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Research Article

Determination of the Levels of Selected Essential Metals in Sycamore (*Ficus sycomorus* L) Fruit and Seed Using Flame Atomic Absorption Spectrophotometry

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Background. Edible wild fruits are nature's gift to mankind. Considering the growing need to identify alternative bio-nutritional sources, some underutilized species of *Ficus sycomorus* L. of the family Moraceae were evaluated as wild edible fruits to study its nutritive and mineral composition in order to prioritize its edibility for people. *Methods*. The concentration of macro (K, Ca, and Mg) and micro essential elements (Fe, Mn, Zn, and Cu) metals in sycamore fruit and seed samples was determined by using a flame atomic absorption spectrophotometer (F AAS). The wet digestion procedure was evaluated using the standard addition (spiking) method, and an acceptable percentage recovery was obtained in the range of 81–119 and 80–118 for the metals in fruit and seed samples, respectively. 0.5 g of oven-dried samples was digested using 10 mL of conc. HNO_3 and 5 mL of H_2O_2 at 110°C for 1 hour. *Results*. Significant amounts of both the major and trace elements were found in both the fruit and seed samples. The highest levels of macro essential metals, such as Mg (400 ± 10), K (133 ± 3.291), and Ca (33 ± 0.404) all in $mg{\cdot}kg^{-1}$, and micro essential elements, such as Fe (5.7 ± 0.5), Zn (2.3 ± 0.55), and Cu (3.6 ± 0.15) all in $mg{\cdot}kg^{-1}$, were found in fruit of *Ficus sycomorus* L., but the concentration of essential metals in seed sample was Mg (333 ± 5.7), K (122 ± 1.6), Ca (31 ± 0.77), Fe (4.19 ± 0.87), Zn (2.06 ± 0.42), and Cu (3.38 ± 0.15) all in $mg{\cdot}kg^{-1}$. Mn ($3.04 \pm 0.16\ mg{\cdot}kg^{-1}$) was found in equal amount in both the seed and fruit of *F. sycomorus* L. *Conclusion*. In general, the concentration of macro and micro essential metals in *F. sycomorus* fruits was found; Mg > K > Ca and Fe > Cu > Zn, respectively. Similarly, the concentration of macro and micro essential metals in *Ficus* sycomorus seeds was found; Mg > K > Ca and Fe > Cu > Zn, respectively. The results were compared with values reported in the literature.

1. Introduction

Ficus sycomorus L. is part of the Moraceae family; it has been cultivated since ancient times [1]. It requires wasp pollination of a particular species of wasp to produce seeds [2]. The development of the F. sycomorus L. are dependent upon small chalcidoid wasps of the family Agaonidae. No other means of pollination of fig flowers are available to the plant, and the wasps cannot develop anywhere except in the gall flowers of the fig. The female agaonids carrying pollen enter the young receptacles at the time the female flowers are ready for pollination [3]. *F. sycomorus* L. is a widely known and consumed Mediterranean plant (Figure 1). Its fruit is without fat and cholesterol; it contains lots of vitamins and good source of dietary fiber. It is also a good source of mineral elements. In medicine, it is internally used to control digestion. As a part of the Mediterranean diet, its little laxative effect is quite useful. Fresh *F. sycomorus* L. fruit contains lots of pectin, which influences the human body to reduce the cholesterol amount. It contains a lot of antioxidants, a good source of polyphenols and flavonoids [4].

Fruits are truly among nature's great gifts because they provide many nutrients that are essential for the health and maintenance of our bodies [5]. Seed of sycamore recorded rich sources of minerals, e.g., phosphorus, magnesium, calcium, and iron. The phytochemical components of seeds

Figure 1: *Ficus sycomorus* L. plant with its fruits and seeds.

are below the recommended toxic levels, and this implies that the overall nutritional value of the seeds will not be toxic to human nutritional factors [6]. The seeds of sycamore contain substantial levels of nutrients [7]. Dry fruits have substantial quantities of essential nutrients in a rational proportion. They have considerably more energy than fresh fruits because the nutrients are concentrated in solids when the water is removed. Fig fruit (*F. sycomorus* L.) is one among such nutritious dry fruit, which is available throughout the year [8].

Micronutrient deficiency is still a public health problem in Ethiopia despite the effort that has been made to eliminate it. World Health Organization reported that about 30% of the population in developing countries suffers currently from one or more of the multiple forms of nutritional deficiencies especially that of micronutrient [9], which stated that the incidence of malnutrition is higher in rural areas than urban slums, particularly protein and micronutrient deficiencies [10].

In most developing countries, three micronutrient deficiencies are common. These are vitamin A deficiency (VAD), iron deficiency anemia (IDA), and iodine deficiency disease (IDD). These deficiency diseases were caused partly because of the food gap seasonality in which people experience food abundance, especially vegetables during the rainy season and severe scarcity during the dry season [11].

Mineral elements play an important role in affecting the proper mechanism of the human body. These components are usually obtained from nutrition, but usually not enough is gained. Nowadays, lots of supplements are commercially sold, but hardly any of them contains the needed elements in the right natural form; therefore, their absorption or bioavailability in the human body is not as it is expected. Nutrition is the best for gaining these elements in natural form. Previous studies indicate that *F. sycomorus* L. is a good source of minerals, vitamins, and dietary fiber [12]. In this study, mineral contents (macro and micro essential metals) in fruit and seeds of sycamore (*F. sycomorus* L) were analyzed.

