NUTRITIONAL, ANTI-NUTRITIONAL AND SENSORY PROPERTIES OF COCOYAM FUFU (*USUNG IKPONG*) PRODUCED FROM COCOYAM (*Xanthosoma atroviren*) AND CASSAVA (*Manihot esculenta* Crantz) FLOUR BLENDS

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ABSTRACT
This study evaluated the nutrient composition and sensory properties of cocoyam fufu (Usung Ikpong) produced from cocoyam and cassava flour blends. Cocoyam fufu was prepared from (A) cooked fresh cocoyam; (B) 100% cocoyam flour; (C) 94.34% cocoyam and 5.66% cassava flour blend; (D) 89.29% cocoyam and 10.71% cassava flour blend; (E) 84.75% cocoyam and 15.25% cassava flour blend and (F) 80.65% cocoyam and 19.35% cassava flour blend. Chemical analyses were carried out according to standard procedures. Sample A had significantly higher values for moisture (82.04%), fat (0.16%) and zinc (0.07 mg/100 g) contents, but significantly lower values for fibre (0.13%), protein (1.38%), carbohydrate (16.09%), energy (302.91 kj), calcium (7.67 mg/100 g), magnesium (3.60 mg/100 g) potassium (0.71 mg/100 g), sodium (2.95 mg/100 g) and iron (0.01 mg/100 g) than others. Sample C had significantly higher values for crude fibre (0.29%), ash (0.37%), protein (3.88%), zinc (0.05 mg/100 g), iron (0.07 mg/100 g) and sodium (8.81 mg/100 g), while sample B had significantly higher values for calcium (14.93 mg/100 g), phosphorus (8.08 mg/100 g), magnesium (8.59 mg/100 g), and potassium (3.53 mg/100 g) compared to other samples prepared from flour blends. Sample C had significantly higher values for most anti-nutrients-HCN (0.61 mg/100 g), oxalate (92.03 mg/100 g) and phytate (1.46 mg/100 g). There were no significant differences in appearance; sample F scored significantly higher in texture; whereas sample A scored significantly higher in taste, flavor and general acceptability. Usung Ikpong prepared from cocoyam and cassava flour blends, particularly 94.34% cocoyam and 5.66% cassava flour blend can serve as a convenient replacement (with better nutritive value and comparative sensory attributes) for fresh pounded cocoyam and should therefore be incorporated in usual intakes.

Keywords: *Cocoyam Flour; Usung Ikpong; Nutrient Compositions; Anti-nutrients; Sensory Properties.*

INTRODUCTION
Cocoyam is an herbaceous perennial crop cultivated solely for its edible corms, cormels, leaves and inflorescence (Vaneker and Slaats, 2013; Boakye *et al*., 2018) and occupies a central role in ensuring food security especially in West African region including Nigeria, Ghana, and Cameroon (Onyeka, 2014). It is a food crop with considerable nutritive value; its tuber serves as good source of carbohydrate, an appreciable source of food energy, protein, vitamins and mineral elements including calcium, phosphorous, magnesium, potassium and zinc (Opara, 2003; Boakye *et al*., 2018 and Wada *et al*., 2019). Its higher nutritive value over other roots and tubers is due to its comparatively higher protein digestibility and mineral composition (Boakye *et al*., 2018; Wada *et al*., 2019).
As food, cocoyam has many culinary applications - most traditional uses include cooking by boiling, roasting, or frying, either alone or in combination with other ingredients to obtain delicacies (Boakye *et al*., 2018). In southern Nigeria, especially Akwa Ibom State, the yellow fleshed tannia (*Xanthosoma atroviren),* popularly called "*asimeka*" in Ibibio is often cooked and pounded to produce a fufu analogue, "*Usung Ikpong*". *Usung Ikpong* is often used as swallow to eat any light soup especially that thickened with cormels of cocoyam.

