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Effect of Niacin Supplementation on Growth, Nutrient Utilization and Blood Biochemical Profile in Male Buffalo Calves

Ravindra Kumar and R. S. Dass*

Mineral and Vitamin Nutrition Laboratory, Center of Advanced studies in Animal Nutrition
Indian Veterinary Research Institute, Izatnagar-243 122, India

ABSTRACT : In order to investigate the effect of different levels of niacin supplementation on growth, nutrient utilization, their balance and blood biochemical profile, 15 male buffalo calves (9-10 months of age, 88.4±4.37 kg average body weight) were divided into 3 equal groups each of 5 calves, following a completely randomized design, and fed individually for 120 days with wheat straw and concentrate mixture to meet their nutrient requirements. In addition calves were supplemented with 0 ppm (control, group I), 100 ppm (group II) and 200 ppm (group III) niacin. After 90 days of experimental feeding a metabolism trial was conducted to estimate the digestibility of nutrients and their balance. Fortnightly body weights were recorded to assess their growth rate and blood was collected from the jugular vein at day 0 and subsequently at 30-day intervals from all the experimental buffalo calves to study blood biochemical parameters. Results showed that intake and digestibility of dry matter, organic matter, crude protein, ether extract, total carbohydrates, neutral detergent fibre, acid detergent fibre, cellulose and hemicelluloses were statistically similar in the 3 groups. Buffalo calves in all three groups were in positive nitrogen, calcium and phosphorus balance, without showing any significant effect of the treatments. Dry matter, crude protein, digestible crude protein and total digestible nutrient intake (g/d/kg $W^{0.75}$) were similar in the control and niacin supplemented groups. Digestible crude protein (%) and total digestible nutrients (%) in the ration of the 3 groups were 8.07, 7.99, 7.92 and 56.70, 56.63, 56.74, respectively, and were comparable among the groups. The average daily gain (g) in-group II (567.50) was not significantly ($p>0.05$) higher than group I (500.0) and group III (510.0). Blood biochemical constituents (glucose, total protein, albumin, globulin, urea-N, insulin) showed no significant effect of niacin supplementation. However, serum cholesterol (mg/100 ml) was significantly ($p<0.01$) lower in the 200 ppm niacin-supplemented group than in the control and 100 ppm niacin-supplemented groups. It can be concluded that supplementation of niacin at 100 and 200 ppm in the diet of buffalo calves had no significant beneficial effect on their growth and nutrient utilization. (**Key Words :** Buffalo Calves, Niacin, Growth, Nutrient Digestibility, Blood Biochemical Profile)

INTRODUCTION

Niacin functions as a coenzyme for the pyridine nucleotide electron carriers NAD (H) and NADP (H). Consequently niacin plays a critical role in mitochondria respiration and the metabolism of carbohydrate, lipids and amino acids. The importance of niacin as an essential nutrient was reported by Elvehjem et al. (1937) in black tongue cure and they also isolated nicotinamide from the liver of animals. Niacin present in the feeds is generally in bound form and is unavailable to animals and human beings (McDowell, 1989). In ruminants, rumen microorganisms synthesize niacin and its synthesis was considered to be adequate for their optimum performance (Hungate, 1966). But, recent research findings suggest that microbial production of niacin in the rumen is not as per the requirements of calves and high producing dairy cows in early lactation (Girard, 1998). Shields et al. (1981) fed 100 ppm of niacin to lambs and observed increased gain and feed efficiency. Oral administration of niacin has resulted in an increased microbial protein synthesis and higher weight gain in growing animals (Flachowsky, 1993) and rumen fermentation (Kumar and Dass, 2005). Beneficial effects of niacin supplementation have been reported on the growth of young ones of some species, but no work has been reported on buffalo calves. Therefore, an experiment was conducted on buffalo calves to see the effect of graded levels of niacin supplementation on growth, nutrient utilization, and their balance and blood biochemical profile.

