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Chemical Composition of Two Commonly Consumed Cocoyam (*Colocassia esculenta*) Based Dishes in Umunneochi Abia State, Nigeria

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Abstract

Cocoyam (*Colocasia esculenta*) was purchased from the cocoyam unit in the National Root Crop Research Institute (NRCRI). Other ingredients that were used for the preparation were purchased from Ubani Market in Umuahia, Abia State. The proximate compositions of the meals were determined using standard methods. Mineral elements were determined using wet-acid digestion method for multiple nutrients determination. The β – carotene, riboflavin, niacin and thiamin of the products were determined using spectrophotometer, while ascorbic acid was determined using titration method. All tests were carried out in duplicates and the data generated were analyzed using standard methods. Moisture ranged between 51.2 - 53%, protein (3.7 - 5.3%), crude fat (24.1 - 30.2%), crude fiber (1.8 - 3.7%), calcium (7.8 - 5.5 mg/100g), phosphorus (12.8 - 10.6 mg/100g), potassium (11.1 - 6.9 mg/100g), sodium (22.3 - 18.9 mg/100g), Vitamin A obtained for cocoyam + ugba (120 mcg/100g) was significantly higher than that of cocoyam + beans (10 mcg/100g). Vitamins B1, B3 vitamin C were only found in cocoyam + oil bean. Most of the phytochemical evaluated with the exception of alkaloids and flavonoids were below 1mg/100g. The study revealed that consumption of cocoyam meal will contribute significantly to intake of protein, fat, crude fiber, minerals of individuals.

Keywords: *Colocassia esculenta; Indigenous Recipes; Oil Bean; Cowpea; Underutilized*

Introduction

Hunger and malnutrition have continued to be a serious problem for many people particularly in the developing countries [1]. In Nigeria, the underlying causes of malnutrition are poverty, inadequate food production, inadequate food intake, ignorance and uneven distribution of food, poor food preservation techniques, and improper preparation of foods, food restrictions, taboos, poor sanitation. It is also a common knowledge that a number of indigenous plant foods in Nigeria are now going extinct because they are no longer been consumed by most people [2]. Underutilization of indigenous food in Nigeria could be attributable to the facts that information on their nutritional and functional properties are lacking.

Cocoyam (*Colocasia esculenta*) belongs to the family *Araceae* and sub-tribe *Colocasinae*. It is classified among the underutilized food crops in Nigeria [3,4]. About 30 - 40 species of cocoyam have been identified but only 5 - 6 species are edible [5]. *Colocasia esculenta* (L.) and *Xanthosoma sagittifolium* (L.) are the most common species found in Nigeria. Even though studies have showed that both varieties have nutritional and medicinal values [6-9]; only few individuals still consume cocoyam in Nigeria and this is because cocoyam is viewed as the poor man's food. Another factor that may be responsible for the underutilization of cocoyam is lack of comprehensive information of the nutrient composition of recipes prepared with cocoyam. It is hoped that this work with re-launch the rebirth of the consumption of cocoyam through making public the nutrient composition of two recipes commonly prepared from cocoyam as consumed by Umunneochi people in Abia State, Nigeria.

Materials and Methods

Preliminary Information

The recipes and preparation methods of cocoyam based meals in this study were based on information elicited in Umunneochi Local Government Area of Abia State, Nigeria. The ingredients, weights and methods of preparation were obtained through personal interviews and questionnaire administration on married women of Umunneochi.

Sample Collection

The cocoyam (*Colocasia esculenta*) was purchased from the cocoyam unit in the National Root Crop Research Institute (NRCRI) and was further identified at the Department of Agronomy, College of Crop and Soil Sciences. Other ingredients used in the preparation were purchased from Ubani Market in Umuahia, Abia State.

Selection and Cleaning of Cocoyam

Medium sized healthy cocoyams (local name – "coco india") free from bruises and pests infection were selected and divided into two portions (1.8 kg for cocoyam+oil bean recipe and 800g for cocoyam + beans recipe). The cocoyam (corms) were washed using potable water, peeled and cut into cubes manually with kitchen knives.

