J. Vet. Sci. (2002), 3(2), 141-144

JOURNAL OF
Veterinary
Science

Detection of Cadmium in Mineral Salt Commercial Mixtures for Beef Cattle

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Received Feb. 16, 2002 / Accepted May, 31, 2002

ABSTRACT

The cadmium concentrations in mineral mixtures used in beef cattle feed in the states of São Paulo and Paraná, Brazil was measured. The cadmium concentration was determined by inductively coupled plasma atomic emission spectrometry. Of the 36 analyzed samples, 35 had values > 0.5 ppm (range 0.5 to 11.2 ppm), which is the maximum concentration recommended [4, 18]. These findings show the necessity for careful industrial monitoring, as some mineral mixtures contain sufficient cadmium to cause toxicity in animals.

Keywords : cadmium, beef cattle, and mineral salt

Introduction

The increasing price of raw materials is the main reason that mineral mixture industries are looking to reduce costs with the aim of winning markets and guaranteeing business. Because of this, research into the quality of the raw material sources is being done.

In this respect, it is believed that some new mineral formulations can be contaminated by toxic elements, such as heavy metals and radioactive substances. Cheap raw material sources are the most likely origin of this problem. For this reason, a study aimed at evaluating the level of pollutants in the mineral formulations used in Brazilian cattle, which today number approximately 5,500, was initiated [13].

The main goal of this study was to investigate the xenobiotic presence in some different mineral supplements produced in Brazil. This was accomplished by analysis of the pollutants that may be attached to the macro and micro mineral elements present in the mineral formulations in animal feed.

Cadmium was chosen for this study, as it is considered by many specialists to be an important toxin [2, 5, 13]. Cadmium is highly toxic [4], and can be introduced to cattle via the ingestion of contaminated mineral formulations [1, 14, 18].

Material and Methods

Pooled samples (approximately 200 g) of mineral mixtures were collected from each of the farms selected in two states - São Paulo and Paraná. The samples identified were placed in sealed plastic bags and analyzed by the National Commission of Nuclear Energy (CNEN) Laboratory at Poços de Caldas, Minas Gerais, Brazil. The samples were dried at 110℃ for 2hours, dissolved in nitric acid and then the cadmium was extracted using ammonium pyrrolidine dithiocarbonate (APCD) p.a. at pH 2.3 0.1. The cadmium concentration was determined by inductively coupled plasma atomic emission, at 220.3 nm, using a Varian model 220 FS spectrometer.

The analysis methodology was based on the American Society for Testing and Materials [3, 9]. The detection limit of this method was 0.5 ppm Cd. Statistical analyses were made using the SAS/BASIC program [19].

Results

The cadmium concentrations in the 36 different mineral mixture samples from two states in Brazil are shown in Table 1. Graphical presentation of the results is shown in Figure 1.

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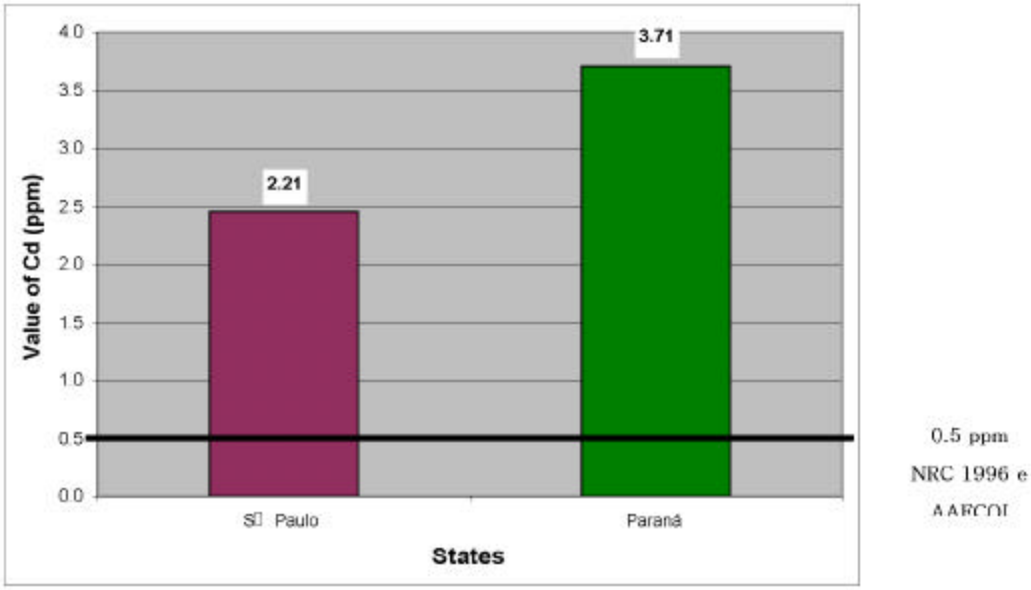
Table 1. Cadmium concentrations found in São Paulo, and Paraná, Brazil.

