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Research Article

NUTRITIONAL QUALITIES OF SELECTED WILD FRUITS FRUITS IN KAFFA ZONE, SOUTH WESTERN ETHIOPIA

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ABSTRACT

The purpose of this research was to physicochemical characterization of wild edible fruit Fruits that used by the indigenous community of Kaffa zone in southwest Ethiopia. The study identified six frequently used WEFPs and on which physicochemical properties were investigated. SPSS version 27 was used for statistical analysis. Tukey post hoc test for one way ANOVA comparission was used. Stock standard solutions containing 1000 mg/L of each metal (Mg, Mn, Ni, Pb, K, Ca, Fe, Zn, Cu, Co, Cr, Na, and Cd) in 2% HNO3 was used for preparation of calibration standards and in spiking experiments. The Correlation coefficient (R^2) of calibration curve value indicates that mineral Mg shown relatively high value which was 0.9999. It was found that proximate compositions of each fruits were satisfying food requirement set by WHO and based on this K, Na, Ca, and Mg respectively are high concentration minerals among sampled fruits and Cadmium (Cd), Lead (Pd) and Cobalt (Co), which are below the technique detection limit. Statistically significant differences high concentration minerals were observed in calcium and potassium ($P \geq 0.05$) at 95% confidence interval. The Multiple Comparisons for Tukey post hoc test revealed that the mean concentration of the four metallic minerals (Ca, Mg, Na and K) were statistically significantly. Accordingly among the given fruit types Peponium vogelii contains high moisture (30.75) and high crude protein (16.38), crude fiber found in Psigium guajava (57.3) and crude fat level was detected in Phsalis peruviana (12.38) based on proper physical and chemical procedure and it is found that they have high potential contribution for important food stuffs and required for daily intake nutritional quality was determined. On contrary to this it was found WEFPs are overlooked despite of their nutritional content. Finally increasing awareness of people to incorporate these Fruits in to daily food demands is necessary as far they hold good nutritional quality.

KEYWORD: Nutritional qualities WEFPs *Kafa* zone south west Ethiopia.

INTRODUCTION

Wild edible Fruits are an important source of food for many communities around the world, particularly in rural areas where access to markets and grocery stores may be limited (Ajesh P.T *et al.*, 2012). These Fruits are often gathered from forests, woodlands, and other wild areas, and can provide a nutritious and sustainable source of food for local people. Some examples of wild edible Fruits include fruits such as berries, tubers such as potatoes and sweet potatoes, and vegetables such as dandelion greens and wild carrots (EPCC, 2015).

Wild edible fruits and vegetables are known to be an excellent source of nutrients such as minerals, vitamins, carbohydrates, and they contribute an important part of diet providing health and nutrition while also serving as an appetizer (Orech F, *et al*, 2007). In view of this, wild foods could become useful for improved nutrition and increased food supply. Studies have shown that there is a connection between the intake of fruits and vegetables and a reduced rate of heart disease, mortality, common cancers, and other degenerative diseases as well as aging, and this is attributed to the fact that these foods may provide an optimal mix of phytochemicals such as natural antioxidants, fibers, and other biotic compounds (Kaur C, 2001).

Wild edible fruits and vegetables are not only a valuable source of nutrients but also provide minerals like sodium, potassium, magnesium, iron, calcium, and phosphorus, as well as dietary fibers that help prevent constipation (Deshmukh B.S. and Ahilya W, 2011).

The Kaffa Zone in southwestern Ethiopia is covered with dense forests, spanning over 7500 km^2 of land, with 47% of it being covered with forests (SNNRP, 2013). This region is home to a variety of wild edible fruit Fruits, including *Ficus sur Forssk* (Shola), *Ficus sycomorus* L. (Shola), *Peponium vogelii* (Hook.f) Eng (Tojo Kafi), and *Phoenix reclinata* Jacq (Zenbaba), among others (Ayele Kebede, 2011).

In this study aimed to investigate physicochemical characteristics of edible wild fruits in the rainforest of Kaffa Zone. The researchers compiled comprehensive understanding of their potential as a sustainable food source for local communities, and how they can contribute to improving food security and nutrition in the region. Overall, wild edible Fruits offer a range of benefits for food security, nutrition, and sustainable development in this region. Therefore for promoting and the sustainable use and conservation of these Fruits, this study can help to ensure that all individuals have access to sufficient, safe, and nutritious food, both now and in the future.

Description of the study area

Kafa zone is located in the south western part of Ethiopia in between 6^{0}24'-8^{0}13' North latitude and 35^0 30'-36^0 46' East longitude, some 449 Kilometer south west of Addis Ababa. The total population of the zone is 858,600 (CSA , 2007) with a population density of 90 persons per Kilometer Square. It is a highland region, with 80 per cent of the total area above 1,500 masl, Most of the mid- and high-altitude areas are found in the northwestern and eastern parts of the Zone; and the lowlands, in contrast, are generally between 600 and 1,500 meters elevation (Yihenew, 2002). On the whole slopes here are steeper than those in the highlands; typically they range from 15 to 45 per cent (MoWR 1996). The lowlands occupy the southern and southwestern parts of the Zone (Yihenew, 2002).

