltd., Bangladesh) to maintain a pH of 4 or lower and taken 10% sub-sample and stored at -20 °C until analyzed.

All the samples and sub-samples of feed, feces, milk and urine were used for analysis. The samples were subjected to chemical analysis for the determination of dry matter (DM), organic matter (OM) and ash following the methods of AOAC (1995). Calcium content was determined by Atomic Absorption Spectrometry (Japan) method (Varma, 1985); using Atomic Absorption Spectrophotometer. All the samples were analyzed in two times and the mean values were recorded.

The chemical composition of feeds used in the trial is given in Table 1. The Ca contents of Napier grass and concentrate mixture was 0.40 and 0.97%, respectively.

Table 1. Chemical composition of feed stuffs

Feed ingredients	% fresh	% DM basis		
	DM	OM	Ash	Ca
Napier grass	19..98	89.75	10.25	0.40
Concentrates	91.43	91.13	8.87	0.97

BCS are positively related to future success in conception, and avoidance of dystocia and retained placenta and other illnesses (Delgado et al. 2004; Morris et al. 2006; Jilek et al. 2008). The ovulation rate of females increases with body condition (or liveweight), and the post-partum anoestrus interval is reduced when cows calve at higher BCS (Markusfeld et al. 1997). Fatcorrected lactation yield is related to BCS at calving (Berry et al. 2007; de Freitas et al. 2008), and calves born to cows with lower BCS may be less viable than those born to cows with higher BCS (Ezanno et al. 2005). For these reasons, cows should reach a BCS of 3 or 3.5 (5-point scale) prior to mating and calving.

The statistical analysis was done using 'SPSS-11.5' statistical program to compute analysis of variance in completely randomized design. Differences among the treatment means were determined by Duncan's Multiple Range Test.

Results and discussion

Total dry matter intake DMI did not differ significantly ($p>0.05$) among the treatment groups. Highly significant differences ($p<0.01$) were found in case of Ca intake & Ca balance. Ca in feces, urine and milk differed significantly ($p<0.05$) among the treatment groups (Table 2). With the increase of DCP intake, there was a highly significant ($p<0.01$) increase of Ca intake (56.82, 78.17, 94.89 and 110.57 g/d in T_0, T_1, T_2 and T_3, respectively) and subsequent increase ($p<0.01$) of their Ca balance (2.94, 28.93, 36.70 and 42.71 g/d in T_0, T_1, T_2 and T_3, respectively). Ca in feces was higher ($p<0.05$) in T_3 followed by T_2, T_0 and T_1 (51.40, 43.39, 43.10 and 34.92 g/d, respectively).Ca was also significantly higher in urine ($p<0.05$) in T_0 followed by T_1, T_2 and T_3 (3.16, 2.89, 2.50 and 2.08 g/d, respectively) and total Ca excretion higher ($p<0.05$) in T_3 followed by T_2, T_o and T_1 (67.86, 58.19, 53.88 and 49.24 g/d, respectively). Ca in milk of T_1, T_2 and T_3 were not differ significantly ($p>0.05$) but they differ significantly from T_0 ($p<0.05$). Increasing level of di-calcium phosphate in T_1, T_2 and T_3 diets increased calcium intake and resulted in higher calcium retention in the body compared to T_0 .

Table 2. Ca balance (Mean±SE) in dairy cows

Parameters	T_0	T_1	T_2	T_3	Sig. level
Total DMI (kg/d)	8.78 ±0.78	8.41 ±0.88	8.34 ±0.97	8.70 ±0.82	NS
Total Ca intake (g/d)	56.82^{d} ±6.86	78.17^{c} ±9.67	94.89^{bc} ±10.33	110.57^{a} ±12.22	**
Ca in feces (g/d)	43.10^{abd} ±4.46	34.92^{c} ±3.96	43.39^{ab} ±5.75	51.40^{a} ±6.21	*
Ca in urine (g/d)	3.16^{a} ±0.36	2.89^{b} ±0.23	2.50^{c} ±0.29	2.08^{d} ±0.34	*
Ca in milk (g/d)	7.62^{b} ±0.39	11.43^{a} ±0.72	12.30^{a} ±0.98	14.38^{a} ±0.78	*
Total Ca excretion (g/d)	53.88^{cd} ±5.32	49.24^{bc} ±4.62	58.19^{ab} ±3.97	67.86^{a} ±5.31	*
Ca balance (g/d)	2.94^{d} ±0.24	28.93^{cb} ± 2.67	36.70^{ab} ± 3.43	42.71^{a} ±4.21	**

