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Selenium Levels in Wheat Grains Grown in Saudi Arabia

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Selenium (Se) is an essential nutrient for humans and animals. The key role of selenium in mammalian metabolism is attributed to the presence of four selenocysteine residues in the enzyme glutathione peroxidase. This enzyme protects human cell membranes and structure from oxidative injury. Selenium, functioning as part of glutathione peroxidase, has been recognized as a cellular antioxidant (Xia et al 1989). In addition, the element is also known, to mention only the most important properties, a protecting agent against heavy metal toxicity (Magos and Webb 1980), cancer (Willett et al 1983; Helzlsour et al 1989), and cardiovascular diseases (Salonen et al 1988; Korpela et al 1989; Korpela 1993). Lack of selenium or disturbance in the metabolism by metals may promote free radical production (Johansson 1991). Dietary selenium deficiency in Chinese people is associated with an endemic cardiomyopathy called “Keshan disease”, which affects primarily children and women of childbearing age. Several clinical studies involving large populations have demonstrated that supplementing the diet with sodium selenite decreases the incidence of Keshan disease significantly (Chen et al 1980; Keshan Disease Research Group 1979).

The soil Se-content of a geographical region is reflected in locally produced foodstuffs, which in turn determine the regional nutritional Se supply of animal and man. Blood Se levels have been widely used as an index of Se status in both animals and humans, and in general there is a good association between levels and the dietary intake of this element over a wide range (Schrauzer and White 1978; Suzuki et al 1989). There is in fact, a close correlation between selenium concentration in foodstuffs and the geochemical characteristics (Kubotal et al 1967; Allaway, 1973; Sun et al 1985) of the area of food production which can often lead to a lack of the element in the diet.

Although the selenium content of food is primarily determined by soil selenium content, it is also characteristically higher for some foods than for others (Combs and Combs 1986). The major source of selenium in most diets are meats and cereal products, which contribute approximately 50% and 25 % to 35 %, respectively of the total Se intakes of the Americans (Litov and Combs 1991). In addition, dairy products and eggs provide 10 % to 20%), while fruits and vegetables provide less than 5 % of the total Se intake.

Wheat is grown locally in Saudi Arabia; the total wheat production rose from 350 thousand tons in 1982 to about 4 million tons in 1991. In general, wheat grain is of great preference among Saudis. This study was undertaken to determine the extent of

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variation in the selenium content in wheat grains samples locally grown in different parts of Saudi Arabia in comparison with white flour.

MATERIALS AND METHODS

Fifty-two samples of wheat grains were collected from eight areas in Saudi Arabia through the Saudi Grain Silos Flour Mills Organization for investigation. Additionally, samples of white flour and whole wheat flour were selected randomly from different supermarkets in Riyadh, capital of Saudi Arabia.

Samples were oven-dried overnight at 100-105°C. A weighed sample of approximately 0.5 gm Standard Reference Material (SRM) 1567a, wheat flour (National Institute of Standards and Technology, NIST, Gaithersburg, MD, USA) was reacted with 3 ml of concentrated “selectipur” nitric acid (E. Merck, D-6100 Darmstaot, Frankfurter Strasse 250 Germany) into a 100 ml reflux Pyrex digestion tube. An automated digestion system 12,0019 with a 1012 Autostep Controller (Tecator AB, Hoganas, Sweden) was programmed as follows: 10 minutes ramp to 120°C and hold for 5 minutes. When the digestion was complete, and the tubes cooled, 2 ml of 5 M hydrochloric acid (Fisher Scientific Co., A.C.S.) were added to each sample converting the selenium to the selenium (IV) state.

The mixture was heated to 90°C for minutes and held for 20 minutes. After cooling for one hour and a half at 4°C, the digestate was filtered through filter paper (Whatman No. 541). The clear supernatant was transferred to polypropylene tubes and diluted to 10 ml with deionised water. Selenium contents were expressed as µg/kg dry weight. The sample was then ready for analysis.

Working standard solutions were made up each day in the range 0.002 to 0.016 µg/mL using 5 M hydrochloric acid solution. A calibration curve of emission intensity versus concentration of selenium was drawn and the concentrations of the unknown samples were read from the calibration graph.