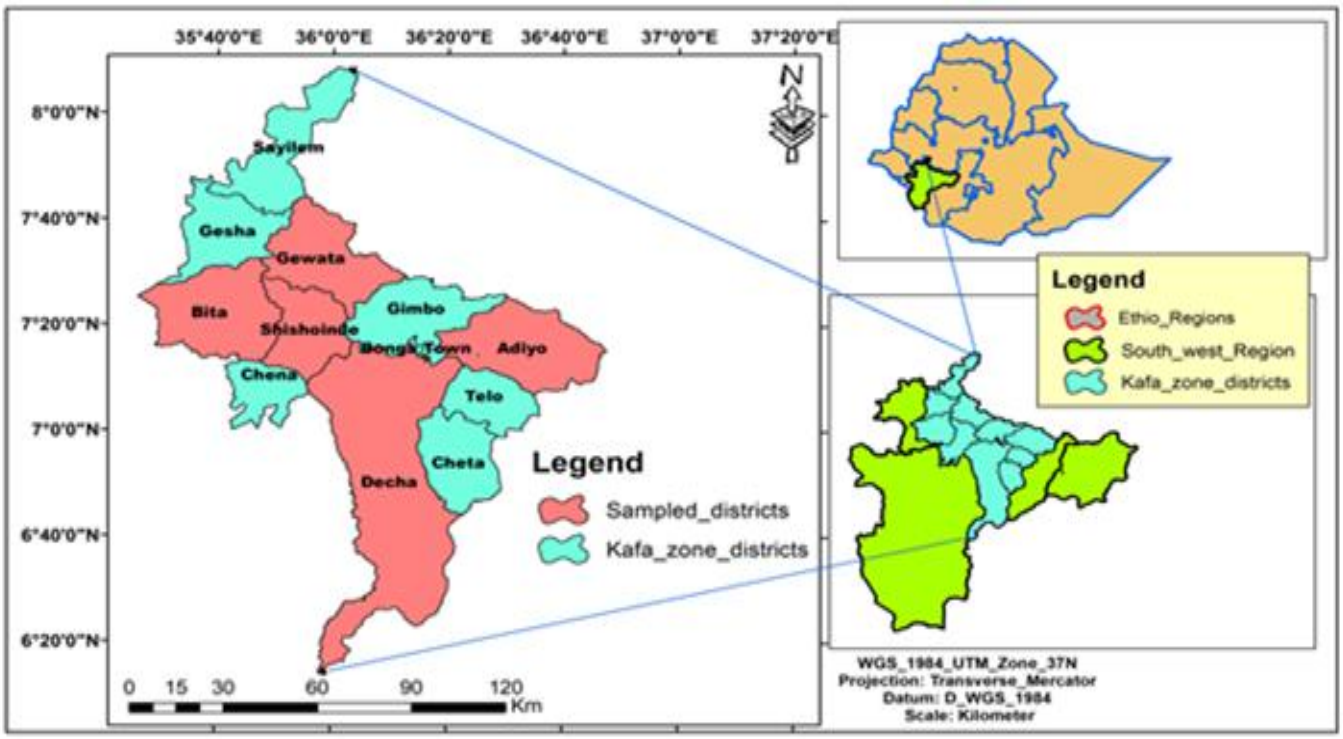

Figure 1: Map of Study area.

RESEARCH DESIGN

A cross-sectional survey was conducted from five woredas the second lowest administrative region of Ethiopia here after districts with relatively high forest coverage to gather detailed information on the use of wild edible fruit plant resources. This allowed us to collect locally used WEFPs. To ensure the representativeness of our findings, we selected districts which are an important factor influencing the availability and diversity of wild edible fruit Fruits (Kimani *et al*., 2016). Our survey for WEFPs included both quantitative and qualitative data collection methods, such as interviews and direct observations of the Fruits in their natural habitat (Hill *et al*., 2017).

SAMPLING AND SAMPLING TECHNIQUES

Reagents and Chemicals

All chemical reagents used for trace analysis were of high purity and analytical grade, as specified by Heinz *et al*., (2007). These reagents was carefully selected to ensure that the concentrations of the elements to be determined are not affected by potentially interfering elements, which should be negligible in comparison to the lowest element concentration being measured. Stock standard solutions containing 1000 mg/L of each metal (Mg, Mn, Ni, Pb, K, Ca, Fe, Zn, Cu, Co, Cr, Na, and Cd) in 2% HNO3 will be used for preparation of calibration standards and in spiking experiments. Deionized water was utilized throughout the

experiment for sample preparation, dilution, and rinsing of apparatus prior to analysis. Additionally, we considered using certified reference materials to validate the accuracy of our results and to account for any potential matrix effects or instrumental drift (ISO 17025, 2017).

Determination of moisture content

The moisture content of seven wild fruits sample was analyzed using an oven drying method and moisture was determined according to AOAC, 2000 using the official method 925.09. Briefly, a clean dried and covered flat aluminum dishes was weigh and about 5 g of the dried samples was transferred into a previously cleaned, dried and weighed aluminum crucible (W_2). The crucible with its content was put into a drying oven at 105°C for 1hr and cooled in a desiccator at room temperature for 30 min. Then, the crucible with residue was reweighed until a constant weight was obtained (W_3) then the moisture content was calculated by the following equation given below.

$$\textbf{\% Moisture} = \frac{(W2-W3)\ X\ 100}{W1}\text{--}$$

Where: W_1 = the mass of the empty crucible

W_2 = mass of the sample plus crucible weight before drying

W_3= mass of the sample after drying

Determination of ash content

The ash content was determined by Association official of Analytical Chemists (2000) using the official method 923.03. The dish used for the analysis was washing and dried for an hour at 105 ^oC in an oven then the mass of the porcelain dish was measured by using analytical balance. About 5 g American black nightshade powder was weigh into the porcelain dish. The sample will gently be heated over a hot plate until it charred at 120^{o}C on a hot plate for about 1 hour until the whole content becomes carbonized. Then the sample was placed in a furnace at 550^{o}C for 5 hours until whitish color appears. The sample was removed from the furnace and placed and cooled in desiccators. Finally, the mass of the total ash content of the sample was calculated by using of the following equation below under here.

$$\%\ Total\ Ash = \frac{(W2-W3)\ X\ 100}{W2-W1}$$

Where: W_1= Weight of empty crucible (g)

W_2= Weight of sample that drying in hot plate (g)

W_3= weight of crucible and sample after ashing

Determination of crude fiber

Crude fiber analysis of the fruits was conducted using the method of AOAC (2000) official method 962.09. About 2g sample was transferred into 500 ml of conical flask and 200 ml of 1.25% sulfuric acid was added and place the mixed sample into hot plate and boiled for 30 minutes. The sample was shacked contained flask periodically to ensure the proper boiling the sample. Then sample was filtered the boiled sample to drain the acid solution and washing the sample contained flask with hot water was removed the acid residue completely.

After that this sample was placed another funnel into conical flask and measure 200 mL of 0.313 M of 1.25% of sodium hydroxide solution and it was washed the previously filtrate sample by this 0.313 M of 1.25% of sodium hydroxide solution and flask was shacked to mix the sample with the solvents and placed into hot plate for 30 minutes.

Then sample was boiled with periodic agitation. After 30 minutes it was also boiled again and filtered to drain sodium hydroxide solution and frequently the flask was washed and filtrated sample with hot water to remove sodium hydroxide residue completely. After the completion the sample was filtered and washed and the sample was filtrated and collected into drying and clean porcelain crucible till not filtrate to left. The extract crude sample was transferred into clean dry crucible and it was placed the crucible into hot oven for two hours *at* 230 ^{o}C. After two hours take out the crucible from the oven and cool into desiccator for 30 minutes. Then weight of the fiber was taken in to crucible and recorded (W_2). After record the weight of oven drying sample was placed again into the crucible and then muffle furnace and the temperature of furnace will be adjusted at 550 ^{0}C for 2 hours and the sample contained crucible was cooled in the desiccator. Finally, the crude fiber content from the sample was calculated by the following equation.

$$Crude\ fiber\ (\%) = \frac{(W2-W3)}{W1} * 100$$

Where: W_1= weight of sample (g)

W_2= Weight of crucible +sample after washing, boiling and drying

W_3= Weight of crucible +sample of ash

Determination of crude protein

Crude protein was determined according to by the method of the Association of Official Analytical Chemists‟ (AOAC, 2000) using a Kjeldahl method using the official method 979.09.

