RETENTION OF SELENIUM IN RATS EXPOSED TO VITAMIN C

ANDRZEJ GROSICKI AND BOGDAN KOWALSKI

Laboratory of Radiological Protection and Isotopic Research,
National Veterinary Research Institute,
24-100 Pulawy, Poland
e-mail: grosicki@piwet.pulawy.pl

Received for publication: May 23, 2006.

Abstract

Three groups of Wistar rats (control and two vitamin C exposed) were treated intragastrically with traces of sodium selenite (selenium-75) and vitamin C (1 g/L, group II and 2 g/L group III) in drinking water daily for 28 d. Selenium-75 activities were determined in the carcass eight times within 28 d after treatment. The carcass retention of selenium-75 and calculated AUC values indicated that vitamin C given at the two doses increased selenium intake from the gastrointestinal tract. It should be also stressed that the increases depended upon the vitamin C doses and showed a decreasing tendency in rats exposed to the higher dose of vitamin C.

Key words: rat, vitamin C, radioselenium, carcass, distribution.

Selenium is an essential trace element for humans and animals (2, 11). The dietary intake of selenium ranges from high to low according to the food and soil content of the element (2, 3, 14, 15). Selenium-deficiency diseases such as reproductive impairment, growth depression, and myopathy of the heart and skeletal muscles have been recognised on a wide scale in livestock in several countries including Poland (3, 10, 11, 14, 15).

Vitamin C is a nutrient that may be involved in the metabolism of various elements particularly copper and iron (9, 12, 13). It was also found that vitamin C decreased tissue retention of undesirable elements such as cadmium, lead, and mercury and reduced their toxic action (1, 6, 8). Considering a potential influence of vitamin C on dietary selenium absorption and a very narrow range of the same selenium intake (3), the purpose of this study was to evaluate if moderate supplements of vitamin C to a standard diet affect selenium retention in the body.

Material and Methods

One hundred and thirty-five male Wistar rats with a mean initial weight of 212 g ± 11 g were housed in groups of 5 animals in stainless steel cages in a room with controlled temperature (about 22°C) and relative humidity (about 55%). After an acclimatization period of one week, the animals were randomly assigned into three dietary groups each of 45 rats: the controls (group I) and vitamin C exposed animals (groups II and III). The animals were offered a standard rodent chow LSM ad libitum (Fodder Manufacture at Motycz, Poland) and tap water fortified with vitamin C (Merck, for foodstuffs) at a level of 1 g/L (group II) and 2 g/L (group III). The water vitamin C solution was prepared daily to reduce possible oxidation of this agent. An average selenium concentration of the LSM diet was 0.118 mg/kg according to the manufacturer. During the experiment all the rats were given daily for four weeks (except weekends) a water solution of traces of sodium selenite labelled with selenium-75 (Polatom, Poland) at a volume of 0.5 mL. The selenium solution was administered by an intragastric tube. Body weight gains and feed and water intake were recorded weekly during the experiment.

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. Erythrocyte and leukocyte counts, haematocrit value, and haemoglobin level were measured using an Auto Counter AC 920 (Swelab). GSH activities in blood were measured spectrometrically (Unicam 8625 UV/VIS spectrometer) using Randox kits (Randox Laboratories Ltd.)

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 the last radioselenium administration. Radioselenium in the carcass (whole body without the stomach and intestines) was measured using a whole-body scintillation counter ZM 701 (Polon, Poland). The response of the counter to various body sizes was
examined by the use of polyethylene bottles filled with water comprising radioactive selenium. The stability of the counter was monitored by counting an iodine-129 source. Counting measurements were corrected for background and then expressed as percentage of the doses administered. Reference standards for quantification of carcass radioselenium were prepared by intraperitoneal injection of the appropriate radioselenium solution to rats which were killed 45 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.

The experimental protocol was approved by the local Ethic Committee for Animal Experiments in Lublin, Poland.

Results

No differences were noted in LSM consumption (about 31 g/d/rat) and tap water intake (about 29 mL/rat/d) among rats drinking both tap water and tap water supplemented with 1 g of vitamin C/L and 2 g of vitamin C/L. The final body weight gain at the end of the experiment was similar in all examined rats although rats exposed to vitamin C via drinking water showed a trend towards a higher body weight gains (data not shown).

Rats from all tested groups demonstrated similar erythrocyte and leukocyte counts, haematocrit value, and haemoglobin level (results not shown). No statistically significant differences were found among the examined groups.

The GSH activity ranged from 697 ± 87 IU/g Hb to 943 ± 123 IU/g Hb in the controls and from 653 ± 67 IU/g Hb to 889 ± 82 IU/g Hb and from 683 ± 44 IU/g Hb to 919 ± 129 IU/g Hb in groups II and III, respectively. Differences were not statistically significant.

The total content of selenium-75 in the carcass is shown in Fig. 1. Results indicate that the content of radioselenium within 28 d after treatment decreased gradually in all examined rats. In the controls, the carcass selenium-75 burden decreased from 21% at 3 h to about 5% of the total dose at 28 d, whereas in animals exposed to 1 g of vitamin C/L and 2 g of vitamin C/L selenium-75 content decreased from 47% to 19% and from 43% to 14%, respectively. Differences between the controls and vitamin C exposed groups were statistically significant during the whole experimental period. On the other hand, no statistically significant differences were found between rats exposed to 1g and 2 g of vitamin C/L although the content of selenium-75 in rats exposed to the higher dose of vitamin C was visibly lower.

The AUC values showing integrated exposure to radioselenium in groups II and III were enhanced by 79.3% and 62.3% in comparison to that noted in the controls.

Discussion

No alterations in body weight gain, blood parameters and GSH activities suggest that the amounts of vitamin C included to diet were well tolerated by rats. Similar findings were reported by others (4, 13). On the other hand, higher doses of vitamin C (10 g/kg diet) given to rats were found to decrease significantly haemoglobin concentrations and haematocrit values but failed to affect body weight gains (12).

Fig. 1. Selenium content in the carcass (% of total dose).

* P<0.05
Several reports indicate that the influence of vitamin C on the absorption of trace elements from the gastrointestinal tract may be unambiguous. For example, there is evidence that ascorbic acid enhances a dietary absorption of iron (9) and aluminium (5) whereas a reduced absorption of copper was noted in rats fed a diet fortified with this vitamin (12, 13). The mechanism of vitamin C influence on the absorptive processes of these trace elements was not elucidated although there are suggestions that vitamin C acts by reduction or formation of stable chelates with the elements or competing elements making the examined elements less or more absorbable from the gastrointestinal tract (9).

The doses of vitamin C in the present experiment corresponded to about 30 mg and 60 mg/rat/d or 100 mg or 200 mg/kg b.w. and were rather low as compared to those consumed by animals in the experiments mentioned earlier (8, 12, 13). However, these moderate vitamin C doses included to diet increased selenium intake from the dietary source. Moreover, the use of the two doses of vitamin C demonstrated that vitamin C may influence selenium intake in a dose-dependent manner; the rats exposed to 2 g of vitamin C/L revealed a slightly reduced selenium intake as compared to that found in the rats exposed to 1 g of vitamin C/L. The mechanism of these findings is not clear. However, if the showed tendency is supported by the experiments involving higher doses of vitamin C than those included in the present studies, the role of a massive vitamin C intakes in selenium absorption may be undesirable, at least for humans and animals consuming low or marginal amounts of this element.

References