* Corresponding Author: R. S. Dass. E-mail: rsd@ivri.up.nic.in
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Table 1. Chemical composition of feeds fed to experimental buffalo calves (% on DM basis)

Nutrients	Wheat straw	Concentrate mixture
Organic matter	90.5	91.21
Crude protein	2.9	20.8
Ether extract	0.98	2.27
Total carbohydrate	86.6	68.2
Neutral detergent fibre	81.6	24.9
Acid detergent fibre	44.1	11.8
Cellulose	37.5	9.0
Hemicellulose	37.5	13.1
Calcium	0.38	1.89
Phosphorus	0.13	1.01

MATERIALS AND METHODS

Animals and feeding

Fifteen male buffalo (*Bubalus bubalis)* calves of 9-10 months, weighing 88.4±4.37 kg were assigned in equal numbers to three groups following a completely randomized design. All buffalo calves were fed on wheat straw and concentrate mixture to meet their nutrient requirement for a daily gain of 500-600 g as per Pathak and Verma (1993). Wheat straw was offered after the complete consumption of the concentrate mixture and ratio of concentrate mixture to wheat straw was 1:1 (DM basis) in all the three groups of animals. Buffalo calves were supplemented with 0 ppm (control, group I), 100 ppm (group II) and 200 ppm (group III) niacin in their concentrate mixture. Concentrate mixture consisted of soybean cake (25%), maize crushed (40%), wheat bran (32%), mineral mixture (2%) and common salt (1%). During the experiment, buffalo calves were kept in well-ventilated shed with individual feeding and watering arrangements. Clean drinking water was offered to all the calves at 09.00 and 15.00 h daily. The animals were weighed at the start and after every fortnight to assess the change in body weight. The feeding practice continued for a period of 120 days, at the end of which a metabolism trial of six days was conducted to know the digestibility of nutrients by harnessing all the calves in metabolic cages. During the collection period, feed intake and leftover were measured; samples of feed offered and left over were taken in separate polythene bags for each animal daily for chemical analysis. Faeces voided and urine excreted by each individual animal in 24 h was recorded at 10.00 h daily and a suitable aliquot of the thoroughly mixed faecal samples were taken for dry matter (DM) and nitrogen (N) estimation; similarly, a suitable aliquot of urine was preserved in sulphuric acid for N excretion through urine. Urine samples were also preserved for the estimation of urinary calcium and phosphorus. Feed and faecal material was dried in a hot air oven and ground to pass through 1 mm screen in a Wiley mill and preserved in air tight bottles for chemical analysis. . Blood was collected from jugular vein of all the buffalo calves before feeding and watering at 0 day and subsequently at an interval of 30 days; serum was separated and kept frozen until analysis.

Chemical analysis

Samples of feed, faeces and urine were analyzed for proximate principles (AOAC, 1995). The fibre fractions, neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were analysed as per Van Soest et al. (1991). Hemicellulose and cellulose were calculated as NDF-ADF and ADF-ADL, respectively. Calcium in feed, faeces and urine was estimated following the procedure of Talapatra et al. (1940) and total inorganic phosphorus by spectrophotometric method (AOAC, 1995), using molybdovandate as the coloring reagent. The chemical composition of the feeds offered to experimental buffalo calves is presented in Table 1. Blood serum glucose was estimated by the glucose oxidase (GOD) and peroxidase (POD) method, as described by Henry (1963), where glucose was oxidized by the enzyme glucose oxidase to give D-gluconic acid and hydrogen peroxide followed by peroxidase catalysed reaction; the oxygen thus liberated was accepted by the chromogen system to give a red coloured quinoneimine compound, whose absorbance measured at 505 nm was directly proportional to the glucose concentration (mg%). The serum total protein (TP) and albumin (A) were estimated by biuret and bromocresol green (BCG) dye binding method (Doumas et al., 1971). Serum protein was bounded with copper ion in an alkaline medium of biuret reagent, which produced a purple colour complex, whose absorbance at 550 nm was proportional to the protein concentration (g/100 ml). Serum albumin when reacted with BCG in acidic condition produced green colour, whose absorbance measured at 630 nm, was directly proportional to the albumin concentration (g%). Serum globulin (G) was calculated by subtracting the serum albumin from serum total protein. Serum albumin: globulin ratio (A:G ratio) was calculated by dividing the values of serum albumin by serum globulin. Diacetyl mono oxime (DAM) method as described by Wybenga et al. (1971) was followed to estimate the concentration of serum urea. Urea reacted with DAM in an acidic medium, produced a pinkish colour complex, which was intensified by using thiosemicarbazide and cadmium salt; the absorbance of the colour complex was proportional to the urea concentration (mg %). Serum cholesterol was estimated as per the method of Wybenga et al. (1970), where cholesterol reacted with ferric perchlorate in the presence of ethyl acetate and sulphuric acid to produce lavender coloured complex on heating in a boiling water bath. The intensity of the colour measured at 560 nm was directly proportional to the cholesterol concentration (mg/dl). Radioimmunoassay technique was used for the estimation of insulin in blood