State	Sample No.	City	Value o Cadmium (ppm)
SÃO PAULO	01	Avaré	5.0
	02	Avaré	0.85
	03	Avaré	1.0
	04	Mogi Mirim	1.7
	05	Ribeirão Preto	<0.5
	06	Araçatuba	1.8
	07	Piracicaba	2.6
	08	Batatais	2.1
	09	Birigüi	2.1
	10	Birigüi	1.7
	11	São Vicente	5.0
	12	Presidente Prudente	1.9
	13	General Salgado	2.4
	14	Campinas	3.8
	15	Fernandópolis	4.3
PARANÁ	16	Londrina	0.8
	17	Londrina	5.2
	18	Rolândia	11.2
	19	Cornélio Procópio	1.2
	20	Maringá	1.0
	21	Cascavel	6.0
	22	Paranaguá	1.5
	23	Londrina	1.3
	24	Cambé	2.3
	25	Umuarama	1.1
	26	Umuarama	3.1
	27	Umuarama	1.84
	28	Jandaia do Sul	2.5
	29	Jandaia do Sul	4.2
	30	Maringá	2.5
	31	Londrina	5.4
	32	Londrina	7.1
	33	Londrina	5.8
	34	Maringá	2.0
	35	Colombo	3.0
	36	Catanduvas	5.2



NRC = National Research Council
AAFCOI = Association of American Feed Control Officials

Fig. 1. Average (N=36) cadmium concentrations in the mineral salts from two states in Brazil correlated with the reference values from the National Research Council (NRC, 1996), and the Association of American Feed Control Officials (2001).

Discussion

Cattle nutrition has improved over the last 30 years in many countries. This activity has become complex, and impressive progress has been achieved in the field of mineral supplements.

In Brazil, the subject of sanitary control in animal feed has received more attention, and today it appears to be increasingly important due to specialist participation with practical objectives [13, 14].

With this in mind, the presence of heavy metals and pollutants in mineral mixtures is quite important today where epidemics of animal-related health diseases (Mad Cow Disease and Foot and Mouth Disease) has threatened the agricultural industry of many countries. Animal feed has become a concern in animal health, and the safety of products is the main objective of this study.

Due to the high number of mineral formulations sold around the country (5,500 different marks), samples of mineral mixtures were collected from some manufacturing states. The approach was to work in some federation states that have a significant herd. The reason for choosing São Paulo and Paraná was because they hold many of the developed cattle raising farms in the country. These two states together are responsible for 14.06% of bovine production in Brazil, which today has a population of approximately 160,154,357 head [10]. In addition, this study was carried out in these states because of an established collaboration in each location.

The results show that 97.22% of the samples exceeded the maximum limit of 0.5 ppm cadmium proposed by the Association of American Feed Control Official Incorporated [4] and by the National Research Council [18]. The largest value (11.2 ppm) refers to a mineral formulation sold in Paraná, which is one of the states with highest quality of life and development in Brazil. Currently, with the aid of modern technology, it is expected that the National Research Council as well as the American Association of Feed Control, should revise these reference values so that lower fluctuation values can be found. Moreover, it is recommended that a zero cadmium concentration should be present in any analyzed sample.

It should be noted that cadmium impairs the function of essential elements, such as zinc, in some key enzymatic systems. Furthermore, it can cause several pathological processes as renal dysfunction, cancer, testicular necrosis, arteriosclerosis, central nervous system damage and the inhibition of growth in human and animals [2]. Cadmium accumulates in milk, eggs and meat, and its concentration in the tissues is proportional to its consumption [20]. Other research [8] has also shown that cadmium toxicity is a public health danger, as it can cause problems in the testes and kidneys, and can result in anemia and sterility. Moreover, [22] cadmium causes renal disease in humans inducing osteomalacia by proximal tubular atrophy with disturbances in phosphate reabsorption.

It is most likely that cadmium as well as lead have common sources of macro elements, such as phosphorus

[13], which represent the highest costs in the mineral salt composition [6, 7, 13, 14].

The next phase of our investigation will be to determine possible subclinical effects of cadmium toxicity in cattle receiving mineral mixtures with the highest cadmium content. The possible interference in the reproductive cycles of the cows and decreased levels of performance will be the main areas examined [11, 12, 17, 21]. This can be one explanation for the low cattle birth rate in Brazil, which is as low as 16% [16].

If the quality of mineral salt mixtures does not improve, the quality of the final product will be compromised. This in turn will pose a threat to human health through a contaminated food chain [15].

The purity of the raw materials used in animal feed supplements should be one of the main subjects in marketing. An ecological label induces buyers to acquire certain products, and should be a large driving force for improving the purity of food production.

Conclusion

Among the 36 analyzed formulations, only one sample presented results below the 0.5 ppm threshold proposed by the Association of American Feed Control Official Incorporated [4] and by the National Research Council [18].

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