From well-organized and homogenized 0.5g of the eight wild fruits sample and 0.5 g of catalyst was weighed and mix with 6 mL of concentrated sulfuric acid (98%). Finally, place the flask on the digested unit carefully and turn on the digested power and set the temperature at 230 ^{0}C and digest the sample for 2 hours.

After the digestion completed 20 mL of distilled water was added into the digested sample and transferred into 100 mL of volumetric flask and the flask was filled with distill water up to the mark. After that 30 mL of 4% boric acid will be measure and poured into a solution conical flask. Place the conical flask on the distillate collection unit.

Then 10 mL of digested sample was taken to transfer into digestion flask and 50 mL of 40% sodium hydroxide and additional another 50 mL of distilled water was also be added in to solution. Finally, the valve was opened to drain the mixture into the bottom of the flask.

After that, the distillation was run at 200 ^{0}C and turn on the circulation pump. After 1 hour later the distillation was turned off and collecting approximately 100 mL of distillate. Once, the completion of distillation process and collected distillate sample now ready sample for titration process. For titration process takes 0.1 N of HCl into burette and read the initial point of the burette. Then a few drops of methyl red indicator was added into the distillate sample and start titration process by using of HCl solution. Finally stop the titration process if the orange color was observed and finally calculate the crude protein content from the sample by using of the following equation below:

$$\% \text{ Nitrogen} = \frac{V1 * N1 * F1 * M}{W * 10}$$

Crude protein (%) = %Nitrogen x Factor x F_2

Where: V = final burette reading – initial burette reading
N1= normality of HCl
F1= acid factor M=molecular weight of nitrogen
W= weight of sample taken

Determination of Mineral Elements

Thirteen elements Chromium (Cr), magnesium (Mg), Nickel(Ni), calcium (Ca), zinc (Zn), cupper (Cu), cadmium(Cd), manganese (Mn), Irone (Fe),Sodium (Na), Lead (Pb). Potacium (K) and cobalt (Co) was measured by ashing of fruit sample of 10g at 560°C overnight. The resulting ash was then dissolved in 10 mL of a mixture of HNO_3 (1M) and HCl (1M) (1:1), making the volume of the resulting solution up to 60 mL with deionized water (González Paramás *et al*., 2000). Matrix modifiers were used for minerals that showed spectral interference like KCl and La2O3. KCl was added for measuring magnesium and calcium; and CsCl for sodium and potassium. Elemental analysis was done on (AAS) absorption atomic spectrophotometer. Analysis of each sample was done in triplicate. Potassium and sodium was determined using Flame photometer. The flame exited atoms of potassium and sodium emit radiation at different specific wavelengths, which was measured using different filters (Saha *et al*, 2014).

Working standard solution preparation

Determination of the concentration of Cd, Cu, Mn, Ca, Co, Fe, Cr, Pb and Zn minerals from six Fruits such as:- *Ficus sycomorus* L., *Peponium vogelii*(Hook.f) *Eng, Phoenix reclinata* Jacq, *Psidium guajava*, *Rubus steudneri*, and *Physalis peruviana* etc.. are some traditionally used wild edible Fruits.) was carried out by Atomic Absorption Spectrophotometer while K and Na was determined by flame emission. Calibration curves instrument for each mineral was obtained to ensure the accuracy of the atomic absorption spectrophotometer and to confirm that the results of determination was true and reliable. Calibration of the instrument was carried out with range of standard solution prepared by serial dilution of concentrated stock solution of 1000 mg/L to yield 10g/mL intermediate solution of all minerals except Cadmium, which needs 1g/ml intermediate solution. From these intermediate solutions the calibration standards (0.1, 0.5, 1.0, 2.0 and 4 ppm) was prepared for copper, potassium, sodium, manganese, calcium, cobalt, iron, chromium and zinc (0.05, 0.25, 0.5, & 1.0) for nickel, (0.005, 0.02, 0.06 and 0.12) for cadmium and (0.1, 0.3, 0.6, 1.2) for lead . A calibration curve of Absorbance versus concentration was established for each mineral and used for determination of mineral concentration in the samples.

Method Detection Limit

The detection limit is defined as the concentration of the element which was producing a signal/noise ratio of 3. Thus, the detection limit considers both the signal amplitude and the baseline noise and is the lowest concentration which can be clearly differentiated from zero (Elmer, 1996). A method detection limit (MDL) is the minimum concentration of a substance that can be measured. The determinative procedures involve digesting and diluting the blank solutions and then analyzing the concentration of each element of the samples in accordance with the optimized procedure. Then, the standard deviation of the six replicate readings of blanks was calculated (Childress, *et al* 1999).

Method Detection Limit (MDL) = t (n-1, 1-α = 0.99) (S)

Where: MDL = the method detection limit based on spiked samples

t (n-1, 1-α = 0.99) = the Student's t-value appropriate for a single-tailed 99th percentile

t statistic and a standard deviation estimate with n-1 degrees of freedom.

S = sample standard deviation of the replicate spiked sample analyses.

STATISTICAL ANALYSIS

The recorded data were subjected to one-way analysis of variance (ANOVA) to assess the influence of different variables on the concentrations of metallic metals in the fruit tested. All the statistical analyses were computed with SPSS software version 27. The analysis of the minerals in SPSS was fulfilled the reliability assumption such as normality of data distribution, expected extreme outliers data and homogeneity of recorded data.

Physicochemical analysis of wild edible fruit species

Physicochemical analysis were performed on six widely used plant species such as *Ficus sycomorus*, *Peponium vogelii, Phoenix reclinata*, *Psidium guajava*, *Rubus steudneri*, *Physalis peruviana*.

