Original Research Article

Assessment of Nutritional Composition of Wild and Semi-Wild Edible Fruits in Northwest Tigray,Ethiopia

ABSTRACT

Background: *Wild and semi-wild edible fruit-bearing trees play crucial role in fulfilling food security during food shortage and daily basis in rural and urban communities in Tigray. However, information on their nutritional compositions is still lacking. Thus, the objective of study was to assess the macronutrient and mineral values of the most commonly used wild and semi-wild edible fruit trees.*

Method: *In total, 21 physically healthy and mature stands of wild and semi-wild plants were purposely selected (3 from each plant species). Mature and disease-free fruits were collected from each plant species. These fruits were transported in an icebox to the Ethiopian Health and Nutritional Research Institute laboratory for analysis.*

Result: *The protein contents were higher in Ziziphus abyssinica Hochst. ex A.Rich.* (8.1 ± 2.1 %*) followed by Ziziphus spina-christi (L.) Desf.* (L.) Desf. *(*6.2 ± 1.1 %*) and Vangueria edulis Vahl* (6.1 ± 1.7 %*) and lower in Mimusops kummel Bruce ex A.DC.* (2.6 ± 0.9 %*) and Diospyros mespiliformis Hochst. ex A.DC. (2.7* ± 0.8 %*). Crude fiber and fat had higher in Diospyros mespiliformis Hochst. ex A.DC. and Ficus vasta Forssk. while lower ash and higher moisture content was recorded in Diospyros mespiliformis Hochst. ex A.DC. and Mimusops kummel Bruce ex A.DC. respectively. Ficus vasta Forssk. fruit contain higher Iron (55.5* ± 5.3 *miligram/100 gram), calcium (584.3* ±14 *miligram/100gram) and copper (0.9* ± 0.1 *mili gram/100 gram) while the amount of zinc was higher in Ficus vasta Forssk. (1.6* ± 0.2*) and Diospyros mespiliformis Hochst. ex A.DC.* (1.5 ± 0.4*) fruits. The potassium and phosphorus contents were 3030.3 miligram/100 gram, 30.9 miligram/100 gram for Balanites aegyptica (L.) Del., 2704.0 miligram/100 gram, 106.6 miligram/100 gram for Ziziphus spina-christi (L.) Desf. , 2002.9 miligram/100 gram, 85.8 miligram/100 gram for Vangueria edulis Vahl, 1477.1 miligram/100 gram, 83.3 miligram/100 gram for Ficus vasta Forssk., 760.5 miligram/100 gram, 26.1 miligram/100 gram for Mimusops kummel Bruce ex A.DC., 1597.7 miligram/100 gram 104.9 miligram/100 gram for Ziziphus abyssinica Hochst. ex A.Rich. and 1127.8 miligram/100 gram, 40.4 miligram/100 gram for Diospyros mespiliformis Hochst. ex A.DC. respectively. Higher total carbohydrate content (76.8* ± 5.1 *%, 65.6* ± 5 *%, 64.1* ± 5.2 *%, and 57.4* ± 5.3 *%) and energy values (337.2* ± 8.4 *kilocalori/100*gram*, 301.7* ± 5.4 *kilocalori/100* gram*, 298.4* ± 9.8 *kilocalori/100gram, and 264.2* ± 6.1 *kilocalori/100gram) were recorded in Balanites aegyptica (L.) Del., Ziziphus* *spina-christi (L.) Desf.* , *Ziziphus abyssinica Hochst. ex A.Rich.*, and *Vangueria edulis Vahl* *respectively.*

***Conclusion**: While the nutrient composition of the Wild and semi-wild fruits is generally favorable, some minerals and vitamins may still require supplementation from other dietary sources to meet the recommended daily intakes, especially for vulnerable populations like infants, children, and pregnant/lactating women.*

Keywords: *Macronutrient; Minerals; Vitamin C, Wild and semi wild edible fruits*

1. Introduction

Food and nutrition security is a significant global challenge in the present era [1]. It is estimated that approximately two billion people suffer from micronutrient deficiencies, which not only make them more vulnerable to diseases but also hinder economic growth [2]. The problem of food security is particularly severe in sub-Saharan African countries that heavily rely on food imports [3]. However, the continent possesses highly biodiverse environments that harbor valuable wild edible plants, which are often overlooked and neglected [4].