Table 2. Change in body weight and average daily feed intake in buffalo calves

Parameter	G-I	G-II	G-III	SEM
Initial body weight (kg)	90.0	88.4	86.8	4.37
Final body weight (kg)	150.0	156.5	148.0	8.19
Gain in body weight (kg)	60.0	68.1	61.2	4.55
Gain in body weight (g/d)	500.0	567.5	510.0	37.9
Concentrate mixture intake (kg/d)	2.04	2.05	1.98	0.93
Wheat straw intake (kg/d)	1.52	1.60	1.51	0.18
Total DM intake (kg/d)	3.56	3.65	3.49	0.25

G-I = Wheat straw+concentrate mixture, G-II = Wheat straw+concentrate mixture+100 ppm Niacin.
G-III = Wheat straw+concentrate mixture+200 ppm Niacin.

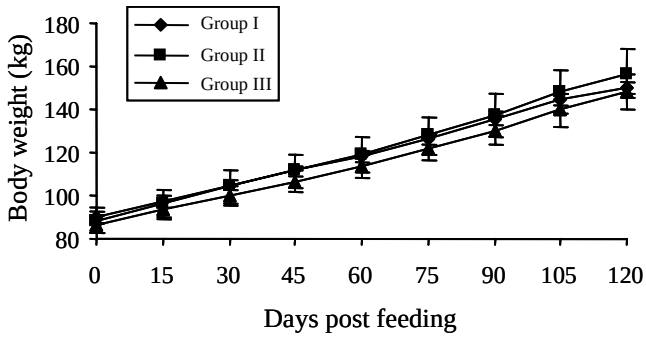

Figure 1. Fortnightly body weight change in buffalo calves.

plasma using an automatic gamma counter (Packard, USA, Model Cobra II) by the method suggested by Bhandarkar and Pillai (1982), using diagnostic kits supplied by M/s Medicorp Comp, Canada. Standard curve for insulin was prepared and its concentration in the unknown samples was obtained from the standard curve by interpolation.

Statistical analysis

A completely randomized design was used to determine the effect of niacin supplementation on the performance of buffalo calves. One-way analysis of variance (ANOVA) was carried out on the experimental data using treatments as independent variable (Snedecor and Cochran, 1980). Significance of difference between means was compared using Duncan's new multiple range test (Steel and Torrie, 1980). Data were statistically analysed using a SPSS (1996) computer package.

RESULTS AND DISCUSSION

Growth

Changes in body weight and intake of wheat straw and concentrate mixture are given in Table 2. In all the three groups there was a gradual increase in body weight with the advancement of feeding period (Figure 1). Results revealed no significant difference in body weight gain and average daily gain (ADG) during 120 days of experimental feeding in three groups. These results are in accordance with the findings of Riddell et al. (1981), who reported that average daily gains between paired lots of heifers receiving niacin (100 ppm) or no niacin were similar. Similarly, Camacho-Fernandez (1988) supplemented 100, 200, 300 and 400 ppm niacin in 5 groups of heifers and found daily average gain of 443, 428, 443, 426 and 365 g, respectively indicating no statistical significant difference in weight gain due to different levels of niacin supplementation. Horton (1992) supplemented the diet of lambs with different levels of niacin and did not find any significant effect on weight gain due to niacin supplementation. Magliocca et al. (1994) supplemented 200 mg niacin per day in the diet of young bulls and reported that niacin did not improve the performance of bulls in terms of live weight gains. Failure of supplementary niacin to improve animal performance may be due to its breakdown in the rumen by rumen microbes with little subsequent increase in its intestinal absorption (Zinn et al., 1987).

