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Nutritional Evaluation of a Wild Edible Fruit *Mondia whitei* (Hook .f.) Skeels Consumed by Some Human Populations in Izzi Clan, Ebonyi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Mondia whitei 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/100 g. It had very low riboflavin content but thiamin and niacin had values of 1.53 mg/100 g and 3.04 mg/100 g. Results also indicated the presence of antioxidant vitamins C and E which had values of 14.50 mg/100 g and 2.45 µg/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.

Keywords: Mondia whitei; proximate composition; total sugars; vitamin; minerals; phytochemicals.

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1. INTRODUCTION

Wild food plants are categorized as underutilized or neglected crops which grow in the 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 source but also to select promising types for domestication [8]. *Mondia whitei* fruit is consumed as a wild edible fruit by some human populations in Izzi land in Ebonyi State South-East Nigeria. 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. It is in view of this that nutrient and phytochemical content of *Mondia whitei* 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 whitei* 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-like aroma [11]. The flowers are arranged in panicles of cream-yellow buds which open to reveal deep reddish-purple inner petals [11]. *Mondia whitei* 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 8-12 cm by 2-4 cm, 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].

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Samples

Mature fruits of *Mondia whitei* was procured between the months of December 2016 and January 2017 from Abakpa market Abakaliki in Ebonyi State. Abakaliki is located on Latitude 6º19'29.46''N and Longitude 8º06'49.25''E [14]. 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 whitei* fruit pulp was found by established methods described by [15]. Crude protein determination was done by the micro Kjedhal 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 - [% Moisture + % Ash + % Fat + % Crude fiber +% 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 whitei* fruit pulp was determined colorimetrically by the anthrone method [16]. 5 g of pulverized pulp was boiled in 100 ml of 2M HCl solution for 30 mins 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 1 ml of the filtrate was mixed with 6ml Anthrone reagent in a test tube and boiled in a water bath for 10 mins and cooled. Similarly, a standard curve of glucose was prepared by taking 0.1, 0.2, 0.4, 0.6, 0.8 and 1 ml 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 1 ml using distilled water. Then 6ml of anthrone reagent was added to each test tube and mixed well before boiling in a water bath for 10 mins and then cooled. A reagent blank was prepared by mixing 1 ml distilled water with 6 ml anthrone reagent in a test tube before boiling in a water bath for 10mins and cooled. the absorbance of these solutions were measured at 620 nm 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:

$$\% \text{ Total Sugar} = \frac{100}{W} \times \frac{Au}{As} \times \frac{C}{1} \times \frac{Vt}{Va}$$

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 whitei* fruit pulp was determined by dinitrosalicylic acid method [15]. Non reducing sugar was calculated using the formula:

% Non reducing sugar = % Total sugar - % Reducing sugar [15].

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 [15]. 5 g of the fruit pulp was ashed in a muffle furnace and allowed to cool in a desiccator and 2 ml of 2M HCl was added to it in a conical flask. Deionized water was added to each sample solution up to the 100 ml 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 [15]. Zinc was analyzed colorimetrically while iron was analyzed by Orthophenanthroline red ferrous complex method both described by [17].

2.1.3 Vitamin analysis

Vitamins A, C and E were determined by the methods described by [18] while vitamins B1, B2 and niacin were determined by the methods described by [19]. All vitamins were determined using a UV-spectrophotometer except Vitamin C. Vitamin A was extracted from 5 g *Mondia whitei* fruit pulp using a mixture of absolute ethanol and 5% potassium hydroxide (10:1) which was boiled for 30min under reflux before cooling under running water. The resultant solution was transferred into a separating funnel and 150 ml 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 10 ml isopropyl alcohol. Similarly, 10 ml isopropyl alcohol was added to 1 ml Vitamin A to give a standard solution containing 100 mg of vitamin. Absorbance of test samples and standard were measured in a spectrophotometer at 540 nm.

Vitamin C was determined by homogenizing the sample in 50 ml EDTA solution before filtering. 20 ml of the filtrate was taken, 10 ml 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 5 g *Mondia whitei* fruit pulp using a mixture of 20 ml absolute ethanol and 20 ml ethanolic sulphuric acid solution (1:2) in a volumetric flask wrapped with aluminum foil. The mixture was boiled under reflux for 45 min and cooled. 50 ml distilled water was added to boiled mixture and transferred to a separating funnel wrapped in aluminum foil. 150 ml diethyl ether was added. The lower aqueous layer was discarded while the supernatant was recovered. 1 ml of the supernatant was put into a test tube and 1 ml HNO_3 was added drop wise before the solution was boiled at 90°C in a boiling water bath for 3 min and cooled. Similarly, 1 ml HNO_3 was added to 1 ml Vitamin E to give a standard solution containing 100 mg of vitamin. Absorbance of test samples and standard were measured with spectrophotometer at 470 nm.

2.1.4 Phytochemical analysis

Polyphenol was determined by Folin-Ciosptean spectrophotometric method [20] while oxalate was determined by titrimetric method [21]. Folin Dennis colorimetric method was used for the analysis of tannin [18]. 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 510 nm [22]. Alkaloid was determined using alkaline precipitation and gravimetric measurement while saponin was determined using double solvent extraction and gravimetric measurement described by [23]. Carotenoid was extracted using organic solvents and measured gravimetrically while flavonoids were analyzed by precipitation using ethyl acetate and gravimetric measurement described by [23]. Phytosterol was analyzed by precipitation and spectrophotometric measurement described by [24].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Results on the proximate composition of *Mondia whitei* 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 ulmifolins* (75.11%) [5], *Grewia tillifolia* (67%), *Ficus racemosa* (71.66%) [25]. However it was comparable to moisture content of *Grewia sapida* (81.06%) on fresh weight basis [2], *Opuntia ficus* (87.07%) [26] 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 [27]. Therefore, *Mondia whitei* fruit will not keep for a long time due to its high moisture content.

