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## Cadmium concentration in mineral salt mixtures used as supplementation in beef cattle food

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### ABSTRACT

Cadmium concentrations were measured in samples of mineral mixtures used in beef cattle feed in the states of São Paulo, Paraná, Mato Grosso, Mato Grosso do Sul and Goiás, Brazil. Cadmium content was determined by inductively coupled plasma atomic emission spectrometry. Of the 37 analyzed samples, 33 had values greater than 0.5 ppm (range <0.5 to 11.2 ppm), which is the maximum concentration recommended by the National Research Council and the Association of American Feed Control Officials Incorporated. These findings show the necessity for careful industrial monitoring, since some mineral mixtures contain sufficient cadmium to cause toxicity in animals.

**Key words:** cadmium, beef cattle, mineral salt

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### Introduction

The increasing price of raw materials, which make up a part of the mineral salt mixtures provided for animal consumption in Brazil, is the main reason why mineral mixture industries are being forced to consider reducing

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costs, with the aim of winning markets and guaranteeing their future business. Because of this, many industries have used raw materials sources that are less expensive, some of them without the adjusted quality to compose the mineral mixtures.

In this aspect it is believed that some new mineral formulations can be contaminated by toxic elements, many of these being heavy metals and radioactive substances. Cheap sources of raw material could therefore be the origin of this problem. For this reason an investigative research was initiated with the intention of evaluating the level of pollutants in mineral formulations used in Brazilian cattle production, where today there are approximately 5.500 different mineral mixtures being sold throughout the Brazilian national market (MARÇAL et al., 1999).

The main goal of the present research is to investigate the xenobiotic presence in some different mineral supplements produced in Brazil. The investigative process occurred throughout laboratory analysis to quantify pollutants that can be attached to macro- and micro-mineral elements present in mineral formulations given to animal feed.

Cadmium was the element chosen for the study, which is considered by many specialists as being an inorganic element of great risk to cattle consumption (ANDRIGUETTO et al., 1990; BRITO, 1993; MARÇAL et al., 1999). The element is regarded as highly toxic by the Association of American Feed Control Officials Incorporated (ANONYMOUS, 2001b), in that its vehiculation is possible to animals through the ingestion of contaminated mineral formulations (ALLEN, 1992; ANONYMOUS, 1996; MARÇAL et al., 2001b).

### **Materials and methods**

Pooled samples (approximately 200 g) of mineral mixture were collected from each of the farms selected in five different states – São Paulo, Paraná, Mato Grosso, Mato Grosso do Sul and Goiás. Identified samples were placed in sealed plastic bags and then sent for analysis by the National Commission of Nuclear Energy (CNEN) Laboratory at Poços de Caldas, Minas Gerais, Brazil. Samples were dried at 110 °C for two hours, dissolved in nitric acid. The cadmium was then extracted with ammonium pyrrolidine dithiocarbonate (APCD) p.a. at pH  $2.3 \pm 0.1$ . Cadmium content was

determined by inductively coupled plasma atomic emission, at 220.3 nm, using a Jarrel-Ash model 975 spectrometer.

Analysis methodology was made based on the American Society for Testing and Materials (ANONYMOUS, 1980) and EATON et al. (1995). The lower limit of determination of the method was 0.5 ppm of cadmium.

Statistical analyses were made with the SAS/Basic Program, as described in SAS Procedures Guide (ANONYMOUS, 1990).

### Results

Cadmium concentrations in 37 different samples of mineral mixtures from five states of Brazil are presented in Table 1 and graphically in Fig. 1.

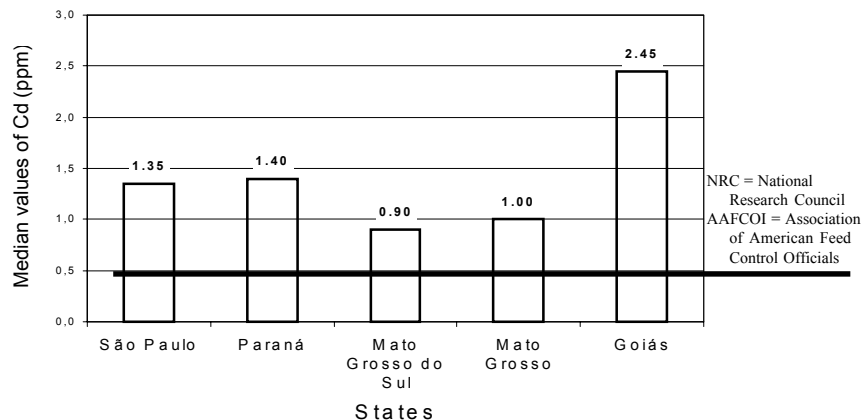


Fig. 1. Median values for cadmium concentrations in mineral salt from five states in Brazil correlated with reference values from the National Research Council ANONYMOUS (1996), and Association of American Feed Control Officials (ANONYMOUS 2001b).