Preparation of Cocoyam and "Ugba" (Ede Agworoagwo)

Red palm oil (375ml) was heated in a pot for one (1) minute after which chopped onion (157.1g) was added and allowed to fry for two (2) minutes. Milled crayfish (25g), pepper (75g) and parboiled cocoyam (1 kg) was added and allowed to fry for two (2) minutes with continuous stirring using a cooking spoon. Water (500 ml) was added and the food was allowed to simmer for two (2) minutes after which salt (10.5g), 8g of bouillon cubes and milled African nutmeg (5.4g) were added and stirred. The oil bean "ugba" (175g) and the chopped garden egg leaves (75.6g) were added and allowed to simmer for three (3) minutes.

Preparation of Cocoyam and cowpea Porridge

The cowpea (Ife brown variety) was boiled for 1hr after which parboiled diced cocoyam was added and boiled for another 50 minutes. Other ingredients (palm oil (250ml), pepper (60g), crayfish (75g) and chopped onion (156.2g) were added and allowed to cook for five (5) minutes. Salt (12.5g) and 8g of bouillon cubes were finally added and allowed to cook for 2 minutes.

Recipes for the preparation of cocoyam +oil bean and cocoyam + beans

Ingredients	Quantities	
	Cocoyam+ Ugba	Cocoyam+ cowpea
Cocoyam	1.8kg	800g
Beans	-	1kg
Ugba	175g	-
Palm oil	375ml	250ml
Onion	140.9g	148g
Crayfish	25g	75g
Pepper	75g	60g
Salt	17.5g	12.5g
Bouillon cube	8g	8g
Garden egg leave	75.6g	-
"Ehuru"	5.4g	-
Water	500ml	3250ml
Total Yield	2.51kg	5.9kg

Chemical Analyses

The proximate compositions of the sample were determined using standard AOAC [10] methods. Moisture content of the seed was determined gravimetrically. The crude protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The crude fat content was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600°C in a muffle furnace. Carbohydrate was obtained by difference, while energy was calculated using the Atwater Conversion factors in KJ and Kcal (17KJ/4Kcal, 17KJ/4Kcal, and 37KJ/9Kcal, for protein, carbohydrate and lipid respectively.

Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC [10]. About 0.2g of the processed sample material was weighed into a 150 ml Pyrex conical flask. Five (5.0) ml of the extracting mixture (H_2SO_4 – Sodium Salicylic acid) was added to the sample. The mixture was allowed to stand for 16 hours. The mixture was then placed on a hot plate set at 30°C and allowed to heat for about 2 hours. Five (5.0) ml of concentrated perchloric acid was introduced to the sample and heated vigorously until the sample was digested to a clear solution. Twenty (20) milliliters of distilled H_2O was added and heated to mix thoroughly for about a minute. The digest was allowed to cool and was transferred into a 50 ml volumetric flask and made up to the mark with distilled water. The digest was used for the determinations of calcium (Ca) and magnesium (Mg) by the ethylamine di-tetra acetic acid (EDTA) Versanate Complexiometric titration method. Potassium (K) and sodium (Na) were evaluated by flame photometry method and phosphorus (P) by the Vanadomolybdate method using the spectrophotometer. The trace metals (zinc, iron, copper, selenium, manganese and iodine) were determined using the atomic absorption spectrophotometer 969 instrument. The appropriate cathode lamp was fixed for each element. The sample was introduced to the atomizer and the value concentration of the element printed out as mgX/liter.

The β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC [10]. Ascorbic acid was determined as described by AOAC [10] using titration method. Gravimetric method [11] was used to determine alkaloids. Saponin was determined by gravimetric oven drying method as described by the method of AOAC [10]. Tannin content of the sample was determined using the method of spectrophometry as described by Kirk and Sawyer [12]. Phenol was determined by the folin-ciocatean spectrophotometry method [10]. Flavonoid was determined by gravimetric oven drying method as described by Harborne [11].

Statistical Analysis

All determinations were done in duplicates. The data generated were entered into the computer and analyzed using Statistical Package for Social Sciences (SPSS version 20) Means and standard deviation obtained from the chemical analysis were calculated. Level of significance was accepted at $p < 0.05$.