Pounding of cocoyam using mortar and pestle is often discouraging due to drudgery in preparation and low binding capacity. The high energy and time demands in preparation usually scare people from preparing the dish and over time have led to underutilization, especially among those in the city. Where the issue of drudgery is naturally overcome, the loose nature of the dish constitutes some form of hindrance to acceptance. Low binding capacity of *Usung Ikpong* prepared by pounding only cooked fresh cocoyam corms constitute the most important reason for adding any gelling agent to improve its texture and gain acceptance. Fufu or gari can be used, but the most often used binder is gari, especially yellow gari (prepared with added palm oil), being the most common type available and consumed in the region.
Also, the presence of anti-nutrients, especially oxalate underscores the nutritive value of cocoyam based dishes by interfering with nutrient bioavailability as well as conferring acridity and a bitter-astringent taste to cocoyam dishes (Owusu-Darko *et al*., 2014; Coronell-Tovar *et al*., 2019). When consumed beyond certain threshold, these anti-nutrients can pose serious harmful health effects in consumers (Boakye *et al*., 2018; Coronell-Tovar *et al*., 2019). Besides, cocoyam is a seasonal food and most likely to run out of supply during the off season except properly processed and preserved for future use. It is therefore important to produce cocoyam into safe and suitable forms that will reduce the drudgery usually associated with its preparation and also determine the level of a binding factor that can be used to produce an attractive blend thereby increasing its acceptability and wide consumption. This study was therefore aimed at assessing the nutritional and sensory properties of *Usung Ikpong* produced from cocoyam and cassava flour blends.

MATERIALS AND METHODS

Raw Materials Procurement

Cocoyam corms and cassava tubers were obtained from selected households in Ikot Akpan Abia, Uyo Local Government Area of Akwa Ibom State. Freshly harvested cocoyam corms, along with the stem and leaves were taken to the Department of Botany and Ecological Studies, University of Uyo for identification and authentication by a Taxonomist. Cassava tubers were freshly harvested while cocoyam corms had been harvested and kept for a period ranging from 4-8 months before use.

Production of Cocoyam Flour

Cocoyam flour was processed according to the method described by Obiegbuna *et al.* (2013). The corms were washed to remove dirt, peeled and rewashed under running water. Peeled cocoyam corms were sliced into 0.5 cm in thickness, blanched for 5 min and oven dried using Samsung Chef (NX58H9500WS/AA, USA) oven at 60 °C until dry and crispy when broken. Dehydrated corms were thereafter milled into flour using grinding mill with petrol engine and stored in air-tight containers. Package flour was kept at room temperature (29±2 °C) for further use.

Processing of Cassava into High Quality Cassava Flour (HQCF)

Cassava flour was processed according to the method described by Oti *et al.* (2010). Fresh cassava tubers were sorted, peeled and thoroughly washed with clean running water and grated. The resultant mash was put in a clean sack and allowed to ferment for 48 h. Fermented mash was dewatered in a manual screw press, crushed and sieved using stainless steel sifter. The sieved grit was spread in very thin layer in trays and sundried until completely dry when rubbed on the palm. Dried cassava grit was milled using a grinding mill with petrol engine. The resultant product was packaged into zip-lock bags and stored at room temperature (29±2 °C) for further use.

Production of Gari

Fresh cassava tubers were sorted, peeled and thoroughly washed with clean running water and grated. The resultant mash was put in a clean sack and allowed to ferment for 48 h. Fermented mash was dewatered in a manual screw press, crushed and sieved using stainless steel sifter. The resultant grit was toasted to produce gari.

Determination of Standard Recipe
Raw cocoyam corms and some quantity of gari were given to nine (9) indigenous home makers (women) who were acquainted with the proper method of preparing *Usung Ikpong*. The women were selected from different rural communities across nine LGAs (3 from each senatorial district) in the state. This semi-focused group research was carried out to establish the ratio of cocoyam to gari (on weight basis) usually used in preparing the dish. The recipes collected from individual home makers were then used to derive a standard recipe using an established method of recipe standardization (Ericson, 1960).

Treatment Groups
The study adopted a total of six treatment groups as shown in Table 1. The first group was prepared by pounding cooked fresh cocoyam corms. The remaining five (5) groups were prepared using cocoyam-cassava flour blends. Thus, *Usung Ikpong* prepared from cocoyam-cassava flour blends comprised 0%, 5.66%, 10.71%, 15.25% and 19.35% cassava flour respectively. The amount of cassava flour providing an equivalent quantity of starch in gari used in the standard recipe was used to replace gari as gelling agent in the treatment groups. Since gari contains an approximate starch content of 48% (Ogbo and Okafor, 2015), the quantity of gari used in the standard recipe was calculated to have 72% starch. Cassava flour on the other hand has an average starch content of 84% (Fakir *et al*., 2012). The quantity of cassava flour that gives 72% starch was derived to be 86 g.