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Table 1. Values of cadmium concentrations founded in different states in Brazil

State	Sample N°	City	Value of 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
Paraná	07	Londrina	0.8
	08	Londrina	5.2
	09	Rolândia	11.2
	10	Cornélio Procópio	1.2
	11	Maringá	1.0
	12	Cascavel	6.0
	13	Paranaguá	1.5
	14	Londrina	1.3
Mato Grosso	15	Tangará da Serra	1.0
	16	Tangará da Serra	6.35
	17	Juína	1.0
	18	Cuiabá	<0.5
	19	Rondonópolis	<0.5
	20	Rondonópolis	<0.5
	21	Rondonópolis	1.4
	22	Rondonópolis	9.15
Mato Grosso do Sul	23	Panaraíba	1.25
	24	Panaraíba	5.7
	25	Campo Grande	0.8
	26	Dourados	0.65
	27	Inocência	0.9
	28	Dourados	1.0
	29	Panaraíba	0.7
Goiás	30	Goiânia	3.3
	31	Goiânia	1.2
	32	Goiânia	5.3
	33	Goiânia	0.8
	34	Goiânia	0.9
	35	Goiânia	6.85
	36	Goiânia	1.6
	37	Goiânia	5.75

### **Discussion and conclusions**

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

In Brazil, the subject of sanitary control in animal feeding has received great attention and today seems to be increasingly strengthened due to specialist participation, with practical objectives (MARÇAL et al., 1999; MARÇAL et al., 2001a).

Within this aspect, investigating the presence of pollutants in mineral mixtures is a type of research unique in its nature in the country as a whole.

Due to the high number of mineral formulations sold around the country (5.500 different brands), samples of mineral mixtures were collected in a number of manufacturing states. The approach was to work in some federation states that hold a significant number of cattle under their effective control. The reason to choose the states of São Paulo, Paraná, Mato Grosso, Mato Grosso do Sul and Goiás was because they hold many of the developed cattle raising farms that exist in the country. Together, all investigated states are responsible for 48.3% of bovine production in Brazil that today has a population of approximately 163.154.357 animals (ANONYMOUS, 2001a). Also, the study was carried out in these states because of established levels of cooperation in each location.

Results show that 89.2% of samples exceeded the maximum limit of 0.5 ppm for cadmium concentration as proposed by the Association of American Feed Control Officials Incorporated (ANONYMOUS, 2001b) and by the National Research Council (ANONYMOUS, 1996).

It is important to remember that cadmium impairs the function of essential elements, such as zinc, in some key enzymatic systems. Also, it is one of the factors that cause several pathological processes, such as renal dysfunction, tumour and testicular necrosis, arteriosclerosis, damage to the central nervous system and inhibition of growth in humans and animals (ANDRIGUETO et al., 1990). Cadmium accumulates in milk, eggs and meat and the concentration in the tissues is proportional to consumption (SHIRLEY, 1985). CHURCH and POND (1977) also point out that toxicity from cadmium

poses a danger to public health because it can cause problems in the testicles and kidneys, anaemia and sterility. Additionally, TAKEBAYASHI et al. (2000), confirm that cadmium is responsible for renal disease in humans, inducing osteomalacia by proximal tubular atrophy, with disturbances of phosphate reabsorption.

It is most probable that cadmium as well as lead comes from common sources of macro-elements, such as phosphorus (MARÇAL et al., 1999), which represent the highest costs in mineral salt composition (CAMPOS NETO, 1992; CAMPOS NETO and MARÇAL, 1996; MARÇAL et al., 1999; MARÇAL et al., 2001a).

If mineral salt mixture industries do not raise the level of their quality concerns related to the aspect of raw material purity, increasing commercialization will ease the presence of more pollutants in animal feed. This in turn can threaten human health through the contaminated food chain.

The aspect of raw materials purity used in supplements for animal feed should be one of the main subjects of marketing. A great part of this is due to the fact that the ecological label induces buyers to acquire certain products whose production essence demonstrates concern with the environment and the preservation of the meat and milk quality.

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**SAŽETAK**

Koncentracije kadmija bile su mjerene u uzorcima mineralnih mješavina rabljenih kao dodatak u hrani za tov junadi u državama Sao Paulo, Parana, Mato Grosso, Mato Grosso do Sul i Goias u Brazilu. Koncentracije kadmija bile su određene metodom atomske emisijske spektrometrije induktivno spregnutom plazmom. Od ukupno 37 pretraženih uzoraka u 33 uzorka potvrđene su veće koncentracije od 0,5 ppm (od <0,5 do 11,2 ppm), što je ujedno i najveća koncentracija koju preporučuje Nacionalni istraživački savjet (National Research Council) te Američko društvo inspektora za nadzor hrane. Ovi nalazi upućuju na potrebu industrijskog nadzora s obzirom da neke mineralne mješavine sadrže preveliku koncentraciju kadmija što može dovesti do otrovanja u životinja.

**Ključne riječi:** kadmij, tovná junad, mineralni dodaci

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