There are many wild fruits in Ethiopia which were popular in the past but are no longer popular in the present time [13]. The fruits are not owned by a particular individual, and they could be collected freely and consumed by the community to increase nutrient intake. Some of the wild fruits are available during dry season when many domestic fruits and vegetables are scarce and very expensive. Despite the abundance of these fruits, there is still problem of nutrient deficiency in Ethiopia [13]. Hence, there is need to identify and evaluate the nutrient levels of wild fruits. The fruits could be integrated in the food-based approach for fighting nutrient deficiency in Ethiopia.

There are few reports about the metallic contents of fruits and seeds of *F. sycomorus* plant in other countries of the world [7, 14]. However, there is no any study where made as macro and micro essential metals (elements) for fruits and seeds of *F. sycomorus* plant grown in Ethiopia. Therefore, this study aimed at determining the levels of selected essential metals found in fruits and seeds of *Ficus sycomorus* plant grown and consumed at Dera Woreda of South Gondar zone, Amhara region state, Ethiopia.

The overall objective of this study was to determine levels of selected essential metals in sycamore (*F. sycomorus* L.) seeds and fruits in Dera Woreda, South Gondar zone, Amhara region state, Ethiopia. The major significance of this study is to provide information about the level of essential metals in *F. sycomorus* L. fruits and seeds. The study will provide baseline information on the nutrient composition of *F. sycomorus* L. fruits and seeds. The study will assist in the estimation of dietary requirement of the fruits and seeds.

The accurate information on the nutrient composition of these fruits and seeds will also help to integrate them into the food-based approach for fighting micronutrients deficiency. Determination of K, Mg, Ca, Fe, Zn, Cu, and Mn in fruits and seeds may help provide alternative cheaper and accessible sources of such essential elements which will in turn provide remedies to diet-related diseases including diabetes and cancer [15]. Such a strategy will in addition help lower medical costs involved in caring for and managing diet-related diseases. Consequently, dietary intervention will significantly improve quality of life, productivity, and longevity. The study will document levels of K, Mg, Ca, Fe, Zn, Cu, and Mn in fruits and seeds. Information gathered will be used to sensitize people on the nutritive value of plant food sources and medicinal plants growing naturally and their role in human health as therapeutic agents [14]. Since most Ethiopians cannot afford food supplements and balanced diets, these research findings will be used to encourage people to forage for wild plant products.

2. Materials and Methods

2.1. Description of the Study Area. Dera is one of the districts in the Amhara Regional State in Ethiopia. It is one of the 14 districts in the South Gondar Administrative Zone. It is bordered in the south by the Abbay River which separates it from the West Gojjam Zone, in the West by Lake Tana, in the North by Fogera, in the northeast by Misraq Este, and on the east by Mirab Este. Dera district is located 42 km from Bahir Dar, which is the capital city of Amhara Regional State, and about 79 km from Debre Tabor, the capital city of the South Gondar zone. The Woreda lies between 37°25′45″ E–37°54′10″E longitude and 11°23′15″–11°53′30″N latitude with an area of 152,524.13 ha [16].

2.2. Sample Collection. For this study, mature figs of *F. sycomorus* L. were collected from the major branches of a tree. The *F. sycomorus* L. fruit was randomly collected in March from the study site, Dera Woreda of South Gondar Zone, Amhara regional state, Ethiopia. During collection, ripened *Ficus sycomorus* L. fruits were picked up using a stick plant wisely (seeds known inside the fruits). Then, the fruits were washed with fresh water to release their spines and other foreign materials and dried by the sun, and then, the seeds of the sample were separated from the fruit. Finally, the fruit and seeds were stored in clean polyethylene plastic bags, and labelled and transported to the laboratory for further treatment.

2.3. Apparatus and Instruments. Glass bottles were used while preserving the grinded and homogenized samples before the actual laboratory experiments. Mortar and pestle were used for grinding and homogenizing the samples. A digital analytical balance (Napco Precision Instrument Ltd.) with a precision of ±0.0001 g was used to weigh *F. sycomorus* L. sample. A drying oven (G.P.O. BOX58, Ambala Cantt-133 011, INDIA) was used to dry the *F. sycomorus* L fruit sample in order to pulverize *F. sycomorus* L samples. Round bottom flasks (250 mL) fitted with a reflux condenser were used to digest the dried and powdered *F. sycomorus* L. fruit samples on a standard laboratory hot plate.

Filtration funnels and filter paper (Whatman–41) were used for the filtration of the sample solution after digestion during the sample preparation processes. Volumetric flasks (50, 100, and 250 mL) were used during dilution, preservation of samples, and preparation of metal standard solutions.

A refrigerator (CXFG1685W ESKISEHIR, TURKEY) was used for sample preservation after digestion and before AAS analysis. Micropipettes of size 50–200 μL and 100–1000 μL were used for measuring reagents used during sample preparation, preparation of standard solutions, and spiking. A flame atomic absorption spectrophotometer (BUCK Scientific-210 VGP, USA) equipped with a deuterium background corrector was used for the analysis of the metals K, Mg, Ca, Fe, Zn, Cu, and Mn using an air acetylene flame.

