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Short communication

Boron profile in common feedstuffs used in tropical livestock systems

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ABSTRACT

In the scenario of increased reports on boron (B) supplementation in animal diets for beneficial effects, there is inadequate information on B content of animal feeds. The present study was carried out to quantify the level of B in animal feeds commonly used in tropical feeding systems. Samples of a total of 225 feeds were procured. The feed samples were oven dried, ground to 1 mm size and wet digested, filtered using Whatman filter paper (no 42) and volume made up to 100 ml by deionized water. Boron (B) content was estimated using inductively coupled plasma optical emission spectroscopy (ICP-OES). The level of B in fibrous feeds ($n = 83$) was higher than in concentrate feeds ($n = 120$) and unconventional feeds ($n = 22$). The range of B content among the feed samples analyzed ($n = 225$) showed a wide range from rice bran to cowpea fodder (0.69–59.1 mg/kg). The spatial distribution of B indicates that most feed samples analyzed showed B content lower than 20 mg/kg with mean and median of 17.7 ± 0.96 and 14.4, respectively. It is evident from the present study that appreciable quantity of B is detected in all the major categories of feedstuffs which was comparable to the levels of essential trace elements like copper and zinc. These findings would facilitate in assessing the supplementary value of tropical feeds for boron.

1. Introduction

Boron (B) is a Group IIIA element with atomic weight of 10.81. Its abundance is low in nature and contributes to about 0.001 percent of earth's crust. Major miners for B in the world are USA, Turkey, Argentina, China, Bolivia and Peru. Turkey accounts for more than 70 percent of B extraction in the world.

Boron is likely to influence the calcium metabolism. The precise information on B requirement and toxicity aspects is not clearly understood. Recently, increasing reports across the world indicate the adverse effects of B deficiency in diet and importance of B supplementation in animal feeding systems. Recent studies on effect of dietary B supplementation in poultry suggest an improved growth performance and bone mineralization (Bozkurt et al., 2012), bone strength (Mizrak et al., 2010; Cufadar et al., 2011) and both interior and exterior quality of eggs (Olgun et al., 2009; Mizrak et al., 2010). The studies in pigs supplemented with dietary B indicate its role in improving growth and immune status (Armstrong et al., 2001) and also reproductive and bone parameters (Armstrong et al., 2002). Although, limited research has been done in other animals about the role of B, some studies reveal that supplementing B prevents metabolic disorders during periparturient period in

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Table 1
Operating conditions for Optima 8000 ICP-OES.

Parameter	Value
Nebulization gas flow rate	0.55 L/min
Auxillary gas flow rate	0.2 L/min
Plasma gas flow rate	15 L/min
Sample flow rate	1.5 ml/min
Operating power	1300 W
View	Axial/Radial
Sample volume uptake rate	1.0 ml/min
Spray chamber	Cyclonic
Nebulizer type	Cross flow
Replicates	2

dairy cattle (Kabu et al., 2013), and alleviates fluoride toxicity in buffalo calves (Bharti et al., 2008) and rats (Krishnamoorthy et al., 2015).

The essentiality of B as a micronutrient for plants was suggested initially by Warrington (1923). Subsequently, several reports have confirmed that B is absolutely essential for seed maturation, vegetative and reproductive stages of growth in plants. Wojcik et al. (2008) indicated that plant uptake of B from soil depends upon variety of soil factors, thereby B status of plant. Few reports reveal that most of the soils have less than 10 ppm B (Woods, 1994), suggesting B deficiency (Shorrocks, 1997). Thus, it is evident that B uptake occurs from soil suggesting the existence of soil–plant relationship. In the scenario of most soils deficient in B, application of B is a prerequisite management practice in modern agriculture. On the other hand, there exists an absolute research gap to demonstrate the B uptake and utilization by livestock upon feeding the forages.

In view of the above, there is a need to conduct studies to elucidate the biochemical role of B in animal body, so as to suggest novel supplemental strategies and confirm its essentiality in farm animal nutrition. As a prelude, the present study attempts to generate data pertaining to B content in commonly used animal feedstuffs under tropical livestock systems, so as to assess their supplementary value.

2. Materials and methods

2.1. Sample collection

The present investigation was carried out at Micronutrient Laboratory, Animal Nutrition Division, National Institute of Animal Nutrition and Physiology, Bangalore, India. Commonly used feed/fodder samples of different categories in tropical animal feeding systems were procured from feed/fodder production units from different centers of National Agricultural Research System across the country.

2.2. Estimation of boron in feed samples

Feed samples were oven dried at 80 °C, ground to 1 mm fineness and subjected to wet digestion by tri-acid mixture (HNO_3:$HClO_4$:H_2SO_4 = 9:3:1) (AOAC, 2000). Quartz ware was used instead of borosilicate glassware to avoid contamination during analysis. About 2–3 g of dried feed sample was taken in quartz digestion tubes and digested with 25–30 ml of tri-acid mixture at 100–120 °C for 2–3 h cooled and filtered using Whatman filter paper (no 42). Volume was made up to 100 ml with deionized water to prepare mineral extract and stored in polymethylpentene (PMP) volumetric flask. Boron content of feed samples was estimated in inductively coupled plasma optical emission spectroscopy (ICP-OES) (Optima 8000, Perkin Elmer, Shelton CT#064840, USA) using the operating conditions mentioned in Table 1. Mineral standard (ICP multi-element standard solution VIII, Merck Millipore) for B (100 mg/L) was prepared and run in each analysis to ensure the accuracy of estimation.

2.3. Statistical analysis

The data generated was subjected to statistical analysis using 20th version of Statistical Package for Social Sciences (SPSS) to derive mean and median. Boron content in different categories of animal feeds is presented as mean and range values with standard error.

3. Results

The analyzed values of B (mg/kg) in fibrous feeds are presented in Table 2. Among the straw/stover, the analyzed values (minimum, maximum) of B were observed in paddy straw and wheat straw, respectively, while khamadhenu grass and cowpea fodder showed minimum and maximum values of B among the green forages. The B content of concentrate feeds is presented in Table 3. The analyzed values (minimum, maximum) of B were observed respectively among oil cakes like coconut cake, soybean meal; milling byproducts like rice bran, red gram husk and grains like maize, horse gram. Among the