INFLUENCE OF BENTONITE ON TRACE ELEMENT KINETICS IN RATS. III. SELENIUM

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Received for publication September 03, 2004.

Abstract

Dietary bentonite (2% additive) given to rats for 28 d together with traces of sodium selenite (selenium-75) produced moderate but persistent decreases in the radioselenium absorption and organ content. In contrast, the bentonite additive did not influence feed intake, organs to body ratios, and haematological values although an improved body weight gain following bentonite treatment was found.

Key words: rat, bentonite, radioselenium, absorption, distribution.

Beneficial effects of dietary bentonite on health of people and domestic animals have been examined by numerous researchers (1, 4 - 6, 9 - 11, 15, 18, 19). Some of the protective actions of bentonite may result from a great number of sorption sites on the surface of this agent (12). Bentonite given as a feed additive can sorb various contaminants such as radiocaesium (14), radiostrontium (13), aflatoxins (16) and cadmium (7) making them less available for uptake from the gastrointestinal tract into the body. On the other hand, bentonite may also interfere with the indispensable trace elements present in the intestine lumen of the tract e.g. iron, calcium, copper, manganese and zinc (8, 9, 13, 18). The interference of bentonite with minerals may be especially undesirable when this additive diminishes the absorption of the elements that are known to have a narrow optimum range of intake (3). The purpose of the present study was to investigate the effect of dietary bentonite on the selenium uptake and distribution in rats.

The rationale for the present studies refers to information that selenium is an indispensable element, demonstrates a very narrow range of optimum intake and the requirement for selenium in the body is not fulfilled in numerous areas of the world (2). In addition, these studies are complementary to our earlier reports considering iron and calcium uptake in rats fed a bentonite fortified diet (8, 9).

Material and Methods

Ninety male Wistar rats weighing 215 g ± 11 g were used. After an acclimatization period of one week the animals were randomly assigned into two dietary groups each of 45 rats: the controls (group 1) and bentonite (group 2) which were offered tap water and a standard rodent chow LSM ad libitum (Fodder Manufacture at Motycz, Poland) and the same diet fortified with 2% of bentonite (LSM-B), respectively. The total selenium content of the LSM diet was 0.118 mg/kg according to the manufacturer. However, the detailed composition of the LSM is not accessible without the manufacturer permission. The bentonite used originated from the Polish geological sources (Zębiec); its total selenium content is unknown (4). The animals were on these diets for the whole experimental period. Body weight gains and feed and water intake were recorded weekly during the feeding period.

Sodium selenite (labelled with selenium-75, Polatom, Poland) in a 0.5 mL water solution comprising about 20 kBq per rat was given daily for 28 d except weekends by an intragastric tube to all the rats. The blood was collected weekly by cardiac puncture at a volume of 1 mL into a tube containing calcium disodium versenate as anticoagulant from day 0 through day 28. The blood samples were analysed for erythrocyte and leukocyte counts, haematocrit value, and haemoglobin level. Rats were killed by immersion in gaseous carbon dioxide 6 h, 1 d, 2 d, 4 d, 7 d, 14 d, and 28 d after dosing. Radioselenium in the carcass (whole body without the stomach and intestines) was measured using a whole-body counter ZM 701 (Polon, Poland) and that in the blood, liver, kidneys, small intestine (initial 15 cm), spleen, heart, testicles, brain, and muscles in a well-type scintillation counter ZR 11 (Polon, Poland). Reference standards for quantification of carcass radioselenium were prepared by intraperitoneal injection of the appropriate solution to rats which were killed 30 min thereafter.

The area under the curves (AUC) of radioselenium content versus time points was...
calculated by the trapezoidal rule. Data were analysed statistically using Student’s *t*-test at P<0.05.

**Results**

No differences were noted in feed consumption between rats fed the diet supplemented with bentonite and rats fed the diet without the additive. However, at the end of the experiment the final body weight gain was markedly greater (by about 15%) in rats fed the diet with bentonite (detailed data not shown).

The organ to body ratios for the liver, spleen, heart, testicles, and kidneys were similar in the two groups of rats at the end of the experiment (data not shown).

The blood values obtained for the rats fed bentonite enriched diet are lower than those found in the controls. However, differences were not statistically significant (data not shown).

The content of selenium-75 in the carcass within a 28-day period after the exposure is illustrated in Fig. 1. The data indicate that the distribution of selenium-75 in the carcass did not vary in the two groups examined except a significant decrease on day 2 in rats fed the bentonite enriched diet as compared to that in the controls.

The AUC values showing integrated exposure to radioselenium indicate that the content of radioselenium in the carcass of rats fed the bentonite diet (AUC=10200) was visibly lower than that in the rats fed the LSM diet (AUC=11090).

The content of radioselenium in the organs examined is expressed by AUC values in Table 1. The rats fed both the standard and bentonite fortified diet accumulated highest proportions of radioselenium in the liver, testicles and kidneys. Markedly lower amounts were taken by the remaining organs examined. The results in Table 1 demonstrate that in the rats fed the bentonite enriched diet the AUC values in the liver, kidneys, heart, and testicles were markedly lower in comparison to those found in the controls. The time-course of selenium-75 distribution (not shown) within a 28-day period postdosing in the organs mentioned above exhibited several significant decreases in selenium content.

![Fig. 1. Selenium content in the carcass (% of total dose).](image)

* P<0.05

**Table 1**

<table>
<thead>
<tr>
<th>Blood</th>
<th>Intestine</th>
<th>Muscles</th>
<th>Liver</th>
<th>Kidneys</th>
<th>Heart</th>
<th>Spleen</th>
<th>Brain</th>
<th>Testicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSM</td>
<td>96</td>
<td>11</td>
<td>20</td>
<td>2194</td>
<td>564</td>
<td>70</td>
<td>60</td>
<td>29</td>
</tr>
<tr>
<td>LSM-B</td>
<td>78</td>
<td>10</td>
<td>16</td>
<td>1530</td>
<td>433</td>
<td>53</td>
<td>78</td>
<td>35</td>
</tr>
</tbody>
</table>

Liver, kidneys, testicles, heart, and spleen as a whole organ
Brain, small intestine, muscles and blood as 1 g samples
Discussion

No alterations in organ to body ratios and blood values demonstrated in the rats fed the bentonite enriched diet confirm results reported in other studies (8, 9). Moreover, a higher growth response in rats fed the bentonite enriched diet was also found by numerous researches using several animal species in their experiments (10, 11). The involvement of bentonite in the stimulation of growth was discussed in details in an earlier report (8).

The experimental evidence obtained in these studies concerning the determination of selenium-75 in the carcass without the gastrointestinal tract permitted us to evaluate the true absorption of radioseleum. The results indicated that rats fed the bentonite supplemented diet absorbed less selenium given intragastrically. In addition, as a result of bentonite feeding the organ concentrations of selenium were also lower especially in the organs that are extremely active in selenium metabolism. To our knowledge the literature on the bentonite-selenium interference in an animal model is very scarce. Moreover, the response of the mineral metabolism to bentonite treatment seems to be variable with respect to the element involved (17).

The finding that bentonite reduced selenium uptake in the present studies suggests that in spite of the known beneficial actions of bentonite in animal nutrition, this agent may also cause side effects. The results presented here indicated that the reduction of selenium uptake seems to be moderate, at least under the experimental condition involved in this study. However, the intake of selenium in many parts of Poland and the world is marginal or not adequate (2). Thus, consideration should be given to translating the experimental finding into animal health practice.

References