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Nutritional Composition of Selected Wild Fruits from Minna Area of Niger State, Nigeria

John O. Jacob, Abdullahi Mann, Olanrewaju I. Adeshina, Mohammed M. Ndamitso

Abstract**—***Strychnos spinosa*, *Detarium microcarpum*, *Diospyros mespiliformis*, *Dialium guineese* and *Gardenia ternifolia* are some of the wild fruits consume in the villages around Minna, Niger State. This investigation was conducted to assess the nutritional potentials of these fruits both for human consumption and for possible application in animal feed formulations. Standard analytical methods were employed in the determination of the various nutritional parameters. The proximate analysis results showed that the moisture contents ranged between (6.17-10.70%); crude fat (2.04-8.85%); crude protein (5.16-6.80%); crude fibre (7.23-19.65%); Ash (3.46-5.56%); carbohydrate (57.77-69.79%); energy value (284.49-407 kcal/mg); Vitamin C (7.2-39.93 mg/100g). The mineral analysis shows that the selected wild fruits could contribute considerable amount of both micro and macro elements to human nutrition potassium, sodium and calcium range between; potassium (343.27-764.71%); sodium (155.04-348.44%); calcium (52.47-101%). The macro element for the fruits pulp were in the order K>Na>Mg>Ca, hence, they could be included in diet to supplement daily nutrient requirement and in animal feed formulations. The domestication of these fruits is also encouraged.

Keywords**—**Minerals, nutrition, supplements, wild fruits.

I. Introduction

THE relevance of wild fruits and the need to introduce more plant foods in order to bridge the gap of alarming food shortage in human nutrition have aroused attention of researcher throughout the world, and especially Nigeria [1]. Wild fruits are gaining increased attention as potential food supplement or cheaper alternative of domesticated exotic fruits across the world [2]. The role played by wild fruits in food security and economy welfare of rural communities in developing countries cannot be over emphasized [3].

Detarium microcarpum (dattock) belongs to the family Leguminosae. It is a small tree that grows up to 15m-25m [4]. The fruiting takes place between September-January [5]. The fruits are edible, rich in vitamin C and some mineral elements. Vautier et al. [6] reported that the roots, stems, bark and leaves are employed in the treatment of various ailments such as diarrhea, meningitis, tuberculosis, itching and syphilis.

Diospyros mespiliformis (African ebony) belongs to the family Ebenaceae. It grows in tropical areas of Africa stressing from Sudan to South Africa and has medicinal value [7]. The fruit is sweet but has a lemon-like taste. It is often eaten raw when fully ripe, particularly by children and is also used in the production of fruit juice and alcoholic drinks [8].

John O. Jacob, Abdullahi Mann, Olanrewaju I. Adeshina and Mohammed M. Ndamitso are with the Federal University of Technology, PMB, 65, Minna, Nigeria (e-mail: jacobasol@yahoo.com).

Strychnos spinosa (monkey orange) is a small tree 1-9m in height belongs to the family Strychnaceae. It is usually found in savannah forests all over tropical Africa. The fruits are juicy with sweet-sour taste, containing numerous hard brown seeds. Fruits serve as supplementary source of food to the rural dwellers in times of food shortage and also to stimulate breast milk [9].

Dialium guineense (velvet tamarind), a woody plant that occurs in the rain forest region of West Africa belongs to the family Caesalpiniaceae. It grows up to 15 m high and valued for its high ascorbic acid content, minerals and sugar [10]. The fruits are usually circular and flattened, black in colour with stalk 6mm long [11]. Adepoju [12] reported that the fruits are used in medicinal remedies, as source of vitamin C, as flavour in snacks and non-alcoholic beverages.

Gardenia ternifolia (yellow gardenia), a shrubby-tree of up to 18m high, widely found in tropical and sub-tropical region of Africa and southern Asia belongs to the family Rubiacea. Fruits are ellipsoid to globoid and are up to 6.5cm long with persistent calyx having numerous but tiny seeds embedded in a fleshy pulp [13].