**, p<0.05); **, p<0.01; Means with different superscripts in the same row differed significantly; NS, not significant; T_0, Napier+concentrate; T_1, Napier+concentrate+100g DCP; T_2, Napier+concentrate+150g DCP; T_3, Napier+concentrate+200g DCP*

The result of this study is supported by Das et al. (2010). He reported that the increased oxalate intake resulted in an increased Ca intake, in feces, urine and total excretion but decreased Ca balance of animals fed Napier. James and Butcher (1972) also reported that the increased oxalate intake resulted in an increased calcium excretion in feces of crossbred sheep fed different levels of oxalate in the form of Halogeton.

Non-significant difference ($p>0.05$) was found in case of DM in feces (%), DM in feces (kg/d) and milk production among the treatment groups except urine excretion (Table 3). Urine excretion among T_1, T_2 and T_3 did not differ significantly ($p>0.05$) but when these diets compared with non DCP diet (T_0) the difference was highly significant ($p<0.01$) between DCP diets and non DCP diet (19.26, 11.86, 11.76 and 11.47 g/d for T_0, T_1, T_2 and T_3 diets, respectively).

Huque et al. (2006) reported that feeding fresh Napier grass results increased urination and soft dung. Das et al. 2010 also found increased level of DM in feces (%) and DM in feces (kg/d) after feeding increasing amount of oxalate through Napier grass. Chang et al. (2004) stated that feeding increasing amount of oxalate through Napier grass increased DM content with the reduction of water content in feces. James and Butcher (1972) stated that feeding oxalate at an increasing level might have an effect on increased urine production. Napier diets failed to supply required amount of calcium for both maintenance and production.

Table 3. Effects of DCP intake on milk production, feces and urine excretion (Mean±SE)

Parameters	T	T_1	T_2	T_3
Milk production (L/d)	9.45 ±1.42	10.69 ±0.98	10.48 ±1.31	11.76 ±1.61
DM in feces (%)	18.22 ±0.91	20.03 ±1.02	19.93 ±0.92	19.88 ±0.88
DM in feces (kg/d)	3.04 ±0.16	3.12 ±0.14	2.83 ±0.09	2.96 ±0.11
Urine excretion (L/d)	19.26[a] ±2.23	11.86[b] ±1.25	11.76[b] ±1.33	11.47[b] ±1.51

Means with different superscripts in the same row differed significantly (p<0.01); T_0; Napier + concentrate, T_1, Napier + concentrate + 100g DCP; T_2, Napier + concentrate + 150g DCP; T_3, Napier + concentrate + 200g DCP

It is apparent from Figure 1 that there was a linear increase of body condition score (BCS) in case of di-calcium phosphate diets (T_1, T_2 and T_3), but BCS was linearly declined in case of non DCP diet (T_0).

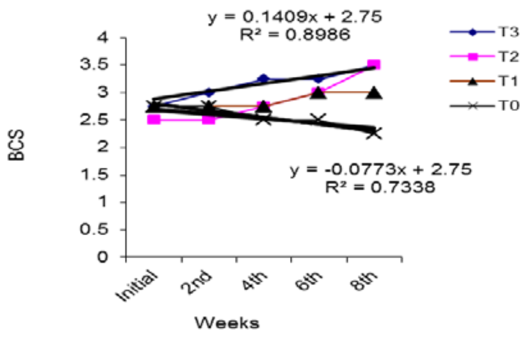

Fig.1. BCS of different group

The BCS was better in T_3 followed by T_2, T_1 and T_0. Calcium balances of the non DCP diet/Napier diet (T_0) failed to support body requirement and prolonged feeding which may affect the BCS. The higher reduction of calcium balance may affect on BCS of dairy cows. The BCS was better in T_3 followed by T_2, T_1 and T_0. Poor body condition and weakness was also observed by Huque et al. (2006) in animals fed fresh Napier grass. Das et al. (2010) found that the oxalate content of Napier silage may significantly reduce the balance of calcium and phosphorus in bulls that may cause retarded growth and poor body condition of bulls.

Conclusion

From the findings it could be suggested that 150g di-calcium phosphate may be used for optimizing Calcium balance and body condition score of dairy cows fed Napier grasses.

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