2.4. Chemicals and Reagents. Analytical grade chemicals, reagents, distilled, and deionized water were used throughout. All glassware and plastic containers used were washed with a detergent solution followed by soaking in 10% (v/v) nitric acid and then rinsed with deionized water. HNO_3 (65%) and H_2O_2 (30%) were used to digest the matrix samples to a 100 mL volumetric flask containing about 0.5 g of $LaCl_3$.

The cooled solution was filled to the mark (100 mL) with deionized water. Lanthanum chloride was used to avoid refractory interferences and used to minimize the precipitation of Ca and Mg ions in the form of phosphates and sulphates [17]. The standard stock solutions contain 1000 mgL^{-1}, in 1% HNO3, of the metals Ca, Mg, K, Zn, Fe, Cu, and Mn and hydrochloric acid; HCl was used for the preparation of calibration standards in the analysis of unspiked and spiked samples. Distilled water was used for the dilution of samples, intermediate, and working metal standard solutions prior to analysis and for rinsing glassware.

2.5. Sample Preparation for Elemental Analysis. Sample-holding glass bottles were soaked in the cleaning solution for 24 hours, washed and rinsed with distilled water, and then dried in the oven for storing the prepared samples for digestion.

Fruit and seed of F. sycomorus L were rinsed with tap water and then washed with distilled water in order to remove surface contamination and dried at 55 to 60°C in an oven. A portion of the dried fruit and seed *F. sycomorus* L was homogenized by using a mortar and pestle, and the powder was transferred to put in a clean sample container.

2.6. Digestion of the Samples. A 0.50 g of sample was weighed by using an electronic balance. The weighed sample was then placed in a digestion flask to await digestion. Wet acid digestion was done by standard methods reported by [18]. A 0.5 g of the powdered sample was added to 10 mL of conc. HNO_3 in 50 mL beaker and placed on the electric hot plate for 1 hour to get semidried sample at 110°C. Again, 10 mL of conc. HNO_3 and 5 mL of H_2O_2 were added and again kept on the hot plate and heated vigorously.

The addition of HNO_3 and H_2O_2 was continued till the solution was colourless and its volume reduced up to 2-3 mL. It was cooled and filtered with the help of the Whatman 41 filter paper. The filtrate was stored in a 100 mL sample bottle. It was diluted to 100 mL with 1 mL $LaCl_3$ and distilled water.

$LaCl_3$ was added to the digested solution to eliminate the chemical interference of Ca and Mg ions, and the solution was then filled to the mark (50 mL) with deionized water. The solutions were stored in the refrigerator until put in actual measurement. Digestion of the reagent blank was also performed in parallel with each of the seeds fruit samples keeping all digestion parameters the same and stored in the refrigerator until the analysis [19].

2.7. Preparation of Standard Solutions and Blanks. Stock solutions were prepared from analytical grade salts of each metal. Each salt of the metals was weighed and transferred into 250 mL volumetric flasks. Stock solutions of K, Mg, and Fe were prepared by dissolving 0.25 g of chloride salts in 25 mL HCl and diluting it to the mark using distilled water to give 1000 $\mu g \cdot mL^{-1}$. Stock solutions of Ca, Zn, and Cu were prepared by dissolving 0.25 g of nitrate salts in 25 mL HCl and diluting it to the mark using distilled water to give 1000 $\mu g \cdot mL^{-1}$. For the Mn stock solution, sulphate salt was used. The stock solutions were in 1% nitric acid and during dilution steps; the final acid concentration was maintained at about 1% to keep the metal in a free ionic state. The stock solutions were stored in polyethylene bottles. Working standards were freshly prepared from stock solutions each time an analysis was to be carried out.

2.8. Instrument Calibration. Calibration of an instrument or a piece of equipment involves making a comparison of a measured quantity against a reference value. In this study, atomic absorption spectroscopic standard solutions containing 1000 mgL^{-1} were used for preparing intermediate standard solutions (20 mg/mL) in a 100 mL volumetric flask.

Calibration curves were plotted with five points for each of the selected macro and trace essential metals standard using absorbance against concentrations (mgL^{-1}), and the calibration curve is given in Figure 2. Immediately after calibration using the standard solutions, the sample solutions were aspirated into the AAS instrument, and direct readings of the metal concentrations were recorded. Three replicate determinations were carried out on each sample.

Intermediate secondary stock solutions containing 20 mgL^{-1} of each metal were prepared from the corresponding 1000 mgL^{-1} stock solutions, and working standards of 0.4, 0.8, 1.2, and 1.6 mgL^{-1} solutions were prepared from the secondary stock by serial dilution with deionized water. Each metal (K, Mg, Ca, Fe, Zn, Cu, and Mn) exhibited linear calibration plots with respective linear R^2 values of 0.9919, 0.9906, 0.9945, 0.9959, 0.9952, 0.9916, and 0.9917 based on triplicate measurements of the blank, and the four concentrations mentioned previously.

2.9. Sample Analysis. The mineral elements in *F. sycomorus* L fruits and seeds were measured using a flame atomic absorption spectrophotometry with flame atomisation operated under the working conditions. The measurements were made in hold mode with air acetylene flame, where the air (as oxidant) was maintained at a flow of 50 $mL \cdot min^{-1}$, and the acetylene (as fuel) was maintained at a flow of 20 $mL \cdot min^{-1}$, to reach a flame temperature of 2,600°C.

