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Determination of Iron and Moisture Content in Commonly Consumed Vegetable Samples of Gubrie and Wolkite Town, Southern Ethiopia

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Abstract

Concentration of iron was determined in vegetables of spinach, cabbage and potato randomly purchased from local markets of Gubrie and Wolkite Town and analyzed using UV-Vis spectrophotometry by thiocyanate colorimetry. The concentration of iron in potato (*Solanum tuberosum*), Cabbage (*Brassica oleracea* var. *capitata*) and Spinach (*Spinacia oleracea*) was $1.10 \pm 1.29 \times 10^{-3}$ mg/100 g, $0.931 \pm 1.29 \times 10^{-3}$ mg/100 g and $1.08 \pm 2.36 \times 10^{-3}$ mg/100 g respectively. The level of iron in each vegetable samples were lower than FAO/WHO guidelines (0.03 mg/100 g). In addition, cabbage shows a highest mean moisture content (95%) and potato shows the least moisture content (83%). according to Analysis of Variance (ANOVA) at 95% confidence level, the mean moisture content percentage between vegetable samples is statistical significance difference and there is no statistical significance difference in mean concentration of iron. The observed differences in moisture contents in each vegetable samples may as a result of variation in soil type, difference in capacity of preventing water from evaporation.

Keywords: Vegetables; Iron content; Moisture content; UV-Vis spectrophotometer

Introduction

The word vegetable refers to edible part of the plant that stores food in different parts of it like roots, stems, or leaves. Most often vegetables are consumed as salads or cooked in savory or salty dishes, while culinary fruits are usually sweet and used for desserts [1]. Including vegetables in the diet can give us different advantages. These are reduction of the incidence of cancer, stroke, cardiovascular disease and other chronic ailments [2-4]. Vegetables are looks like green and leafy-like in appearance behaves edible stems or leaves and roots of plants [5]. Commonly the food value of vegetable is low due to the large amount of water (79-96%). The nutritious value of vegetables is increased greatly, because they contain mineral salts and vitamins, they also serve as roughages that help in digestion of food [5]. Vegetables are very important for essential diet since they are contributing proteins, vitamins, iron, calcium, and other nutrients that are in short supply and most of them do have low fat and calories content, but they are bulky and filling [6]. In addition, vegetables also contain essential and toxic elements over a wide range of concentrations. A research is conducted on fatty acid patterns in vegetable oils, fats and fat-rich foods commonly consumed in Egypt also showed that vegetables comparatively do have less fat content than other source of oil [7]. However, metals that found in vegetables may pose a direct threat to human health, which is absorbed by them from contaminated soils and wastewater used for irrigation as well as deposits on different parts of the vegetables exposed to the air from polluted environment [8].

Iron contribution in body is dominantly through diet. The two main forms of iron are heme and non-heme. These forms of iron differ significantly in the molecular mechanisms of their absorption and bioavailability. The former obtained from meat, fish, poultry and the latter obtained from plant source. It has been reported that heme iron is well absorbed and is not much affected by other components of the foods eaten in the same meal. The absorption of non-heme iron is greatly influenced by meal composition. Thus, both the total amount of iron and the form of iron in food nutrition are significantly important [9-12].

Most of the time malnutrition arising from dietary deficiency of analytically important mineral micronutrients such as iron is a serious problem affecting nearly half of the world's population [13]. Fatigue and reduction in work performance are caused iron deficiency, even in absence of anemia [14]. It is very important to our health; on the other hand extremely high doses of iron (in the hundreds or thousands of mg) can cause organ failure, coma, convulsions, and death. Furthermore, accidental iron poisoning for children can be reduced through child-proof packaging and warning labels on iron supplements. Some people have an inherited condition of hemochromatosis that causes toxic levels of iron to build up in their bodies. Without medical treatment, people with hereditary hemochromatosis can develop serious problems like liver cirrhosis, liver cancer, and heart disease and these disorders can be avoided using iron and vitamin C supplements [15,16]. The research gap has observed that the community around the sampling area could not have a knowhow of obtaining iron from vegetables that were easily grown in the area. This may be due to, lack of knowledge and awareness to afford many for the nutritional values of vegetables [17]. Thus, the main objective of this study was to determine the concentration of iron and moisture content percentage composition in spinach, cabbage, and potato.

Materials and Methods

Sample collection and sample preparation

Sampling and sample collection: one kilogram of each vegetable samples were purchased randomly from local market found in Gubrie

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and Wolkite town which are matured for edibility. All the samples were labeled and transported to the laboratory using previously cleaned polyethylene plastic bag. The collected samples were preserved in refrigerator to prevent the sample from any damage, loss or contamination until processing at Chemistry Department laboratory, Wolkite University.