In Ethiopia, there is a rich diversity of wild and semi-wild edible fruit-bearing tree species [5]. About 413 kinds of wild edible plant species are consumed in Ethiopia [6]. These wild wild edible species play a crucial role in ensuring food security and fulfilling supplementary dietary needs [7], a valuable source of income generation for local communities [8]. Previous studies indicates that many of the wild edible plant species contain higher concentrations of vitamins and other important nutrients compared to domesticated agricultural plant varieties [5].

Edible fruit-bearing tree and shrub species are utilized to restore degraded lands and conserve biodiversity, thereby enhancing ecosystem productivity [9]. Furthermore, wild edible woody species serve as an alternative livelihood option, providing a source of traditional medicine by rural communities, particularly by women and youth [10]. Despite the vital roles that wild and semi-wild edible plant species play, their food and nutritional contributions, as well as their medicinal value, have not been thoroughly investigated in Ethiopia [11]. Similar to other areas, wild and semi-wild edible fruits are not only relied upon during times of drought but also play a significant role in meeting food consumption needs and generating income in Tigray region. However, despite their substantial contribution, there is limited information available on the macronutrient and mineral composition of the most commonly used wild and semi-wild edible trees. Therefore, the objective of this study was to provide scientific insights and document the macronutrient and mineral composition values of the wild and semi wild edible plants (WSWEP) of *Ziziphus abyssinica Hochst. ex A.Rich.* (Za), *Balanites aegyptica (L.) Del.* (Ba), *Ziziphus spina-christi (L.) Desf.* (Zsc), *Ficus vasta Forssk.* (Fv), *Vangueria edulis Vahl* (Ve), *Mimusops kummel Bruce ex A.DC.* (Mk), and *Diospyros mespiliformis Hochst. ex A.DC.* (Dm) tree species.

2. Material and Methods

2.1. Fruit sample collection and preparation

Healthy and disinfected ripe fruits were collected from phenotypically healthy trees. All fruit samples were washed to remove any unwanted materials and prepared for drying. To ensure appropriate and comprehensive sampling, each sampling unit was replicated three times. In total, 21 samples (7 tree species × 3 replications) were collected. The samples were preserved in an icebox and transported to the Ethiopian Health and Nutritional Research Institute laboratory. In the laboratory, the fruits underwent crushing, grinding, and homogenization. A 100 g portion of the dry sample was used to analyze the macronutrient, vitamin C, and mineral compositions of the selected wild and semi-wild edible fruits.

2.2. Crude protein determination

Initially, all nitrogenous compounds were converted into ammonium using concentrated sulfuric acid (H_2SO_4), orthophosphoric acid, hydrogen peroxide, and a catalyst. The mixture was then digested at 350°C for 2–3 hours until it became colorless. After cooling, the solution was distilled using steam distillation with 40% sodium hydroxide, releasing ammonium in the form of ammonia. The ammonia was trapped using 1% boric acid and titrated with 0.1 N hydrochloric acid (HCl). The crude protein content was calculated by determining the nitrogen percentage in the sample using the Kjeldahl method and multiplying it by a factor of 6.25.

$$\%\ \text{protein} = \text{percentage of nitrogen content x } 6.25 \text{------------------------------Eq.1}$$

2.3.2. Crude fiber estimation

A 1–2 g sample of fat-free or low-fat content material was treated with 200 milliliters (ml) of 1.25% H_2SO_4 and boiled for 30 minutes, with a watch glass placed over the mouth of the beaker. After exactly 30 minutes, the residue was treated with 28% potassium hydroxide and gently boiled for another 30 minutes, stirring occasionally. Following the boiling process, the residue was filtered, and the crucible was washed twice more with hot distilled water. The washed residue or dry crucible was then dried in an electric oven at 130°C for 2 hours. It was cooled in a desiccator for 30 minutes and weighed (W_1). The crucible was subsequently transferred to a muffle furnace for 30 minutes at 550–600°C, cooled in a desiccator, and weighed again (W_2).

$$\text{The crude fiber in } \% = \frac{(W1 - W2)X100}{W3} \text{---Eq. 2}$$

Where: W1- Crucible weight before drying

W2- Crucible weight after drying

W3- Sample dry weight

A clean drying box with its inverted lid was placed in a drying oven at 92°C for 1 hour. The box was then covered with the lid, cooled in a desiccator for 30 minutes, and weighed. A 5–10 g sample (W_1) was transferred into the drying box, dried at 92°C overnight, cooled again in a desiccator for 30 minutes, and weighed. To ensure complete dryness, the box with the sample (uncovered) was placed back into the drying oven at 92°C for an additional hour, cooled in a desiccator, and weighed again (W_2). Finally, the moisture content was calculated using the formula provided in [12].