One of the effective ways of bridging the gap of malnutrition and achieving food security is through the exploitation of wild fruits in order to meet the need of the growing population. Knowledge of these fruits is necessary in order to encourage their domestication and proper utilization [14]. This investigation was therefore conducted to provide information on the proximate, mineral and vitamin C compositions of five selected wild fruits, which are commonly eaten by the people of Minna, Niger State, so as to prioritize the promising ones for domestication and possible utilization in animal feed formulation.

II. Materials and Methods

A. Sampling and Sample Treatment

The samples of the wild fruits were collected from villages in Minna area of Niger State, Nigeria. The sites were chosen because of the abundance of the fruits in these areas. All reagents used were of analytical reagent grade unless otherwise specified. Distilled water was used in the preparation of solutions and dilution unless otherwise stated.

B. Proximate Analysis

1. Determination of Moisture Content

This was in accordance with AOAC [15]. Thoroughly washed crucibles were placed inside a drying oven at 105 ^{o}C for 3 hrs. After that, the crucibles were cooled in the

desiccator and weighed. 3 g of the milled samples each in triplicate were placed inside the crucibles and then reweighed. The samples were then dried in a thermostatically controlled oven at temperature of 105 ºC until a constant weight is obtained. The dried samples were then cooled and weighed. Moisture content in percentage of sample was then calculated as:

$$Moisture\ contents\ (\%) = \frac{W2 - W3}{W2 - W1} \times 100$$

where: W1 = Initial weight of empty crucible; W2 = Weight of crucible + sample prior to drying; W3 = Final weight of crucible + sample after drying.

2. Determination of Ash

5 g of samples each in triplicate was added to the crucibles, previously prepared as above, and the weighed. They were then placed in pre-heated muffle Furnace at 550 ºC for 3hrs [15], until a light greyish residue is obtained. The crucibles were then cooled in a desiccator and the new weight of the crucible + Ash recorded. The Ash contents in percentages were calculated as:

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

where: W1 = Weight of empty crucible; W2 = Weight of crucible + sample prior to ashing; W3 = Weight of crucible + Ash.

3. Determination of Crude Fat

250 ml clean boiling flasks were dried in a thermostatically controlled oven at 105 ºC for 30 min. They were the cooled in a desiccator and weighed. 2 g each of the various samples were accurately weighed into appropriately labeled extraction thimbles and were lightly plugged with cotton wool. The pre-weighed boiling flasks were filled with 300 mL of petroleum ether. The Soxhlet extraction apparatus were assembled with the thimbles placed inside and was allowed to refluxed 8hrs. The heating rate was adjusted to temperature of 50-55 ºC so as to give a condensation rate of 2-3 drops/sec [15]. The thimbles were then carefully removed and the ether reclaimed for reuse. When flask was almost free of petroleum ether, they were removed and dried at 105 ºC for 1hr or until the solvent was completely dried. They were cooled in desiccators and weighed. The crude fat was calculated using the formula:

$$Crude\ Fat\ (\%) = \frac{W1 - W2}{W1} \times 100$$

where: W1= Weight of sample before extraction; W2= Weight of sample after extraction.

4. Determination of Crude Protein

Nitrogen content in the sample was estimated by using micro Kjeldahl method as described by [16]. The crude protein was calculated by multiplying the evaluated nitrogen by 6.25. 1 g each of the various samples were accurately weighed and transferred into digestion flasks where 2 tablets of selenium were added as catalyst. 12 ml of sulphuric acid was added and the tubes were heated until clear solutions were obtained. The clear solutions were transferred into a 50 ml volumetric flask each and made up to mark. The protein digestion results in production of ammonium sulphate solution:

$$\text{Organic N} + H_2SO_{4\,(aq)} \rightarrow (NH_4)_2SO_{4\,(aq)} + H_2O_{(l)} + CO_2 + \text{Other sample matrix by-products}$$

