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ASSESSING SELENIUM CONTENT IN FOODS: A COMPARATIVE STUDY OF COOKING METHODS

Komal Pareek[1], Pooja V. Jagasia[2]

[1] Student, Department of Chemistry, Vivekanand Education Society's College of Arts, Science and Commerce 400071, Chembur, Mumbai, Maharashtra, India
[2] Professor, Department of Chemistry, Vivekanand Education Society's College of Arts, Science and Commerce 400071, Chembur, Mumbai, Maharashtra, India

ABSTRACT

This study aimed to investigate domestic cooking methods, including boiling, steaming, blanching, and microwaving, to determine selenium. All food items were grinded and were further analyzed for suitable cooking methods. It suggests that Steaming is recommended for cooking broccoli, cabbage, and fenugreek. The loss of selenium was less in red cabbage and Garlic after Microwave treatment. Blanching foods, except ginger, suggest major selenium loss.

Keywords: Selenium, Cooking Methods, Food Items, Spectrophotometer, ICP-MS

Corresponding Author
Komal Pareek
Komal.pareek.18936@ves.ac.in

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1. INTRODUCTION

Human selenium intake primarily comes from our daily diet, mainly through selenium-enriched foods, which are excellent sources of this essential nutrient. Selenium is vital for human health, reducing the risk of various diseases. Selenium intake should be adequate across all age groups. (1) Before consumption, many food items undergo cooking methods such as boiling, steaming, blanching, and microwaving. Foods like broccoli, cabbage, red cabbage, fenugreek, garlic, and ginger are rich in selenium. (2) Among these, broccoli stands out as particularly valuable due to its high content of vitamins, polyphenols, fiber, and selenium, offering both nutritional and medicinal benefits, including cardioprotective properties. (3) Cabbage and red cabbage, belonging to the same family, are nutritious cool-season vegetables. (4) Fenugreek seeds are widely used as dietary supplements by people of all ages. Rich in various biologically active ingredients, fenugreek is a great source of health benefits and has applications in traditional medicine as a dietary

supplement, antidiabetic, gastric stimulant, and antibacterial agent. (5) In this study, four cooking methods were analyzed to determine their effect on the selenium content in foods such as broccoli, cabbage, red cabbage, fenugreek, garlic, and ginger.

2. MATERIALS AND METHODS

2.1 SAMPLE COLLECTION

This study includes six food items: broccoli, cabbage, red cabbage, fenugreek, garlic, and ginger. All food items were purchased from a local supermarket in Kalyan. All samples were stored at 25°C to protect or eliminate contamination from the loss of Se.

2.2 SAMPLE PREPARATION

All samples were cut into small pieces and then ground using a grinder, and 5g of each sample was used for further analysis of different cooking methods for selenium determination.

2.3 APPARATUS

All glassware used for the experimental purposes was made of Pyrex glass. The buret, pipette, and standard flasks were calibrated as described by Vogel (6)

2.4 INSTRUMENT

The absorption measurements were carried out on a visible-light 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 sulfuric acid solution. (7)

2.5 CHEMICALS

All the reagents were of analytical grade, and distilled water was used throughout the study—potassium iodide, HCL, pyridine, HNO_3, sodium hydroxide, EDTA, and sodium selenite.

2.6 COOKING TREATMENTS

Four different cooking methods were tested: boiling, steaming, blanching, and microwaving. For boiling, 5 g of small cut pieces of each sample were immersed in 100 ml of boiling water. The materials were drained after boiling for 5 min for further analysis. For steaming, 5 gm of samples above 100ml of boiling water for 5 min in a steamer with a lid. For blanching, samples were boiled for 2.5 min, stored in ice water for 2.5 min, and then drained off for analyses. The samples were chopped and 10ml of water was added to the microwave. A microwave oven was maintained at 180 °C for 5 min for each sample. In addition, 5 g of fresh-cut samples were collected. All samples were collected and used for further selenium analyses.

2.7 PROCEDURE FOR THE DETERMINATION OF SELENIUM IN SAMPLES

A 5g of food samples were freshly cut and ground and were digested with 10 ml of HNO_3 for 20 min. After colling 10ml of distilled water and 5ml of HCL, they were added and boiled for 10 min. The solution was neutralized at pH=7 with 10% NaOH and diluted to 50ml after adding 5ml of 5% EDTA. An aliquot of this solution (3ml) was analyzed for selenium content according to the general procedure.