The samples were analyzed in replicates, under the same conditions as standards and blank. For better precision, standards were measured before and after the sample solutions. The blank was measured between standards and samples to ensure the stability of the baseline. The operating conditions of the AAS are given in Table 1.

The limit of detection is the smallest mass of analyte that can be distinguished from statistical fluctuations in a blank, which usually correspond to the standard deviation of the blank absorbance times a constant. Usually, it is defined as the amount of analyte that gives a signal equal to three times the standard deviation on the blank [20].

For both fruit and seed samples, the method detection limits were calculated by multiplying the standard deviation of the reagent blank by three ($LOD = 3 \times S$ blank $n = 3$) measured in triplicate by three. The method detection limits are generally comparable with that of instrument *F. sycomorus* fruit.

The lowest concentration level at which a measurement is quantitatively meaningful is called the limit of quantitation (LOQ). The LOQ is most often defined as 10 times the signal/noise ratio. If the noise is approximated as the standard deviation of the blank (SB), then LOQ is $10 \times SB$ [21].

The LOQ was calculated by multiplying pooled standard deviation of the reagent blank by ten ($LOQ = 10 \times S$ blank $n = 3$), and the value for each element was listed in Table 2.

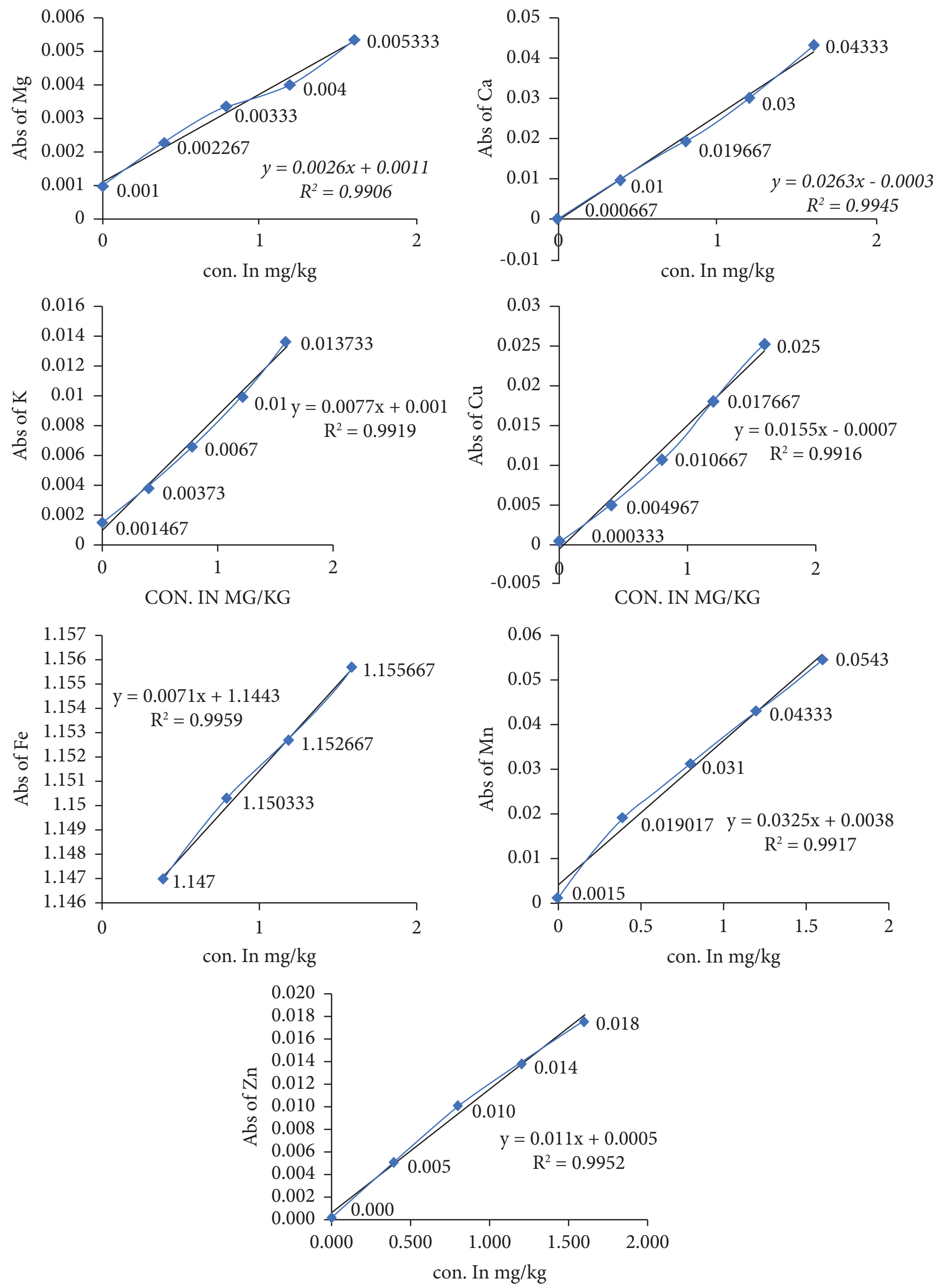

Figure 2: Absorbance and concentration of selected essential metals.