10 ml of digest followed by 10 ml of 40 % NaOH solution was pipette into Kjeldahl distiller. A conical flask containing 5 ml of 2% boric acid and 3 drops of mixed indicator was placed under the condenser outlet. Upon the completion of the distillation, the ammonium sulphate solution produced is converted into ammonia.

$$(NH_4)_2\,SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)} + 2NH_{3\,(g)}$$

Ammonia gas produced condenses and collected as liquid into the conical flask containing the boric acid and mixed indicator.

$$B(OH)_3 + H_2O + NH_3 \rightarrow NH_4^+ + B(OH)_4^-$$

The nitrogen in the distillates was determined by titrating with 0.01 M of HCl. Colour changes from green to pink marks the end point. The amount of nitrogen and crude protein in samples were calculated respectively as:

$$\%N = \frac{(S - B) \times \text{N}acid \times 0.014 \times D \times 100}{Weight\ of\ sample \times V}$$

% Crude Protein = 6.25* x %N (*. Correction factor)

where: S = Sample titration reading; B = Blank titration reading; N = Normality of HCl; D = Dilution of sample after digestion; V = Volume taken for distillation; 0.014 = milliequivalent weight of Nitrogen.

5. Determination of Crude Fiber

This is in accordance to AOAC, [15]. 2 g of defatted sample was weighed into a 250 ml conical flask and 200 ml of 1.25% sulphuric acid solution was added. The sample was heated for about 30 min and filtered using poplin cloth in a Buchner funnel and washed until traces of acid was undetected using pH litmus paper. The residue obtained was transfer back into the 250 ml conical flask and 200 ml of 1.25% NaOH solution added. The sample was heated again for 30 min and filtered using poplin cloth and washed with water until base was undetected. The whole material was transferred into a crucible and dried in the oven, cooled and weighed. After that, the crucible was placed in a muffle furnace at 550 ºC and ashed for 12 hrs, cooled and weighed. The weight of the fibre was calculated by difference using the formula:

$$Crude\ fibre\ (\%) = \frac{Wcd - Wca}{Ws} \times 100$$

where: Wcd = Weight of crucible + dried residue; Wca = Weight of crucible + ashed residue; Ws = Weight of the sample.

6. Estimation of Carbohydrate

The total carbohydrate content was determined by difference method. The sum of the percentage ash, crude lipid, crude protein, and crude fibre was subtracted from 100% as described by AOAC [15].

$$Carbohydrate\ (\%) = 100 - (\%Ash + \%Protein + \%Lipid + \%Fibre)$$

7. Estimation of Nutritive Value

The calorific value of each plant samples were determined by multiplying the values obtained for protein, fat and available carbohydrate by the factors of 4.00, 9.00 and 4.00, respectively and adding up the values. The values were expressed in kilocalories [17].

8. Determination of Vitamin C

The ascorbic acid in the pulps and seeds of the samples were determined by titration with 2, 6-dichlorophenol-indophenol solution. 2 g of the milled fruits samples each were weighed into 250 ml conical flasks and 100 ml of distilled water added. It was allowed to stand for 10 minutes for it to extract. The mixture was then filtered into 100 ml volumetric flask and made to mark. 2 ml acetic acid was added to 5 ml of the extracted sample, to stabilize the ascorbic acid and thus avoid degradation. This was then titrated with 2, 6-dichlorophenol-indophenol dye to a faint pink colour which persists for 15seconds. The formula below was used to calculate the ascorbic acid content of the samples [16].

$$Vitamin\ C\ \left(\frac{mg}{100mL}\right) = 20 \times V \times C$$

where: V = Titre value of 2, 6-dichlorophenol-indophenol

$$C = \frac{Conc.\ of\ standard\ ascorbic\ acid}{Volume\ of\ indophenol\ dye\ used}$$

Vol. of indophenol used = 11.6
Conc. of std. ascorbic acid = 0.5mg/5ml

C. Mineral Analysis

1. Acid Digestion

One gram of dried powdered wild fruit sample each was weighed into a micro-Kjeldahl digestion flask and 12 cm^3 of mixture of concentrated, HNO_3, H_2SO_4, and 60% $HClO_4$ added to each sample in the ratio 9:2:1 v/v respectively. The flask was put on a heating block and digested to a clear solution, cooled and the content transferred into a 100 cm^3 volumetric flask and made-up to mark [17].

