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Artigo

Concentração de vanádio nas misturas de sal mineral utilizadas na suplementação de bovinos

Vanadium concentration in mineral salt mixtures used as supplementation in bovines

Wilmar Sachetin Marçal[1], André Hiroshi Quadros Watanabe[2]

[1]Universidade Estadual de Londrina, Docente, Departamento de Clínicas Veterinárias, Londrina, Paraná, Brasil. Endereço eletrônico: wilmar@uel.br
[2]Universidade Estadual de Londrina, Acadêmico de Medicina Veterinária, Londrina, Paraná, Brasil. Endereço eletrônico: andrehiroshiw@hotmail.com
Endereço eletrônico para correspondência:

Resumo: O comércio de suplementos minerais para bovinos no Brasil cresceu muito desde a última década. Muito embora seja necessária a utilização de matérias primas sem contaminantes, é possivel que alguns fabricantes ainda utilizem fontes de fósforo mais baratas. Essa situação pode veicular metais pesados na mistura mineral pronta, o que, em médio prazo, pode intoxicar os animais. Por essa razão, foi mensurada a concentração de Vanádio nas amostras de misturas de sal mineral usadas na suplementação de gado de corte nos estados do Paraná, Brasil. A concentração de vanádio foi determinada pela indução da espectrometria acoplada à emissão de plasma atômico. Das 22 amostras analisadas, 17 tinham valores maiores que 50 ppm (variando entre 66 e 128 ppm), a concentração máxima recomendada pelo Conselho Nacional de Pesquisa e pela Associação Americana de Controle Oficial de Alimentação. Esses resultados mostram a necessidade de um monitoramento industrial cuidadoso, porque algumas misturas de minerais contém quantidade suficiente de vanádio para causar intoxicação nos animais.

Termos para indexação: animais, intoxicação, misturas de minerais, monitoramento industrial.

Abstract: The commercialization of mineral supplements for cattle in Brazil has grown a lot since the last decade. Although it is necessary to use raw materials without contaminants, it is possible that some manufacturers still use cheaper sources of phosphorus. This situation can serve heavy metals in the ready mineral mixture, which in the medium term, can poison animals. For this reason, we measured vanadium concentrations in samples of mineral mixtures used in cattle feed. Vanadium concentration was determined by inductively coupled plasma atomic emission spectrometry. Of the 22 analyzed samples, 17 had values greater than 50 ppm (ranging between 66 to 128 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 because some mineral mixtures contain sufficient vanadium to cause toxicity in animals.

Index terms: animals, industrial monitoring, mineral mixtures, toxicity.

Endereço eletrônico para correspondência: * wilmar@uel.br
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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 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., 2015).

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.

Vanadium was the element chosen for the study, which is considered for many specialists to be an inorganic element of great risk to cattle consumption (FRANK et al., 1996; MCCRINDLE et al., 2001; GUMMOW et al., 2006). The element has high toxicity (AAFCOI, 1993) with possible animal vehiculation through the ingestion of contaminated mineral formulations (ALLEN, 1992; NRC, 1996; MARÇAL et al., 2001).

Material and Methods

The samples were collected directly from the main commercial resellers in different cities, where there were many cattle. Each sample weighed about 200 grams, and noted the manufacturing date, expiry period and batch number. At harvest the containers were sealed, with original factory. Samples were paid an identification code to prevent the disclosure of the brand and manufacturer, with respect to research ethics. The samples were placed in sealed plastic bags and then sent to be analyzed in the National Commission of Nuclear Energy (CNEN) Laboratory at Poços de Caldas, Minas Gerais, Brazil. The samples were initially dried at 110ºC for two hours, dissolved in nitric acid and then the vanadium was extracted with pyrrolidine ammonia dithiocarbonate (APCD) p.a. at pH 2.3 ± 0.1. Vanadium content was determined by spectrometry of atomic emission plasma induction coupled at 220.3 nm using a Jarrel-Ash model 975 spectrometer. Analysis methodology was made based on ASTM (1980). Limit of determination of the method was 0.5 ppm. Statistical analyses were made with the SAS/Basic Program, as described in SAS PROCEDURES GUIDE (SAS, 1990).

