

Nutritional evaluation of a wild edible fruit *Mondia whytie* (Hook .f.) Skeels consumed by some populations in Izzi clan, Ebonyi State, Nigeria.

ABSTRACT: *Mondia whytie* fruit is consumed as a wild edible fruit by some human populations in Izzi land in Ebonyi State South-East Nigeria. There is dearth of information on its nutritional value, therefore a study was conducted by evaluating its proximate composition, sugar, mineral, vitamins and phytochemical contents on fresh weight basis. Results indicated a high moisture content of 88.20% while total sugar content was 15.70% and reducing sugars had a value of 9.63%. Its energy value was 40.80 KCal/100g. It had very low riboflavin content but thiamin and niacin had values of 1.53mg/100g and 3.04mg/100g. Results also indicated the presence of antioxidant vitamins C and E which had values of 14.50mg/100g and 2.45µg/g respectively. Potassium and sodium were the most abundant mineral elements analyzed. It had insignificant amount of antinutritional phytochemicals, hence the fruit is not toxic for human consumption.

1. INTRODUCTION: Wild food plants are categorized as underutilized or neglected crops which grow in wild or are grown in small scale such that their economic potential is poorly addressed and restricted to traditional and local use [1]. Many of them are available in forests and large quantities are usually not collected and wasted because their therapeutic properties and potential as subsidiary food sources are not well known within the locality they are found [2]. They serve as alternative to staple foods during periods of food depletion and are valuable supplements for a nutrient balance and the main alternative source of income for many resource poor communities and source of species for domestication [3].

The study on the nutritional and therapeutic values of forest foods is very much important as it will encourage people to consume substantial quantity of food and provide them with a better balance of nutrients [2]. Wild fruits contain higher amount of nutrients and bioactive compounds [4] than many cultivated species [5]. Fruits and vegetables also contain abundant dietary fiber, vitamins, minerals and large quantities of phytochemicals [6]. Although phytochemicals are considered to be responsible for some positive outcomes [6], among such is that they provide a number of antioxidants which combat oxidative stress induced by oxygen and light [7]. However, some phytochemicals found in food plants (including wild fruits) may be deleterious to health such as being antinutrients when found in high concentration. Antinutritional phytochemicals in foods may be one major factor which discourage consumption and hence reducing the popularity and consumption of such wild edible fruits and vegetables. Currently, there is increased interest to evaluate nutrient as well as phytochemical contents of many unpopular and underutilized wild food plants consumed in various localities. This is important not only for identification as potential food sources but also to select promising types for domestication [8]. There is report on food and medicinal uses of the roots which is an export material for some countries but there is dearth of information on the nutritional value of the fruits which

are consumed as wild edible fruit. In Izzi land Ebonyi State, South-East Nigeria, the fruits are more popular and are consumed as wild edible fruit. It is in view of this that nutrient and phytochemical content of *Mondia whytei* fruit was investigated.

Mondia whytei (Hook .f.) skeels belongs to the family formerly Asclepiadaceae sub family Periplocoideae now Apocynaceae [9, 10]. It is commonly called 'White's ginger' (English), 'La racine' (French) [9], 'Umondi/Mundi/Mindi' (Zulus in South Africa) [11]. In Izzi land (an Ibo speaking clan) in Ebonyi State, Nigeria it is called 'Akoro'. *Mondia whytei* is endemic to South, Central, East and West Africa [11], it grows in forests, bush lands and wastelands and is a deciduous canopy-climbing liane [12]. This vigorous climbing plant reaches a height of about 3-6m [11]. It has a characteristic large oppositely positioned heart-shaped leaves [10] and a vanilla aroma [11]. The flowers are arranged in panicles of cream-yellow buds which open to reveal deep reddish-purple inner petals [11]. *Mondia whytei* root is the most popular plant part that is used in traditional medicine by some African people to treat various ailments [10] and for culinary purposes [9]. In Sudan, the fruits are considered edible while its leaves are used as a food condiment in Nigeria and Uganda [9]. The fruit consists of a pair of obliquely ovoid, glabrous follicles each 8-12cm by 2-4cm, green, apex rounded and many seeded [9] with seeds in a wool-like structure. It dehisces to release 180-320 comose seeds that are wind dispersed [13].

