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Nutrient intake, acid base status and growth performance of growing male buffalo calves fed varying level of dietary cation anion difference

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Abstract

Influence of +110, +220 and +330 mEq/kg of dry matter (DM) dietary cation anion difference (DCAD) on growth performance of growing male buffalo calves was examined in a randomized complete block design. Three DCAD diets were randomly allotted to three groups, ten calves in each group. A linear increase in nutrient intake was recorded with increased DCAD level. However, digestibilities of nutrients remained unaltered across all diets. Calves fed +330 DCAD diet had higher nitrogen balance than those fed +110 DCAD diet. Blood pH and serum HCO_3 increased with increased DCAD level. Serum chloride was high in calves fed +110 DCAD diet, while serum (Na+K)−(Cl+S) increased linearly with increased DCAD level. Serum calcium increased with decreased DCAD level while serum magnesium and phosphorus remained unaffected. Ca balance remained unaltered by calves fed varying level of DCAD. Urine pH increased with increased DCAD level. Calves fed +220 and +330 DCAD diets gained more weight than those fed +110 DCAD diet. In conclusion, increased DCAD level not only increased dry matter intake but also weight gain in growing buffalo calves.

Keywords: DCAD; Buffalo calves; Nitrogen and calcium balance; Growth

1. Introduction

Dietary minerals are integral part of all biological functions in animal body. They play a key role in transfer of fluids from cell to cell, tissue to tissue and organ to organ which ultimately play a vital role to fulfill the diverse needs of production, growth and reproduction of animals. In animal, body transfer of fluids is important because of the electrical potential, produced by the difference of positively and negatively charged particles, especially minerals. The minerals may be cation (positively charge) and anion (negatively charge) and the difference between these cations (like Na, K) and anions (like Cl, S) is referred as dietary cation anion difference (DCAD) or dietary cation anion balance (DCAB) and the equation mostly used to know the difference is (Na+K)−(Cl+S) mEq/Kg dry matter (DM) (Tucker et al., 1992).

The DCAD affects the acid base status which plays a key role in body physiology (Sanchez, 2003). Any change in DCAD induces certain changes in blood chemistry for example if DCAD decreases; it causes an increase in blood H^+ and decrease in blood HCO_3, blood pH and urine pH (Block, 1994; Spanghero, 2004). The reduction in blood HCO_3 and urine pH works as a compensatory mechanism (Block, 1994; Sanchez et al.,

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1997). Alteration in blood pH affects insuline secretion and its effectiveness (Schade et al., 1981; Robertson, 1987) and growth hormone (Challa et al., 1993). Alteration in DCAD also affects the dry matter intake (DMI) and growth in calves (Fettman et al., 1984; Jackson et al., 1992; Jackson and Hemken, 1994). It is assumed that increased DMI in calves fed high DCAD diet might be due to increased buffering capacity due to alkalogenic nature of high DCAD diet (Block, 1994).

In tropical and subtropical, growing calves are well known victims of high temperature and humidity which reduce not only the DMI but also growth performance and ultimately profitability of the enterprise. Feeding high DCAD diet to growing calves might be an important nutritional tool to improve acid base status which may increase growth rate through increased DMI during hot summer. However, scientific information regarding alteration of DCAD on performance of male buffalo calves is limited. Therefore, the present study was planned to determine the influence of varying level of DCAD on acid base status, nutrients intake, Ca and nitrogen balance and growth rate for growing buffalo male calves.

2. Materials and methods

The experiment was planned to determine the effects of varying level of DCAD on acid base status and growth performance of growing *Nili Ravi* male buffalo calves. It was conducted at Animal Nutrition Research Center, Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Pakistan.

The DCAD is the difference between milliequivalents of cation (Na, K) and anions (Cl, S) in the whole feed. The most common equation (Tucker et al., 1992; Roche et al., 2003, 2005) used for the said purpose was as under:

$$\mathrm{DCAD} = (\mathrm{Na} + \mathrm{K}) - (\mathrm{Cl} + \mathrm{S})\ \mathrm{mEq/kg\ DM}.$$

Three diets were formulated to have +110, +220 and +330 mEq/kg DM DCAD. The +110, +220 and +330 DCAD levels were attained by using $CaCl_2$ and $NaHCO_3$. All diets were formulated to be *iso*-nitrogenous and *iso*-caloric using NRC (2001) values for energy and protein (Table 1). Thirty *Nili Ravi* male buffalo calves of about 12 months of age, were randomly allocated to three dietary treatments in a randomized block design, ten calves in each group.

Calves were housed on concrete-floored separate pens and no mechanical means were used to control the house temperature. The first 20 d were adaptation period while last 10 d of each month were collection period.

Table 1
Ingredients and chemical composition of DCAD diets for growing buffalo calves

	DCAD[a] (mEq/kg of DM)		
	+110	+220	+330
Ingredient			
Wheat straw	50.0	50.0	50.0
Corn grain cracked	11.0	11.0	11.0
Molasses	7.0	7.0	8.45
Wheat bran	9.55	9.70	6.70
Sunflower meal	12.0	12.0	12.0
Canola meal	6.0	6.0	6.0
Vegetable oil	1.5	1.5	2.0
Urea	1.0	1.0	1.2
DCP[b]	1.0	1.0	1.0
Salt	0.50	0.50	0.50
$CaCl_2$	0.45	0	0
$NaHCO_3$	–	0.30	1.15
Chemical composition			
ME (Mcal/kg)	2.24	2.24	2.24
CP[c]	14.0	14.0	14.1
NDF[d]	48.3	48.1	47.10
ADF[e]	31.4	31.4	31.0
NFC[f]	27.8	27.8	27.6
Ca	0.72	0.56	0.56
P	0.58	0.58	0.55
Na	0.29	0.37	0.60
K	1.49	1.5	1.51
Mg	0.28	0.28	0.27
Cl	0.92	0.67	0.64
S	0.22	0.22	0.22

[a] Dietary cation anion difference {(Na+K)−(Cl+S)}.
[b] Dicalcium phosphate.
[c] Crude protein.
[d] Neutral detergent fiber.
[e] Acid detergent fiber.
[f] Non-fermentable carbohydrate.

The diets were mixed daily and fed twice (0300 and 1400 h) a day *ad libitum* but at 10% weighback during collection period. The experiment lasted for 120 d.

Feed intake was recorded daily and their representative samples were taken for analysis. The calves were weighed weekly. Faeces were collected daily, dried at 55 °C, bulked and mixed at the end of each collection period. Digestibility was determined by using total collection method (Sarwar et al., 1996). During collection periods, complete collections of urine and faeces were made according to the procedure described by Williams et al. (1984). The faeces of each calf were collected daily, weighed, mixed thoroughly and 20% of it was sampled and dried at 55 °C. At the end of each collection period, dried faecal samples were composted by calf and 10% of the composted samples were taken for analysis. For urine collection, small special metal