Results and Discussion

Proximate Composition of cocoyam+ ugba and cocoyam+ cowpea

The proximate result of the products is shown Table 1. It is worth noting that the results obtained in this study cannot be compared with those from other similar works because there are no standardized recipes in Nigeria. The moisture contents of the recipes in this study ranged between 51.2 - 53%, with cocoyam + beans having the highest moisture (53.2%) and cocoyam + oil bean (ugba) the least (51.2%). The high moisture obtained in cocoyam + bean could be attributable to the higher amount of water that was used in the preparation of the food. Crude protein (5.3%) and crude fat (30.2%) obtained for cocoyam + oil beans were significantly ($p < 0.05$) than those of cocoyam + beans (3.7% and 24.1% respectively). Naturally cocoyam is not very good source of protein [13] but combining it with other foods of rich protein sources will increase cumulative protein intake. The crude fiber values of the products ranged between 1.8 - 3.7% with cocoyam + bean having the highest crude fiber (3.7%) value while cocoyam + oil bean the least crude fiber value (1.8%). The high crude fiber seen in cocoyam + bean recipe may be due to the inclusion of beans in the recipe. The carbohydrate and energy obtained for both recipes were low. Low protein, low fiber, low carbohydrate and energy obtained made the products an interesting one that could be incorporated in diet of individuals with physiological condition.

Nutrients	Cocoyam + Ugba	Cocoyam + Beans
Moisture content (%)	$51.2^{b} \pm 0.05$	$53.2^{a} \pm 0.20$
Crude protein (%)	$5.3^{a} \pm 0.00$	$3.7^{b} \pm 0.00$
Crude fat (%)	$30.2^{a} \pm 0.10$	$24.1^{b} \pm 0.10$
Crude fiber (%)	$1.8^{b} \pm 0.00$	$3.7^{a} \pm 0.00$
Ash	$0.39^{a} \pm 0.01$	$0.26^{b} \pm 0.00$
Carbohydrate	$11.1^{b} \pm 0.15$	$14.9^{a} \pm 0.27$
Energy (Kcal/KJ)	337/1398	291/1206

Table 1: *Energy and proximate composition of cocoyam based recipes.*

Means in the same column with different superscript are significantly different at (P < 0.05) from each other.

Mineral content of cocoyam+ ugba and cocoyam+ cowpea

The mineral composition of the samples is on Table 2. Most of the macrominerals appear to be significantly higher in cocoyam + oil bean. Calcium ranged between 5.5 - 7.8 mg/100g with cocoyam + oil bean having the highest calcium value (7.8 mg/100g) while cocoyam + cowpea had the lowest calcium value (5.5 mg/100g). Calcium is an essential component of bone and it plays an important role of regulating of blood pressure [14].

The Phosphorus (12.7 mg/100g), potassium (11.1 mg/100g), sodium (22.3 mg/100g) obtained for cocoyam + oil bean were also higher than the, phosphorus (10.6 mg/100g), potassium (6.9 mg/100g), sodium (18.9 mg/100g) obtained for cocoyam+ cowpea. The difference observed in their macronutrient composition could be a function of difference in the components of their ingredients. The magnesium obtained for cocoyam + cowpea (4.6 mg/100g) was however significantly ($p < 0.05$) higher than the magnesium obtained for cocoyam + oil bean (2.1 mg/100g). Magnesium is important in the regulation of blood pressure, improvement of serum lipid profile, prevention of stroke, and skeletal growth and development [15]. The difference observed in their macronutrient composition could be a function of difference in the components of their ingredients. The result of micromineral on Table 2 shows that that copper (0.71 mg/100g), zinc (1.6 mg/100g), iron (1.4 mg/100g) were significantly ($p < 0.05$) higher in cocoyam + beans. No selenium was found in cocoyam + bean but some quantity of selenium was found in cocoyam +oil bean (0.01 mg/100g). Consumption of food that contains microminerals in is known to prevent physiological or structural abnormalities [16].

Nutrients	Cocoyam +Ugba (mg/100g)	Cocoyam + Beans(mg/100g)
Calcium	$7.8^{a} \pm 0.01$	$5.5^{b} \pm 0.02$
Phosphorus	$12.8^{a} \pm 0.05$	$10.6^{b} \pm 0.05$
Potassium	$11.1^{a} \pm 0.10$	$6.9^{b} \pm 0.08$
Sodium	$22.3^{a} \pm 0.10$	$18.9^{b} \pm 0.01$
Magnesium	$2.1^{b} \pm 0.01$	$4.6^{a} \pm 0.01$
Copper	$0.50^{b} \pm 0.00$	$0.71^{a} \pm 0.03$
Selenium	$0.01^{a} \pm 0.00$	$0.00^{b} \pm 0.00$
Zinc	$1.3^{b} \pm 0.00$	$1.6^{a} \pm 0.05$
Iron	$1.3^{b} \pm 0.00$	$1.4^{a} \pm 0.00$

Table 2: *Mineral composition of the cocoyam based recipe.*

Means in the same column with different superscript are significantly different at (P < 0.05) from each other.