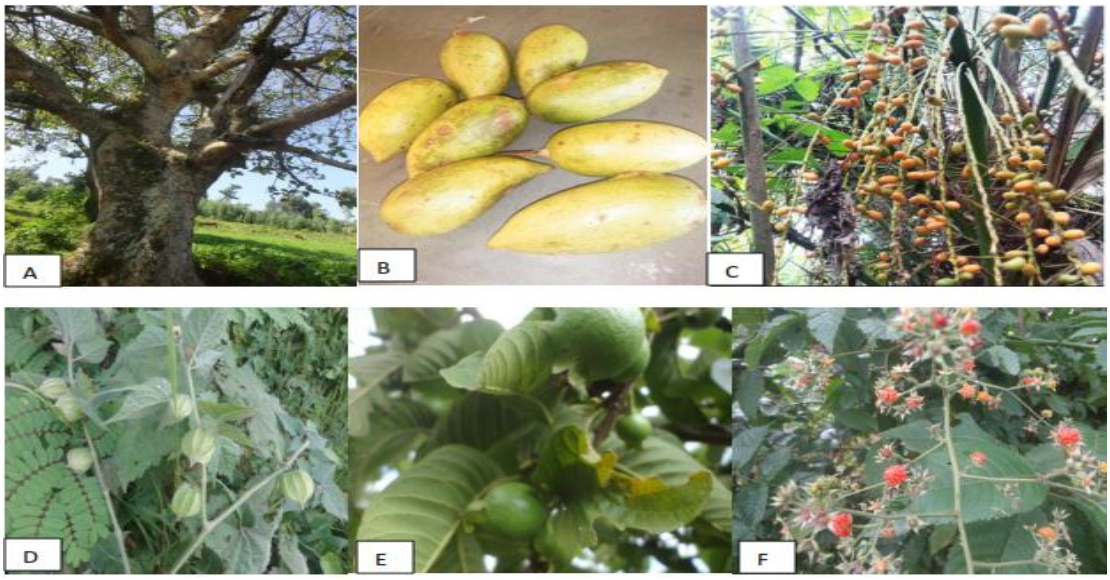

Figure 2. Selected fruit edible Wild plant.

Selected wild fruit edible plant species are collected and stored in laboratory by continuous follow up and steering allowed to remove all the moisture in it.

Sample Digestion

Following proper drying of air and oven to remove moisture content wild fruit edible plant species are allowed to crush and digest by grinding by the machine per the procedure indicated in proposal. Powder was labeled and packed in Pippete to get ready for mineral analysis.

Digestion of edible portion of Fruit samples applying the optimized procedure, One gram of crushed, powdered, sieved and homogenized samples was weighed and transferred to a 250 mL round bottom flask. To this 8 mL of 6:2 ratios of a mixture of HNO_3 (69–72%) and $HClO_4$ (70%) were added. The mixture was digested on a digestion apparatus by setting the temperature to 200^{0}C for 2h.The digested solution was allowed to cool for 10 min without dismantling the condenser from the flask and for 10 min after removing the condenser. To the cooled solution, 15 mL of distilled–deionized water was added to dissolve the precipitate formed on cooling and to minimize dissolution of filter paper by the digest residue while filtering with Whatman's, (110 mm; diameter), filter paper. The round bottom flask was rinsed subsequently with 5 mL distilled deionized water until the total volume reached around 45 mL. To this final solution,1%lanthanum nitrate solution was added (for the determination of calcium, lanthanum so/n was added to both standards and samples) and the solution was filled to the mark (50 mL) with distilled deionized water. Triplicate digestions were carried out for each bulk sample. Blank solutions were prepared following the same digestion procedure as the sample. The method blank accounts for contamination that may occur during sample preparation and analysis. These could arise from the reagents, the glassware or the laboratory environment (PerkinElmer Inc.1996).

Preparation of working solution for FAAS determination

The solutions used for calibration of FAAS were prepared from standard solution of each metal considered in this study. Using the stock solutions (1000 ppm) for each metal (Pb, Cd, Mn, Cu, Co, Ca, Cr, Fe and Zn) intermediate solutions (10 ppm) was prepared. Serial dilutions of Pb, Cd, Mn, Cu and Ni were prepared from the 10-ppm intermediate standard solutions using deionized water. Using the appropriate wavelength in the spectrometer, the absorption of the calibration standards was measured to provide the corresponding calibration curves.

Instrument Calibration

Secondary standard solutions containing 10 mg/L were prepared from the atomic absorption spectroscopy standard stock solutions that contained1000 mg/L. These secondary standards were diluted with deionized water to obtain four working standards for each metal of interest. Na, K, Ca, Mg, Mn, Cd, Co, Cr, Zn, Ni, Pb, Fe, and Cu were analyzed with MODEL 210 VGP BUCK SCIENTIFIC (USA) atomic absorption spectrophotometer using air-Acetylene flame and BUCK SCIENTIFIC PURO-GRAPHIC™ was used for preparation of calibration standard solution. The analysis of Na and K were determined in the emission mode of the spectrometer.

The qualities of results obtained for metals analysis using AAS are seriously affected by the calibration and standard solution preparations procedures. The instrument was calibrated using four series of working standards. The working standard solutions of each metal were prepared freshly by diluting the intermediated standard solutions mentioned under section 3.4. Concentrations of the intermediate standards, working standards and value of

correlation coefficient of the calibration graph for each of the metals are listed in Table 4.5. The calibration graph of each of metals of interest is shown in Table 4.5. Concentrations of the standard solutions used to establish calibration graphs for the determination of metals in samples and their corresponding correlation coefficients standard solution.

Table 1: Corresponding correlation coefficients standard solution.

S.no.	Metal	Intermediate Standard concentration in mg/L	Standard concentration in mg/L	Correlation coefficient (R^2) of calibration curve
1	Cd	10	0.01, 0.1, 0.5, 1	0.9989
2	Mn	10	0.03, 0.1, 0.3, 0.5	0.9995
3	Cu	10	0.01, 0.5, 1.5, 2	0.9996
4	Cr	10	0.04, 0.5, 1, 2	0.9993
5	Pb	10	0.04, 0.1, 0.5, 1	0.9998
6	Zn	10	0.01, 0.5, 1, 2	0.9997
7	Co	10	0.05, 0.5, 1, 2	0.9988
8	Ca	10	0.05,1, 2, 4	0.9995
9	Fe	10	0.025, 0.25, 0.75, 1	0.9996
10	Ni	10	0.05, 0.1, 0.5, 1	0.9997
11	Mg	10	0.05, 1, 2, 4	0.9999
12	Na	100	10,30,60,80	0.9987
13	K	100	10,30,60,80	0.9995

Method Detection Limit

Method detection limit is defined as the minimum concentration of analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero (Santos, *et al*, 2004). In other word, method detection limit is the lowest analyte concentration that produces a response detectable above the noise level of the system, typically three times the noise level but not necessarily quantitated as an exact value. For the present study, replicate analyses for ten blank samples for some of the elements and six blank samples for the others were performed and the pooled standard deviation of the ten blank reagents was calculated. The detection limits were obtained by multiplying the pooled standard deviation of the reagent blank by three. As can be seen from Table 2, the method detection limit of each element is above the instrument detection limit.

Table 2: Method detection limit and instrumental detection limits for Fruit sample samples (n =7for all metals).