MATERIALS AND METHODS

2.1 Collection and preparation of samples

Mature fruits of *Mondia whytie* was procured between the months of December 2016 and January 2017 from Abakpa market Abakaliki in Ebonyi State. Whole green mature fruits were cut open to remove the seeds enclosed in a wool-like substance. The edible portion was pulverized in its fresh weight using a mortar and pestle and this was used for analysis.

2.1.1 Proximate composition analysis

Proximate composition analysis of *Mondia whytei* fruit pulp was found by established methods described by [14]. Crude protein determination was done by the micro Kjeldhal method, and nitrogen content was multiplied by 6.25 and expressed in percentage. Ash content was analyzed by the muffle furnace incineration gravimetric method at 550°C while fat was determined by gravimetric solvent extraction method. Crude fiber was determined by the Weende method while moisture determination was done by drying the pulverized pulp in an oven at 65°C to a constant weight. Carbohydrate was calculated by difference as nitrogen free extract using the formula: $100 - [\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Crude fiber} + \% \text{ Crude protein}]$. Energy value of the fruit pulp sample was estimated in Kcal/100g by multiplying the percentage of crude protein, lipid and carbohydrate by the factor of 4,9 and 4.

Total sugar of *Mondia whytei* fruit pulp was determined colorimetrically by the anthrone method [15]. 5g of pulverized pulp was boiled in 100ml of 2M HCl solution for 30mins to hydrolyze sugars in it. After which, the solution was

allowed to cool at room temperature and then filtered through Whatman No.1 filter paper into a beaker. Aliquot of 1ml of the filtrate was mixed with 6ml Anthrone reagent in a test tube and boiled in a water bath for 10mins and cooled. Similarly, a standard curve of glucose was prepared by taking 0.1, 0.2, 0.4, 0.6, 0.8 and 1ml of standard glucose solution in different test tubes containing 10, 20, 40 60, 80 and 100µg of glucose respectively, and the volume was made up to 1ml using distilled water. Then 6ml of anthrone reagent was added to each test tube and mixed well before boiling in a water bath for 10mins and then cooled. A reagent blank was prepared by mixing 1ml distilled water with 6ml anthrone reagent in a test tube before boiling in a water bath for 10mins and cooled. the absorbance of these solutions were measured at 620nm using the reagent blank to standardize the spectrophotometer to 0.

The amount of total sugar present was calculated from the standard curve of glucose. The percentage of total sugar was calculated using the formula:

$$\% \text{ Total sugar} = \frac{100}{W} \times \frac{A_u \times C}{A_s \times 1} \times \frac{V_t}{V_a}$$

Where:

W- Weight of sample analyzed, Au- Absorbance of sample, As- absorbance of standard sugar solution, C- Concentration of standard sugar solution (mg/ml), Vt- total volume of hydrolyzed sample, Va-Volume of hydrolyzed sample analyzed

Reducing sugar content in *Mondia whytei* fruit pulp was determined by dinitrosalicylic acid method [James, 1995]. Non reducing sugar was calculated using the formula:

$$\% \text{ Non reducing sugar} = \% \text{ Total sugar} - \% \text{ Reducing sugar [14]}$$

2.1.2 Mineral analysis

Minerals namely calcium, magnesium, phosphorus, sodium, potassium, iron and zinc were analyzed based on the role they play in symptoms associated with some metabolic and deficiency diseases. They were analyzed by dry ash extraction method [14]. 5g of the fruit pulp was ashed in a muffle furnace and allowed to cool in a desiccator and 2ml of 2M HCl was added to it in a conical flask. Deionized water was added to each sample solution up to the 100ml mark. This was used for analyzing the various mineral elements. Sodium and potassium were analyzed by flame photometry; phosphorus was analysed by the Vanodomolybdate yellow colorimetric method, calcium and magnesium were done by Vernasate EDTA Complexometric titrimetry all described by [14]. Zinc was analyzed

colorimetrically while iron was analyzed by Orthophenanthroline red ferrous complex method both described by [16].

