

Evaluation of Nutritional Quality of Some Wild Edible Plants in Central Cross River, Nigeria

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Abstract: According to the Nigerian National Population Commission 2006, the population of the nation was conservatively estimated to be over one hundred and seventy million. The challenge of nutritional quality to feed an increasing national population places a higher demand on poorly grown conventional plants. Thus the need to incorporate wild edible plants to bridge the extended gap between the conventional vegetable and the wild indigenous edible plants informs this research. The daily intake of vitamins and minerals are obtained from vegetables. Wild edible plants serve as food and medicine. In this study, the delicacies were prepared from two novel wild edible vegetables - *Ceiba Pentandra* (CPD) and *Ficus glumosa* (FGD). They were evaluated for nutritional quality. Their minerals and vitamins content were determined using standard methods. These delicacies were fortified with a diet of experimental rats. Twenty four (24) albino rats weighing 43.99 - 81.49 g were randomly arranged into six groups (n = 6) of six rats per group. Two groups were fed with the formulated experimental diets, while the other two were fed with protein-free (casein) and basal diets. Vitamins C and E, carbohydrate and protein were significant in CPD delicacy at (28.47±3.17%). The mineral composition showed low Na⁺ level, while Ca²⁺ concentration was also low in CPD and FGD. Phosphorus and Mg²⁺ were high in FGD. The FGD-fed rats had a low biological value (%) (1.38±0.01%) compared to CPD (2.29±0.01) and reference (casein) group (3.02±0.01). The reference group consumed the highest amount of food - 97.06±14.70 g, followed by the basal group (88.98±10.61, with CPD having (76.46±18.78) and FGD (48.27±18.27), respectively. There were no differences in the body weight, protein efficiency ratio, net protein utilization, net protein retention, true digestibility, fecal and carcass protein levels in all the test groups. Findings indicate that nutrients from these wild vegetable delicacies may have good quality and could meet the nutritional needs of the consumer if utilize as per the standard.

Keywords: Delicacies, Wild Vegetable, Nutrition, *Ceiba pentandra* and *Ficus glumosa*

Introduction

Historically, before the advent of animals and plants domestication, all humans lived as nomadic owing to their absolute reliance on animals and plants for food (Kwazo *et al.*, 2015). As people gained knowledge about plants' growth, the practice of domesticating plants commenced (Barker, 2006). Subsequently, humans transited from hunting and gathering to agricultural practices. Agrarian revolution (sometimes called

Neolithic revolution) was reported to have started in Southeast Asia about 10,000 years ago and spread to other parts of the world (Pollard *et al.*, 2015). The migration of people during the pre-agricultural era exposed people to many different wild edible plants (Shermer, 2002). This accounted for their high resistance to diseases/infections and low mortality rate. In contrast, as agriculture begins to gain momentum; farming activities resulted in the selective breeding of edible plants which narrow the nutritional diversity (Barker, 2006).

However, effective way of tackling nutritional insufficiency especially in developing countries could be the promotion of increased consumption of nutritious wild indigenous edible plants (Álvaro and Burlingame, 2006). A larger number of these nutritious plants still exist in the wild and are distributed in vast ecological zones (Freedman, 2015).

Ceiba pentandra plant is also known as “kapok tree”, “Fromager” (in French), “Otorokpa” (in Yala, Cross River State). It is a massive tree which grows to about 200 m height (Hellmuth, 2011). The seeds are edible, while its young leaves are used to prepare soup in some localities (Friday *et al.*, 2011). *Ceiba pentandra* plant can elicit hepatoprotective responses against paracetamol-induced hepatotoxicity in rats. It also possesses angiogenesis, antihelminthic activities and diverse pharmacological spectrum (Elumalai *et al.*, 2012). *Ficus glumosa* is called the mountain fig or African rock fig; its local names in Nigeria are “Kudung” (in Obudu dialect) and “Baure” (Hausa). *F. glumosa* is a tree of small to medium size which grows to 5.0 – 10 m tall and 50 cm in diameter (Ntchapda *et al.*, 2015). When ripe, its red-coloured edible fruits are succulent, sweet and flavorsome. The young leaves are consumed as vegetables in local delicacies (Ntchapda *et al.*, 2015). These plants are capable of improving human nutrition and offsetting the insecurity associated with food quality by serving as a buffer especially during the time of food shortages (Diehl *et al.*, 2004). In order to enhance the diets of vulnerable populations, it is necessary to factor the qualitative aspect of the nutritional value of such diets (Heywood, 2011). Considering the rapid decline in knowledge about the diversity of wild plants, their choices as foods are difficult to establish due to toxicity and intoxication Weidmann and Craik (2016). In the local communities, consumers are poorly informed on the nutritional benefits of some delicacies with respect to the basic nutrients and anti-nutrients or general food quality. Incidences of delicacies shortages usually arise when the anticipated harvest of cultivated plants has not been achieved and/or when there is depletion of stored dietary resources. The seasonal scarcity of important edible plants also limits the availability of popular foodstuffs (Bhattarai *et al.*, 2009). Aggravating these unfortunate scenarios is the challenge of feeding an increasing world population which places a higher demand on the already poorly grown conventional plants. Therefore, the need to incorporate wilder edible plants to bridge the wide-spread gap between the conventional vegetable and the wild indigenous edible plants informs this research.

