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## SELENIUM INTAKE FOR INFANTS IMMEDIATELY AFTER DELIVERY

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**Abstract** Selenium content of colostrum milk and mature milk in 5 months after birth was determined by fluorometry with 2,3-diaminonaphthalene. In the first milk after birth selenium was contained to be the highest amounts of 29.4 ng/g but selenium concentration decreased to about 9 ng/g after the birth of 1 week. In the lactation period of 10 to 171 days, the concentration was almost constant to be  $9.0 \pm 1.2$  ng/g. The content of infant formulas (milk powder for young infants) based on cow's milk was  $42.9 \pm 8.4$  ng/g corresponding to  $6.0 \pm 1.2$  ng/ml in the liquid milk prepared for lactation. Therefore selenium intake was calculated to be about  $17 \mu\text{g/d}$  in the colostrum milk-feeding infants after delivery and about  $8 \mu\text{g/d}$  in mature milk-feeding infants at the age of more than 1 month after birth, whereas it was  $3-6 \mu\text{g/d}$  in formula-feeding infants.

## INTRODUCTION

Though selenium is widely distributed in nature, it does not occur evenly throughout the lithosphere. A geometric mean 8.6 ng selenium/g for 115 igneous rocks and 88.1 ng/g for 46 sedimentary rocks have been reported by the authors.<sup>1</sup> In rock-forming minerals selenium is enriched in alkali feldspar and plagioclase and selenium(IV) is dissolved in saturated CO<sub>2</sub> water from the minerals, whereas selenium(VI) is not.<sup>1</sup> In the hydrosphere selenium(IV), selenium(VI) and organically complexed selenium are widely distributed in river and sea water<sup>2, 3, 4</sup>, groundwater used for brewing<sup>5</sup> and drinking<sup>5</sup> and reservoir<sup>1</sup> used as a drinking-water supply.

In the biosphere, selenium was first recognized as an essential trace element for mammals in 1957, and then as an integral component of glutathione peroxidase (GPx) in human blood in 1973. Erythrocyte and plasma GPx activities as well as selenium concentrations are lower in newborns than in their mothers and other adults.<sup>6</sup> Low selenium intake of young infants lead to very low selenium concentration and low GPx activities in serum and whole blood.<sup>6</sup> Therefore the GPx activities depend on selenium content of milk in the course

of lactation. Although the selenium concentration of human breast milk has been reported by a few workers; an average 15.2 ng/ml<sup>7)</sup> in U.S.A., 31.0 - 17.6 ng/ml<sup>8)</sup> in Germany, 10.7 - 5.7 ng/ml<sup>9)</sup> in Finland, 10 - 20 ng/ml<sup>9)</sup> for almost all populations in the world and the lowest 2.6 ng/ml<sup>9)</sup> in China. In contrast the selenium concentration in infant formulas based on cow's milk is lower than in breast milk, and is less than about 5 ng/ml.<sup>9)</sup> Accordingly, the purpose of this work is to elucidate the daily selenium intake of breast milk feeding and formula feeding young infant after delivery up to about 5 months after birth.

## MATERIALS AND METHODS

### Breast and formula milk samples

Breast milk was collected from three healthy mothers, from the first colostrum milk after delivery to about 5 months after birth. The milk was stored in a freezer at -70 °C, and then was sterilized by autoclaving at 121°C and 1.1 kg/cm<sup>2</sup> for 30 min before analysis.

Formula milk, 6 samples, commercially available for infant milk powder, and sterilized cow's milk, 13 samples, which were produced in each district in Japan and were also commercially available were used for experiments.

### Selenium analysis

Sterilized milk 1 g was decomposed by wet-ashing with HNO<sub>3</sub>-HClO<sub>4</sub>, and all the selenium was reduced to selenium(IV) by the boiling HCl solution. The nano gram amounts of selenium was fluorometrically determined with 2,3-diaminonaphthalene after the extraction and back-extraction to remove trace interfering organic substances.<sup>10, 11</sup> Selenium content of standard reference materials of NBS SRM-1577 bovine liver and SRM-1571 orchard leaves was fairly equal to that determined by this method.<sup>10</sup> The detection limit of this method is 0.05 ng selenium (0.005 ng/ml) and is suitable for the analysis of a few amounts of samples. The precision of this selenium analysis was shown as an example in cow's milk, 17.1 ± 0.62 ng/g (n=4).

Effects of the sterilization of breast milk on the analytical value of selenium were examined using 3 samples. As a result, selenium content did not vary in all the samples of the sterilized and non-sterilized milk (standing for 0, 1 and 15 hours before a wet-ashing treatment).