2.1.3 Vitamin analysis

Vitamins A, C and E were determined by the methods described by [17] while vitamins B1, B2 and niacin were determined by the methods described by [18]. All vitamins were determined using a UV-spectrophotometer except Vitamin C. Vitamin A was extracted from 5g *Mondia whytei* fruit pulp using a mixture of absolute ethanol and 5% potassium hydroxide (10:1) which was boiled for 30mins under reflux before cooling under running water. The resultant solution was transferred into a separating funnel and 150ml petroleum ether was added. The lower aqueous layer was discarded while the supernatant was recovered and evaporated to dryness on a rotary evaporator before re-dissolving in 10ml isopropyl alcohol. Similarly, 10ml isopropyl alcohol was added to 1ml Vitamin A to give a standard solution containing 100mg of vitamin. Absorbance of test samples and standard were measured in a spectrophotometer at 540nm.

Vitamin C was determined by homogenizing the sample in 50ml EDTA solution before filtering. 20ml of the filtrate was taken, 10ml of 30% potassium iodide was added to it followed by 1% starch solution. The mixture was titrated against 0.1M Copper sulphate solution.

Vitamin E was extracted from 5g *Mondia whytei* fruit pulp using a mixture of 20ml absolute ethanol and 20ml ethanolic sulphuric acid solution (1:2) in a volumetric flask wrapped with aluminum foil. The mixture was boiled under reflux for 45 mins and cooled. 50ml distilled water was added to boiled mixture and transferred to a separating funnel wrapped in aluminum foil. 150ml diethyl ether was added. The lower aqueous layer was discarded while the supernatant was recovered. 1ml of the supernatant was put into a test tube and 1ml HNO₃ was added drop wise before the solution was boiled at 90°C in a boiling water bath for 3 mins and cooled. Similarly, 1ml HNO₃ was added to 1ml Vitamin E to give a standard solution containing 100mg of vitamin. Absorbance of test samples and standard were measured with spectrophotometer at 470nm.

2.1.4 Phytochemical analysis

Polyphenol was determined by Folin-Ciocalteu spectrophotometric method [19] while oxalate was determined by titrimetric method [20]. Folin-Denis colorimetric method was used for the analysis of tannin [Kirk and Sawyer, 1998]. Hydrogen cyanide was determined by alkaline picrate spectrophotometric method while phytate was determined using 2,2-Bipyrimidine solution and absorbance was measured in a spectrophotometer at 510nm [21]. Alkaloid was

determined using alkaline precipitation and gravimetric measurement while saponin was determined using double solvent extraction and gravimetric measurement described by [22]. Carotenoid was extracted using organic solvents and measured gravimetrically while flavonoids were analyzed by precipitation using ethyl acetate and gravimetric measurement described by [22]. Phytosterol was analyzed by precipitation and spectrophotometric measurement described by [23]

3 RESULTS AND DISCUSSION

3.1 Proximate Composition

Results on the proximate composition of *Mondia whytei* fruit on wet weight basis (i.e fresh weight, fw) is shown in Table 1. Its moisture content was 88.20%. This value was higher compared to moisture content reported for some other wild edible fruits on fresh weight basis such as *Arbutus unedo* (57.56%), *Crataegus monogyna* (69.06%), *Prunus spinosa* (68.06%), *Rubus ulmifolius* (75.11%) [5], *Grewia tillifolia* (67%), *Ficus racemosa* (71.66%) [24]. However it was comparable to moisture content on fresh weight basis for *Grewia sapida* (81.06%) [2], *Opuntia ficus* (87.07%) [25] but lower than moisture content of *Gomphogyne cissiformis* (96.01%) [8]. Most fruits have a relatively high moisture content which makes them susceptible to microbial attack especially in uncontrolled cold storage conditions [26]. Therefore, *Mondia whytei* fruit will not keep for a long time due to its high moisture content.

Ash content of *Mondia whytei* fruit was less than 11.50% dry weight (dw) for ash content in *Vitex doniana* fruit pulp [27] and some other wild edible fruits such as *Artocarpus gomezianus* (3.13% dw), *Baccaurea sapida* (5.31% dw), *Gomphogyne cissiformis* (11.03% dw), [8], *Ziziphus spina-christi* (5.1% dw), *Hyphaene thebaica* (7.04% dw), *Tamarindus indica* (4.23% dw) [28]. However ash content of *Mondia whytei* fruit was higher than that of *Grewia sapida* (0.29%, freeze dried) reported by [2]. Ash is an index of mineral content. Therefore low ash content of *M. whytei* fruit on fresh weight basis may not provide much minerals except when dehydrated. [26] reported that drying concentrates some nutrients.