Procedure: A standard (100ppm) stock solution of selenium was prepared by dissolving $NaSeo_3$ in distilled water. Different concentrations of solutions containing 2-20 ug were prepared. A volume of 1 ml of 2% potassium iodide was added, and 0.2 ml of 2M HCL was added. The solution was gently shaken and 1ml of 0.2% pyridine was added to it to obtain a yellow-orange color complex. The contents were filled to the mark with distilled water, and the absorbance was measured at 400 nm against a blank reagent. The samples were determined using 3ml of solution. The results of the above-proposed method were compared with those of the reference method using potassium iodide and starch as reagents. (8)

The analysis of selenium is also carried out by ICP-MS. The samples prepared were directly used after detecting pH without any dilutions. The operating parameters are listed in Table 3.

3. RESULT AND DISCUSSION

Selenium-enriched foods are good supplements for selenium-deficient populations. Diet is the main source of selenium intake for most people. Vegetables are excellent sources of selenium. This study evaluated the effect of four cooking

methods (boiling, steaming, blanching, and microwaving) on food items to determine selenium. 5g of each food item was cooked using different cooking methods for selenium content.

Summary of Effects of Cooking Methods on Selenium Content: (Table 1)

The study evaluated the selenium content in various food items subjected to four cooking methods: boiling, steaming, microwaving, and blanching. The results are expressed in mean ± standard deviation, as shown in Tables 1 & 2.

Overall, steaming generally resulted in higher selenium retention for most food items, while blanching often led to the lowest selenium content.

The "Reference method" data in Table 2 provides insights into the selenium content of various food items after being subjected to different cooking methods: boiling, steaming, microwaving, and blanching. The results are presented as mean values with standard deviations, which indicate the variability of the measurements.

4. EFFECTS OF COOKING METHODS ON FOOD ITEMS

Table 1: Proposed method

Samples	Boiling	Steaming	Microwaving	Blanching
Broccoli	4.11 ± 0.015	14.23 ± 0.015	8.06 ± 0.015	2.04 ± 0.005
Cabbage	4.10 ± 0.015	8.06 ± 0.011	4.78 ± 0.040	6.37 ± 0.040
Red Cabbage	7.27 ± 0.005	11.24 ± 0.011	18.55 ± 0.015	5.9 ± 0.011
Fenugreek	6.98 ± 0.015	16.35 ± 0.026	10.62 ± 0.011	10.92 ± 0.015
Garlic	7.08 ± 0.015	10.26 ± 0.020	16.38 ± 0.011	2.2 ± 0.040
Ginger	6.96 ± 0.026	15.62 ± 0.015	12.25 ± 0.005	20.44 ± 0.005

Table 2: Reference method

Samples	Boiling	Steaming	Microwaving	Blanching
Broccoli	4.39 ± 0.017	14.6 ± 0.025	13.31 ± 0.011	2.71 ± 0.052
Cabbage	4.3 ± 0.015	13.16 ± 0.011	4.17 ± 0.025	6.7 ± 0.03
Red Cabbage	7.35 ± 0.020	11.91 ± 0.03	18.79 ± 0.017	5.11 ± 0.011
Fenugreek	6.75 ± 0.011	16.37 ± 0.03	10.1 ± 0.392	11.03 ± 0.056
Garlic	7.2 ± 0.03	10.91 ± 0.03	16.35 ± 0.041	2.80 ± 0.017
Ginger	6.43 ± 0.017	15.35 ± 0.052	12.01 ± 0.025	20.63 ± 0.032

SELENIUM CONTENT ANALYSIS

The results from the ICP-MS analysis are compared with those obtained from a spectrophotometer, another method for measuring selenium content. The values are expressed in parts per million (ppm), indicating the selenium concentration in each food sample.

Broccoli, Cabbage, Red Cabbage, Fenugreek, Garlic, and Ginger: Table 4 shows the selenium content measured by both the proposed ICP-MS method and reference spectrophotometer methods. The values indicate how much selenium is present in each food item, with variations between the two methods.