Table 1: Instrumental operating conditions for determination of metals using F AAS.

Parameters	K	Mg	Ca	Fe	Zn	Cu	Mn
λ (nm)	404.6	285.2	422.7	248.3	213.9	324.7	279.5
S.W (nm)	0.7	0.7	0.7	0.2	1.0	0.7	0.7
Flame type	Air-acetylene						
L.C (mA)	4.5	1	2	3.5	0.2	1.5	3
Sample energy (eV)	3.06	4.35	2.93	4.99	5.80	3.82	4.44

L.C = lamp current, nm = nanometre, mA = milliampere, eV = electron volt, S.W = slit width, λ = wavelength.

Table 2: Instrument detection limit, method detection limit, and quantitation limit for metals of interest determined in *F. sycomorus* L. fruit and seed sample.

Metal	Instrumental detection limit (mgL^{-1})	Method detection limit ($mg\cdot kg^{-1}$)	Quantitation limit ($mg\cdot kg^{-1}$)
K	1.9090	0.7423	2.4744
Mg	1.1993	0.8660	2.8868
Ca	0.2999	0.1332	0.4441
Fe	0.1432	0.0003	0.00082
Zn	0.4545	0.2727	0.9091
Cu	0.4933	0.1154	0.3849
Mn	0.0749	0.0595	0.1804

It is the process used to confirm that the analytical procedure employed for a specific test is suitable for its intended use. The efficiency of the method was assessed by spiking fruit and seed *F. sycomorus* L. with known amounts of metals, and each of the metals was analyzed in triplicate.

The percentage recoveries of the analytes were calculated by the use of equation (1). Recovery was calculated using the following equation [22]:

$$\%\text{ of Recovery }(R) = \frac{(\text{amount of spiked} - \text{amount of unspiked})}{\text{amount of add e d}} \text{ x } 100. \quad (1)$$

The recovery values of fruit and seed of *F. sycomorus* L. samples are given in Tables 3 and 4, respectively. The tables show that the recovery results for the metals lie in the range 80–120%. The results show the validity of the proposed methods for fruit and seed of *F. sycomorus* L. analysis.

3. Results and Discussion

The accuracy and precision of the results were checked with the aid of different statistical methods after the determination of the levels of metals in seed and fruit samples. The mean values were determined from a triplicate analysis of each sample. The mean values determined were reported in terms of mean values $(X) \pm \text{SD}$, for all the metals in this study. The F-AAS method was applied for the determination of the levels of seven metals (K, Mg, Ca, Fe, Zn, Cu, and Mn) in fruit and seed of *Ficus sycomorus* L. samples. Results determined from each sample are listed in terms of mean value and standard deviation of $mg\cdot kg^{-1}$ in Table 5.

Mineral elements are essential for human health. The concentration of these elements has an important physiological effect on different organs and cellular mechanisms; therefore, it is necessary to know the levels of essential elements in sycamore seeds and fruits [23]. Metals absorbed by plants from different sources are accumulated in different parts of the plant's body, such as roots, stems, leaves, fruit, seeds, and other parts. The amount of metals accumulated in the plants' body parts is variable. The focus of this study is on the level of some essential metals in seeds and fruits of *F. sycomorus* L. the common edible part by human beings (Figure 3).

3.1. Potassium. Potassium is one of the most important minerals in the body. It helps regulate fluid balance, muscle contractions, and nerve signals. What's more, a high-potassium diet may help reduce blood pressure and water retention, protect against stroke, and prevent osteoporosis and kidney stones [24]. In this study, potassium was the second accumulated metal in *F. sycomorus* L. samples with concentrations in $mg\cdot kg^{-1}$ $(133 \pm 3.291$ and $122 \pm 1.6)$ for fruits and seeds, respectively. The higher concentration was recorded in the fruit sample.

3.2. Magnesium. The most well-known role of Mg is its occurrence at the center of the chlorophyll molecule. Besides its function in the chlorophyll molecule, Mg^{2+} is required in other physiological processes. One major role of Mg^{2+} is as a cofactor in almost all enzymes activating phosphorylation processes. Mg is therefore important throughout the metabolism [25] Magnesium is the first most accumulated among seven metals in *F. sycomorus* L. samples analyzed in this study. The concentration level of Mg in $mg\cdot kg^{-1}$ was 400 ± 10 and 333 ± 5.7 for fruit and seed samples, respectively.

3.3. Calcium. Calcium is an essential macronutrient for both plants and animals. It is involved in cell division, bone and teeth building, and blood coagulation. Calcium in plants is a critical component of cell walls and membranes stabilizing and also assists in protein formation and carbohydrate transport [26]. In this study, calcium was the third accumulated metal in *F. sycomorus* L. samples with

Table 3: Percent of recovery results obtained after spiking with standard solutions for fruit sample in.

Metal	Conc. (mg·kg^{-1})	Added	Found	Recovery (%)
K	133.33	4	179.04	114.3
Mg	400	4	436.66	91.7
Ca	33.33	4	65.89	81.4
Fe	5.7	4	10.286	114.3
Zn	2.303	4	6.812	112.7
Cu	3.556	4	7.933	109.4
Mn	3.04	4	7.833	119.8

Table 4: Recovery results obtained after spiking with standard solutions for seed sample (mg·kg^{-1}).