Fat content of *M. whytei* fruit (1.02%) was comparable to that of *B. sapida* (1.11% dw) [8]. However it was lower than fat content for some other wild edible fruits such as *Zanthoxylum armatum* (12.54% dw), *A. gomezianus* (9.67% dw) [8] but higher than fat content of *Adansonia digitata* (0.21% dw) [28], *O. ficus* (0.40% fw) [25] as well as some wild edible fruits consumed in southern Odisha, India which ranged between 0.0006 and 0.075mg/g fresh weight reported by [1]. Fats provide the body with more energy, approximately twice that of protein and carbohydrate and facilitate intestinal absorption and transportation of fats soluble vitamins [29]. Results therefore indicates that *M. whytei* fruit will not provide high amount of storable energy because of its low fat content.

Crude fiber content of *M. whitei* fruit was 1.40% and this was higher compared to that of *B. sapida* (0.80% dw) [8] but comparable to values reported for

crude fiber in freeze dried samples of *Grewia sapida* (1.71%) [2], *O. ficus* (1.37%) on wet weight basis [25]. It was reported that fiber in the diet reduces serum cholesterol level [30] and aids digestion. It does this by changing the nature of the contents of gastrointestinal tract and change how other nutrients and chemicals are absorbed through bulking and viscosity [31]. Results therefore indicate that fiber from *Mondia whytie* fruit may contribute fiber but will not be sufficient to perform the function of providing bulk during digestion to a significant extent.

Crude protein content of *M. whytei* fruit was comparable to crude protein content of some wild edible fruits such as *H. thebiaica* (2.62% dw), *A. digitata* (2.39% dw) [28] but lower than crude protein content which ranged from 6.94% - 20.83% dry weight reported by [8] for some wild edible fruits. Protein is an important source of amino acids and is required for body development and maintenance [32]. However, fruits are not good sources of protein.

M. whytei fruit had a carbohydrate content of 5.60%. This value was higher than 4.6% reported for papaya which had a moisture content of 90.8% but lower than carbohydrate of both commonly consumed as well as some wild edible fruits. [33] reported that variability in moisture content affects the composition of the food. Therefore low carbohydrate as well as other nutrients in *Mondia whytie* fruit could be attributed to high moisture content in the fruit because analysis was determined on fresh weight basis. Carbohydrate content of *M. whytei* fruit was low and this may result to a low glycemic index when compared with other wild fruits and commonly consumed fruits which have high glycemic index. It had an energy value of 40.8KCal/100g. Its energy value was higher than what was reported by [8] for some fruits and vegetables on fresh weight basis as well as that of *O. ficus* [25].

Total sugar content of *M. whytie* fruit (15.70%) was higher than total sugar for some other wild edible fruits such as ripe *Grewia tilifolia* (5.17% fw), *Schleichera oleosa* (7.23% fw) [24] but lower than total sugars of *Ficus racemosa* (29.43% fw), *Antidesma ghasembilla* (11.8% fw), *Elaeagnus conferta* (22.32%) [24] as well as total sugar of some wild edible fruits consumed in southern Odisha, India which ranged between 29 and 39.17 mg/g fresh weight reported by [1]. Its reducing sugar content was higher than its non-reducing sugar content. Sugar is a carbohydrate and an important source of quick fuel for the brain which solely depends on it for proper function alongside many other organs of the body. What was found in *M. whytie* fruit will therefore contribute in supplying energy needed for the body's normal function.

Table 1: Proximate Composition and sugar content of *Mondia whytei* fruit on fresh weight basis.

Parameters	Values
Moisture (%)	88.2±00.00
Ash (%)	0.60±0.14
Crude fat (%)	1.20±0.00
Crude fiber (%)	1.40±0.00
Crude protein (%)	2.50±0.00
Carbohydrate (%)	5.00±0.14
Total sugar (%)	15.70±0.00
Reducing sugar (%)	9.63±0.32
Non-reducing sugar (%)	6.13±0.25
Energy value (KCal/100g)	40.80±5.56

Values are Means ± Standard Deviation.