SELENIUM CONTENT OF COW'S MILK AND FORMULA MILK

Selenium concentrations in 13 cow's milk were in the range of 10.3 - 22.4 ng/g with an average of  $18.0 \pm 3.7$  ng/g, and they tended not to be influenced by milk-fat content, sterilization temperature and production area in Japan. Selenium content of infant formula milk, 6 samples, was in the range of 32.1 - 57.9 ng/g with an average of  $42.9 \pm 8.4$  ng/g corresponding to 6.0 ng/ml in the prepared solution for lactation.

SELENIUM CONTENT OF HUMAN BREAST MILK

Figure 1 shows the selenium concentration of breast milk from 3 women. The maximum 29.4 ng selenium /g contained in the first milk after delivery, and it decreased down to about 9 ng/g in 10 days after birth. Zinc concentration in the same samples also decreased, and a positive correlation between selenium and zinc was obtained. In more than 10 days up to 5 months of lactation, selenium concentration was almost constant of  $9.0 \pm 1.2$  ng/g for 33 samples.

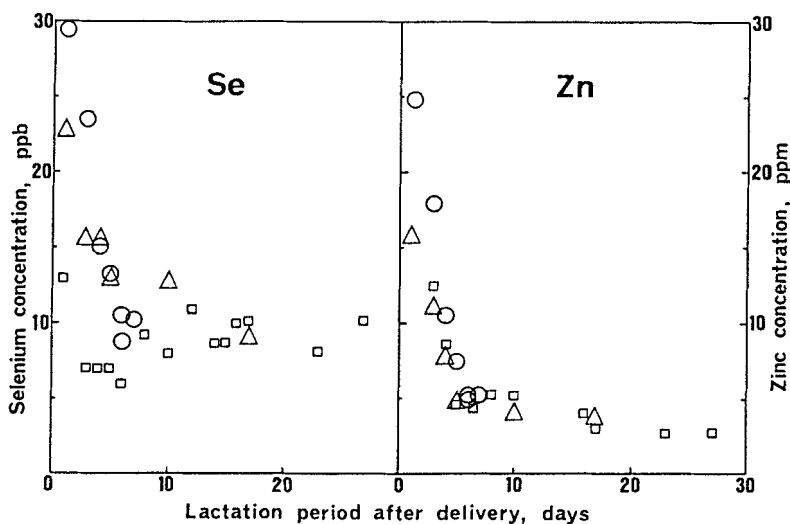


FIGURE 1 Selenium and zinc concentrations in breast milk.

SELENIUM INTAKE OF YOUNG INFANTS

Considering the average milk requirement of young infants, daily selenium intake was calculated for breast milk- and formula milk-

feeding infants at the age of 0 - 5 months. Figure 2 shows the selenium and zinc intake of infants. In the first lactation the maximum selenium  $17 \mu\text{g/d}$  was found and the intake amounts decreased down to about  $3 - 5 \mu\text{g/d}$  at the age of 10 days after birth. A same tendency was found in zinc in the breast feeding infants. However, selenium intake amounts increased to be  $7 - 9 \mu\text{g/d}$  in 0.5- 5 months aged infants fed on breast milk. In contrast the  $3 - 6 \mu\text{g/d}$  in formula feeding infants was found, since the selenium concentration in drinking water used for preparing the milk for lactation did not effect; from the fact that selenite ions were contained in the drinking water to be in the range of  $0.3 - 54.6 \text{ ng/L}$  with an average  $11.5 \pm 12.6 \text{ ng/L}$  for 29 samples and selenate ions of  $0.1 - 20.5 \text{ ng/L}$  with an average of  $3.8 \pm 4.7 \text{ ng/L}$  for 25 samples<sup>5</sup>, and that total selenium was contained in the reservoir used for drinking water supply to be about  $5 \text{ ng/L}$ .<sup>1</sup>

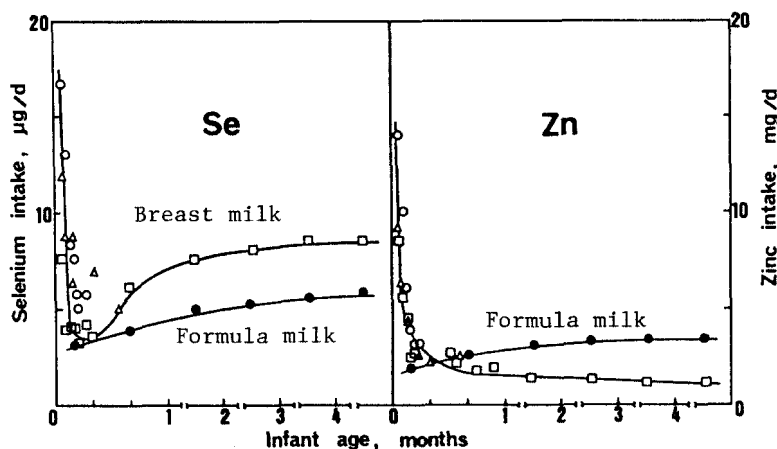


FIGURE 2 Selenium intake of infants fed on breast and formula milk.

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