2. Mineral Determination

Aliquots of the digests were used to determine the level of calcium, magnesium, iron, manganese, zinc, and copper by Atomic Absorption Spectrophotometer (AAS, Accusys 211 model, bulk scientific USA). Sodium and potassium were determined with Flame Photometer [17].

D. Statistical Analysis

Statistical analyses were performed using SPSS (version 19). All determinations were done in triplicates and the data generated were expressed as mean ± standard error of mean. Analysis of variance (ANOVA) was used to determine significant differences between values ($p < 0.05$).

III. Results and Discussion

Table I shows the results of proximate analysis and Vitamin C contents of the pulp of the investigated samples. The superscript a, b, c, d and e indicates the level of significance of the investigated parameters of the samples at P<0.05.

The percentage moisture content ranged between 6.17±0.01% for *Dialium guineense* and 10.76±0.01% for *Gardenia ternifolia. Gardenia ternifolia* has the highest moisture content of 10.76±0.01%, followed by *Detarium microcarpum* and *Strychnos spinosa* which has 8.16±0.01% and 7.12±0.03% respectively.

The crude fat values obtained in this investigation ranges between 2.04 and 8.85±0.02% for *S. spinosa* and *D. microcarpum* respectively. The pulp of *D. microcarpum* the highest crude fat value as compared to the other fruit pulp in this study. This is an indication that it is a comparative good source of oil-soluble vitamins [12]. The value obtained is comparable with that *of D. mespiliformis* (8.74±0.04). Uzoma and Odusanya [18] reported a smaller value of 1.57 and 1.94% for *D. microcarpum* and *S. spinosa* respectively. This variation could be due to climatic factor. The fruits with low crude fat can be recommended as weight reducing diet, since low-fat food reduces the level of cholesterol and obesity.

Crude protein obtained from the analysis ranges from 5.16±0.05 to 8.74±0.04% for *G. ternifolia* and *S. spinosa*. Mariod et al. [4] reported a higher value of 29-30% for *D. microcarpum*. Nevertheless, a slightly higher value (7.88±1.00%) was reported [19]. The crude protein value of *S. spinosa* (8.72±0.02%) is lower compare to the 11.7% reported [21]. It is however higher than the 3.3% reported by [20]. *D. guineense* pulp produced a lower amount (5.23±0.01%) against 7.79 ± 0.42% stated by [24]. Protein is an essential component of diet needed for survival of human and animals alike, as they supply the adequate amount of required amino acid for nutrition.

For this investigation, the range of crude fibre obtained was within the range of 7.23±0.06% to 19.65±0.01%. For *S. spinosa*, and *D. miscrocarpum* pulp the crude fibre obtained (15.78±0.00% and 7.23±0.06%) were lower than those reported (23.96% and 26.28%) by [21]. Osanaiye [11] reported 1.05 % for *D. guineense*, a value lower than the one produced in this analysis. 5.9%, a value lower than the one obtained for *D. guineense* was also reported [22]. Fibre helps

the maintenance of human health and known to reduce cholesterol. Presence of high crude fibre improves glucose tolerance [23].