$$\text{Moisture content } (\%) = \frac{(W1 - W2)X100}{SW} \text{--Eq.3}$$

Where:

W_1: the weight of cap and fresh sample

W_2: the weight of dry sample and cap

SW: sample weight

2.3.3. Fat determination by diethyl ether

A 3.5 g sample was weighed, covered with fat-free cotton, and attached to a magnetic ring to suspend the thimble in the extraction chamber. The extracted material was placed in cool water and treated with 70 ml of diethyl ether in a clean aluminum cup through the condenser to regulate the heating device. After this, the aluminum cup was removed from the extraction unit, placed in a drying oven at 92°C for at least 30 minutes, and then cooled in a desiccator for at least 30 minutes. The aluminum cup was weighed immediately after being taken out of the desiccator. The condensed solvent was collected by connecting the tubes to a bottle. The crude fat was extracted using peroxide-free ether in a Soxhlet apparatus, and the solvent was evaporated from the extraction flask (aluminum cup). The amount of fat was then calculated based on the difference in the weight of the aluminum cup before and after extraction, as shown below.

$$\text{Fat}\ (\%) = \frac{W f X100}{SW}$$ --Eq.4

Where, Weight of fat, W_f = Weight of aluminum cup after extraction minus weight of aluminum cup before extraction

SW= weight of samples

2.3.4. Ash determination

A 2.5g sample was weighed in a crucible and heated in a muffle furnace at 550°C for 1 hour. Exactly after 1 hour, the crucible was taken out of the furnace. It was then allowed to cool and moistened with a few drops of deionized water, and the water was evaporated on a hot plate. The sample was heated again in the furnace for half an hour, cooled, and treated with a few drops of deionized water and 5 drops of concentrated nitric acid (HNO3). This process was repeated consequently until the weight became constant [12].

2.3.5. Determination of total Ascorbic Acid (Vitamin C) spectrophotmetrically

5g of the sample was extracted with 100ml of 6% trichloroacetic acid using a mortar and pestle for 2-5 minutes at room temperature. The suspended solids were removed by centrifugation or filtration. In a conical flask containing the sample solution, 1-2 drops of saturated bromine solution were added. One tube was set aside to serve as a blank, and to each of the remaining tubes, 1ml of 2,4-Dinitrophenyl hydrazine was added. All the test tubes were then placed in a water bath at 37°C for 3 hours, cooled in an ice bath for approximately 5 minutes, and 5ml of 85% H2SO4 was added while the tubes were still in the ice bath. All the tubes were then mixed with 1ml of 2% Dinitrophenyl hydrazine and allowed to stand at room temperature for 30 minutes. Finally, the absorbance of the standards, blanks, and test samples was measured spectrophotometrically at 515 nanometers.

2.3.6. Determination of trace metals (Zn, Ca, Fe, Cu) by Flame Atomic Absorption Spectroscopy (FAAS)

Before measuring the required samples, the crucibles were washed with 6N HCl, and the glassware was washed with 10% nitric acid. The washed items were then placed in an oven at 100°C for 30 minutes, cooled in a desiccator for 30 minutes. 2.5g of the sample was measured and charred on a hot plate, starting at a low temperature under a hood. The samples were then ashed in a muffle furnace at 550°C for 1 hour. Subsequently, the crucible was taken out of the furnace, cooled, and moistened with a few drops of deionized water. The ash was ashed again for 30 minutes at 550°C, cooled, and then treated with some drops of deionized water and 5 drops of concentrated HNO3. Ash content was treated with 5-10 ml of 6N HCl to wet it completely and carefully taken to dryness on a low-temperature hot plate. Next, 15 ml and 10 ml of 3N HCl were added step-by-step and the crucible heated on the hot plate until the solution just boiled, cooled, and filtered through filter paper into a graduated flask. After the removal of organic materials by dry ashing, the residue was dissolved in dilute acid and sprayed into the Flame Atomic Absorption Spectroscopy, and the absorption of the metals was measured at a specific wavelength [12]. Also, the potassium content was estimated by Flame photometer.

2.3.7. Carbohydrate, Energy and Phosphorous

The total carbohydrate was obtained by calculating the difference (the sum of protein, fat, ash and crude fiber on a dry basis is subtracted from 100) The energey value or energy content was estimated by multiplying the percentages of crude protein, crude fat and total carbohydrates by 4, 9 and 4 respectively [14]. Phosphorous was determined using official methods of analysis [13].