RESULTS

The vanadium concentrations in 22 different samples of mineral mix of Brazil are presented in Table 1. Graphical presentation of the results is in Figure 1.

From the data set: Average: 73.22727; SD: 25.00752; Coefficient of variation: 34.15055; Median: 70.875.

Table 1: Values of vanadium concentrations founded in Brazil

Sample number	Sample code	Lab code	Values of Vanadium (ppm)
01	VPR 39 80/12	22767	87 ± 4,35
02	VPR 52 80/25	22768	71 ± 3,55
03	VPR 50 80/23	22769	31 ± 1,55
04	VPR 47 80/20	22770	85 ± 4,25
05	VPR 45 80/18	22771	68 ± 3,4
06	VPR 34 80/17	22772	100 ± 5
07	VPR 33 80/16	22773	82 ± 4,1
08	VPR 51 80/14	22774	45 ± 2,25
09	VPR 10 65/10	22775	67 ± 3,35
10	VPR 54 80/27	22776	66 ± 3,3
11	VPR 36 80/19	22777	67 ± 3,35
12	VPR 42 80/15	22778	102 ± 5,1
13	VPR 29 80/12	22779	38 ± 1,9
14	VPR 08 65/18	22780	32 ± 1,6
15	VPR 40 80/13	22781	64 ± 3,2
16	VPR 41 80/14	22782	64 ± 3,2
17	VPR 48 80/21	22783	128 ± 6,4
18	VPR 38 80/11	22784	46 ± 2,3
19	VPR 32 80/05	22785	95 ± 4,75
20	VPR 09 65/09	22786	97 ± 4,85
21	VPR 37 80/10	22787	95 ± 4,75
22	VPR 31 80/04	22788	81 ± 4,05