Materials and Methods

Collection and Identification of Vegetables

The vegetables were randomly collected from Cross River State, Nigeria as follows: *Ceiba pentandra*

“Otorokpa” - Okpoma, Yala and *Ficus glumosa* “Kudung” by the Abochiche, Bekwarra people. They were verified and authenticated by Dr. S. Udo - Department of Biological Science, Cross River University of Technology, Calabar. Besides the vegetables, all the food ingredients used for the preparation of the delicacies were purchased from Watt market Calabar, Cross River State, Nigeria.

Methods of Preparing Delicacies

The selected fresh vegetables were thoroughly cleaned under running tap water and used to prepare the delicacies based on the traditional recipes of the study area: *Ficus Glumosa* Delicacy (FGD) and *Ceiba pentandra* delicacy (CPD) delicacies were blended into pastes using an electric hand blender after which they were dried in a hot-air circulating oven at 70°C for 24 hr. They were then removed, ground into powder using a pestle/mortar, poured into airtight containers and properly stored in a refrigerator (3-5°C) for analyses.

Chemical Analysis

The following methods were adopted for analysis of properties. Determination of fiber, Ash content estimation, Vitamin analyses, mineral elements and total carbohydrates (AOAC, 1995) method.

Determination of energy values, antinutritional elements Onyeike *et al.* (2000). Determination of oxalic acid (Munro and Bassir (1969), Phytate (Onwuka, 2005). Analysis of hydrogen cyanide was done according to the method prescribed by Agbaire (2011).

Statistical Analysis

The data obtained were analyzed using SPSS statistical package (version 20.0) and results expressed as the mean \pm standard deviation. Between the means, significant differences were established by one way ANOVA at $P < 0.05$ followed by least square difference (LSD) post-hoc test.

Results

Table 1 represents the different components of the test samples, beginning with the basal diet, reference diet, CPD delicacy and FGD delicacy. Their composition comprised of cornstarch, casein, test material, sucrose, glucose, soy oil, cellulose, vitamin and mineral. They are summed to 1200 and bear different amounts, respectively. The cornstarch was purchased from marina market in Calabar municipality, while the components of mineral and vitamin mix were gotten from a scientific shop in Calabar.

Vitamin Content

The different Vitamins - A, C and E content ($\mu\text{g}/100\text{ g}$) showed observable variation among the delicacies. The *Ceiba pentandra* (CPD) had the highest amount of vitamin A, while the *Ficus glumosa* (FGD) had the highest Vitamin A and lowest vitamin E content. Comparatively, each delicacy varies considerably from one other in vitamin E content (Table 2).

Mineral Content

The essential mineral content ($\text{mg}/100\text{ g}$) of the delicacies - magnesium (Mg^{2+}), sodium (Na^+), calcium (Ca^{2+}) and Phosphorus (P) is shown in Table 3. There was observable difference in Mg^{2+} concentration of delicacies - *Ficus glumosa* (FGD) and *Ceiba Pentandra* (CPD). The test samples showed low Na^+ content except for Phosphorus, Ca^{2+} and Mg^{2+} , respectively.

Biological Evaluation (Food Intake)

The rats fed with reference (casein) diet consumed the highest amount of food (g) followed by group fed with basal (protein-free) diet, although the difference was statistically non-significant. Data in Table 4 shows that the groups fed with FGD and CPD recorded the lowest food intake during the experimental period compared to the basal and reference group.

Body Weight Changes

Body weight changes (g) of rats measured during 10 days of the study are presented in Table 5. It was

observed that there were no significant differences among the treated groups at $P < 0.05$

Results showed non-significant differences among the treated groups at $P < 0.05$ as regards their Protein Efficiency Ratio (PER). Among the treated groups, there were no observable significant differences ($P < 0.05$) in Net Protein Utilization (NPU). No significant differences were detected in the Net Protein Ratio (NPR) among the treated groups ($P < 0.05$). The True Digestibility (TD) of the experimental animals showed no observable significant differences among the groups at $P < 0.05$. The Biological Values (BV) of all the sample groups were significantly different from each other with the reference diet and *Ficus Glumosa* Delicacy (FGD) administered groups having the highest and lowest biological values, respectively see Table 6.