2.4. Statistical Analysis

The mean value of the macronutrient, vitamin C and mineral contents of the WSWEP fruits were computed using a statistical package for social science software version 20 at a 5% significance level.

3. Results and Discussion

3.1. Proximate compostion of WSWEP

The nutrient composition varied considerably among the WSWEP fruits (Table 1). The protein content of the studied WSWEP fruits ranged from 2.6% to 8.1%, with Za having the highest and Mk the lowest protein content. Compared to previous studies, the protein content reported in this study was higher than the values reported for Ba (1.40%), Zsc (2.13%), and G. flavescens (1.51%) in other semi-arid regions of eastern Ethiopia [8]. Similarly, the protein content of Zsc, Fv, Ba, Ve, and Za was higher than the values of 4.1% (Zsc), 3.95% (Za), and 2.9% (*Ziziphus mauritiana*) reported in a previous study from Sudan [15]. The crude fiber content was significantly higher in Dm fruit (26.3 ± 3.5%) compared to other WSWEP fruits, including Fv (16.5 ± 1.9%), Ba (2.1 ± 0.4%), Ve (25.6 ± 2.9%), Za (11.4 ± 3%), Mk (6.8 ± 1%), and Zsc (7.3 ± 0.9%). Compared to previous studies, the crude fiber content in all the WSWEP fruits, except for Ba, was higher than the values reported for Ba (5.94%), Zsc (3.78%), and G. flavescens (6.68%) [14], as well as the previously reported crude fiber content of 6.09 ± 0.02% in Zsc fruit [10]. The crude fat content varied significantly among the studied fruits, with Fv having the highest value (6.0 ± 2.0%) and Za the lowest (1.0 ± 0.3%). The crude fat content of all the studied species was higher than the values reported by [15], which found 0.9%, 0.8%, and 0.3% for Zsc, Za, and Z. *mauritiana*, respectively. Moisture content ranged from 10.7 ± 2% to 37.4 ± 5%, with the highest observed in Dm and the lowest in Mk fruit. Compared to other studies conducted on Ba, G. flavescens, and Zsc fruits [14], all the studied fruits had lower moisture content. This indicates that the studied wild and semi-wild edible fruits are rich in energy content and less susceptible to spoilage. The ash content was highest in Zsc fruit (4.9 ± 0.8%) and lowest in Mk fruit (1.4 ± 0.2%). Generally, the studied fruits had lower ash content compared to the values reported for Ba, Zsc, and G. flavescens [14], as well as *Carissa carandas L*., *Phyllanthus emblica L*., and *Morinda pubescens* J.E. Smith [16]. The total carbohydrate content was 76.8 ± 5% (Ba), 65.6 ± 5% (Zsc), 57.4 ± 5% (Ve), 44.2 ± 4.9% (Fv), 51.0 ± 4.4% (Mk), and 64.1 ± 5.2% (Za). These values were lower than the total carbohydrate content of 86.83%, 82.04%, and 89.46% reported by [14] for Ba, Zsc, and G. flavescens, respectively. The calculated nutritive or energy value was highest in Ba (337.2 ± 15.4 kcal), followed by Zsc (301.7 ± 32.2 kcal), and lowest in Dm (150.6 ± 22.6 kcal). This calculated nutritive value, based on crude protein, crude fat, and total carbohydrate content, was relatively lower than the values reported in previous studies [14, 17].

Table 1: Proximate composition of the seven selected WSWEP (Mean ± SD)