TABLE I
PROXIMATE COMPOSITION OF FRUIT PULP (%)

Parameter	*Detarium microcarpum*	*Strychnos spinosa*	*Diospyros mespiliformis*	*Dialium guineense*	*Gardenia ternifolia*
Moisture	8.16±0.01[d]	7.12±0.00[c]	6.89±0.01[b]	6.17±0.01[a]	10.76±0.01[e]
Crude Fat	8.85±0.02[e]	2.04±0.00[a]	8.740±0.04[d]	6.41±0.06[c]	2.21±0.06[b]
Crude Protein	6.80±0.31[d]	8.72±0.02[c]	6.99±0.02[b]	5.23±0.01[a]	5.16±0.05[a]
Crude Fibre	7.23±0.06[a]	15.78±0.00[d]	12.24±0.01[c]	8.81±0.04[b]	19.65±0.01[e]
Ash	5.56±0.09[e]	3.86±0.00[c]	4.66±0.02[d]	3.60±0.00[b]	3.46±0.03[a]
Carbohydrate	63.40±0.33[d]	62.47±0.03[c]	60.47±0.05[b]	69.79±0.11[e]	57.77±0.06[a]
Energy value*	342.83±0.22[c]	303.38±0.23[b]	348.86±0.37[d]	357.74±0.19[e]	280.52±0.23[a]
Vitamin C**	7.20±0.00[a]	18.04±0.03[c]	21.62±0.00[d]	39.93±0.10[e]	12.50±0.00[b]

* in kcal/100g ** is in mg/100g.

TABLE II
MINERAL COMPOSITION OF THE FRUITS PULP (MG/100G)

Parameters	*Detarium mirocarpum*	*Strychnos spinosa*	*Diospyros mespiliformis*	*Dialium guineesnse*	*Gardenia ternifolia*
Calcium	71.40±0.10[d]	52.47±0.02[a]	101.67±0.09[e]	57.15±0.18[b]	65.96±0.10[c]
Magnesium	91.40±0.10[c]	45.39±0.00[a]	116.67±0.09[d]	125.54±0.01[e]	71.11±0.01[b]
Zinc	1.52±0.03[b]	2.71±0.00[e]	2.60±0.01[d]	1.73±0.02[c]	1.25±0.00[a]
Copper	0.82±0.02[b]	0.53±0.01[b]	0.61±0.01[c]	1.82±0.01[e]	0.31±0.00[a]
Manganese	3.59±0.01[e]	2.24±0.01[c]	1.81±0.00[a]	2.13±0.01[b]	2.54±0.01[d]
Iron	3.89±0.02[e]	1.72±0.00[b]	1.58±0.00[a]	2.63±0.01[d]	1.90±0.01[c]
Potassium	740.71±0.30[d]	764.68±0.17[e]	660.01±0.00[c]	410.46±0.02[a]	343.27±0.03[b]
Sodium	348.44±0.03[e]	301.98±0.02[d]	155.04±0.02[a]	162.99±0.02[b]	231.50±0.00[c]

Values with different superscript along a row are significantly different at P<0.05.

The percentage ash content ranged between 3.46±0.03 and 5.56± 0.09%. The percentage ash contents for the pulp was in the order; *D. microcarpum* > *D. mespiliformis* > *S. spinosa* > *D.* guineense > *G. ternifolia*. Amarteifio and Mosase [20], as well as Lockett et al. [21] reported the ash content of *S. spinosa* to be 4.6% and 2.58% respectively.

Earlier study revealed *D. guineense* to have 3.53% [24]. Osanaiye et al. [11] stated 12.5%. The value reported for pulp by [24] agrees with the one obtained in this research while that of [11] differs with a wide margin. Samples with high percentages of ash contents are expected to have high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development [12].

The percentage composition (by estimate) of carbohydrate falls within the range of 57.77±0.06 to 69.79±0.11%. The order was; *D. guineense* > *D. microcarpum* > *S. spinosa* > *D. mespiliformis* > *G. ternifolia*. Their corresponding values are presented in Table I. The order showed that *D. microcarpum* and *G. ternifolia* produced the highest and the least composition respectively. Different authors reported the carbohydrate composition of *D. guineense* to be; 69.93% [22]; 79% [12]; 82.64% [25]; 89.2% [26]. The result obtained in this investigation agrees with the result of Onwuka and Nwokorie [22], while it is lower compared with others. Anhwange et al. [27], reported a lower value (42.2%) for *D. microcarpum* seed while [21] reported a higher value (61.67%). A slightly lower value (59.82%) was reported for *S. spinosa* [21]. In this investigation, the fruit pulps will provide considerable calories of energy to their consumers. Samples with low carbohydrate contents might be ideal for diabetic and hypertensive patients requiring low sugar diet and for those that want to lose weight.