Instrumentation and chemical reagents

Instrumentation: Ultra Violet and Visible spectrophotometer (Buck Scientific Model 210 VGP, East Norwalk, USA) were used to determine the concentration of Fe.

Chemicals and reagents: Analytical grade of $FeCl_3$, distilled water, conc. HCl, and KSCN were used.

Cleaning of apparatus

Apparatus used during sample preparation and analysis were soaked with 10% (v/v) HNO_3 for 24 hours, rinsing with deionized water, dried in oven and kept in dust free place until analysis.

Sample preparation for determination of Fe

Each vegetable samples were washed with tap water and distilled water and cut into small pieces with the pre-cleaned knife. The vegetable samples were dried at 25°C. 2.5 g of dried vegetable samples was placed on a three different crucible and the crucibles were heated over a Bunsen burner until the sample is reduced completely to ash [18].

Determination of moisture content

The moisture content of all the samples were determined by the following method and calculated as:

Moisture Content (%)=A-B/B-C × 100

Where, A=mass of wet vegetable with crucible; B=mass of dry vegetable with crucible; C=mass of empty crucible.

Statistical analysis

Statistical Package for Social Scientists (SPSS) version 13.0 were used to analyze Mean, Standard deviation, List Significance Difference (LSD) and Analysis of Variance (ANOVA). Hypothesis test about the differences between three or more means and significance variation of the concentration of the parameters in each sample were tested by using ANOVA at 95% confidence levels [19-21].

Results and Discussion

UV-Vis spectrometer instrument calibration

Regression analysis was used to evaluate the linearity of the UV-visible calibration curves. The results of correlation coefficient r^2=0.99985 for iron indicated a highly positive correlation between absorbance and concentration. The concentration of iron in the vegetable samples were determined by preparing serious of working solutions and drawing a calibration curve of concentration vs. absorbance. Figure 1 shows calibration curve for the working solution concentrations.

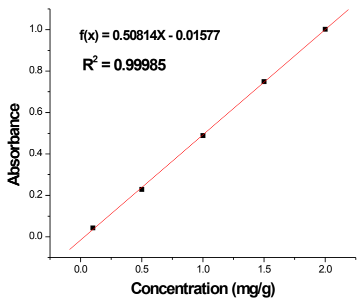

Figure 1: Standard calibration curve of iron concentration against absorbance.

he absorbance values were determined by the UV-Vis spectrophotometer and the concentration determined by interpolation or extrapolation of the calibration curve. Thus, iron content in each vegetable samples were tabulated in an increasing order as shown in Table 1.

Samples	Scientific Names	Mean iron content (mg Fe/100 g of vegetable)	%RSD
Cabbage	*Brassica oleracea* var. *capitate*	0.931 ± 1.29 × 10^{-3}	0.14
Spinach	*Spinacia oleracea*	1.08 ± 2.36 × 10^{-3}	0.12
Potato	*Solanum tuberosum*	1.10 ± 1.29 × 10^{-3}	0.07

Table 1: Mean concentration of iron, $\bar{x}$ ± SD (n=3) and relative standard deviation (%RSD) in vegetable sample.

Variance, standard deviation or coefficient of variation is usually used to evaluate the precision of an analytical procedure of a series of measurements [20]. In this study the precision of analytical results were evaluated by percent relative standard deviation (%RSD) in three samples (n=3) and triplicate readings for each sample meaning that a total of nine measurements for a given bulk sample.

Determination of iron content in vegetable samples

A total of three vegetable samples were studied, Iron content in each vegetables are presented in Table 1. The quantitative analysis of vegetables for their iron content was performed by dry ashing method and the determination of iron content was determine using UV-Vis Spectrophotometer. The chemical analysis of iron content in potato (*Solanum tuberosum*) show maximum amount (1.10 ± 1.29 × 10^{-3} mg/100 gm) whereas its content in cabbage (*Brassica oleracea* var. *capitata*) is lower (0.93 ± 0.29 × 10^{-3} mg/100 gm). The content of iron in the vegetable samples were in the order of potato>spinach>cabbage. The variation in concentration of iron in vegetable samples may be as a result of variation in absorption ability of iron from soil, water and atmosphere.

Deficiency of iron is one of the most common non-communicable diseases that needs urgent, effective and corrective measures. Reports indicate that it is the major health challenge and the common nutrient deficiency which is prevalent across the globe and in which the world is facing [22,23]. In addition, cognitive performance and physical growth of most children is greatly influenced by the amount of iron content in the food they consumed [24,25]. 24% RSD shows that the precision of analytical measurement in the determination of iron content is high in all vegetable samples (because %RSD is less than ten [20].