Test groups with no superscripts are significantly different at $P < 0.05$. $n = 6$. For Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Net Protein Retention (NPR), True Digestibility (TD) and Biological Values (BV) of rats fed with *Ceiba Pentandra* Delicacy (CPD), *Ficus Glumosa* Delicacy (FGD), basal diet and Reference diet. Test groups with identical superscripts are not significantly different at $P < 0.05$.

Table 7 showed that the fecal protein (FePr) content (%) among the groups, they were not significantly different from one another ($P < 0.05$). The carcass protein content (%) of the delicacies showed observable significant differences between groups at $p < 0.05$. The overall trend was in the decreasing order of *Ceiba Pentandra* Delicacy (CPD), basal diet, Reference diet and *Ficus Glumosa* Delicacy (FGD) groups.

Table 1: Composition of the Experimental Diets

Components	Basal diet	Reference diet	Test delicacy 1 (CPD)	Test delicacy 2 (FGD)
Cornstarch	840	720	418	3
Casein	-	120	-	-
Test material	-	-	422	1,162
Sucrose	120	120	120	3
Glucose	60	60	60	3
Soy oil	60	60	60	3
Cellulose	60	60	60	5
Vitamin mix	12	12	12	6
Mineral mix	48	48	48	15
Total	1200	1200	1200	1200

Test delicacy 1: *Ceiba Pentandra* Delicacy (CPD)

Test delicacy 2: *Ficus Glumosa* Delicacy (FGD)

Basal diet: Protein-free diet

Reference diet: Casein-based diet.

Table 2: Vitamins Concentration in Delicacies

Delicacies	Vitamin A ($\mu\text{g}/100\text{ g}$)	Vitamin C ($\text{mg}/100\text{ g}$)	Vitamin E ($\mu\text{g}/100\text{ g}$)
CPD	106.83 \pm 0.06	64.07 \pm 2.98	6.30 \pm 0.26
FGD	95.83 \pm 0.35	56.90 \pm 1.40	5.77 \pm 0.31

Test groups with no identical superscripts are significantly different at $p < 0.05$. $n = 3$, for Vitamin A ($\mu\text{g}/100\text{ g}$), vitamin C ($\text{mg}/100\text{ g}$) and vitamin E ($\mu\text{g}/100\text{ g}$) of *Ceiba pentandra* (CPD) and *Ficus glumosa* (FGD) delicacies.

Table 3: Mineral composition of delicacies

Delicacies	Calcium (mg/100 g)	Magnesium (mg/100 g)	Phosphorus (mg/100 g)	Sodium (mg/100 g)
CPD	61.90±0.66 ^b	68.43±1.91 ^b	29.90±0.70 ^a	9.80±0.20 ^{a,b}
FGD	59.53±0.85 ^b	73.30±1.71 ^a	33.53±0.67	9.70±0.56 ^{a,b}

*Test groups with identical superscripts are not significantly different at $p < 0.05$ while test groups with non-identical superscripts are significantly different at $p < 0.05$. $n = 3$, for contents of selected minerals (mg/100g) of *Ceiba pentandra* (CPD) and *Ficus glumosa* (FGD) delicacies.*

Table 4: Food Intake by dietary groups

Dietary groups	Amount of Food intake (g)
CPD	76.46±18.78 ^b
FGD	48.27±18.27 ^a
Basal	88.98±10.61 ^{b,c}
Reference diet	97.06±14.70 ^c

*Test groups with identical superscripts are not significantly different at $p < 0.05$, while test groups with non-identical superscripts are significantly different at $P < 0.05$. $n = 6$. For the food intakes (g) of rats fed with *Ceiba pentandra* delicacy (CPD), *Ficus glumosa* delicacy (FGD), and basal diet and Reference diet.*

Table 5: Body weight changes of rats fed reference, basal and experimental diets

Dietary groups	Initial weight	Final weight	Body weight changes
CPD	65.72±2.62	71.12±8.91	5.40±4.07 ^a
FGD	66.62±0.47	72.69±7.75	6.07±4.85 ^a
Basal	72.33±1.87	75.17±3.14	2.84±1.65 ^a
Reference diet	78.74±2.16	84.18±4.84	5.44±3.05 ^a