3.2 Vitamin Contents

Vitamin content of *Mondia whytei* fruit on fresh weight basis are shown in Table 2. Thiamine content of *M. whytei* fruit was 1.53mg/100g. This value was higher than thiamine content of some wild edible fruits consumed in southern Odisha, India which ranged between 0.0003 and 0.0024 mg/g fresh weight reported by [1] but much lower compared to 18.33mg/100g dry weight for thiamin in *V. doniana* reported by [27]. Recommended Daily Allowance (RDA) for thiamin is 1.20 mg/day [34]. This therefore suggests that *M. whytei* fruit can contribute in providing thiamine in human nutrition and health. It had low riboflavin content while niacin was the most abundant of the B vitamins analyzed. Niacin deficiency leads to pellagra and its over dose results to liver damage especially with slow release formulations [35].

Fruits are a major food source which contribute to vitamin C in human nutrition. Vitamin C content (14.50mg/100g) was comparable to vitamin C content of *Cratagus monogyna* (15.19mg/100g fw), *Rubus ulmifolius* (17.09mg/100g fw) [5] but higher than what was reported *Prunus spinosa* (7.73mg/100g) [5], *G. sapida* (8.6mg/100g fw) [2] and some wild edible fruits consumed in southern Odisha, India which ranged between 0.02 and 5.16 mg/g fresh weight reported by [1]. Vitamin C acts as a reducing substance and enhances the absorption of non-haem iron [36]. The Recommended Dietary Allowance (RDA) of vitamin C is 60mg/day for a male adult [37]. Thus, *Mondia whytei* fruit cannot satisfy the daily vitamin C requirement. Results also indicated the presence of Vitamins A and E in *M. whytei* fruit. Vitamin E is a naturally occurring antioxidant which plays a crucial role in preventing chronic ailments such as heart diseases, cancer, diabetics, stroke and Alzheimer disease by combating oxidative stress [38].

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Table 2. Vitamin composition of *Mondia whytei* Fruit on fresh weight basis.

Parameters	Values
Thiamine (mg/100g)	1.53±0.11
Riboflavin (mg/100g)	0.22±0.00
Niacin (mg/100g)	3.04±0.00
Vitamin A (µg/g)	8.35± 0.09
Vitamin C (mg/100g)	14.50±0.28
Vitamin E (µg/g)	2.45±0.00

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Values are Means ± Standard Deviation.

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3.3 Mineral Contents

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Table 3 presents mineral contents in *Mondia whytei* fruit. Potassium (68.50mg/100g) and sodium (65.33mg/100g) were the most abundant elements analyzed. Its sodium content was higher than sodium for *Opuntia ficus* (18.7mg/100g) [25], some wild edible fruits consumed by local people of Meghalaya , India which ranged between 0.17 and 0.66 mg/100g dry weight [8], *Tamarindus indica* (46.7 mg/100g dw) [28], *Grewia sapida* (3.873 mg/100g freeze dried) [2], *Zizyphus jujuba* (16.18 mg/100g dw) [39] but lower than sodium content for *Hyphaene thebaica* (133.58mg/100g dw), *Zizyphus spina-christi* (95.4 mg/100g dw), *Adansonia digitata* (110.4mg/100g dw) [28]. Excess intake of sodium has been implicated in inducing hypertension. Adequate intake for sodium is 1.2 to 1.5 grams per day [40]. What was present in *M. whytie* fruit was quite low to induce hypertension. Potassium content of *M. whytie* was quite higher than reported values for wild edible fruits consumed in Sudan which ranged between 7.78 and 18.78 mg/100g dry weight [28], some wild edible fruits consumed by local people of Meghalaya , India which ranged between 6.16 and 57.22 mg/100g dry weight [8], but lower than what was reported for *G. sapida* (1243.788mg/100g freeze dried) [2], *O.ficus* (108.8mg/100g) [25]. Sodium and potassium are important cationic macro elements which are located in the extracellular and intracellular fluids respectively. Sodium works in concert with potassium to maintain healthy water balance in the body [41]. Potassium has been reported to play a major role in regulating blood pressure [42]. Calcium, magnesium and phosphorus are macro-elements but were found to be low in *M. whytie* fruit. This entails that it may not be a good source of these mineral elements. Results also indicated the presence of zinc and iron which were comparable to zinc and iron content reported for some wild edible fruits. Zinc and iron are essential cationic microelements required for human health. Zinc deficiency results to a number of negative effects especially during growth period and can affect a number of organs such as the epidermal, gastrointestinal, central nervous, immune, skeletal and reproductive systems [43]. It is required for growth and development, protein and DNA synthesis, neuro-sensory functions, cell-mediated immunity, thyroid and bone