Elements	Parameters					
	Wave length (nm)	Slit width (nm)	Lamp current (mA)	Energy (eV)	Instrumental detection limit (mg/L)	MDL
Co	240.7	0.2	4.5	3.106	0.050	0.067
Ca	422.7	0.7	2.0	3.912	0.010	0.035
Cu	324.7	0.7	1.5	3.938	0.005	0.009
Zn	213.9	0.7	2.0	3.237	0.005	0.017
Mn	279.5	0.7	3.0	3.913	0.030	0.038
Fe	248.3	0.2	2.0	3.782	0.050	0.053
Pb	283.2	0.7	2.0	2.874	0.040	0.041
Cd	228.9	0.7	2.0	3.219	0.010	0.012
Cr	357.9	0.7	2.0	2.712	0.040	0.043
Ni	341.5	0.2	7.0	2.624	0.020	0.028
Mg	285.2	0.7	1.0	3.787	0.001	0.008
Na	589 (emittedλ)			-	0.5	0.7
K	766 (Emittedλ)			-	0.5	0.6

Evaluation of Analytical Method

The ability to provide timely, accurate and reliable data is central to the role of analytical chemistry. Method validation is the process of providing that analytical method is acceptable for its intended purpose. Therefore, analysts are increasingly impelled to validate analytical procedures and to estimate uncertainty associated to the results. Since there is no certified reference material fruits in our laboratory, the validity of the optimized digestion procedure for Fruits were checked by carrying out with a lower level of traceability, such as spiked samples. As shown in Table 3, the percentage recovery for fruit sample is between 92 to 110% (100 ± 10), which are within the acceptable range for all metals were obtained.

Table 3: Method detection limit test for validation of method used.

Elements	[a] Conc. in sample (mg/L)	Amount added (mg/L)	[a] Conc. in spiked sample (mg/L)	[b] Recovery (%)
Mn	0.127	0.1	0.229 ± 0.012	102 ± 3.5
Cu	0.753	0.2	0.197± 0.010	98.5± 4.8
Zn	0.134	0.1	0.230± 0.013	96 ± 6.4
Pb	0.041	0.02	0.059± 0.007	90 ± 4.8
Cr	0.017	0.01	0.028± 0.005	110 ± 2.7
Fe	8.15	2	10.10± 0.49	97.5 ± 5.2
Ca	19.25	4	22.98± 0.64	93 ± 4.3
K	88.71 ± 0.12	5.0	93.78± 6.6	101.4 ± 1.48
Ni	0.076 ± 0.001	0.05	0.122 ± 0.003	92 ± 1.28

[a] Concentration values are average of analyzed samples ± standard deviation.
[b] Recovery values are mean ± standard deviation.

Determination of Metals

Flame AAS was used to determine the concentration of twelve metallic elements (K, Ca, Fe, Zn, Mn, Pb, Mg, Co, Cd, Cu, Na, and Cr) in digested and diluted solutions of edible fruits. Except for Cadmium (Cd), Lead (Pd) and Cobalt (Co), which are below the technique detection limit, all of the detected elements have been identified and are displayed in Table 4.8. The fruits have a wide range of mineral contents. K, Ca, Na and Mg are the four most common metals among the macro elements, while Mn. Zn and Cu contents are the most common of the measured metals.

The result of chemical analysis for the six (6) different Fruits is given in the following table 4. The result of each metallic minerals shows that each fruits have their own quality.

Table 4, 8. The Mean ±SD of metallic mineral analysis of each fruits in mg/100g.

Table 4: Table 4: The Mean ±SD of metallic mineral analysis of each fruits in mg/100g.

Fruit	Ca	Mg	Na	K	Mn	Fe	Zn	Co	Cr	Cd	Pb	Cu	Ni
P. guajava	26.47±0.027	18.13±0.03	55.29±0.25	88.44±0.04	8.85±0.02	0.26±0.01	1.15±0.02	0.07±0.002	ND	ND	ND	1.88±0.01	0.05±0.04
P. vogelii	28.42±0.04	20.23±0.02	45.95±0.04	83.3±2.3	2.84±0.03	0.75±0.03	1.75±0.02	0.033±0.002	ND	ND	ND	1.07±0.03	0.09±0.003
P. reclinata	50.65±0.036	40.23±0.05	62.8±0.02	98.23±0.06	4.79±0.03	0.45±0.03	1.13±0.02	0.03±0.002	ND	ND	ND	1.8±0.017	0.06±0.002
R.steudneri	74.42±0.06	55.40±0.01	60.54±0.03	94.15±.0.03	3.63±0.03	0.65±0.04	1.14±0.02	0.03±0.01	ND	ND	ND	1.16±0.02	0.08±0.002
F. sycomorus	23.42±0.03	15.27±0.06	80.84±0.03	136.33±0.02	2.68±0.56	0.74±0.02	1.26±0.03	0.03±0.001	ND	ND	ND	1.46±0.04	0.064±0.003
P. peruviana	100.44±0.04	65.31±0.04	73.25±0.03	83.74±0.03	1.22+0.01	0.27±0.03	1.08±0.5	0.047±0.003	ND	ND	ND	1.65±0.04	0.074±0.004
Grand mean ±sdv	**50.64±0.04**	**35.76±0.04**	**63.11±0.07**	**97.37±0.41**	**4.00±0.32**	**0.52±0.3**	**1.25±0.10**	**0.04±0.003**	**ND**	**ND**	**ND**	**1.50±0.3**	**0.07±0.01**

Concentration of major metallic mineral (K, Na, Ca and Mg) in six variety of fruits

Metal-containing minerals Dietary macro minerals include calcium, sodium, potassium, and magnesium; important minerals are those that an adult needs in amounts more than 100 mg per day of (Santos, et al., 2004). As indicated table 4 above, the hierarchy of metallic minerals in K > Na> Ca > Mg, in six varieties of fruits. From the four major metallic minerals, potassium is the most available metallic nutrient in fruits. Three metallic minerals such as Cadmium, Chromium and Lead below instrumental detection limit in (ppm) are not common in sampled plant species. The result of one way ANOVA analysis of fruit illustrate in the table 5, bellow indicate the significant different of each major metallic mineral among the different species of fruit.

Table 5: The mean ±std descriptive analysis of major metallic minerals in different six fruits mg/100g.

