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Spectrophotometric Determination of Selenium in Food Items

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Abstract

Selenium (Se) is an essential element that is obtained from food. To increase the level of selenium in the body, we should consume selenium-rich foods in our diet. The objective of this study was to develop a simple spectrophotometric method for the quantitative analysis of selenium present in food. This study included six food items such as broccoli, cabbage, red cabbage, fenugreek, garlic, and ginger. The new method is based on the yellow colour complex formed by the reaction between 2% potassium iodide and 0.2% pyridine in acidic medium with the selenium. Absorbance was measured at 400 nm against the reagent blank. The results of the above proposed method were compared with the reference method of using potassium iodide and starch as reagents. The selenium content in the examined food samples was determined from the regression equation of the calibration curve y= 0.0799x+0.3477 respectively. All the analyses were performed in triplicate, and the results are expressed as mean ± standard deviation. The highest mean selenium value was obtained in ginger and garlic 18.70 & 18.32 µg/g, respectively among all the studied samples, while the lowest value was in fenugreek seeds 7.38 µg/g. The proposed method is simple, rapid, sensitive, and obeys Beer–Lambert's law. The proposed method was successfully applied to determine food items. Selenium has been quantitatively analysed for its potential to protect the body from many degenerative diseases. Selenium-rich food, as studied here, should be used as a supplement in the human diet.

Keywords: *Food items, Quantitative analysis, Selenium, Visible Spectrophotometer.*

1. Introduction

In the human body, selenium is a crucial trace element. The dietary intake of selenium has many physiological processes. (Fawzya Moatkhef 2020) Selenium acts as a trace element, including nutritional and toxicological interest. Selenium intake reduces the risk of heart diseases and low-density lipoprotein levels in blood and improves the immune system. In a recent study, it has been shown that asthmatic patients have lower levels of selenium in their blood than the healthy population. Selenium compounds are generally very efficiently absorbed by humans. (Zhao Tan 2020) It is also a nutrient for antioxidants and anticancer which is obtained from agricultural food and the environment. (Sanskriti ravi 2019) The amount of selenium in the human body depends primarily on its diet and is estimated that for adults, the intake of selenium is 60 µg/day for women and 70 µg/day for men. (Yancui Huang 2020) In the present study, food items such as fresh vegetables such as broccoli, cabbage, red cabbage, fenugreek, garlic and ginger were used for the determination of selenium. Broccoli (Brassica olaracea, var. Italica) is mainly consumed for its florets and is widely consumed by people. Broccoli and cabbage belong to the cabbage family which is a vegetable plant family of Brassicaceae. Broccoli contains various minerals such as calcium, selenium and iron. It can be eaten

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raw and can be consumed by different cooking methods. Cabbage is a vegetable that has many nutritional properties and contains minerals. (Vladimir V. Martirosyan 2023). Fenugreek is an annual leguminous Bentham belonging to the Fabaceae family, and it has been used to heal wounds, aid digestion, and provide other health benefits to humans. Fenugreek seeds are the most important and useful part of plants. It is an herbal medicine used for the cure of diabetes [1-5]. The biological and pharmacological actions of fenugreek are mostly attributed to the variety of its bioactive chemical constituents (EMAWATI E" YULIANTINI A 2020) Ginger belongs to the Zingiberaceae family. Ginger plants add nutritional value to our daily lives. The antioxidant property of ginger is a significant activity that can be used as a preventive agent against many diseases. Selenium of food items using UV-Visible spectrophotometric method with a wavelength of 400 nm. (Belgin Izgia 2006) The objective of this study is to develop a simple spectrophotometric method for the quantitative analysis of selenium present in food items such as Broccoli, Red cabbage, Cabbage, Ginger, Garlic, and Fenugreek seeds [6].

2. Materials and Methods

2.1 Sample Collection

This study included six food items such as broccoli, cabbage, red cabbage, fenugreek, garlic, and ginger. All the food items were taken from a local supermarket in Kalyan. All samples were stored in 25ºC to protect or to contaminate from the loss of Se.

2.2 Sample Preparation

All the samples were cut into small pieces and then ground using a grinder and 5g of each sample was used for the further analysis of Se.

2.3 Apparatus

All glassware used for the experimental purpose was made up of Pyrex or borosil glass. The burette, pipette, and standard flasks were calibrated using the method described by Vogel (Arthur I. Vogel 1989)

2.4 Instrument

The absorption measurements were performed on a visible spectrophotometer, model LMSPV320, LABMAN, using 1-cm matched glass cells. The spectrophotometer was calibrated by measuring the absorption spectra of potassium chromate in potassium hydroxide solution and that of potassium permanganate in sulphuric acid solution. (Sandell E. B 1944)

2.5 Chemicals

All the reagents used were of analytical grade, and distilled water was used throughout the study. Potassium iodide, HCL, pyridine, HNO3, sodium hydroxide, EDTA, sodium selenite.

