Analysis of Selenium Contents in Plant Foods Consumed by Korean adults

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1. Introduction

Selenium(Se) is an essential anti-oxidative trace mineral and plays a key role in protecting cells from oxidative stress derived by free radicals or reactive oxygen species. Thereby, Se has been known to prevent chronic degenerative disease in animals and human. Se exhibited a relatively small range of adequate ingestion level for health. An accurate investigation of Se consumption in Korean population has been rare because the database of food containing selenium is rather small. The table of Se content in food is a basic tool for calculating selenium intake. Since diet is the main source of Se intake, the Se content in various foods and personal dietary practices would be primarily determined to evaluate the nutritional status of Se for a population. To evaluate the Se intake levels of a population, a Se food database should be generated based on data produced by high-precision analytical techniques[1-3]. In addition, this database should contain the Se contents of foods that are regularly consumed by the studied population.

Plant foods contain lower Se levels when compared to animal products. However, grains, potatoes, starches, and legumes have been the main sources of carbohydrates and proteins in traditional Korean diet. Since grains such as rice are a staple food and remain the most consumed foods in Korea, their contribution to dietary Se intake might be considerable. However, no reports on the selenium content from plant foods have been compiled for the Korean population. The goal of this study was to measure the Se content in common consumed plant foods such as grain, potatoes, legumes and their products

2. Methods and Results

2.1 Plant food samples

For selection of commonly eaten food items for Se analysis, which can use for the estimation of selenium intake from plant foods, we analyzed the dietary intake dataset of 4th KNHANES[4]. We extracted 40 grains, legumes, and potatoes and starch foods. Each plant food items was purchased and samples from 3 different regions of Korea were included to reflect the different product location. One hundred grams of 3 food items were pooled to make one sample for each plant food item. Each food samples was ground using a blender with a titanium blade, and a 20-30g of the ground sample was put into falcon tubes and stored at -25^{o}C until freeze-drying. The ground food samples were lyophilized under vacuum condition for 48-96 hour and then ground using an agate mortar with non-adhesive properties

2.2 Analysis of selenium content in plant foods

Se content of lyophilized food samples was analyzed using the instrumental neutron activation analysis(INAA). Each freeze-dried and homogenized food sample about 1g was irradiated for 3 hrs by thermal neutrons (Φ_{th} = 2.8 x 10^{13} n/cm^2·s, $R_{cd,Au}$ = 80), γ–rays from the irradiated samples was measured for 20,000s after cooling for 20 days and a long half-lived nuclide (^{75}Se, $T_{1/2}$: 119.77 days, E_γ : 264.7 keV) was used for the determination of Se contents.

Accuracy of Se analysis by INAA was verified using standard reference materials(SRM, 8436-durum wheat flour, 1570a-spinach leaves) from the National Institute of Standards and Technology(NIST), USA. The relative errors obtained from four repetitive analysis on the SRMs using the INAA method within 6%

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Table 1. Analytical results of NIST SRMs by INAA

Elements	Certified Value ± Unc.	Mean ± SD	Rel. Error (%)	SRM No.
Se	1.23 ± 0.09	1.3 ± 0.1	5.4	8436
	0.117 ± 0.009	0.123 ± 0.08	5.1	1570a

2.3. Selenium contents of grain and starches

The Se contents in 100g of each grain, starch, legume and their products are shown in Table 2. Se contents among those plant foods varied according to the plant food group and food processing. The Se contents of the different type of raw grain ranged from 0.19 μg to 10.56 μg in 100g of sample, and the highest Se content was detected in glutinous brown rice. The rice, the major staple food in Korean diet, showed wide range of Se contents from 0.55 μg to 10.56 μg per 100g of sample. By cooking, the Se content in 100g of white rice, declined from 2.11 μg to 0.74 μg per 100g sample.

The Se contents in grain products varied according to the type of grain processing. Breads and noodles were unique in that they contained relatively higher quantities of Se among grain products ranging from

1.64 μg to 25.20 μg for breads and 3.26 μg to 32.10 μg for the noodles per 100g of sample. Excluding the buckwheat noddle, most of these products were wheat products. Among breads, loaf bread contained the highest amount of Se with 25.20 μg /100g sample, whereas among noodles, dried spaghetti showed the highest Se content with 32.10 μg/100g sample. Wheat flours contained Se in a range from 2.81 μg to 11.35 μg in 100g food. One hundred grams of legumes contained 0.58 μg to 10.42 μg of Se, and soybeans exhibited the highest Se content. However, the processed products of soybeans contained lower Se contents(0.81-2.23 μg in 100g of sample). The Se contents in potatoes and starches ranged from 0.28 μg to 0.66 μg per 100g sample.

Table 3. Se contents of grain, starch, legume and their by-products

Plant food group	Food name	Se(μg/100g)
Rices & Barley	White rice, polished, raw	2.11
	White rice, cooked	0.74
	Brown rice, germinated	2.26
	White rice porridge	0.55
	Glutinous rice, polished, raw	3.64
	Naked barley, polished, raw	1.12
Miscellaneous	Oats	1.66
	Regular millet	2.05
	Sorghum	<LOD*
	Adlay	3.03
	Buckwheat	6.08
	Prosomillet	2.31
	Corn	0.19
Wheat Flour	Wheat flour for frying	2.81
	Wheat flour	8.01
Breads	Loaf bread, with whole milk	25.2
	Sponge cake	16.83
	Bread filled with small red bean paste	5.6
	Steamed breads, with small red bean	4.09
	Doughnuts, Dunkin	14.7
	Cheese cake	1.64
Noodles	Plain noodle	13.14
	Naengmyeon, cold noddle, dried	19.57
	Buckwheat noddle	4.04
	Spaghetti, dried	32.1
Legume	Seoritae	1.95
	Soybean, yellow	1.35
	Small red bean	2.4
	Kidney beans	1.77
	Black bean	3.2
	Mungbean, peeled	3.78
Legume Products	Unpressed soybean curd	0.81
	Soybean curd	1.81
	Fried soybean curd(for sushi)	2.23
	Soybean milk	2.05
Potatoes	Sweet potato	0.66
Starches	Potato	<LOD
Potatoes	Glass noddle	<LOD
Starches	Acorns starch jelly	0.08
products	Devil's tongue jelly	0.56

*LOD= Limit of detection

3. Conclusions

The legume rich in protein contained relatively high amount of Se when compared to other plant food type. The raw wheat and wheat product which have been imported from abroad showed higher amount of Se than rice mostly produced in Korea. The acquired Se value is useful to assess the Se intake of Korean adults from plant foods. The INAA is a credible method to measure the trace amounts of Se in plant foods.

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