	Macronutrients

WSWEP	Crude protein (%)	Crude fiber (%)	Crude fat (%)	Moisture (%)	Ash (%)	Carbohydrate (%)	Energy value (Kilocalori/ 100gram)
Ba	4.6 ± 1[a]	2.1 ± 0.4[a]	1.3 ± 0.3[a]	10.7 ± 2[a]	4.5 ± 1[a]	76.8 ± 5.1[a]	337.2 ± 8.4[a]
Z sc	6.2 ± 1.1[b]	7.3 ± 0.9[b]	1.6 ± 0.6[b]	12.4 ± 1.9[abc]	4.9 ± 0.8[a]	65.6 ± 5[b]	301.7 ± 5.4[bf]
Ve	6.1 ± 1.7[b]	16.5 ± 1.9[c]	1.1 ± 0.2[a]	15.9± 3[b]	2.9 ± 0.7[b]	57.4 ± 5.3[c]	264.2 ± 6.1[c]
Fv	4.7 ± 1[a]	25.6 ± 2.9[d]	6.0 ± 2[c]	14.7 ± 2[ab]	4.8 ± 0.7[a]	44.2 ± 4.9[d]	250 ± 5.4[d]
Mk	2.6 ± 0.9[c]	6.8 ± 1[b]	2.1 ± 0.4[d]	36 ± 5.5[d]	1.4 ± 0.2[c]	51.0 ± 4.4[e]	233.4 ± 6.6[e]
Z a	8.1 ± 2.1[d]	11.4 ± 3e	1.0 ± 0.3[a]	12 ± 2.0[bc]	3.2 ± 0.4[b]	64.1 ± 5.2[b]	298.4 ± 9.8[f]
Dm	2.7 ± 0.8[c]	26.3 ± 3.5[d]	2.9 ± 0.5[e]	37.4 ± 5[e]	2.3 ± 0.4[d]	28.4 ± 3.4[f]	150.6 ± 9.6[g]
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Means in colomun with similar letters are not significantly different at $P<0.05$.

3.2. Mineral composition

Minerals play a crucial role in supporting the optimal functioning of the immune system [18]. They are involved in various processes, including immune cell development, regulation of inflammatory pathways, and enhancement of the body's ability to combat infections and illnesses. The recommended daily intakes of minerals vary based on age and life stage. The iron, zinc, calcium, copper, potassium, and phosphorus contents of the studied WSWEP fruits are presented in Table 2. The results showed that Fv fruit contained the highest concentrations of iron (55.5 ± 5 mg/100 g), zinc (1.6 ± 0.2 mg/100 g), calcium (584.3 ± 14 mg/100 g), and copper (0.9 ± 0.1 mg/100 g) compared to Ba, Zsc, Ve, Mk, Za, and Dm fruits. The concentrations of zinc and copper in all the studied fruits were similar to those reported for other wild edible fruits, such as *Arbutus pavarii*, *Nitraria retusa*, and *Ficus palmata* [17].

The potassium content was significantly lower in Mk (760.5 ± 20.4 mg/100 g) and highest in Ba (3030.3 ± 0.3 mg/100 g) among the studied tree species. According to the Dietary Reference Intakes (DRI) reported in [19], the recommended daily potassium intake is at least 3,510 mg/day for adults and less for children. Therefore, the potassium content of all the studied WSWEP fruits would need to be supplemented with additional foods to meet the daily potassium requirement. The phosphorus content varied across the studied WSWEP fruits (Table 2). Zsc (106.7 ± 11 mg/100 g) and Za (105 ± 7.2 mg/100 g) contained the highest phosphorus levels among the studied fruits, which could meet the recommended daily allowance for infants aged 0–6 months. However, according to the recommended daily phosphorus intake reported by [20]—100 mg/day for infants 0–6 months, 275 mg/day for infants 7–12 months, 460–500 mg/day for children aged 1–8 years, 1,250 mg/day for individuals aged 9–18 years, and 700 mg/day for adults—the studied WSWEP fruits would require supplementation to satisfy the phosphorus needs of older children, adolescents, and adults.

Table 2**:** Mineral composition (mg on dry basis) of the seven selected WSWEP (Mean ± SD)

WSWEP	Minerals					
	Fe (mg/100g)	Zn (mg/100g)	Ca (mg/100g)	Cu (mg/100g)	K (mg/100g)	P (mg/100g)
Ba	13.8 ± 1.7^{a}	0.5 ± 0.1^{a}	255.6 ± 5^{a}	0.5 ± 0.0^{a}	3030.3 ± 0.3^{a}	30.9 ± 5.0^{a}
Z sc	8.5 ± 2^{b}	0.9 ± 0.1^{b}	402.9 ± 12^{b}	0.5 ± 0.1^{a}	2704 ± 8^{b}	106.7 ±11^{b}
Ve	4.2 ± 0.9^{c}	0.4 ± 0.1^{a}	204.9 ± 9^{c}	0.6 ± 0.1^{a}	2002.9 ± 2^{c}	85.8 ± 10.9^{c}
Fv	55.5 ± 5.3^{d}	1.6 ± 0.2^{d}	584.3 ±14^{d}	0.9 ± 0.1^{b}	1477.1 ± 6^{d}	83.3 ± 13.2^{c}
Mk	6.0 ± 2^{e}	0.32 ± 0.1^{a}	362.2 ± 8.3^{e}	0.1 ± 0.0^{c}	760.5 ± 9^{e}	26.1 ± 2.1^{a}
Za	10.6 ± 2.4^{f}	1.3 ± 0.2^{e}	515.1 ± 7^{f}	0.6 ± 0.2^{a}	1597.7 ± 3^{f}	105 ± 7.2^{b}
Dm	14.4 ±2.9^{a}	1.5 ± 0.4^{de}	481.8 ± 21.7^{g}	0.5 ± 0.1^{a}	1127.8 ± 8.1^{g}	40.4 ± 4.8^{d}
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Means in colomun with similar letters are not significantly different at $P<0.05$.