metabolism [44]. Iron is a component of the respiratory pigments and enzymes concerned with tissue oxidation, essential for oxygen and electron transport within the body [36].

Table 3. Mineral Composition of *Mondia whytei* fruit on fresh weight basis.

PARAMETERS	Values
Magnesium (mg/100g)	15.00±0.00
Potassium (mg/100g)	68.50±0.00
Sodium (mg/100g)	65.33±0.18
Calcium (mg/100g)	18.80±0.00
Phosphorous (mg/100g)	5.85±0.21
Zinc (mg/100g)	1.25±0.00
Iron (mg/100g)	4.48±0.39

Values are Means ± Standard Deviation.

3.4 Phytochemical Contents

Table 4 shows results on the phytochemical contents of *Mondia whytei* fruit. Phytochemicals are medicinally active secondary metabolites [2] and are produced from primary metabolites (sugars, amino acids and lipids) via alternative pathways in response to stress conditions. *Mondia whytei* fruit had very low levels of antinutritional phytochemicals such as oxalates, phytates and hydrogen cyanide when compared with some antinutritional factors of some wild edible fruits in northern Nigeria [45]. Tannins, alkaloids and saponins tend to be antinutritional which is based on type and concentration present in the food ingested. What was present in *Mondia whytei* fruit was quite low as to elicit such antinutritional activity associated with them when consumed in high concentrations.

Table 4. Phytochemical Analysis of *Mondia whitei* Fruit on fresh weight basis.

Parameters	Value
Tannin (%)	0.08±0.00
Phenol (%)	0.02±0.00
Phytate (%)	0.02±0.00
Sterol (%)	ND
Carotenoid (%)	0.40±0.00
Oxalate (%)	0.35±0.00
Saponin (%)	0.02±0.00
Flavonoid (%)	0.02±0.00
Alkoloid (%)	0.12±0.00
Hydrogen cyanide (mg/kg)	0.06±0.00

Values are Means ± Standard Deviation, ND- Not detected.

4 CONCLUSION

The study revealed that *Mondia whytie* fruit consumed as a wild edible fruit has high moisture content and low energy value. The quantity of thiamin present can contribute to daily requirement in human nutrition. Results also indicated that it had high potassium and sodium contents than every other mineral analyzed. There was an insignificant amount of antinutritional phytochemicals, hence the fruit is not toxic for human consumption.

REFERENCES

1. Misra, S and Misra, MK. (2016). Ethnobotanical and nutritional evaluation of some edible fruit plants of southern Odisha, India. International Journal of Advances in Agricultural Science and Technology, 3(1):1-30.
2. Islary A, Sarmah J, Basumatary S. proximate composition, mineral content, phytochemical analysis and invitro antioxidant activities of a wild edible fruit (*Grewia sapida* Rosb. exDC) found in Assam of North-east India. Journal of Investigational Biochemistry. 2016; 5(1):21-31.
3. Shrestha, PM and Dhillion, SS. (2006). Diversity and traditional knowledge concerning wild food species in a locally managed forest in Nepal. Agroforestry Systems, 66:55-63.
4. Barros L, Carvalho AM, Morias JS, Ferreira ICRF. Strawberry tree, blackthorn and rosefruits. Detailed characterization in nutrients and phytochemicals with antioxidant properties. Food Chemistry. 2010; 120: 247-254.
5. Morales P, Ferreira ICRF, Carvalho AM, Fernandez-Ruiz V, Sanchez-Mata MC, Camara M, Morales R and Tardio J. Wild edible fruits as potential source of phytochemicals with capacity to inhibit lipid peroxidation. European Journal of Lipid Science and Technology. 2013; 115: 176-185.
6. Li, AN, Li, S., Zhang, YJ., Xu, XR., Chen, YM and Li, HB. (2014). Resources and biological activities of natural polyphenols. Nutrients, 6:6020-6047.
7. Lobo, V., Patil, a., Phatak, A and Chandra, N. (2010). Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Review, 4:118-126.
8. Seal T, Pilla B, Chaudhuri K. Nutritional potential of wild edible fruits traditionally used by the local people of Meghalaya state in India. indian Journal of natural products and Resources. 2014; 5(4):359-364.
9. Lamidi M, Bourobou- Bourobou H. *Mondia whitie* (Hook.) Skeels. Internet record from PROTA4U. Schmelzer GH and Gurib-Fakim A (Editors). PROTA-Plant Resources of Tropical africa, Wageningen, Netherlands. (Assessed 17 august, 2016).