All the samples produced calorific values corresponding to the proportion of their crude fat, crude protein and carbohydrate. The seeds of *D. mespiliformis* produced the highest calorific value of all the samples because it had the highest proportion of crude fat, an average amount of protein and carbohydrate; since energy value is a function of crude fat, protein content and carbohydrate. *G. ternifolia* pulp has the least energy value of all the samples. This however, is expected since it has the least values of crude fat and crude protein. The energy values produced were in the order; *D. guineense* > *D. mespiliformis* > *D. microcarpum* > *S. spinosa* > *G. ternifolia*. Their corresponding values are presented in Table I. High calorie providing fruits could be recommended as dietary supplement for people who required a lot of energy, such as athletes.

The ascorbic acid (vitamin C) values of the samples were within the range of 7.2mg/100g and 39.93mg/100g for *S. spinosa* and *D. guineense* pulps respectively. *D. guineense* recorded the highest concentration of ascorbic acid. The ascorbic acid content of the *Dialium guineense* pulp agrees with the 41.85±0.01mg/100g and 41.28±2.21 mg/100g observed by [25], and [24] respectively. Adepoju [12] reported a slightly lower value of 35.7mg/100g, while [22] reported 24.6mg/100g. The value obtained in this research compare to values obtained for some common fruits, such as mango, orange and watermelon which were reported to have ascorbic acid contents of 57.3mg/100g, 69.7mg/100g and 23.2mg/100g

[28]. This is in line with the statement that the ascorbic acid content of *D. guneense* pulp is sufficient enough to serve as food supplement to man [25]. 88.0mg/100g was reported for *S. spinosa* [20] against 18.04±0.03mg/100g obtained in this research. Ascorbic acid is generally used for protein metabolism and collagen synthesis. Considerable amount of ascorbic acid present in these fruits showed that they will contribute to the daily human dietary intake of the vitamin. Maintenance of daily dietary intake of vitamin C leads to the prevention of scurvy which is the deficiency disease state of vitamin C.

Table II shows the results of mineral composition of the pulps of the selected wild fruits. The results were expressed in milligram per one hundred gram of the sample based on dry weight.

The concentration of calcium, in mg/100g, ranged between 52.47±0.00 and 101.67±0.09 (Table II). The proportion of calcium which is said to function as a constituent of teeth and bone, nerve and muscle regulation, obtained in this investigation for *D. microcarpum* fruit pulp was lower than what was reported by [21]. It reported 175mg/100g against 71.40mg/100g obtained here. He also reported 130 mg/100g for *S. spinosa*, a value higher than what was observed in this analysis. Adepoju [12] and Ambrose and Ibiam [24] reported the fruit pulp of *D. guineense* to have calcium contents of 47.0±0.40mg/100g and 46.33±0.39mg/100 respectively. Rickets in children and osteomalacia in adults results due to calcium deficiency [24].

The concentration of Magnesium in the investigated samples fruit pulp varied from 55.92±0.05 mg/100 g for *G. ternifolia* to 205.25±0.13 in *S. spinosa*. In an earlier study 300.0±14.14 mg/100g was reported for pulp of *D. guineense* [12]. This value is greater than what this investigation produced. Higher values, of 97.07 mg/100 g and 209 mg/100 g were recorded for *D. microcarpum* pulp and seed respectively [21]. The value cited for *S. spinosa* (49mg/100g) is comparable to the one obtained (45.39±0.00) in this research. The RDA for magnesium is 400mg per day. This means that the pulps could supply the body with about 11.35-31.39% per 100g of the daily requirements. Asthmatic patients are able to breathe with ease due to the role-play by magnesium in relaxing the muscles along airway to the lung. The symptoms of deficiency or diseases include mal-absorption, chronic or excessive vomiting, and diarrhoea [29]. From the result obtained, both the pulps and seeds of these samples can serve as a good source of magnesium.