Metal	Conc. (mg·kg^{-1})	Added	Found	Recovery (%)
K	124	4	168.57	111.9
Mg	333	4	380.0	116.7
Ca	31	4	62.82	80.1
Fe	4.19	4	8.762	114.3
Zn	2.06	4	6.788	118.2
Cu	3.38	4	7.833	111.4
Mn	3.04	4	7.708	116.7

Table 5: Mean concentration and standard deviation (mean ± SD, mg·kg^{-1}) of selected metals in both fruit and seed of *Ficus sycomorus* L. sample analyzed by F-AAS in mg·kg^{-1}.

Metal	Samples concentration (mean ± SD)	
	Fruit	Seed
Mg	400 ± 10	333 ± 5.7
K	133 ± 3.29	122 ± 1.6
Ca	33 ± 0.40	31 ± 0.77
Fe	5.7 ± 0.5	4.19 ± 0.87
Cu	3.6 ± 0.15	3.38 ± 0.15
Mn	3.04 ± 0.16	3.042 ± 0.163
Zn	2.3 ± 0.55	2.06 ± 0.42

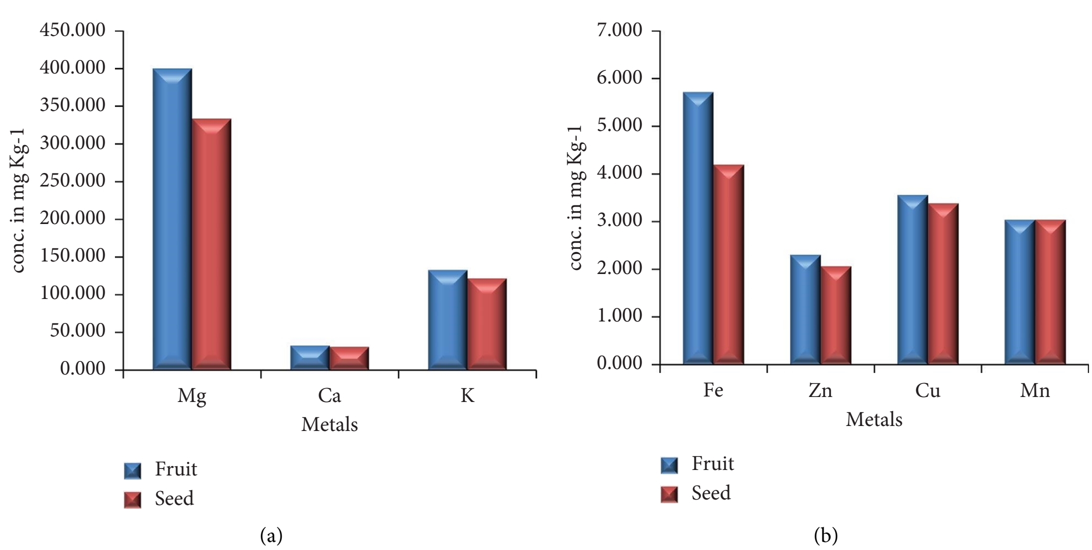

Figure 3: Essential metals in sycamore samples. (a) Macro (K, Mg, and Ca) and (b) micro (Fe, Zn, Cu, and Mn).

concentrations in $mg{\cdot}kg^{-1}$ (33 ± 0.404 and 31 ± 0.77) for fruits and seeds, respectively. The higher concentration was recorded in the fruit sample.

3.4. Copper. Copper is an essential micronutrient for many plants and animals. For human being, 1-3mg of copper per day is recommended for normal body condition. Human toxicity from copper is generally rare, but prolonged exposure to children may damage the liver and cause death. Copper is taken up by the plant in only very small quantities. Copper concentration in this study was in $mg{\cdot}kg^{-1}$ (3.6 ± 0.15 and 3.38 ± 0.15) for fruits and seeds, respectively. The higher level of copper was found in fruits than seed samples. The permissible limit set by FAO/WHO in edible plants was $3.00\,mg{\cdot}kg^{-1}$ [27].

3.5. Iron. Iron is an essential element for both plant productivity and nutritional quality. Improving plant iron content was attempted through genetic engineering of plants overexpressing ferritins. However, both the roles of these proteins in plant physiology and the mechanisms involved in the regulation of their expression are largely unknown [28]. Iron is essential for the synthesis of chlorophyll and heme or haemin which function as prosthetic groups [29].

Iron is by far the most accumulated metal with in micro essential metals determined in the *Ficus sycomorus* L. samples studied in this work. The concentration was in $mg{\cdot}kg^{-1}$ (5.7 ± 0.5 and 4.19 ± 0.87) for fruit and seed samples, respectively. The permissible limit set by FAO/WHO in edible plants was $20\,mg{\cdot}kg^{-1}$ [27, 30].