Table 1. Proximate composition and sugar content of *Mondia whitei* 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/100 g)	40.80±5.56

Values are Means ± Standard Deviation

Ash content of *Mondia whitei* fruit was less than 11.50% dry weight (dw) for ash content in *Vitex doniana* fruit pulp [28] 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) [29]. However ash content of *Mondia whitei* 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. whitei* fruit on fresh weight basis may not provide much minerals except when dehydrated. Drying concentrates some nutrients [27].

Fat content of *M. whitei* 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) [29], *O. ficus* (0.40% fw) [26] as well as some wild edible fruits consumed in southern Odisha, India which ranged between 0.0006 and 0.075 mg/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 [30]. Results therefore indicates that *M. whitei* 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 [26]. It was reported that fiber in the diet reduces serum cholesterol level [31] 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 [32]. Results therefore indicate that fiber from *M. whitei* fruit may contribute fiber but will not be sufficient to perform the function of providing bulk during digestion to a significant extent.

Its crude protein content was comparable to crude protein content of some wild edible fruits such as *H. thebiaica* (2.62% dw), *A. digitata* (2.39% dw) [29] 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 [33]. However, fruits are not good sources of protein.

M. whitei 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. The variability in moisture content affects the composition of the food [34]. Therefore low carbohydrate as well as other nutrients in *Mondia whitei* fruit could be attributed to high moisture content in the fruit because analysis was determined on fresh weight basis. Carbohydrate content of *M. whitei* fruit was low and this may result to a low glycemic index when compared with other wild fruits as well as commonly consumed fruits which have high glycemic index. It had an energy value of 40.8 KCal/100 g. 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* [26].

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) [25] but lower than total sugars of *Ficus racemosa* (29.43% fw), *Antidesma ghasembilla* (11.8% fw), *Elaegnus conferta* (22.32%) [25] 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 good 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.

3.2 Vitamin Contents

Vitamin content of *Mondia whitei* fruit on fresh weight basis are shown in Table 2. Thiamine content of *M. whytei* fruit was 1.53 mg/100 g. 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 18.33 mg/100 g dry weight for thiamin in *V. doniana* reported by [28]. Recommended Daily Allowance (RDA) for thaimin is 1.20 mg/day [35]. This therefore suggests that *M. whitei* 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 [36].

Table 2. Vitamin composition of *Mondia whitei* fruit on fresh weight basis

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

Values are Means ± Standard Deviation

Fruits are a major food source which contribute to vitamin C in human nutrition. Vitamin C content (14.50 mg/100 g) was comparable to vitamin C content of *Cratagus monogyna* (15.19 mg/100 g fw), *Rubus ulmifolius* (17.09 mg/100 g fw) [5] but higher than what was reported *Prunus spinosa* (7.73 mg/100 g) [5], *G. sapida* (8.6 mg/100 g 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 [37]. The Recommended Dietary Allowance (RDA) of vitamin C is 60 mg/day for a male adult [38]. Thus, *Mondia whytei* fruit cannot satisfy daily vitamin C requirement.

Results also indicated the presence of Vitamins A and E in *M. whitei* 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 [39].

3.3 Mineral Contents

Table 3 presents mineral contents in *Mondia whitei* fruit. Potassium (68.50 mg/100 g) and sodium (65.33 mg/100 g) were the most abundant elements analyzed. Its sodium content was higher than sodium for *Opuntia ficus* (18.7 mg/100 g) [26], some wild edible fruits consumed by local people of Meghalaya , India which ranged between 0.17 and 0.66 mg/100 g dry weight [8], *Tamarindus indica* (46.7 mg/100 g dw) [29], *Grewia sapida* (3.873 mg/100 g freeze dried) [2], *Zizyphus jujuba* (16.18 mg/100g dw) [40] but lower than sodium content for *Hyphaene thebaica* (133.58 mg/100 g dw), *Zizyphus spina-christi* (95.4 mg/100 g dw), *Adansonia digitata* (110.4 mg/100 g dw) [29]. Excess intake of sodium has been implicated in inducing hypertension. Adequate intake for sodium is 1.2 to 1.5 grams per day [41]. What was present in *M. whitei* fruit was quite low to induce hypertension. Potassium content of *M. whitei* was quite higher than reported values for wild edible fruits consumed in Sudan which ranged between 7.78 and 18.78 mg/100 g dry weight [29], some wild edible fruits consumed by local people of Meghalaya, India which ranged between 6.16 and 57.22 mg/100 g dry weight [8], but lower than what was reported for *G. sapida* (1243.788 mg/100 g freeze dried) [2], *O.ficus* (108.8 mg/100 g) [26]. 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 [42]. Potassium has been reported to play a major role in regulating blood pressure [43]. Calcium, magnesium and phosphorus are macro-elements but were found to be low in *M. whitei* 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 [44]. It is required for growth and development, protein and DNA synthesis, neuro-sensory functions, cell-mediated immunity, thyroid and bone metabolism [45]. Iron is a component of the respiratory pigments and enzymes concerned with tissue oxidation, essential for oxygen and electron transport within the body [37].

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

Parameters	Values
Magnesium (mg/100 g)	15.00±0.00
Potassium (mg/100 g)	68.50±0.00
Sodium (mg/100 g)	65.33±0.18
Calcium (mg/100 g)	18.80±0.00
Phosphorous (mg/100 g)	5.85±0.21
Zinc (mg/100 g)	1.25±0.00
Iron (mg/100 g)	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 whitei* 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 [46]. 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 whitei* 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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