Mineral		Mean ±std	Minimum	Maximum
Ca	*P.gvajava*	26.47±0.03	26.44	26.49
	P.vogelii	28.42±0.04	28.38	28.46
	P.reclinata	50.65±0.04	50.61	50.68
	R.standerii	74.42±0.06	74.37	74.48
	F.sycomorus	23.42±0.03	23.4	23.45
	P.peruviana	100.44±0.04	100.4	100.48
	Total	**50.63±0.04**	16.73	16.75
Mg	*P.gvajava*	18.13±0.03	18.1	18.16
	P.vogelii	20.23±0.02	20.21	20.25
	P.reclinata	40.23±0.05	40.19	40.28
	R.standerii	55.41±0.02	55.39	55.42

	F.sycomorus	15.27±0.06	15.21	15.32
	P.peruviana	65.31±0.04	65.27	65.34
	Total	**35.76±0.04**	**35.73**	**35.80**
Na	*P.gvajava*	55.29±0.03	55.27	55.32
	P.vogelii	45.94±0.04	45.91	45.98
	P.reclinata	62.81±0.02	62.79	62.83
	R.standerii	60.53±0.03	60.51	60.57
	F.sycomorus	80.84±0.03	80.81	80.87
	P.peruviana	73.25±0.03	73.23	73.29
	Total	**63.13±0.03**	**63.09**	**63.14**
K	*P.gvajava*	88.44±0.04	88.41	88.49
	P.vogelii	84.64±0.03	84.61	84.66
	P.reclinata	98.23±0.06	98.18	98.29
	R.standerii	94.15±0.03	94.12	94.18
	F.sycomorus	136.33±0.02	136.31	136.35
	P.peruviana	83.74±0.03	83.71	83.77
	Total	**97.58±0.03**	**97.56**	**97.62**

The result of mineral analysis indicated in the table 4.9 above that three plant species *P.puveriana* (100.4 – 100.5mg/100g), *R.standerii* (74.4 – 74.5 mg/100g) and *P.reclinata* (50.65±0.04mg/100g/ having dry weight ranked from 1-3 respectively in calcium concentration. This study also illustrates that high amount of calcium (100.44±0.04mg/100g) and high amount of magnesium (65.31±0.04mg/100g) was found in *P.pruveriana,* high amount of sodium (80.84±0.03mg/100g) and potassium (136.33±0.02mg/100g) in *F.sycomorus* plant.

The comparison of mean value of each element between the group of plant species showed in table 6, through one way ANOVA revealed that the strong significance different between the group of plant species.

Table 6: The one way ANOVA comparison of the mean values of the each metallic mineral between fruit groups.

comparison of the mean values of the each metallic mineral between fruit groups						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Ca	Between Groups	15636.908	6	2606.151	1855226.332	**.000**
Mg	Between Groups	7544.776	6	1257.463	974417.582	**.000**
Na	Between Groups	3720.137	6	620.023	638258.775	**.000**
K	Between Groups	7153.197	6	1192.199	937684.978	**.000**

From the results so far, we know that there are statistically significant differences between the metallic minerals such as sodium, magnesium calcium and potassium in ($P \geq 0.05$) at 95% confidence interval was observed in calcium and potassium. The Multiple Comparisons table which contains the results of the Tukey post hoc test was used to shows in which group of plant species makes difference of each metallic minerals by one-way ANOVA. A Tukey post hoc test revealed that the mean concentration of the four metallic minerals (Ca, Mg, Na and K) were statistically significantly different after taking the mean concentration of one another.

The concentration of trace minerals (Zn, Pb, Mn, Fe, Co, Cu, Cr, and Cd) in fruits

Trace minerals are the metallic minerals which are needed in milli- or microgram amounts each day. These include lead, molybdenum, manganese, chromium, zinc, copper, cadmium, and zinc and nickel, are among a class of minerals known as ultra-trace minerals that are being researched for potential biological function but do not yet have clearly defined biochemical roles (S.S. Nielsen, 2010). The mean concentration of trace elements of WEFPs was also taken into account in the current investigation. Table 4.11, below displays the descriptive results for the mean, standard deviation, lowest, and maximum values of each trace mineral in different fruits.

Table 4.11. The mean ± Std descriptive analysis of trace metallic minerals in different six fruits mg/100g.

Table 7: The mean ± Std descriptive analysis of trace metallic minerals in different six fruits mg/100g

Trace Minerals	fruit	Mean	Minimum	Maximum
Mn	*P.gvajava*	8.84±0.01	8.830	8.850
	P.vogelii	2.83±0.02	2.810	2.840
	P.reclinata	4.8±0.02	4.760	4.790
	R.standerii	3.6±0.02	3.610	3.640
	F.sycomorus	2.4±0.02	2.340	2.370
	P.peruviana	1.17±0.01	1.160	1.180
	Total	3.94±0.02	1.160	8.850
Fe	*P.gvajava*	0.26±0.01	.250	.270
	P.vogelii	0.75±0.03	.720	.780
	P.reclinata	0.45±0.03	.430	.480
	R.standerii	0.65±0.03	.630	.690
	F.sycomorus	0.74±0.02	.720	.760
	P.peruviana	0.27±0.03	.240	.290
	Total	0.52±0.02	.120	.780
Zn	*P.gvajava*	1.15±0.02	1.130	1.170
	P.vogelii	1.75±0.02	1.730	1.770
	P.reclinata	1.13±0.02	1.110	1.150
	R.standerii	1.14±0.02	1.120	1.160
	F.sycomorus	1.26±0.03	1.230	1.290
	P.peruviana	1.42±0.01	1.410	1.430
	Total	1.31±0.02	1.110	2.480
Co	*P.guajava*	0.071±0.00	.070	.072
	P.vogelli	0.033±0.00	.032	.035
	P.reclinata	0.027±0.00	.026	.028
	R.standerii	0.025±0.00	.024	.026
	F.sycomorus	0.028±00	.027	.029
	P.puveriana	0.047±0.00	.046	.049
	Total	0.04±0.00	.024	.072
Cu	*P.gvajava*	1.88±0.01	1.870	1.890
	P.vogelii	1.07±0.3	1.040	1.090
	P.reclinata	1.81±0.03	1.780	1.840
	R.standerii	1.16±0.02	1.150	1.180
	F.sycomorus	0.46±0.04	.420	.490
	P.peruviana	1.65±0.04	1.620	1.690
	Total	1.34±0.07	.420	1.890
Ni	*P.gvajava*	.076±0.00	.074	.078
	P.vogelii	.092±0.00	.091	.093
	P.reclinata	.063±0.00	.062	.064
	R.standerii	.075±0.00	.073	.077
	F.sycomorus	.064±0.00	.062	.066
	P.peruviana	.072±0.00	.071	.074
	Total	.074±0.00	.046	.093

According to the above table 7, the concentration of the trace metallic minerals varied with different plant species. The highest concentration range of Manganese (8.83 – 8.85mg/100g), Iron (0.720 – 0.750mg/100g) and Zinc (1.73 – 1.77mg/100g) were recorded from P. *gvajava,* and the latter two from *P.vogelli* . In contrary to these the lowest amount of Mn (1.16 – 1.18mg/100g), Fe (0.24 – 0.29mg/100g) and Zn (1.11 – 1.15mg/100g) were recorded from *P.puveriana,* for both Manganese and Iron and *P.reclinata* for zinc.