Table 3: ICP-MS Parameters

Argon Flow rates (L/min)	
Plasma Power	1548
Outer Flow	13.96
Auxiliary Flow	0.795
Nebulizer	1.172
Sample & Skimmer cone	Ni
Dwell Time	0.1 Sec
Sweeps	10 Survey
No of replicates	3
Sample read delay	70 Sec
Wash Time	70 Sec

Table 4:

samples	ICP-MS	Spectrophotometer (Proposed)	Spectrophotometer (Reference)
Broccoli	0.166	0.198	0.194
Cabbage	0.100	0.122	0.126

Red Cabbage	0.119	0.133	0.138
Fenugreek	0.085	0.082	0.086
Garlic	0.141	0.177	0.180
Ginger	0.214	0.279	0.272

ANALYTICAL PARAMETERS

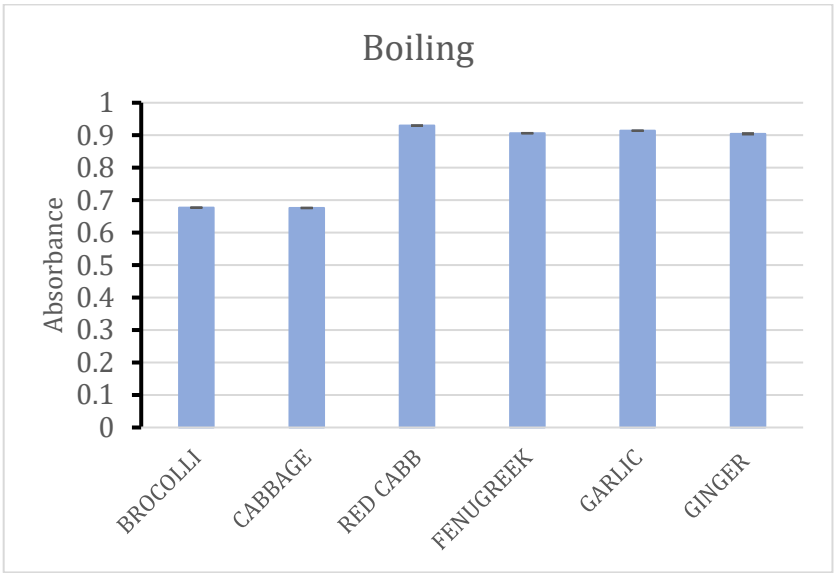
1. pH Levels: The pH of each food sample is measured, which can affect the extraction and detection of selenium. The pH values are relatively close to neutral (around 4.85 to 4.97), which is generally favorable for the analysis.
2. Standard Deviation (SD) and Relative Standard Deviation (RSD):

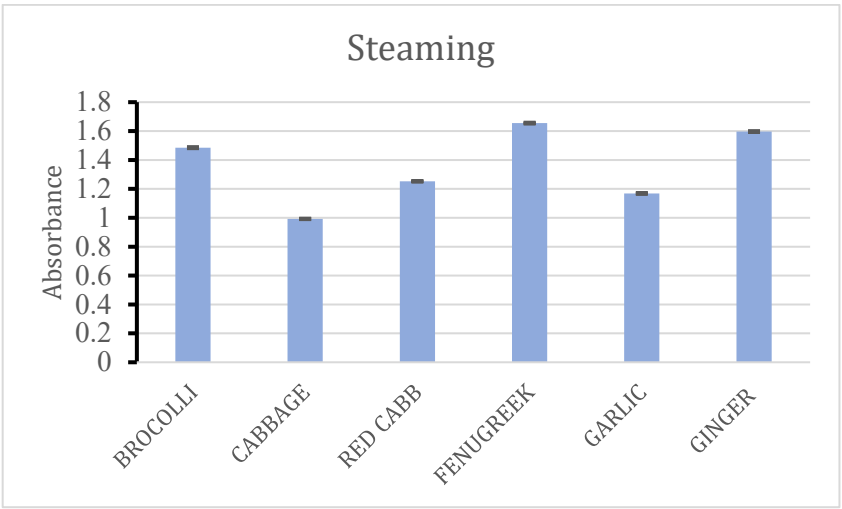
Standard Deviation (SD): This measures the variability of the results. A lower SD indicates that the results are consistent. Relative Standard Deviation (RSD): This is the SD expressed as a percentage of the mean, providing a way to compare the precision of different measurements. Lower RSD values indicate better precision.

