

Evidences of selenium deficiency in Brazil: from soil to human nutrition

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Introduction

Cereal production has kept pace with the human population growth rate. It is anticipated that world demand for food will double in the period from 1990 - 2030, the increase being 3.5 times in developing countries (Daily et al., 1998). Malnutrition has increased, reaching almost half of the world' population, particularly among pregnant women, infants and children (Welch, 2008). This is partly due to soil micronutrient deficiency. Deficiencies of iron (Fe), iodine (I), selenium (Se) and zinc (Zn) are today the major concern in relation to human health especially in developing countries. According to the World Health Organization more than 2 billion people could be anemic as a consequence of Fe deficiency (Allen et al., 2006). It has been suggested that one fifth of the population is not ingesting adequate amounts of zinc (Hotz and Brown, 2004). Combs Jr (2001) estimates that between 0.5 and 1.0 billion people could be deficient in selenium.

Selenium in soils

A world soil-plant study conducted by Sillanpää and Jansson (1992) included Brazil among the low soil Se countries, together with Finland. There are few reports of analyses of Se in Brazilian soils (Table 1), however the data has shown that many soils are in the deficient range.

Table 1. Total Se concentration in Brazilian soils.

State or city	Se ($\mu\text{g kg}^{-1}$)	Reference
Sao Paulo	0 - 800	Paiva Neto and Gargantini (1956)
Goias	1 - 8	Fichtner et al. (1990)
Sao Paulo	38 - 212*	Anno (2001)
Nova Odessa	130*	M.A. Zanetti**
Sao Paulo	68 - 220	Faria (2009)
Deficient range	100 - 600	Lyons et al. (2003)

*Se concentration in $\mu\text{g dm}^{-3}$; **Personal communication - Prof. Dr. Marcus A. Zanetti (USP).

Selenium in agricultural food products

No complete surveys of the occurrence of Se deficiency in the Brazilian population are available. Nevertheless, Ferreira et al. (2002) report that Se in plant foods is considered low, possibly because the soils are low in this element (Table 2). Lucci et al. (1984) determined the Se concentration in grasses and animal feedstuff from 80 locals in the State of Sao Paulo. They found low Se in grasses, average $66 \mu\text{g kg}^{-1}$, and also Se was low in both grain and silage of maize, with 31 to $40 \mu\text{g kg}^{-1}$, respectively.

Table 2. Se in agricultural food products of Brazil.

Plant	Se ($\mu\text{g kg}^{-1}$)	Reference
Pasture grass	66	Lucci et al. (1984)
Pasture grass	67 - 123	Anno (2001)
Dried beans S1*	14	Martens et al. (2004)
Dried beans S2	1,710	Martens et al. (2004)
Dried beans S3	240	Martens et al. (2004)
Brazil nut S1**	30-31,700 [†]	Chang et al. (1995)
Brazil nut S2	1,250-512,000 [†]	Chang et al. (1995)
Maize grains	31	Lucci et al. (1984)
Food crops	< 50	Ferreira et al. (2002)

*Dried beans samples from: S1 - State of Rio Grande do Sul; S2 - State of Ceara; S3 - State of Para. ** Brazil nuts samples from: S1 - States of Acre and Rondonia; S2 - States of Amazonas and Para. [†]Fresh weight

Some agricultural foods have shown high Se concentration, but this depends on the Se status of the soils that the crops plants were grown (Table 2). Unfortunately, data for the soil-Se levels in the states with Se concentration in agricultural products (e.g. Amazonas, Para and Ceara) is not available.

Daily selenium intakes

Studies on the intake of Se by the people in some Brazilian states have showed a low intake of this micronutrient in Sao Paulo and Mato Grosso (Table 3). However, in the Amapa and Amazonas states Se intake is adequate (Maihara et al., 2004).

Table 3. Daily Se intake of Brazilian people*.

State or city	Average ($\mu\text{g day}^{-1}$)
Manaus	94.5
Mato Grosso	19
Santa Catarina	52 [†]
Santa Catarina	139 ^{††}
São Paulo	18
São Paulo city (Children)	26.3
Macapá city (Children)	107
Belém city (Children)	37.4

*Sources: Adapted by Gonzaga et al. (2007) and Maihara et al. (2004). [†]Low social class. ^{††}High social class.

Although there are conclusive evidences of Se deficiencies in Brazil, it has not included in the HarvestPlus biofortification program of Brazil. More research on soil-Se levels and Se levels in agricultural products covering all Brazilian states is needed. It is well known that the application of Se containing fertilizers is efficacious at correcting low Se levels in human diets (such as in Finland, New Zealand and Australia).

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