The conversion of mean value of trace metallic minerals showed in table 4.12, below revealed that the existence of significant difference between the group. From the results so far, we know that there are statistically significant differences between the trace metallic minerals such as Mn, Fe, Ni, Co, Cu and Zn in ($P \geq 0.05$) at 95% confidence interval. The Multiple Comparisons table which contains the results of the Tukey post hoc test was used to shows in which group of plant species makes difference of each metallic minerals by one-way ANOVA.

Table 8: The one way ANOVA comparison of the mean values trace metallic mineral between fruit groups.

		Sum of Squares	Df	Mean Square	F	Sig.
Mn	Between Groups	118.094	6	19.682	111710.153	.000
Fe	Between Groups	1.107	6	.185	276.812	.000
Zn	Between Groups	4.191	6	.699	1264.540	.000
Co	Between Groups	.005	6	.001	583.885	.000
Cu	Between Groups	4.491	6	.748	976.228	.000
Ni	Between Groups	.003	6	.001	210.971	.000

The Tukey post hoc test revealed that statistically significant differences between the Manganese concentrations among different fruit species, as shown in Table 8**,** which shows the Multiple Comparisons of mean of metallic mineral between the groups.

Furthermore, the results of the Tukey post hoc test indicate that the iron content of the different fruit groups varies significantly, with some groups having higher concentrations of iron than others. This is likely due to factors such as soil quality, fertilization practices, ripeness, and variety, as discussed earlier. The fact that there is no significant difference between P. guajava and *P. perveiana*, and *P. vogelii* and *F. sycomorus* suggests that these pairs of fruits have similar iron content. This may be due to shared genetic characteristics or growing conditions that result in similar iron content.

Overall, the results of the Tukey post hoc test provide valuable insights into the iron content of different fruit groups, and can help inform dietary choices and fruit selection for optimal iron intake.

According to the results of our Tukey post hoc test, there was a statistically significant variation in zinc concentrations among different fruit groups ($P < 0.05$). Specifically, we found that the mean concentration of zinc in *P. guajava* was significantly higher than in *P. perviiana* ($P = 0.013$), while the mean concentration of zinc in R. standerii was significantly lower than in *P. reclinata* ($P = 0.047$). These findings suggest that there may be notable differences in zinc concentrations among various fruit groups. Moreover, the World Health Organization (2017) provides guidelines for the evaluation of nutrient variability in foods. According to these guidelines, zinc is an essential mineral that plays a crucial role in many physiological processes, including immune function, wound healing, and growth and development. In the context of our research, the findings suggest that there may be notable differences in zinc concentrations among various fruit groups, which could have implications for human health and nutrition.

According to the results from a Tukey post hoc test showing statistically significant variations in cobalt concentrations among different fruit groups using one-way ANOVA. Specifically, there were no significant differences found between *P. vogelli*, *F. sycomorus* and *R.standerii*. According to, the World Health Organization (WHO, 2017) guidelines for the evaluation of nutrient variability in foods, cobalt is an essential mineral that plays a crucial role in many physiological processes, including the formation of red blood cells and the maintenance of bone health.

The current research, findings suggest that there were notable differences in cobalt concentrations among various fruit groups. However, the lack of significant differences between *P. vogelli*, *F. sycomorus* and *R. standerii* suggests that these three fruits are comparable in terms of their cobalt content.

According to the Tukey post hoc test result, a statistically significant variation in the means of copper, except for the comparison between *P. guajava* and *P. reclinata*, where no significant difference was observed at the 95% confidence interval. Additionally, the results suggest that there are differences in the levels of copper among the different fruit groups, but these differences are not statistically significant for the comparison between *P. gvajava* and *P. reclinata*. This is likely due to the fact that the samples from these two species have similar copper concentrations, and therefore, the difference between them is not considered statistically significant.

The World Health Organization (WHO, 2017) has established guidelines for the maximum allowable limits of certain nutrients, including copper, in food products. According to the WHO, the adequate intake (AI) for copper is 1.2 milligrams per day for adults, and the tolerable upper intake level (UL) is set at 10 milligrams per day. Based on these findings, it seems that the concentrations of copper in the different fruit groups are within the acceptable ranges set by the WHO.

The WHO recommends an adequate intake (AI) of nickel of 200-300 micrograms per day for adults, and a tolerable upper intake level (UL) of 1000 micrograms per day. However, it's important to note that excessive intake of nickel can be harmful, especially for individuals with pre-existing medical conditions such as kidney disease or anemia. Now, based on results from the Tukey post hoc test, it appears that there were statistically significant differences in nickel content among the different fruit groups, except for the comparison between *P. gvajava* and *P. reclinata*. This suggests that while there is some variation in nickel content within each fruit group, the differences are not necessarily statistically significant. According to a study published in *the Journal of Food Science and Technology*, the nickel content in various fruits

can vary significantly. For example, the study found that bananas contain relatively high levels of nickel, with an average concentration of 26.4 micrograms per 100 grams of fruit. In contrast, apples and pears had much lower levels of nickel, with average concentrations of 1.3 and 1.5 micrograms per 100 grams of fruit, respectively.

Crude Fat, Fiber, Protein and Moisture content of WEFPs

Table 9: Crude Fat, Fiber, Protein and Moisture content of WEFPs.

R.no	WEFP species	Percent (%)				
		Moisture Content	C.Fat	C.Fiber	C.Protein	Mean
1	*Peponium vogelii*	30.75	4.82	15.57	16.38	12.26
2	*Phoenix reclinata*	13.94	1.94	15.15	13.5	10.20
3	*Psigium guajava*	11.72	7.33	57.38	5.87	23.53
4	*Rabus standerii.*	12.74	5.5	36.65	11.55	17.9
5	*Phsalis peruviana*	7.88	12.38	33.9	14.44	20.24
6	*Ficus sycommurus*	11.21	3.12	26.37	2.05	10.51
	Mean	14.71	5.85	30.84	10.63	15.21

Protein content

The protein content of the fruits in the table ranges from 2.05% for *F. sycommurus* to 16.38% for *P. vogelii*. According to the WHO (2017), the recommended daily intake of protein is 0.8 grams per kilogram of body weight, which translates to approximately 56 grams of protein per day for an adult weighing 70 kilograms. Based on this recommendation, the protein content of the fruits in the table revealed as for 12.26 grams protein per 100 grams *P. vogelii* fruit, 13.5 grams protein per 100 grams *Phoenix reclinata* fruit which meets the WHO's recommended daily intake of protein. Finally the protein contents of the six fruits (Table 9) meet the acceptable value of WHO standards. Thus, these fruits may be used as alternative source of foods.