Contrary to above Chang et al. (1995) found increased live weight gain in calves supplemented with niacin, but

Table 3. Digestibility coefficient of various nutrients in buffalo calves

Nutrient	G-I	G-II	G-III	SEM
Dry matter	61.87	61.69	61.16	1.25
Organic matter	65.36	65.48	65.44	1.25
Crude protein	60.99	61.36	60.55	0.77
Ether extract	72.72	73.79	67.76	1.49
Total carbohydrate	65.97	65.62	66.17	1.52
Neutral detergent fiber	60.59	60.92	59.31	1.23
Acid detergent fiber	54.73	54.05	52.72	2.57
Cellulose	63.60	59.29	57.99	2.87
Hemi-cellulose	63.91	64.97	62.95	2.14

G-I = Wheat straw+concentrate mixture, G-II = Wheat straw+concentrate mixture+100 ppm Niacin.
G-III = Wheat straw+concentrate mixture+200 ppm Niacin.

Table 4. Plane of nutrition and nutrient retention in buffalo calves

Parameters	G-I	G-II	G-III	SEM
Body wt. (kg)	129.20	130.60	124.60	6.31
Metabolic body wt. (kg $W^{0.75}$)	38.31	38.56	37.26	1.39
DMI (g/d/kg $W^{0.75}$)	93.00	94.11	93.37	3.86
CPI (g/d/kg $W^{0.75}$)	12.27	12.22	12.14	0.19
DCPI (g/d/kg $W^{0.75}$)	7.48	7.50	7.35	0.16
TDNI (g/d/kg $W^{0.75}$)	52.69	53.18	53.23	1.59
Nutritive value of diet				
DCP (%)	8.07	7.99	7.92	0.23
TDN (%)	56.70	56.63	56.74	1.13
Nutrient retention				
Nitrogen (g/d)				
Intake	75.23	75.68	72.50	3.70
Excretion				
Fecal	29.78	27.19	30.03	0.91
Urinary	19.88	20.57	21.58	1.38
Total	49.66	47.76	51.62	1.73
Balance	+25.56	+27.92	+20.88	3.12
Nitrogen balance (% of N intake)	34.03	36.03	28.46	2.67
Nitrogen balance (% of N absorbed)	56.33	56.37	48.63	3.02
Calcium (g/d)				
Intake	41.16	44.84	44.67	2.91
Excretion				
Fecal	24.21	26.57	27.88	1.77
Urinary	6. 34	5.68	6.42	0.03
Total	30.55	32.25	34.30	1.78
Balance	+13.61	+12.58	+10.37	1.42
Phosphorus (g/d)				
Intake	22.27	22.71	21.78	1.46
Excretion				
Fecal	10.35	9.76	8.75	0.86
Urinary	5.43	4.89	5.99	0.22
Total	15.78	14.65	14.74	0.93
Balance	+6.47	+8.05	+7.05	0.84

G-I = Wheat straw+concentrate mixture, G-II = Wheat straw+concentrate mixture+100 ppm Niacin, G-III = Wheat straw+concentrate mixture+200 ppm Niacin.

only during stress period and not during normal growing period. Shields et al. (1981) and Flachowsky et al. (1993) also observed increased live weight gain in lambs and growing bulls, respectively, when animals fed on urea diet were supplemented with niacin. Increased live weight gain in lambs and bulls fed on urea diet might be due to better utilization of urea by rumen microbes for their body protein synthesis and thus higher availability of microbial protein at the lower tract, in the presence of niacin, as niacin is involved intimately in energy metabolism (Horner et al., 1989).

Digestibility of nutrients

Results revealed no significant difference in intake, digested and digestibility of dry matter (DM), organic matter (OM), crude protein (CP) and ether extract (EE) (Table 3). These data concur well with previous reports, in which niacin was supplied in the diet (Erickson et al., 1992), infused in the rumen (Erickson et al., 1990) and in the duodenum (Ottou et al., 1995). Neutral detergent fibre (NDF) digestibility did not differ significantly among the groups. Previous research workers also did not observe any significant difference in NDF digestibility among niacin supplemented and non-supplemented dairy cattle (Erickson et al., 1989; Dittrich et al., 1993; Campbell et al., 1994). However, Horner et al. (1988) reported increased NDF digestibility in dairy cattle supplemented with 6g niacin/day. They attributed this to a shift in the microbial population resulting in greater digestion of NDF. The digestibility (%) of ADF, cellulose and hemi-cellulose were comparable among the three groups. Similarly, Horner et al. (1988) did not find any change in digestibility of ADF in niacin-supplemented cattle. Campbell et al. (1994) also observed non-significant effect of niacin supplementation on ADF intake and its digestibility (%) in lactating cows.

