Evaluation of Selenium Content of Plant Samples Collected from Indigenous Sources for Se-supplementation

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Summary: Selenium contents were evaluated in different plant species such as Canola (*Brassica napus)*. Sunflower (*Helianthus annus)*, Turmeric *(Curcuma longa)*, Soyabean Seeds (*Glycine max*) and Akk (*Calotropis procera*) in order to access their possibility for Se-supplementation. The dry ash of bulb of Turmeric and seeds of Canola, Sunflower, and Soyabean were digested in concentrated HNO_3, $HClO_4$ and HCl to obtain selenium (IV). After adding different reagents, stable blue colored complex was formed. From this colored complex, selenium (IV) was determined by UV/visible spectrophotometer. This work was carried out in an attempt to obtain information concerning the amount of selenium present in different plants. It was observed that Akk is a good accumulator of selenium as it contains almost 30 μg selenium per gram and can be used for different medicinal applications.

Introduction

Selenium is one of the most significant trace mineral which plays dynamic role in different biological systems [1]. selenium is a crucial micronutrient for human health that is an important part of antioxidant enzyme glutathione peroxidase [2]. It is an integral part of enzyme which is critical for the numerous chemical reactions involved in brain and body functions. It usually enters the metabolism through the diet as component of vegetables and cereals. The primary forms of Se found in selenium-enriched vegetables from *Allium* family (garlic, onions, broccoli and sprouts) are Se-methyl selenocysteine (SeMC) and derivatives like γ-glutamyl-Se-methylselenocysteine. These non-protein Se amino acids have also been reported to be present in Se-accumulator plants of the genus *Brassica* and *Astragalus* [3].

The most important source of the selenium for humans and animals is food. Beside the total content of Selenium, the chemical form in which selenium present, is also important due to the differences in bioavailability and toxicity of the different forms. Plants are mostly poor sources of selenium and are capable of accumulating higher amounts of selenium at some stages in cultivation and transforming it into a suitable chemical form, are one of the potential sources for enhancement of selenium daily intake [4-5]. The normal 50-150 mg/day intake of Se in food is enough to meet daily need of essential nutrient because its deficiency is commonly linked with HIV/AIDs and cancer [6-9]. selenium deficiency leads to infertility in men due to reduced testicular growth and also degenerative change in epididymis, which is allied to sperm maturation [10]. Surveys of patients with rheumatoid arthritis have indicated that they have reduced selenium level in their blood [11]. Moreover selenium deficiency includes skeletal muscle disorders, growth retardation in infants and various degree of heart insufficiency [12-14].

Various plants can accumulate selenium up to thousands of ppm and are known as "accumulators". Some of them, like *Arabidopsis thaliana* and *Brassica juncea* (Indian mustard) were investigated in terms of the Se metabolic pathway. In this regard, some of these plant species are excellent candidates for selenium phytoremediation [15-17]. This work was carried out in an attempt to obtain information concerning the amount of selenium present in different plants; therefore this part of our research work is likely to be very useful to act as base-line information for Se-supplementation.

Results and Discussion

The method employed involves acidic medium which is required for the liberation of I_2 from

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KI. Iodine is cooperative in the determination of Se and pH range required for the reaction is 1-1.5.

This method is an indirect determination of Selenium. Chemical reaction involves oxidation of iodide present in KI into iodine by selenium present in test media. In this redox reaction free iodine form a blue stable complex with starch which gives the concentration of selenium in the solution in indirect way as amount of selenium is directly proportional to liberated iodine.

It is noted that almost 0.5 mL of 0.05% starch solution is required for blue coloration of complex by the action of starch with I_2. The optimum amount is 0.5 mL. Its increased concentration causes turbidity in the solution resulting in disturbance during determination of Selenium. Further 2.0 mL of sodium acetate solution was used and this amount was proved to be sufficient for completion and maximum color development in the solution.

The results obtained indicate the different amount of selenium present in these selected plants as shown in Fig 2. The amount of selenium has been found in the range of 1.1 µg/g to 29.7 µg/g. This enormous variation clearly shows the variable capability of different plants towards selenium accumulation and depends on not only their natural habitat but also on nature of plant towards selenium accumulation.

Among our selected plants samples Akk seeds contain highest amount of selenium which is 29.7 µg/g (Table-2). Most probably anticancer properties of the Akk plants are attributed to the high selenium contents present in it. No doubt the Akk plant with this high amount of selenium is poisonous for direct oral intake of selenium as living bodies, especially human bodies has not yet evolved an effective protective mechanism to guard against the overdose of beneficial trace elements like Selenium. But these Akk plants can be extremely useful in special medical treatments, remedies, drugs for different lethal diseases. The seeds and other selenium rich parts of Akk plants can be used for the preparation of selenium supplements for selenium deficient patients.