Fiber content

Fiber is an important component of a healthy diet, and many fruits are rich in fiber. The fiber content of fruits can range from 15% to over 50%, depending on the type of fruit. For example, papaya and mango are high in fiber, while strawberries and raspberries are lower in fiber. Eating a variety of fruits can help you meet your daily fiber needs and support overall health (Abido A, A. *et al.*, 2011).

The fiber content of the fruits in the table ranges from 15.15% for *Phoenix reclinata* to 57.38% for *Psigium guajava*. According to a study published in the Journal of Food Science and Technology, "The fiber content of ripe guavas ranged from 21.5 to 25.5%. Fiber is an important component of a healthy diet, as it can help promote digestive health, lower cholesterol levels, and support weight management. The high fiber content of *Psigium guajava* makes it a particularly good choice for those looking to increase their fiber intake as indicated in table 9.

Moisture content

The moisture content of fruits can vary widely depending on the type of fruit and its ripeness. In general, fruits tend to have higher moisture contents than vegetables. According to a study published in the Journal of Food Science and Technology, "The moisture content of ripe guavas ranged from 21.5 to 25.5%." Another study published in the Journal of Agricultural and Food Chemistry found that the moisture content of papaya ranged from 10.5 to 12.5%.

As indicated in (Table 4.13) the moisture content of fruits rages from 7.88% for *Phsalis pruveriana* fruit to 30.75% for *Peponium vogeli* fruit. The result obtained from this study was strongly agreed with studies of different scholars. According to a study published in the Journal of Agricultural and Food Chemistry, "The moisture content of matured *Peponium vogeli* fruits ranged from 27.9 to 32.6%., but the current study revealed that the moisture content of *Peponium vogeli* is 30.75%. The result of the study shows that the moisture content of *Phoenix reclinata* is 13.94%. According to a study published in the Journal of Horticulture and Forestry, "The moisture content of the *Phoenix reclinata* fruits ranged from 12.2 to 14.8. The moisture content of *Psigium guajava* is 57.38%. According to a study published in the Journal of Food Science and Technology, "The moisture content of ripe guavas ranged from 54.2 to 62.5% and %. According to a study published in the Journal of Plant Breeding and Crop Science, "The moisture content of the *Rabus Spp.* fruits ranged from 10.5 to 12.5%. From this study it is observed that the moisture content of *Rabus Spp*. is 11.55%. For overall concerns, the moisture content of fruits can have important implications for food safety and quality. For example, high moisture content can lead to spoilage and microbial growth, while low moisture content can make fruits more susceptible to dehydration and browning.

Crude fat content

The results show that the highest percentage of crude fats in fruit is found in *Phsalis pruveriana* with 12.38%, followed by *Psigium guajava* with 7.33%. The lowest percentage of crude fats is found in *Phoenix reclinata* with

1.94%. The other species have the following percentages: *Ficus sycommurus* (3.12%), *Rabus Spp*. (5.5%), and *Peponium vogelii* (4.82%). Even though the crude fat content of *Phoenix reclinata* is lower in this study it is still above the WHO recommended daily intake. On the other hand, it's worth noting that the WHO recommends limiting the intake of total fat to 20-35% of total energy intake, with an emphasis on unsaturated fats over saturated fats (World Health Organization, 2015). More over relatively shown that high amount of crude fat content per species as compared to the study conducted by (Yalew Yiblet, 2024)

Ash Content Determination

The ash content was determined by Association official of Analytical Chemists (2000) using the official method. The ash content of *Peponium Vogelli* is relatively low at 1.83% (w/w), which is within the range of other fruits like strawberries and raspberries (FAO, 2013). This suggests that *Peponium Vogelli* may not be as nutrient-dense as other fruits, but it still meets the WHO recommended minimum ash content of 2% for fruits. Comparison to WHO recommended value: The WHO recommends a minimum ash content of 2% for fruits (FAO, 2013). *Peponium Vogelii* meets this requirement.

Phoenix reciliata has significantly higher ash content than *Peponium Vogelii*, at 6.04% (w/w). This is likely due to the fruit's high mineral content, particularly calcium and potassium (Dias *et al*., 2014). The WHO recommends a minimum ash content of 2% for fruits (FAO, 2013), and *Phoenix recilinata* exceeds this requirement. This suggests that the fruit may be more nutritious than others with lower ash content.

The ash content analysis revealed varying levels of nutrient density among the fruits tested. *Peponium vogelii* had a relatively low ash content of 1.83% (w/w), which is within the range of other fruits like strawberries and raspberries. *Phoenix reciliata* had a significantly higher ash content of 6.04% (w/w), which is likely due to its high mineral content. *Psidium guajava* had the highest ash content of all, at 10.78% (w/w), which is well above the WHO recommended minimum ash content of 2% for fruits. These results suggest that *Psidium guajava* may be the most nutritious of the three fruits, followed by *Phoenix reciliata,* while *Peponium vogelii* may be less nutrient-dense compared to the others.

Figure 3: Drying of samples of selected plant fruits.

CONCLUSION AND RECOMMENDATION

Conclusions

Mineral or physicochemical composition found in wild edible fruit plant identified contains important major and trace mineral elements required by normal body functioning and proper health conditions nearly in equal proportions with cultivated fruits Fruits, indicates that they are potential contributors of dietary values. Furthermore food stuffs such ad protein, fats, fibers and moisture content was detected in selected wild edible fruit Fruits. WEFPs in this study were compared to different published reputable international scientific journals they can supply daily minimum intake requirements. Thus equal treatment and conservation strategies needed in the context of biodiversity conservation and nutritional potential of the WEFPS.

RECOMMENDATION

Currently, global human population is increasing in alarming rates, this have direct relation with food requirements for proper growth and development, in the meantime many wild flora species are on the verge of extinction and overlooked for food values. Anthropogenic effects and climate change, some common factors for their loss and consequently decreasing in food Fruits and plant genetic resources in general. There for in order to incorporate WEFPs in to daily food requirements and for proper conservation strategies the following recommendations are proposed hereunder:

- Currently as global human population has been greatly increasing each year; while common food crops yield rate can decrease due to repeated harvesting that may change soil quality; so adapting WEFPS as integral part of daily food consumption is necessary that can used us safeguard for food demand.
- Local and international organizations and NGOs focused on food security, health, and food safety

should encourage the use of WEFPs in daily food intake.

- As many plant species are on verge of extinction from their habitat due to anthropogenic pressures and climate change factors; conservation issue should be considered us biodiversity concern and in light with their nutritional profile.
- Researchers should extend its effort toward study focusing phytochemicals and important secondary metabolite, terpenoids, and alkaloid found among there selected plant species which were not covered under this study.

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