Plane of nutrition and nutrient balance

Results revealed no significant difference in DM, CP and total digestible nutrients (TDN) intake (g/d/kg $W^{0.75}$), and balance of nitrogen (N), calcium (Ca) and phosphorus (P) in buffalo calves due to niacin supplementation (Table 4). Digestible crude protein (DCP) and total digestible nutrients (TDN) (%) in the ration of 3 groups were 8.07, 7.99, 7.92 and 56.70, 56.63, 56.74, respectively, without

Table 5. Blood biochemical profile in buffalo calves

Parameters	G-I	G-II	G-III	SEM
Glucose (mg/dl serum)	56.18	55.93	55.91	1.46
Total protein (g/dl serum)	6.76	6.65	6.47	0.12
Albumin (g/dl serum)	3.24	3.04	3.04	0.10
Globulin (g/dl serum)	3.52	3.61	3.43	0.12
A: G ratio	0.99	0.86	0.92	0.06
Cholesterol **(mg/dl serum)	139.28^{x}	131.30^{x}	117.64^{y}	4.90
Urea nitrogen (mg/dl serum)	22.42	22.79	20.98	1.08
Insulin (pmol/l)	27.54	25.47	26.96	0.91

$^{x, y}$ Means with different superscripts in a row differ significantly ($p<0.01$).

G-I = Wheat straw+concentrate mixture, G-II = Wheat straw+concentrate mixture+100 ppm Niacin.

G-III = Wheat straw+concentrate mixture+200 ppm Niacin.