10. Aremu AO, Cheesman L, Finnie JF, Van Staden J. *Mondia whitie* (Apocynaceae): A review of its biological activities conservation strategies and economic potential. *South African Journal of Botany*. 2011; 77:966-971.
11. South African National Biodiversity Institute (SANBI). *Whites ginger (Mondie whitie; Mondia whitie)*. Stoffel Petrus Bester National Herbarium, Pretoria, South Africa. 2007.
12. Shitanda D, Mukony KW, Simiyu L. Characterization of Kenyan grown *Mondia whytie* roots and thier potential use. papers of the International Agricultural Engineering Conference, Bangkok, Thailand, 3-6 December, 2007.
13. Ross JH. *Mondia whitie*, tab 1792: In Killick DIB (Editor). *flowering plants of Africa*, Vol 45. South African National Biodiversity Institute, Pretoria, South Africa.
14. James CS. *The analytical chemistry of foods*. Blackie Academics and Professional, New-York. 1995.
15. Ojiako, OA, Akubugwo EI. *An introductory approach to practical biochemistry*. CRC Publications, Owerri-Imo State, Nigeria.1997. pp 64-75
16. Jackson ML. *Soil chemical analysis advanced course*. In: IITA. *Selected methods for soil and plant analysis*. Ibadan Manual series No.1. Department of Soil Science, University of Wisconsin, Madison-Wisconsin. 1969.
17. Kirk RS, Sawyer C. *Pearson food composition and analysis*. Longman Education Publisher Ltd. UK. 1988; 703-709.
18. Okwu DE, Josiah C. Evaluation of the chemical composition of two Nigerian medicinal plants. *African Journal of Biotechnology*. 2006;5(4): 357-361.
19. AOAC, *Official Methods of Analysis of the Association of Official Analytical Chemists* (15th Ed). Washington DC,USA. 1990.
20. Day RA, Underwood AL. *Quantitative analysis* (5th edition). Prentice Hall Publication. London. 1986; 701
21. Onwuka GI. 2005. *Food analysis and instrumentation, theory and practice*. Naphtali Prints, Surulere-Lagos, Nigeria. 2005.
22. Harborne JB. *Phytochemical methods: A guide to modern techniques of plant analysis*. Chapman and Hall Ltd, London. 1973; 49-188.
23. Okeke CU, Elekwa IZ. *Phytochemical study of the extract of Gongronema latifolium* (Asclepiadacea). *Journal of Health and Visual Studies*. 2003; 5(1): 47-55.
24. Valvi SR, Rathod VS. *Mineral composition of some wild edible fruits from Kolhapur district*. *International Journal of Applied Biology and Pharmacuetical Technology*. 2011; 2(1):392-396.