3.6. Zinc. Zinc is one of the important metals for normal growth and development in human beings. Deficiency of zinc can result from inadequate dietary intake, impaired absorption, excessive excretion, or inherited defects in zinc metabolism. Zinc deficiency is of growing concern in the developing world because of the consumption of plant foods that have inhibitory components for zinc absorption. Especially, in these populations, zinc deficiency is related to the high consumption of bread made without yeast [31]. Zinc is an essential trace metal involved in growth and DNA synthesis in human with normal daily intake of 7–16 mg per day for adults. The concentration of zinc determined in this study in fruit and seed samples was from 2.3 ± 0.55 to 2.06 ± 0.42, respectively. The level of zinc was the least of seven essential metals in both *Ficus sycomorus* L. samples. The permissible limit set by FAO/WHO in edible plants was $27.4\,mg{\cdot}kg^{-1}$, which is higher than the present study [27].

3.7. Manganese. Manganese is an essential element in respiration and nitrogen metabolism; in both processes, it functions as an enzyme activator. Manganese is also in some way involved in the oxidation-reduction processes in the photosynthetic electron transport system [32].

In this study, manganese was the sixth accumulated metal in fruits and seeds of *Ficus sycomorus* L. with a concentration of 3.04 ± 0.16 and 3.042 ± 0.163 in $mg{\cdot}kg^{-1}$, respectively. Thus, the levels determined in both *Ficus sycomorus* L samples were relatively the same. The permissible limit set by FAO/WHO in edible plants was $2\,mg{\cdot}kg^{-1}$ [27].

3.8. Comparison of Level of Essential Metals in Ficus sycomorus L. Fruit Obtained in the Present Study with Literature. The results obtained in the present study could be compared with the results that have been reported by different authors.

In fact, there is a difference in the sample preparation and analysis techniques. The concentration of magnesium in *Ficus sycomorus* L. fruit in the present study was much less than that in Tunisia. But the level of magnesium was greater than in Nigeria and much less than that in UAE. The concentration of potassium in the present study was the least recorded. The concentration of potassium in UAE, Tunisia, and Nigeria was much greater than in the present study, but in India, the level of potassium was not reported. The concentration of calcium in *Ficus sycomorus* L. fruit in the U.A.E is quite higher than the calcium concentration in the present study and in Nigeria was double of the present study. The iron concentration in the present study was the least compared to the concentration in Tunisia and higher than in Nigeria. Other study reported that Fe in UAE and in India was also determined in *Ficus sycomorus* L. fruit. The concentration of Zn in the present study was relatively close to Tunisia, but in UAE and in India comparatively higher. The concentration of Cu in the present study was almost the same as in UAE and in India. When we compare the level of Cu in the present study was the double of Tunisia and not reported in Nigeria. And finally, the level of Mn in the present study was quite similar to the level of Mn in Tunisia (Tables 6 and 7).

The concentration of potassium in *Ficus sycomorus* L. fruit was relatively the same as in *Psidium guajava* fruit but lower than *Ficus carica* L and *Strychnos spinosa*. The concentration of magnesium in *Ficus sycomorus* L. was the highest compared to *Ficus carica* L, *Strychnos spinosa*, and *Psidium guajava*. Concentration of Ca was the lowest in *Ficus sycomorus* L. compared to *Ficus carica*, *Strychnos spinosa*, and *Psidium guajava.*The concentrations of Fe were relatively the same as Ficus carica L but lower than compared with Strychnos spinosa.. The concentration of Cu in this study was lower than *Psidium guajava* but slightly higher than others. Mn in this investigation was higher than *Strychnos spinosa*.

In general, the level of these metals differs in sycamore fruit and other fruits. The reason may be the types of soil or the ability of plants to absorb and accumulate these essential metals from the soil.

3.9. Comparison of Level of Essential Metals in Ficus sycomorus L. Seed Obtained in the Present Study with Literature. The concentration of potassium in *Ficus sycomorus* L. seed was relatively the same as in Turkey but considerably lower than in India and Pakistan. The concentration of magnesium in this study was higher than in the rest of Turkey and Pakistan and lower than in India. The

Table 6: Comparison of concentrations of metals in the Ethiopian *Ficus sycomorus* L. fruit with that reported in the rest of the world.

Origin	Concentration of metal in fig fruit (mg·kg^{-1})							Ref
	K	Mg	Ca	Fe	Zn	Cu	Mn	
Ethiopia	133.3 ± 3.291	400.0 ± 10	33.0 ± 0.404145	5.7 ± 0.5	2.3 ± 0.55	3.6 ± 0.15	3.04 ± 0.16	Present study
UAE	9668 ± 394	1844 ± 9	5049 ± 53	57.9 ± 4	14.8 ± 1.3	4.7 ± 0.3	14.1 ± 0.2	[33]
India	—	679.04	1545.46	29.49	9.87	5.02	4.75	[34]
Tunisia	9190.38	550.41	179.24	10.17	6.5	1.7	3.6	[35]
Nigeria	860 ± 0.1	116.5 ± 0.02	60.5 ± 0.01	4.72 ± 0.02	—	—	—	[36]

Table 7: Comparison of concentrations of metals in *Ficus sycomorus* L. fruit with other fruits.