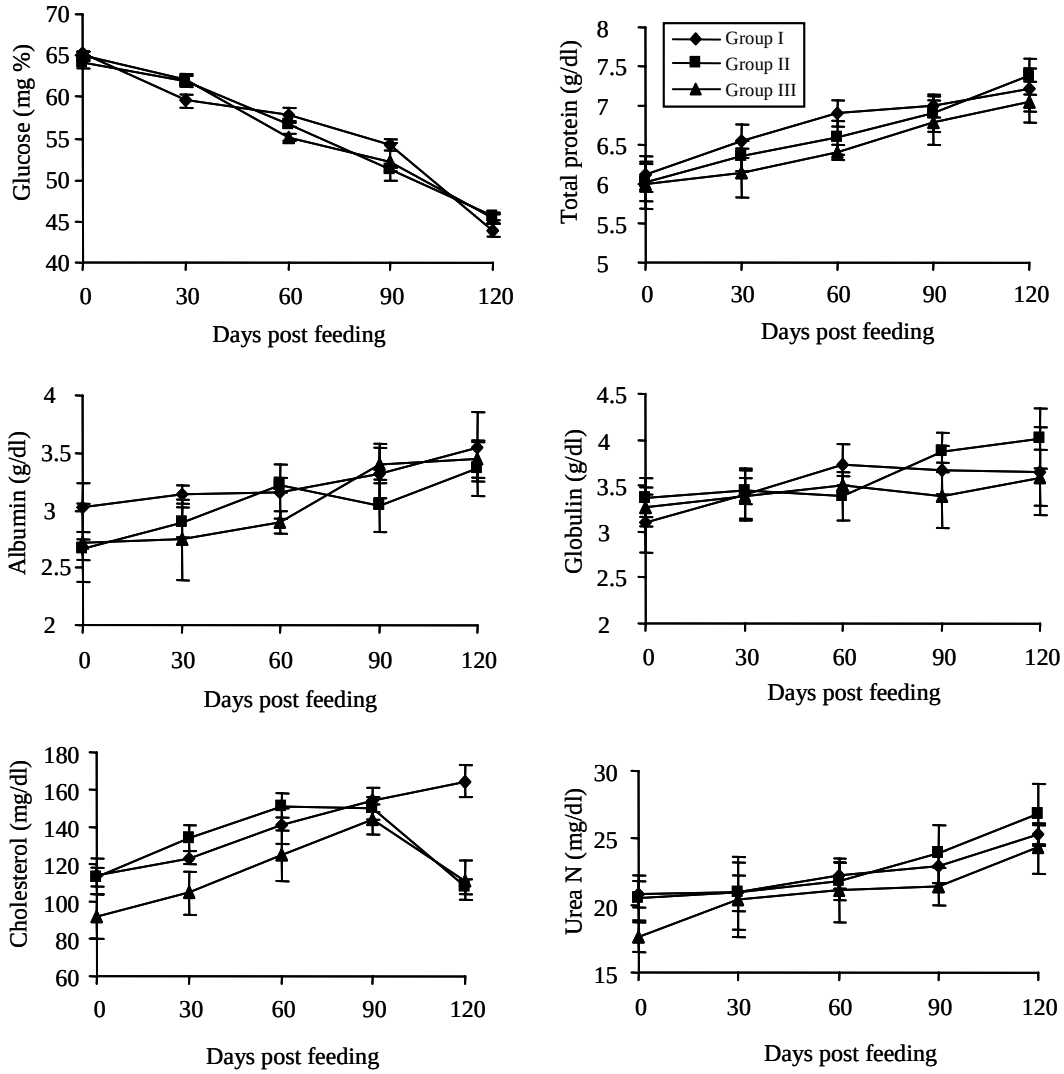

Figure 2. Blood biochemical profile in buffalo calves.

showing any effect of niacin supplementation. Nitrogen intake (g/d), fecal, urinary and total nitrogen excreted (g/d) were statistically similar among the three groups Animals in all the three groups were in positive nitrogen balance. Similar were the findings of Dittrich et al. (1993) who supplemented 0.5 and 1.0 g niacin/kg diet and observed no effect of niacin supplementation on N balance in lambs. Similarly, the intake, excretion and balance of Ca and P were comparable among the three groups.

Blood profile

Effect of niacin supplementation on blood glucose, serum total protein, albumin, globulin, urea-nitrogen, cholesterol (mg/dl) and insulin (pmol/L) at 0 day and subsequently after 30 days interval are depicted in Figure 2 and presented in Table 5. There was no significant effect of niacin supplementation on serum glucose level, but group mean showed a significant ($p<0.01$) decreasing trend with advancement of feeding period. These results are in concurrent with the findings of Horton (1992) in growing lambs and Belibasakis and Tsirgogianni (1996) in dairy cows. Concentration of total protein, globulin, albumin and urea-N in blood serum are indicator of the adequacy or inadequacy of the nitrogen in the diet of animals (Hammond, 1983) and results revealed no statistically significant difference in 3 groups due to treatment or due to period. These results were similar to the findings of Jaster et al. (1983) who supplemented 12 g niacin/day to the Holstein-friesian cows and found no significant effect on serum protein concentration. Contrary to above, Daghash et al. (1999) found increased serum total protein, total globulin and its fractions in niacin supplemented suckling calves; which may be due to non-synthesis of niacin by the microbes in suckling calves due to non-functional rumen. Cholesterol is synthesized from fatty acids inside the body of animals. Its concentration in the serum is the reflection of the body fat metabolism. Results revealed that group III had significantly ($p<0.01$) lower level of cholesterol than group

II and group I, which happened to be alike statistically. The decrease in serum cholesterol concentration due to niacin supplementation may be attributed to the marked inhibition of niacin on fat utilization as niacin has anti-lipolytic properties (Waterman et al., 1972). Similar was the finding of El-Barody et al. (2001) who supplemented 6 and 12 g niacin in the diet of pregnant Egyptian buffaloes and found a decrease in blood serum cholesterol. Results revealed no significant difference in insulin level (pmol/l) in control and niacin supplemented buffalo calves. These results match well with the findings of Horner et al. (1986) and Chillard and Ottou (1995), who also did not find any effect of niacin supplementation on serum insulin concentration in dairy cows. There may not be any effect of niacin supplementation on insulin as its concentration in the blood serum is affected by various factors and serum insulin is a balance between its secretion (stimulated by glucose, amino acids, hormones like glucagons, gastrin, secretin, pancreozymin) and inhibition by hypoglycemia, somatostatin and drugs like dilantin and phenothiazines (Kaneka, 1997).

CONCLUSION

It can be concluded that supplementation of niacin at 100 and 200 ppm levels in the diet of male buffalo calves did not have any significant effect on growth and nutrient utilization.

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