*Test groups with identical superscripts are not significantly different at $p < 0.05$. $n = 6$. The initial weight, final weight, and the change in body weight (g) of the rats fed with *Ceiba pentandra* delicacy (CPD), *Ficus glumosa* delicacy (FGD) and basal diet and Reference diet.*

Table 6: Biological evaluation of rats fed reference, basal and experimental diets

Dietary groups	PER	NPU	NPR	TD	BV
CPD	0.54±0.41 ^a	0.03±0.01 ^a	0.27±0.13 ^a	1.13±1.06 ^a	2.29±0.01
FGD	0.61±0.49 ^a	0.04±0.02 ^a	0.51±0.39 ^a	2.77±2.06 ^a	1.38±0.01
Basal	0.29±0.16 ^a	-	-	-	-
Reference diet	0.54±0.30 ^a	0.01±0.00 ^a	0.36±0.20 ^a	0.46±0.32 ^a	3.03±0.01

*Test groups with no superscripts are significantly different at $p < 0.05$. $n = 6$. For Protein efficiency ratio (PER), net protein utilization (NPU), net protein retention (NPR), true digestibility (TD) and biological values (BV) of rats fed with *Ceiba pentandra* delicacy (CPD), *Ficus glumosa* delicacy (FGD), basal diet and Reference diet. Test groups with identical superscripts are not significantly different at $P < 0.05$.*

Table 7: Faecal and carcass protein of experimental rats

Dietary groups	Faecal protein (%)	Carcass protein (%)
CPD	16.47±3.06 ^a	48.11±3.20 ^a
FGD	16.57±3.29 ^a	30.99±3.39 ^c
Basal	12.89±0.37 ^a	37.40±8.25 ^b
Reference diet	14.43±1.25 ^a	35.60±2.99 ^{b,c}

*Test groups with identical superscripts are not significantly different at $P < 0.05$ whereas test groups with non-identical superscripts are significantly different at $P < 0.05$. $n = 6$. Faecal and carcass protein (%) of rats fed with (CPD), *Ficus glumosa* delicacy (FGD), basal diet and reference diet.*

Discussion

The major aim of conducting an investigation on wild edible food plants is for the purpose of documentation of available indigenous plants for consumption and awareness. Comparative analysis on wild edible plants (WEPs) in different societies and ethnic settings among countries may include the recognition of most widely consumed species for nutritional quality assessment

(De Caluwé *et al.*, 2010). Abiotic components (rainfall, soil and temperature) and agronomic practices are factors responsible for the differences in plants' nutrients concentration (Imran *et al.*, 2007). The composition of different dietary regiment comprised of cornstarch, casein, test material, sucrose, glucose, soy oil, cellulose, vitamin and mineral. There are summed to 1200 and bear different amounts, respectively. For instance, among the delicacies - *Ceiba Pentandra* (CPD) and *Ficus Glumosa*

(FGD) for their composition of the experimental diets had, the composition of cornstarch in basal diet was 840, reference diet 728, CPD 418, while FGD had the lowest 3 see Table 1. Also other components level differs with experimental diets. According to Khan *et al.* (2016), food from plant sources is regarded as a good source of vitamins and minerals. The cardinal functions of vitamins are for enhancement of growth and development (Mutiarra *et al.*, 2013). They are the main sources of nitrogenous compounds (Adamczyk *et al.*, 2010). The vitamins and elemental analyses of *Ceiba Pentandra* (CPD) and *Ficus Glumosa* (FGD) delicacies showed the observable variation among the delicacies for Vitamins - A, C and E concentration ($\mu\text{g}/100\text{ g}$) in Table 2 and the essential mineral content ($\text{mg}/100\text{ g}$) of the delicacies - magnesium (Mg^{2+}), sodium (Na^+), calcium (Ca^{2+}) and phosphorus (P) is shown in Table 3. There was an observable difference in Mg^{2+} concentration of delicacies - *Ficus Glumosa* (FGD) and *Ceiba Pentandra* (CPD). The test samples showed low Na^+ content except for Phosphorus, Ca^{2+} and Mg^{2+} , respectively. The *Ceiba Pentandra* (CPD) had the highest amount of vitamin A, while the *Ficus glumosa* (FGD) had the highest Vitamin A and lowest vitamin E content. Comparatively, each delicacy varies considerably from one other in vitamin E content see (Table 2). This was consistent with Udo *et al.* (2013), who reported the high levels of vitamins in *Ficus glumosa* vegetable relative to *Ceiba pentandra* vegetable. This output was replicated in the energy difference between FGD and CPD. These plants could play a major part as a source of energy and micronutrients (De Caluwé *et al.*, 2010; Ermias *et al.*, 2011). Recently, preliminary researches on the dietary analysis of some WEPs provide promising knowledge on the advocacy and orientation about the need for consuming WEP.