Fruits	Concentration of metal in fig fruit (mg·kg^{-1})							Ref
	K	Mg	Ca	Fe	Zn	Cu	Mn	
Ficus sycomorus L	133 ± 3.291	400 ± 10	33.0 ± 0.404145	5.7 ± 0.5	2.3 ± 0.55	3.6 ± 0.15	3.04 ± 0.16	Present study
Psidium guajava	136.5 ± 2.03	269 ± 0.38	281.3 ± 1.42	ND	2.07 ± 0.15	19.30 ± 2.12	NR	[37]
Ficus carica L.	501.1 ± 2	202 ± 1.06	78.8 ± 0.99	5.95 ± 0.16	3.5 ± 0.01	3.2 ± 0.0	NR	[38]
Strychnos spinosa	181 ± 2	320 ± 1.13	203 ± 0.26	41 ± 0.01	29 ± 0.01	3.3 ± 0.001	0.4 ± 0.001	[39]

Table 8: Comparison of concentrations of metals in *Ficus sycomorus* L. seed with that reported in the rest of the world.

Origin	Concentration of metal in fig seed (mg·kg^{-1})							Ref
	K	Mg	Ca	Fe	Cu	Mn	Zn	
Ethiopia	122 ± 1.6	333 ± 5.7	31 ± 0.77	4.19 ± 0.87	3.38 ± 0.15	3.042 ± 0.163	2.06 ± 0.42	Present study
Turkey	166.73 ± 0.03	53.66 ± 0.01	185.67 ± 3.54	50.26 ± 0.15	22.56 ± 0.43	5.34 ± 0.01	7.77 ± 0.28	[40]
Pakistan	615.15 ± 0.06	202.03 ± 1.42	1094.14 ± 2.75	47 ± 0.24	5.01 ± 0.01	3.003 ± 0.01	2.0 ± 0.01	[41]
India	3825 + 1.14	1105 + 1.85	78.72 + 1.24	56.9 + 0.21	3.2 + 0.01	2.5 + 0.01	NR	[42]

Table 9: Comparison of the level of essential metals obtained in the present study with standards.

Item	Range of metal (mg) for samples and standards							Ref
	K	Mg	Ca	Fe	Zn	Cu	Mn	
Samples	120.4–136.3	327.3–410	30.2–33.4	3.32–6.2	1.6–2.9	3.2–3.8	2.8–3.2	Present study
FNB/IOM/NAS	400–2600	30–420	200–1300	0.27–27	2–13	0.2–1.3	0.003–2.6	[43]

concentration of Ca and Fe was both lower than the other one. The concentrations of Cu were comparatively the same as in India and Pakistan but lower than in Turkey. Mn in this study was the same as in Pakistan and India, but next to Turkey. The concentration of Zn in this study was next to that in Turkey and was the same as in India (Table 8).

3.10. Comparison of Level of Essential Metals in Sycamore Samples with Standard Limits of IOM/FNB/NAS and WHO/FAO. The concentration of essential metals is determined in this study as shown in Table 9. Therefore, the level of magnesium, iron, and zinc is agreed with the standards of FNB/IOM/NAS and WHO/FAO. But the level of potassium and calcium in this work was below the level of standards.

The concentration of manganese and copper was above the standard limits. Hence, manganese toxicity and copper poisoning may occur in our body if taking high amount of *Ficus sycomorus* L. fruits and seeds.

4. Conclusion and Recommendation

The objective of this study was to determine the levels of selected macro and micro essential metals (Ca, K, Mg, Fe, Zn, Cu, and Mn) in *Ficus sycomorus* L. (Shola) using F AAS. *Ficus sycomorus* L (Shola) the common fig was analyzed for essential metal content for its health benefits and its potential to be used as a functional food. In this study, metal levels in *Ficus sycomorus* L. seed and fruit at Dera Woreda, South Gondar, Amhara, Ethiopia were analyzed for their contents of K, Mg, Ca, Fe, Zn, Cu, and Mn using flame atomic absorption spectrometer. A good percentage recovery was obtained (100 ± 119) for all the metals identified. The levels of essential metals in *Ficus sycomorus* L. seed and fruit determined in this study varied in the order (Mg (227–410 mg/kg) > K120–137 mg/kg) > Ca (30–34 mg/kg) > Fe (3–7 mg/kg) > Cu (1–4 mg/kg) > Mn (2–4 mg/kg) > Zn (–3 mg·kg^{-1}).

The results of this work indicated that *Ficus sycomorus* L. fruit and seed accumulate relatively higher amounts of Mg and Fe among the determined macro essential and micro essential metals, respectively. The contents of minerals specially trace metals in *Ficus sycomorus* L. in this study were within the daily recommended level and thus advisable as healthy food for the treatment of different health complications.

Based on the finding of this study, the following recommendations are forwarded. The study found that *Ficus sycomorus* L. has many macro and micro essential metals such as K, Mg, Ca, Fe, Zn, Cu, and Mn. Thus, society should be encouraged to consume fruit and seed. Additionally, the analysis of the soil metal content where *Ficus sycomorus* L. is growing is essential by validating the method of analysis and characterizing and using other instruments like ICP-OES. In order to make users aware of the metal composition and to keep users safe from health risks, further study should be carried out by collecting samples from all *Ficus sycomorus* L. growing areas of the country.

Data Availability

The data supporting the current study are available from the corresponding author upon request.

Disclosure

A preprint of this article has previously been published [44].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Dessie Ashagrie carried out sample collection, experiments, analysis, and discussion of data, and suggested and verified the relevance of statistical analyses. Minbale Admas (Ph.D.) advised and reviewed the manuscript. All authors read and approved the final manuscript.

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