RESULTS AND DISCUSSION

Table 1 shows the results expressed as µg/kg dry weight of Se in wheat grain samples collected from different parts of Saudi Arabia. The Se content of wheat grain samples (n=52) from the areas studied ranged from 8 to 293 µg/kg, with an average of 78.365 µg/kg. The lowest Se concentration was found in the Eastern part of Saudi Arabia. The variation in Se content has been high reflecting differences in geochemical and climatological conditions. Our data compare favorably with data reported in Hungary where Se content in wheat ranged from 5 to 235 µg/kg (Alfthan et al 1992). Low Se values have been reported from Yugoslavia (Maksimovic et al 1992) in the range of 3.6 to 65.5 µg/kg with an average of 18 µg/kg. The most extreme values for the Se content of wheat were reported from Sweden, the Federal Republic of Germany, Scotland and Norway and ranged from 9 to 34 µg/kg (Kumpulainen 1993) In seleniferous areas of Venezuela, Se content in wheat was found to be in the range of 25 to 250 µg/L (Bratter et al 1991). Of the 52 tested wheat grain samples,Wadi Al-Dowasir area had the lowest mean Se content, 50.625 µg/kg in the range of 14 to 92 µg/kg Al-Jouf area had the highest Se content (285.5 µg/kg). The Se content in other areas were more or less similar. A variation in the Se content of wheat from 40 to 2100.4 µg/kg, depending on where the plant was grown, was reported by Schroeder et al (1970).

Table 1. Means, standard deviations and ranges of Se concentrations in locally grown wheat.

Area	No. of samples	Mean ± SD (µg/kg)	Range
Riyadh	5	88.6 ± 21.267	60-120
Wadi Al-Dowasir	8	50.625 ± 29.885	14-92
Qassim	13	70.769 ± 71.874	11-264
Hail	6	88.333 ± 53.679	35-191
Tabouk	3	75.667 ± 18.583	63-97
Jouf	2	285.5	278-293
Eastern	14	65.5 ± 39.814	8-129
Khamas Mushat	1	62	

The concentration of many nutritionally essential trace elements are known to be decreased by milling of grains into cereals (Czerniejewski et al 1964) and analysis of random supermarket samples of white flour (n = 12) contained less Se (69.167 µg/kg) than whole wheat flour (n= 10) where the average Se content was 105.4 µg/kg (Table 2). Similar results were observed (Morris and Levander 1970; WHO 1987). Plants have been divided into three groups depending on their tendency to take up selenium from seleniferous soils (Rosenfeld and Beath 1964): Group 1: primary selenium accumulators which can contain very high amounts of selenium often higher than 1000 mg/kg dry weight; Group 2: secondary selenium accumulators- rarely contain more than a few hundred mg/kg.

Table 2. Means, standard deviations and ranges of Se concentrations in white flour and whole wheat flour samples collected randomly from supermarkets.

Area	No. of samples	Mean ± SD (µg/kg)	Range
White flour	12	69.167 ± 13.279	45-86
Whole wheat flour	10	105.4 ± 78.327	44-295

Finally, Group 3 such as weeds and most crop plants, grasses, and grains is the only group among the three that contribute to the selenium intake of human beings, especially if plants are grown in seleniferous areas. It rarely contains more than 30 mg/kg, even when grown on seleniferous soils; when grown on normal soils generally contains less than .1 mg/kg.

Previous study (Al-Saleh et al, in press) revealed that Se daily intake in 77.8% of breast-fed infants living in Al-Kharj, Saudi Arabia ranged from 0.9 to 15 µg. This was considered to be low when compared to the US National Research Council recommendation in which Se daily intake for infants 0 to 6 months should be 10 to 40 µg. On the other hand, the recommended daily levels of Se intake quoted by the National Research Council (1989) are 70 and 55 µg for adult males and females respectively. No information is available on the average daily intake of Se in Saudi Arabia. Variation in the wheat Se content reflects variation in the Se content of soil in the different regions where wheat grains are grown. This adds further evidence for the necessity to add Se supplement to the soil (Oldfield 1992). The most potential way to increase the selenium level in the food chain is adding sodium selenate to fertilizers or selenium-bearing fly ash as a soil supplement. Finland was the first country which decided to increase the Se content of feed and food by the addition of sodium selenate to fertilizers, to be used in the whole country at a concentration of 16 mg/kg for cereal (Koivistoninen and Huttunen 1985). Therefore, further investigation is needed to check: (1) the Se content of soil where wheat grains are grown; and (2) the Se status among Saudis living in different areas of the country considering the recent changes in Saudi dietary habits particularly between people living in urban and rural areas..

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