The biological evaluation on the intake of food by rats indicated that rats fed with reference (casein) diet consumed the highest amount of food (g) next by the group fed with basal (protein-free) diet, though the difference was statistically non-significant or different, data in Table 4 shows that the groups fed with FGD and CPD recorded the lowest food intake ($48.27 \pm 18.27^{\text{a}}$ g and $76.46 \pm 18.78^{\text{b}}$ g) during the experimental period relative to the basal and reference group ($88.98 \pm 10.61^{\text{b,c}}$ g and $97.06 \pm 14.70^{\text{c}}$ g), respectively. It is correct to say that during cooking/heating, some mineral elements leached into the medium, this agreed with (Nelson and Cox, 2012; Bernhardt and Schlich, 2006) assertion that during cooking, minerals are not destroyed by heat but leached into the fluid medium. The optimal functioning of the body requires vitamins and mineral elements in many biochemical processes e.g. blood clotting, enzymatic activation, neuromuscular activities, formation/development of bone and teeth (Hussain and Khan, 2010; Khan *et al.*, 2016). In the intracellular domain, the most abundant divalent cation is magnesium (Siddique and Prakash, 2014). It helps in the maintenance of cardiovascular tone and cofactor in

reactions catalyzed by enzymes (Vaskonen, 2003). Sodium and phosphorus contribute significantly to many physiological processes such as transport of bio-molecules, energy generation and homeostasis (Esmaeili *et al.*, 2014). Besides other important components of the delicacies, vitamins showed considerable concentration. Vitamins are necessary antioxidants that aid the scavenging of noxious free radicals in the body (Janu *et al.*, 2014).

Comparatively, research conducted by (Adotey *et al.*, 2009; Singhal *et al.*, 2016), both found variations in concentrations of essential elements for different vegetables, for instance, Adotey *et al.* (2009) observed calcium in tomato to vary from 0.002 to 0.24 g/kg with a mean of 0.17 g/kg. The calcium in garden egg ranged from 0.01 to 0.16 g/kg with a mean of 0.10 g/kg. The content of calcium in onion was 0.60 g/kg and ranges from 0.44 to 0.88 g/kg. Singhal *et al.* (2016) observed the concentration of sodium to range from 33 mg/kg to 390 mg/kg, while Calcium varies from 140 mg/kg to 780 mg/kg. Concentration of Fe was 2.5 ± 0.2 mg/kg to 6.75 ± 0.42 mg/kg in different vegetables. Essential element concentration was found to be least in Potato while it was highest in Cabbage. This variability in the content of the element is due to the nature of the plant, site of plantation and translocation capacity of the plant to accumulate and partition the metals. However average daily levels of sodium intake for adult range from 2 to 5 g (WHO, 1979, cited in Singhal *et al.* (2016)

The changes in body weight (g) of rats measured during 10 days of the study are presented in Table 5. It was observed that there were no significant differences among the treated groups at $P < 0.05$. But the changes in the body weights of rats fed reference, basal and experimental diets showed that Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Net Protein Retention (NPR) and True Digestibility (TD) of the experimental animals had no significant differences among the groups see Table 6. Proteins influence body weight, but a decrease in protein quality may lead to lower body weights and vice versa (Sandi *et al.*, 2016). Apparently, variations in growths among the groups were not different as suggested by the observed non-significant differences in the rats' body weight, true digestibility, protein efficiency ratio; net protein utilization, net protein retention, fecal and carcass levels of proteins see Table 7. However, the relatively increased food intake and high quality of the reference diet may have accounted for the corresponding high biological value shown by the respective tested groups compared to the non-test groups. Therefore, considering these results, one can deduce that consumption of this wild *Ceiba pentandra* and *Ficus glumosa* delicacies will be beneficial to human health due to their nutritional value, irrespective of whether there are wild or cultivated.

Conclusion

This study provided basic information on the nutritional profile and benefits of *Ceiba pentandra* and *Ficus glumosa* delicacies which are not readily available in our localities and cities. These novel wild edible vegetables can contribute to food quality and provide essential nutrient required by the body. These wild edible plants can play a beneficial role in scrimmaging food insecurity challenges in Nigeria and Africa.

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Author's Contributions

Obi-Abang Magdalene: Did both the laboratory and field work.

Margaret Akpana Agiang: Designed the work and supervised.

Victor Eshu Okpashi: Wrote the manuscript and laboratory work.

Godwin Eneji Egbung: Supply the relevant literature.

Ethics

Authors hereby declare no competing interest regarding the publication of this article.

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