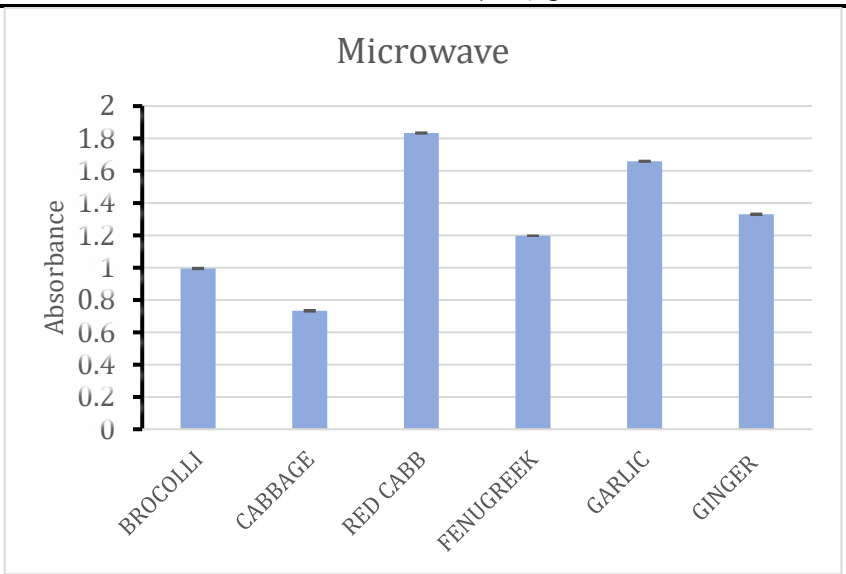
Analytical Parameters:

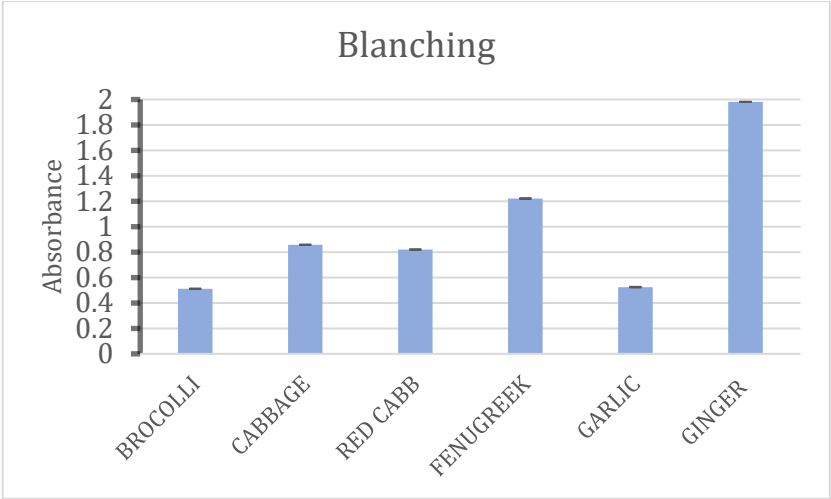
samples	pH	SD	RSD
Broccoli	4.92	1.1	0.7
Cabbage	4.85	7.1	7
Red Cabbage	4.97	6.3	5.3
Garlic	4.88	9.9	7
Ginger	4.94	10.3	4.8

GRAPHS:









5. CONCLUSION

Overall, the ICP-MS parameters and analytical results provide a comprehensive overview of how selenium content is measured in various food items. The careful selection of parameters ensures that the analysis is accurate, while the comparison of results from different methods helps validate the findings. This information is crucial for understanding the nutritional value of these foods and their contribution to selenium intake in the diet. The present study examined the effects of different cooking methods, including boiling, steaming, blanching, and microwaving. cooking may cause changes to the selenium content depending on the type of food item and the method used. The best preserves its nutritional value and selenium content.

CONFLICT OF INTERESTS

None.

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