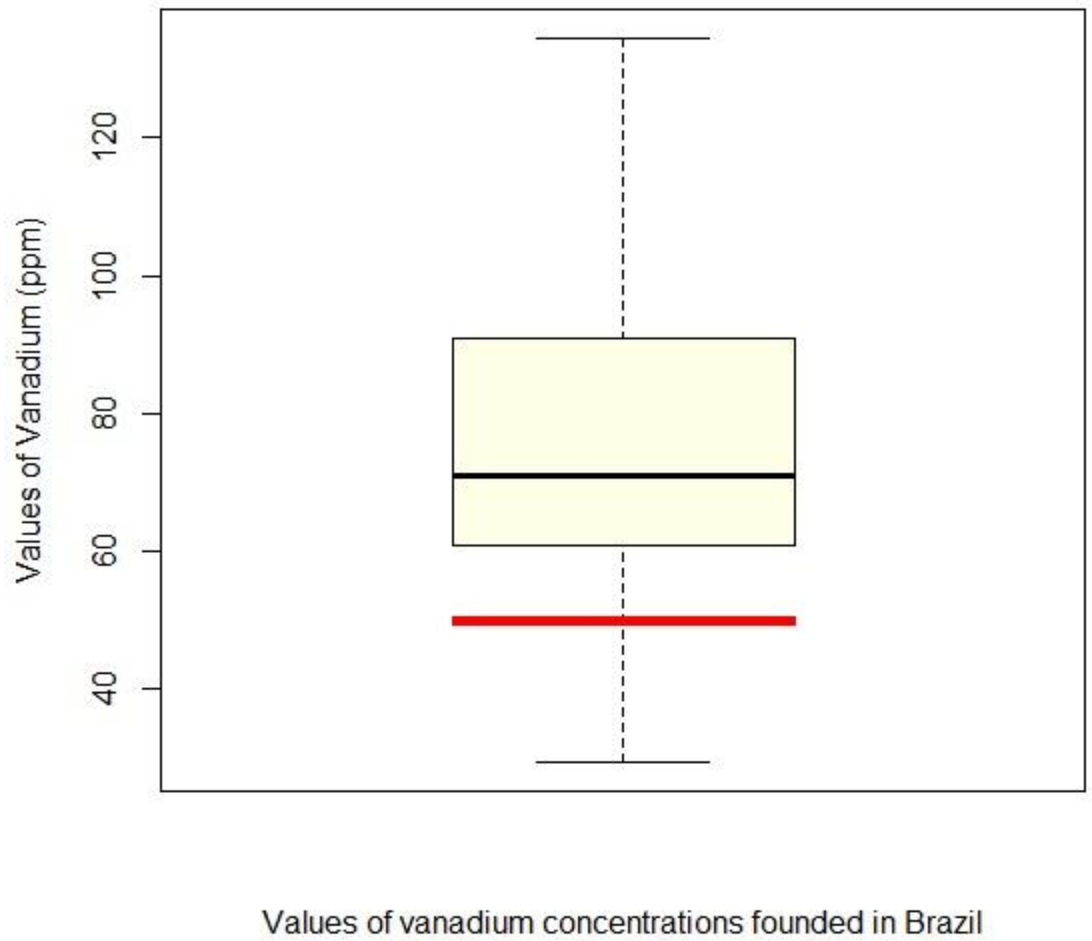

Figure 1: Average values (N=22) for vanadium concentrations in mineral salt in Brazil correlated with reference values from NRC (1996)

In the graph: black line is the median (50 % of the data is above the line / 50% below).

Red line is the maximum acceptable limit of 50 ppm, according to the NRC (1996).

Discussion

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., 2015).

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 cities. The approach was to work in some cities that hold a significant number of cattle under their effective control. This study was carried out in these places because of established levels of cooperation in each location. Samples at harvest were coded, avoiding inconvenience to reviewers.

Results show that 77% of samples exceeded the maximum limit of 50 ppm for vanadium concentration as proposed by the Association of American Feed Control Officials Incorporated (2001) and by the NATIONAL RESEARCH COUNCIL (1996).

It is important to remember that vanadium appears to exert its toxic effect through inhibition of enzymes and cell damage from lysis. Besides, numerous reviews on vanadium toxicity are available (SJOBERG, 1950; STOKINGER, 1955, 1963; FAULKNER-HUDSON, 1964; LILLIE, 1970; NATIONAL RESEARCH COUNCIL, 1974). Vanadium appears to exert its toxic effect through inhibition of enzymes (Underwood, 1977) and cell damage from lysis (WATERS et al., 1975). Vanadate has been found to inhibit (Na, K)-ATrase (Cantley et al., 1977, 1978; Nechay and Saunders, 1978; Goodno, 1979; Nieder et al., 1979) and activate cardiac adenylate cyclase (GRUPP et al., 1979). Signs of toxicosis in calves and lambs include diarrhea, depressed growth and performance, ataxia, and mortality.

Vanadium toxicosis has not been studied as extensively as many of the other minerals, although the recent recognition of high concentrations in some phosphates, coals, and petroleum products has increased interest in the movement of the element from the environment to animals and man.

It is most probable that in this research vanadium as well as lead comes from common sources of macro-elements, such as phosphorus (Marçal et al., 2001), which represent the highest costs in mineral salt composition (MARÇAL et al., 2015). 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.

Nowadays with the 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 less fluctuation values would be found and also will be a concern that no value of vanadium should be found in any analyzed sample.

The next phase of our studies will be to investigate possible subclinical effects of vanadium toxicity in cattle receiving mineral mixes with the highest vanadium content. Possible interferences in the reproductive cycles of the cows and decreased levels of performance will be the main effects sought as referred to by STUART & OEHME (1982), MCDOWELL (1985), MARACEK et al. (1998) and MARÇAL et al. (2003). This can be one of the reasons that can influence the values of birth per breeding that is as low as 22% in Brazil.

Finally, if mineral salt mixture industries do not improve their quality concerns related to the aspect of raw material purity, the increasing commercialization will easy the presence of more pollutants in the animal feeding. This in turn will threat man health, through the contaminated food chain compromising the quality of meat and milk.

Conclusions

The results analysis allow us the following conclusions:

1st) From the 22 analyzed formulations, only five samples presented results below 50 ppm, considered the maximum limit attributed by National Research Council (1996), representing 23% of the analyzed mineral supplements;

2st) In 17 samples, vanadium concentration was greater than 50 ppm, the maximum limit attributed by NATIONAL RESEARCH COUNCIL (1996). This represents 77% of the analyzed mineral formulations;

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