25. Chiveta R, Wairagu N. Chemical and nutritional content of *Opuntia ficus-indica* (L). African Journal of Biotechnology. 2013; 12(21):3309-3312.
26. Amaechi NC, Okorie O, Ajaere UB. *Garcinia kola* fruit pulp: evaluation of its nutrient, phytochemical and physicochemical properties. Journal of Applied Life Sciences International. 2017; 13(2): 1-10.
27. Vunchi MA, Umar AN, King MA, Liman AA. Proximate, vitamins and mineral composition of *Vitex doniana* (Black plum) fruit pulp. Nigerian Journal of Basic and Applied Sciences. 2011; 19 (1): 97-101.
28. Salih N K-E M, Yahia EM. Nutritional value and antioxidant properties of four wild fruits commonly consumed in Sudan. International Food Research Journal. 2015; 22(6):2389-2395.
29. Dreon DM, Vranizan KM, Krauss RM, Austin MA, Wood PD. The Effects of polyunsaturated fat monounsaturated fat on plasma lipoprotein. Journal of American Medical Association. 1990; 263:2462-2466.
30. Abolaji, O.A., Adebayo, A.H, and Odesanmi, O.S(2007). Nutritional Qualities of Three Medicinal Plants (*Xylopia aethiopica*, *Blighia sapida* and *Parinari polyandria*) Commonly Used by Pregnant Women in Western part of Nigeria. Pakistan Journal of Nutrition. 6(6):665-668.
31. Eastwood M, Krichevsky D. Dietary fiber: how did we get where we are? Annu Rev.Nutr. 2005; 25:1-8.
32. Pugalenti M, Vadiuel V, Gurmoorthi P, Janardhana . Comparative Nutritional Evaluation of Little Known Legumes, *Tamarindus indica*, *Erythrina indica* and *Sesbania bispinosa*. Tropical and Subtropical Agroecosystem. 2004; 4:107-123.
33. Greenfield H, Southgate DAT. Food composition data: production, management and use. In Burlingane BA, Charrondiere UR (Editors). FAO Corporate Document Repository. Food and Agricultural Organization of the United Nations, Rome. 2003.
34. Institute of Medicine Food and Nutrition Board. Dietary Reference Intakes: Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic acid, Biotin and Choline. Washington DC: National Academy Press. 1998
35. Brunton LL, Lazo JS, Parker K. Goodman and Gilman's The Pharmacuetical Basis of Therapuetics (11th ed.) New York McGraw-Hill. 2005
36. Tacon AGJ. Essential nutrients-minerals. In: The nutrition and feeding of farmed fish and shrimp, a training manual, the essential nutrients. Chapter 6. A report prepared for FAO Trustfund GCP/RLA/O75/ITA Project support to the regional aquaculture activities for Latin America and the Caribbean. Food and Agricultural Organization of the United Nation, Brazil. 1987.

- 494 37. Ganong WF. Review of Medical Physiology (21st Ed) McGraw Hill Companies Inc,
495 New York 2003. p316-318,514.
496
- 497 38. Lako J, Trenerry VC, Waniquist M, Wattanapenpaiboon N, Sotheswaran S, Premier
498 R. Phytochemical flavonoids, carotenoid and antioxidant properties of wide selection of
499 Fijian fruits, vegetables and other readily available foods. Food Chemistry. 2007;
500 101:1727-1741.
501
- 502 39. Sehgal AB, Sood SK. Nutritional analysis of edible wild fruit (*Zizyphus jujuba* Mill.)
503 used by rural populace of district Hamirpur (HP), India. IOSR Journal of Pharmacy and
504 Biological Sciences. 2013; 6(2): 46-49.
- 505
- 506 40. Food and Nutrition Board, Institute of Medicine United States National Academics.
507 Dietary
508 Reference Intakes: Water, potassium, sodium, chloride and sulphur. 2005.
509
- 510 41. Amerman DF. What are the roles of sodium. Deman Media; 2016.(Accessed 11
511 October 2016)
- 512 42. He FJ, Macgregor GA. Potassium intake and blood pressure. American Journal of
513 Hypertention. 1999; 12: 849-851.
- 514
- 515 43. Roohani N, Hurrell R, Kelishadi R, Schulin R. Zinc and its importance for human
516 health: an integrative review. Journal of Research in Medical Sciences, 2013;18(2):144-
517 157.
518
- 519 44. Meunier N, O'Connor JM, Malani G, Cashman KD, Secker DL, Ferry M, Roussel
520 AM, Coudray C. Importance of zinc in the elderly: the ZENITH study. European Journal
521 of Clinical Nutrition. 2005; 59(2): 51-54.
522
- 523 45. Umaru HA, Adamu R, Dahiru D, nadro MS. Levels of antinutritional factors in wild
524 edible fruits of northern Nigeria. African Journal of Biotechnology. 2007; 6(16): 1935-
525 1938.