It is interesting to note that lowest amount is present in Turmeric *i.e.* 1.1µg /g and 1.62 µg/g of Se is present in Soyabean seeds (Table-2). These amounts are sufficient for normal intake in daily routine to avoid selenium deficiency.

On the other hand 5.0 µg/g of selenium is present in Canola seeds and 7.1 µg/g of selenium is present in Sunflower seeds. So the food containing Canola and Sunflower grains can be used as food remedy for selenium deficient patients. But the regular use of these seeds in daily diet can cause some problems in normal human beings because of higher intake of Selenium. These high concentrations of selenium indicate either these plants also possess selenium accumulation properties like Akk plant or these plants were grown in selenium rich or polluted soil. Scientific data and surveys showed that sufficient amount is present in leaves and other plant parts [10].

Table-1: Absorbance of colored complex formed in standard solutions of selenium (IV) after adding reagents.

Sr. No.	Concentration (ppm)	Absorbance
01	1.0	0.274
02	2.0	0.301
03	3.0	0.324
04	4.0	0.349
05	5.0	0.378

Table-2: Concentration of selenium in various plant samples measured at 546 nm wavelength.

Sample Name	Mean Absorbance at 546nm	Standard Deviation	Significance (P)	Concentration of selenium µg/g
Canola	0.2842	0.0035094	<0.05	5.0
Sunflower	0.2996	0.0022608	<0.05	7.1
Turmeric	0.3252	0.0023094	<0.05	1.1
Soyabean	0.3636	0.0028608	<0.05	1.62
Akk	0.3327	0.0044495	<0.05	29.7

Experimental

Instruments

Spectroscopic studies were carried out by UV/VIS spectrophotometer, (Labomed, UVD3500).

Reagents and Chemicals

All the chemicals and solvents were of analytical grade. 1000 ppm stock solution of selenium dioxide was prepared by dissolving 1.4 g of SeO_2 in 1000 mL of double distilled H_2O. Then sample solutions of 1.0 ppm, 2.0 ppm, 3.0 ppm, 4.0 ppm, 5.0 ppm were prepared by further dilution of the stock solution.

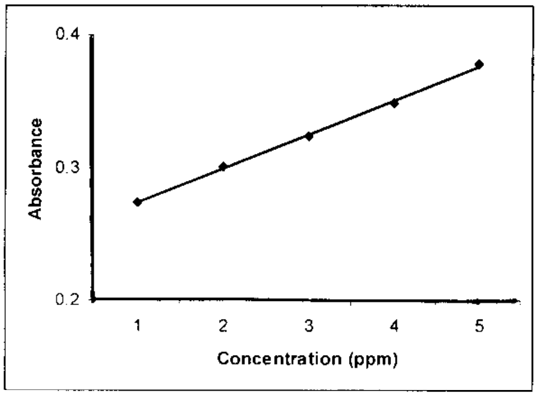

Fig. 1: Calibration curve of colored complex of starch and iodine, formed by adding them in the standard solutions of selenium (IV).

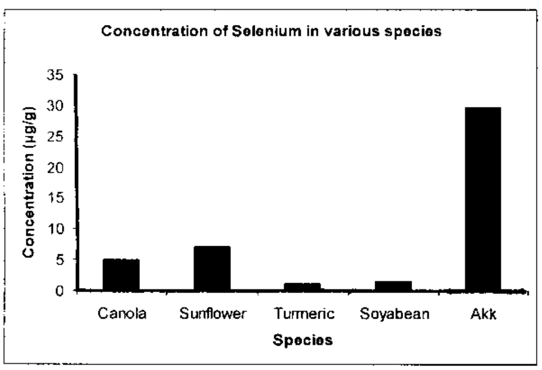

Fig. 2: Comparative concentration of selenium in various plant samples.

mL of $HClO_4$ was added and reboiled for 10 min. Again sample was allowed to cool and 20.0 mL H_2O and 10.0 mL HCl were added, followed by further boiling for 10 minute to complete the conversion. This process converted all other forms of selenium into Se (IV).

Procedure for Colored Complex Solution Formation

After preparation of sample solutions, colored complexes were produced by adding KI, HCl, starch solution and sodium acetate solution in 1.0 mL of each sample solution in the same amount and same sequence, as they were added during the preparation of complex for standard solutions for calibration curve shown in Fig. 1. The absorbance of each sample solution after complexation was noted at 546 nm and reported in Table-2 [18].

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