Vitamin contents of cocoyam+ ugba and cocoyam+ cowpea

The vitamin composition of the recipes is shown on Table 3. Vitamin A obtained for cocoyam + ugba (120 mcg/100g) was significantly higher than that of cocoyam + beans (10 mcg/100g). vitamins B_1 (3.1 mg/100g), B_2 (2.6 mg/100g), B_3 (2.1 mg/100g), and vitamin C (6.1 mg/100g) found in cocoyam + oil bean but vitamins B_1, B_2, B_3 and vitamin C were not detected in cocoyam + beans. The presence of vitamins B_1, B_2, B_3 and vitamin C found in cocoyam + oil bean could be as a result of the leafy green vegetable that added in the recipe. The B- vitamins are known for their significant role in energy metabolism and several body functions. Vitamin E was not detectable in any of the recipe.

Nutrients	Cocoyam + Ugba (mg/100g)	Cocoyam + Beans(mg/100g)
Vitamin A	$0.12^a \pm 0.00$	$0.11^b \pm 0.01$
Vitamin B_1	$3.1^a \pm 0.02$	ND
Vitamin B_2	$2.6^a \pm 0.10$	ND
Vitamin B_3	$2.1^a \pm 0.10$	ND
Vitamin C	$6.1^a \pm 0.01$	ND
Vitamin E	ND	ND

Table 3: *Vitamin analysis of the cocoyam based recipes.*

Means in the same column with different superscript are significantly different at (P < 0.05) from each other.

Phytochemical of cocoyam+ ugba and cocoyam+ cowpea

The phytochemical composition of the meals on Table 4 showed that the flavonoid obtained for cocoyam + oil bean (4.03 mg/100g) was significantly ($p < 0.05$) higher than the flavonoid found in cocoyam + bean (3.2 mg/100g). Garden egg leaves added to cocoyam + oil bean must have increased the value of flavonoid. Flavonoids are known for their antioxidants activities [17]; they are believed to slow down the developments of cataracts in persons with diabetes [18,19]. Tannin and phenol were not found in both products. Phytate, oxalate, cyanide and saponin obtained in both products were below 1 mg/100g. The values of phytate in the product ranged between 0.18 - 0.20 mg/100g, while oxalate ranged between 0.01 - 0.01 mg/100g. The low values of phytochemicals generally found in this study may be due to the effect of processing. It is interesting to note that the Oxalate: Calcium (Ox:Ca) ratio was 0.001; this implies that the food had a safe oxalate content [20]. Consumption of food with a high ratio of Ox:Ca is said to cause chronic calcium deficiency [21]. The cyanide (0.64 - 0.78 mg/100g) and saponin (0.32 - 0.45 mg/100g) obtained in this study were both below the detrimental value stated for cyanide (50 - 200 mg/100g [22,23] and saponin (1 mg/100g) [24]. The alkaloids obtained for cocoyam + beans (1.7 mg/100g) was significantly higher than the alkaloids found in cocoyam + oil bean (1.4 mg/100g). The analgesic, antispasmodic and antibacterial properties of alkaloids have been documented [19,25].

Anti-Nutrients	Cocoyam + Ugba(mg/100g)	Cocoyam + Beans(mg/100g)
Phytate	$0.18^b \pm 0.00$	$0.20^a \pm 0.00$
Tannin	ND	ND
Oxalate	$0.01^b \pm 0.00$	$0.02^a \pm 0.00$
Phenol	ND	ND
Cyanide	$0.64^b \pm 0.01$	$0.78^a \pm 0.01$
Saponnin	$0.45^a \pm 0.00$	$0.32^b \pm 0.01$
Alkaloids	$1.4^b \pm 0.99$	$1.7^a \pm 0.00$
Flavonoids	$4.0^a \pm 0.63$	$3.2^b \pm 0.01$

Table 4: *Phytochemical composition of cocoyam based recipes.*

Means in the same column with different superscript are significantly different at (P < 0.05) from each other.

Conclusion

The result shows that cocoyam + oil bean had higher values of protein, fat, calcium phosphorus and potassium than cocoyam + cowpea, while higher values of crude fiber, magnesium, copper, zinc and iron were found in cocoyam + cowpea. The phytochemicals evaluated were within the permissible levels. Also, the study showed that incorporating vegetable in food can increase vitamin intake.

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