3.3. Vitamin C

The studied WSWEP fruits exhibited varying levels of vitamin C content. Fv fruit had the highest vitamin C content at 55.4 ± 9.5 mg/100 g, followed by Ba at 51.4 ± 6 mg/100 g, Zsc at 42.4 ± 4 mg/100 g, Mk at 22.7 ± 3.3 mg/100 g, Za at 17.6 ± 2.4 mg/100 g, Dm at 6.4 ± 1 mg/100 g, and Ve at 4.4 ± 0.3 mg/100 g. The recommended daily intake of vitamin C varies based on age and life stage. For infants aged 0–6 months, the recommended intake is 25 mg/day, increasing to 30 mg/day for children aged 7 months to 6 years, 35 mg/day for children aged 7–9 years, and 40 mg/day for adolescents. Adults are advised to consume 45 mg/day, pregnant women 55 mg/day, and lactating women 70 mg/day [19].

The analysis of WSWEP fruits revealed that Fv (55.4 ± 9.5 mg/100 g) could meet the recommended daily intake of vitamin C for infants, children, adolescents, adults, and pregnant women but not for lactating women. Similarly, Ba (51.4 ± 6 mg/100 g) can satisfy the requirements for infants, children, adolescents, and adults; however, additional supplementation would be required for pregnant (55 mg/day) and lactating (70 mg/day) women. Zsc (42.4 ± 4 mg/100 g) is sufficient to meet the vitamin C needs of infants, children, and adolescents. Compared to previous studies, the WSWEP fruits Fv, Ba, Zsc, and Mk contain higher vitamin C levels than the fruit of *Cordia africana*, which was reported to have a vitamin C content of 20.2 mg/100 g dry weight in Tigray [21].

4. Conclusion

The nutritional diversity of WSWEP fruits is remarkable, offering a wide range of essential nutrients that contribute significantly to human health. Their nutrient composition, including protein, crude fiber, fat, moisture, ash, and carbohydrates, varies considerably, enhancing their potential to provide diverse nutritional benefits. These fruits are particularly rich in minerals such as iron, zinc, calcium, copper, potassium, and phosphorus, which are essential for numerous physiological functions. For example, iron supports red blood cell formation, zinc plays a vital role in immune function, and calcium is critical for maintaining bone health. The high mineral content in WSWEP fruits highlights their potential to help meet the body's mineral requirements, especially for populations at risk of deficiencies. Certain WSWEP fruits, such as Fv, Ba, and Zsc, are notable for their substantial vitamin C content. Vitamin C is a crucial nutrient with antioxidant properties, playing a key role in immune support and collagen synthesis. These fruits can help individuals, particularly infants, children, and adults, meet their daily vitamin C needs. This is especially advantageous for populations with limited access to other vitamin C-rich foods. However, while WSWEP fruits provide an abundance of nutrients, they may not fully satisfy the recommended daily intake of all essential vitamins and minerals. Specific groups, such as pregnant or lactating women and young children, may require additional supplementation from other food sources to ensure comprehensive nutritional coverage. Overall, WSWEP fruits demonstrate significant potential as supplementary sources of essential nutrients, contributing to improved dietary intake and supporting the nutritional needs of vulnerable populations.

Declarations and verification

The research work has not been published previously or it is not under consideration for publication elsewhere.

Abbreviations

g=gram

mg/100g=milligram per 100gram

min=minutes

ml= milliliter

NHCl=Normality hydrochloric acid

HNO_3=concentrated nitric acid

H_2SO_4= concentrated sulfuric acid

WSWEP=Wild and semi wild edible plants

Ethics approval and consent to participate

Not applicable

Consent for publication

All authors approve and consent for the article to be published.

Availability of data and materials

All necessary data are available on the corresponding author and possible to submit with the reasonable request.

Disclaimer (Artificial intelligence)

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