2.6 Procedure for the Determination of Selenium in the Samples: (Reference Method)

Five grammes of food samples were freshly cut and ground and digested with 10 ml of HNO3 for 20 min. After cooling, 10 ml of distilled water and 5 ml of HCL were added and boiled for 10 min. The solution was neutralised at pH=7 with 10% NaOH and diluted to 50 ml after adding 5 ml of 5% EDTA. An aliquot of this solution (3ml) was analysed for selenium according to the reference method. (Narayana, B 2003)

2.7 Quantitative Determination of Selenium: (Proposed Method)

A standard (100 ppm) stock solution of selenium was prepared by dissolving 0.1910 g of NaSeO3 in 100 mL distilled water Different concentrations of solutions were prepared containing 2-20 ug. A volume of 1 ml of 2% potassium iodide was added, and 0.2 ml of 2 M HCL was added. The solution was gently shaken, and 1 ml of 0.2% pyridine was added. A yellow-orange colour complex appeared, in the nonpolar solvents, iodine reacted with pyridine to form a stable molecular complex The contents were filled up to the mark with distilled water, and absorbance was measured at 400 nm against the reagent blank. The samples were determined using 3ml of solution. The results of the above proposed method were compared with the reference method using potassium iodide and starch as reagents [7].

2.8 Characteristics

Spectral Characteristics: The optimum wavelength of maximum absorption (Ëmax) of

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selenium was scanned on a spectrophotometer in the wavelength region from 340 to 900 nm against a blank. The maximum wavelengths shown were 400 nm.

Optical Characteristics: Selenium adhered to the Beer–Lambert law. The Beer's range obtained was 2–20 µg/ml. A calibration curve was constructed by measuring the absorbance at an appropriate wavelength of a set of solutions containing varying amounts of selenium and a specified amount of reagents against a suitable blank. Beer– Lambert's Law plots are recorded graphically. Analytical Parameter shown in Table 2.

Table 1 Determination of Selenium in Food Samples

Samples	Proposed method	Reference method
Broccoli	15.13 ± 0.05	15.90 ± 0.04
Cabbage	14.19 ± 0.08	14.99 ± 0.03
Red Cabbage	13.06 ± 0.03	13.68 ± 0.04
Fenugreek	07.47 ± 0.01	07.38 ± 0.13
Garlic	18.13 ± 0.11	18.32 ± 0.01
Ginger	18.27 ± 0.04	18.87 ± 0.01

Table 2 Analytical Parameters

Parameters	
Beer's Range	2-20 µg/mL
molar absorptivity	**0.10232** L mol^{-1} cm^{-1}.
sandell's sensitivity	0.0105 µg/mL
Maximum Wavelength	400 nm
LOQ	53.41
LOD	17.62

3. Results and Discussion

Selenium is an essential mineral found in food items. Selenium has been studied for its potential to protect the body from many degenerative diseases. It can also be used as a supplement in the human diet. Based on the data (shown in table 1) from the calibration curve calculated statistically obtained by equation y= 0.0799x 0.3477 with a correlation coefficient of r2 = 0.9982. All the analyses were performed in triplicate and the results are expressed as mean ± standard deviation [8]. These results indicate that the highest mean selenium value was obtained in ginger and garlic 18.70 & 18.32 µg/g, respectively, among all the studied samples, while the lowest value was in fenugreek seeds 7.38 µg/g.

3.1 Analytical Data

Beer's law was studied by measuring the absorbance values of solutions varying in selenium concentration. A straight-line graph was obtained plotting against the absorbance V/S concentration of selenium. This graph shows at 400 nm. The beer range was from 2 to 20 ppm. The molar absorptivity and Sandell's sensitivity were found to be 0.10232 L mol-1 cm-1.and 0.0105 µg/mL. The values obtained from the samples are compared with the reference method.

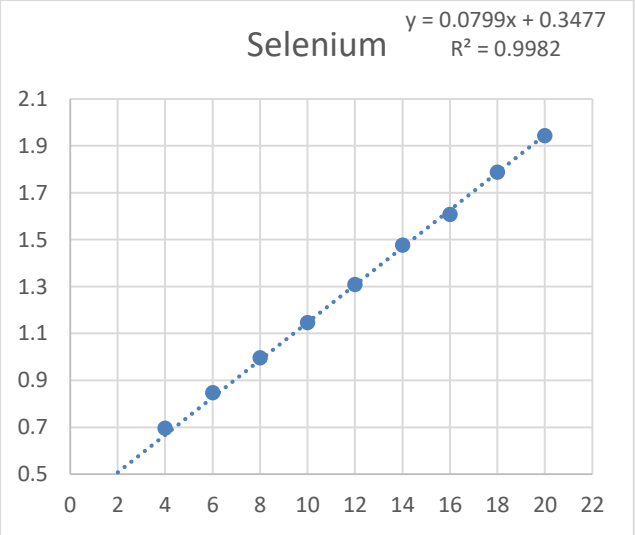

Figure 1 Standard Curve for Selenium

Selenium used as a standard to determine Selenium content. The molar absorptivity 0.10232 L mol-1 cm-1, and the Sandell's sensitivity is 0.0105 µg/mL. Graph shows the straight-line calibration curve. Figure 1 shown in Standard Curve for Selenium.

Conclusion

The proposed method is simple, rapid, sensitive, and obeys Beer–Lambert's law. The proposed method was successfully applied to determine food items. Selenium has been quantitatively analysed for its potential to protect the body from many degenerative diseases. Selenium-rich food, as

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studied here, should be used as a supplement in humans [9].

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