Determination of moisture content

Moisture content is the amount of water that is present in vegetable samples, and removal of water from sample is done by drying out in an oven [26]. Reported literatures indicate that, vegetables like spinach, cabbage, and potato with 79-96% of water content are rich sources of vitamins and minerals. Besides these vegetables are comparatively good sources of dietary fiber [27].

Moisture content (%) of each vegetable samples were analyzed and presented in Table 2. Accordingly, the result shows that cabbage had highest moisture content (95%) and potato had the least moisture content (83%).

Sample	Moisture content (g)	Moisture content (%)
Potato	4.15	83
Cabbage	4.85	95
Spinach	4.475	89.5

Table 2: Moisture content of vegetables.

Comparison of result with international standards

The content of iron in vegetable samples by using UV-Vis spectroscopic method was carried by Narain and Ilango [18], revealed that the content of iron is higher in Spinach (2.273 mg/100 g, 0.58 mg/100 g and 1.76 mg/100 g, 3.27 mg/100 g, respectively) than the current result [28-30]. In addition, the content of iron in Cabbage according to the study conducted by Narain and Ilango [18], (0.764 mg/100 g, 1.85 mg/100 g and 0.185 mg/100 g respectively) is higher than the current result [29,30]. Furthermore, the content of iron in potato according to iron 0.26 mg/100 g is higher than the current result. Moreover, the level of iron in each of the vegetable samples was lower than FAO/WHO guideline values of 0.03 mg/100 g Fe (Table 3).

Vegetable samples	Observed concentration (mg/100 g)	Previous study	Result (mg/100 g)	WHO/FAO (mg/100 g)
		[18]	0.764	
		[28]	1.85	
Cabbage	$0.93 \pm 1.29 \times 10^{-3}$	[30]	0.185	0.03
		[18]	2.273	
		[29]	0.58	
		[18]	1.76	
Spinach	$1.08 \pm 2.36 \times 10^{-3}$	[30]	3.27	0.03
Potato	$1.10 \pm 1.29 \times 10^{-3}$	[30]	0.26	-

Table 3: Comparison of observed iron concentration (mg/100 g) in vegetable samples with literature values and International standards.

The observed differences in the contents of iron studied in the same method may be due to differences in maturity stage and district species of vegetables and this may influence the concentration of mineral elements within the vegetable samples. These factors may include climate, atmospheric deposition, nature of soil on which the plant is grown, irrigation with wastewater and as a results high accumulation of the metal by vegetables [31,32].

Statistical analysis

The statistic F-calculated from one-way ANOVA was greater than F-critical value at $p \geq 0.05$ significant level, for moisture content in vegetable samples. This reveals that there is inter-vegetable variability of mean moisture content availability and this may due to variation in soil type which the plant is grown and the difference in capacity of preserving water from evaporation. Insignificant difference in iron content in each vegetable samples may show that the source of iron for each vegetable samples are under the similar geographical location and may share common climatic conditions.

Least Significant Difference value for iron content indicates, no significance difference between means of each vegetable samples. However, LSD value shows that, there is significance variation in mean moisture content among vegetable samples. Consequently, both the one-way ANOVA and LSD values show that there is statistically significant variation in means of moisture content among vegetable samples. This indicates the distribution of mean percentage of moisture content between the vegetable samples is significant (i.e., the percentage of moisture content is scattered between the vegetable samples).

Conclusion

Iron content in the three vegetable samples was analyzed by using UV-Vis spectrophotometric technique. The results indicated in Table 2 indicates that, the content of iron in vegetable samples were in order of: potato>spinach>cabbage. Moreover, cabbage does have the highest mean moisture content (95%) and potato does have the least moisture content (83%). The observed differences in iron and moisture contents in each of the vegetable samples may be factors that influence the concentration of mineral elements within plants, include climate, atmospheric deposition, nature of soil on which the plant is grown, irrigation with waste water.

Analysis of Variance at 95% probability level shows as there is a significant difference in the mean moisture content among vegetable sample varieties and no significance difference in iron content in vegetable samples. The difference among the concentration of iron in the three vegetable samples attributed only from random error in the analytical procedure. The research finding can be used as a source of information stockholders and other researchers. Moreover, further study should be conducted on essential and non-essential nutrients of vegetable samples by considering other vegetable varieties.

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Competing Interests

Authors have declared that no opposing interests exist.

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