A high concentration of zinc is generally observed in the pulps of the wild fruit. In literature, *S. spinosa* pulp is reported to have 0.22mg/100g; 0.7±0.14mg/100g and 1.08mg/100g [12], [20], [21] respectively. Locket et al. [21] reported 0.78mg/100g for pulp while 2.86±0.55 was reported for *D. guineense* [24]. Zinc, though a trace element is essential for the synthesis of protein and nucleic acid; and normal body development. It plays a significant role in growth and development, important during stages of growth such as infancy, adolescence and during recovery from illness. Deficiency of zinc has been largely ascribed to high phytic acid content in diets leading to weakened immunity, impaired growth and increased morbidity from common communicable infections and increased mortality [29].

The amount of copper determined in the various fruit samples ranged between 0.31±0.0 mg/100g for *G. ternifolia* and 1.82±0.01 mg/100g for *D. guineense* pulps. Copper has the least concentration of all the elements determined in this analysis. Statistically, the amount of copper determined for *S. spinosa* and *G. ternifolia* seeds are not significantly different. Though the levels of copper present in the analyzed fruits were relatively low, they will however help to alleviate symptoms associated with copper and iron deficiency. Cardiovascular and bone disorders, anaemia, and nervous systems disorder have been attributed to deficiencies of copper [23].

Manganese is a microelement essential for human nutrition. It acts as in activator for many enzymes. The range of manganese detected in the samples was between 1.81±0.00 to 3.59.0.01 mg/100 g for fruit pulps. In literature, *D. microcarpum, S. spinosa* were reported to have manganese values of 5.03 and 0.97 mg/100, respectively [21]. Adepoju [12] reported 2.5±0.14 mg/100 g for *D. guineense* pulp. Manganese supports regulation of blood sugar levels; immune system; production of energy and cell reproduction. Blood clothing is enhanced when it works with vitamin K while it helps to control the effects of stress when it works with B-complex vitamins. When an expecting mother does not get enough of manganese birth defects can possibly occur [27].

The amount of iron obtained is within the range of 1.58 mg/100 g to 3.89±0.02 mg/100 g. In literature, [21] reported the pulp of *D. microcarpum* to have 3.89 mg/100g. Mariod et al. [4] reported 2.1-3.22 mg/100 g. This compares with some of the values obtained in this research. Iron is an important micronutrient in the formation of haemoglobin. It also plays a vital role in the normal functioning of Central Nervous System (CNS) and oxidation of carbohydrate; protein; and fat [30]. In order to prevent anaemia and other related diseases, iron is very important in the diet of pregnant women, nursing mothers, infants, convulsing patients and elderly people [12].

Potassium was the most abundant element found in the wild fruit samples investigated followed by sodium. Its concentration ranged from 343.27±0.03 to 764.68±0.17 mg/100 g for pulp. In an earlier study, potassium and sodium contents of *S. spinosa* pulps were reported as 1370 and 49 mg/100 g respectively [20]. Mariod et al. [4] recorded the values of potassium and sodium in *D. microarpum* to be 1453.75±0.62-1475.75±0.62 mg/100 g and 412.50±0.42-424.50±0.36 mg/100 g respectively. Both of these were greater than the result obtained in this investigation. The observed variation in these results may be due to geographical and seasonal variation. Prolonged potassium deficiency may produce severe damage to the kidney [24]. Sodium is also important for acid-base stability and osmoregulation in inter-modular fluid. Low consumption of sodium causes metabolic acidosis [24]. Sodium in combination with potassium takes part in proper maintenance of acid-balance and in nerve transmission in the body.

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