Table 1: Treatment Groups

Sample	Label	Cocoyam Flour (g)	Cassava Flour (g)
A	*Usung Ikpong* prepared from cooked fresh cocoyam	700	-
B	*Usung Ikpong* prepared from 100% cocoyam flour	700	0
C	*Usung Ikpong* prepared from 94.34% cocoyam and 5.66% cassava flour blend	700	42
D	*Usung Ikpong* prepared from 89.29% cocoyam and 10.71% cassava flour blend	700	84
E	*Usung Ikpong* prepared from 84.75% cocoyam and 15.25% cassava flour blend	700	126
F	*Usung Ikpong* prepared from 80.65% cocoyam and 19.35% cassava flour blend	700	168

Preparation of *Usung Ikpong*
Usung Ikpong prepared from fresh cocoyam was prepared by cooking fresh cocoyam after peeling, washing, and cutting into sizable portions. When done, the cooked cocoyam was pounded in a mortar to smooth paste. The pounded cocoyam paste (swallow) was then used as *Usung Ikpong* prepared from fresh *cocoyam*. *Usung Ikpong* prepared from cocoyam and cassava flour blends were prepared by pouring each measured cocoyam-cassava flour blends into a pot containing 150 ml of boiling water and stirred continuously until a smooth cooked paste was obtained. The paste was allowed to cook for 10 min and stirred again to obtain a uniform consistency before the fire was put off.

Determination of Proximate Composition
The proximate compositions of samples were determined using standard methods described by AOAC (2005). Parameters analyzed were moisture, crude protein, fat, crude fibre, ash and carbohydrates. Actual moisture content of samples on fresh weight basis and residual moisture of samples were used to obtain a moisture conversion factor which was used to obtain the nutrient contents of samples on fresh weight basis. Carbohydrate was obtained by difference method. Energy values of the samples were calculated in kilojoules.

Mineral Analyses
Mineral elements were determined using wet digestion method described by AOAC (2005). The digest was made up to 100 ml deionized water and resultant solution stored in clean plastic bottles for determination of elemental composition. Calcium, magnesium, iron, zinc and copper contents were determined on the aliquots of the solutions of the ash by atomic absorption spectrophotometer (Pye-Unicam SP900, England). Potassium, sodium, and manganese

contents were determined by flame photometry method, while phosphorus was determined by the molybdovanadate method.

Determination of Anti-nutrients

Anti-nutrient compositions of samples were determined using standard procedures. Extraction of cyanide content was done according to Alkaline Picrate Method-the Wang and Filled Method described by Williams, (1979). Saponin was determined using the Double Solvent Extraction Method (Harbone, 1973). The Folin-Denis Spectrophotometric method described by Pearson (1976) was used for determination of tannins. Oxalate was determined using the method outlined by Sanchez-Alonso and Lachica (1987). Phytic acid was determined by the method of McCance and Widdowson (1953).

Sensory Evaluation

A panel of twenty untrained persons was asked to describe the sensory attributes of samples for appearance, colour, texture, taste, flavor and overall acceptability. Panelists were given water to rinse their mouth between each test. Sensory evaluations of samples were performed using a 9-point hedonic scale ranking, where 9 represented like extremely and 1 represented dislike extremely.

Statistical Analysis

Results of all determinations were expressed as means of triplicate values. Data were subjected to one-way Analyses of Variance (ANOVA) to assess differences in mean values. Further post-hoc test, using Duncan multiple test range was used to test significant differences among means at 5% level of probability ($p < 0.05$). An IBM SPSS statistical package (version 22.0) was used for the statistical analysis.

RESULTS

Standard Recipe for *Usung Ikpong*

Table 2 presents the findings on recipe standardization of *Usung Ikpong*. It was revealed that women used 700 g fresh cocoyam and 150 g gari in preparing *Usung Ikpong* during the recipe standardization exercise. Thus, the standard recipe of *Usung Ikpong* as consumed by indigenous people of Akwa Ibom State was obtained as shown in Table 2.

Table 2: Standard Recipe for *Usung Ikpong*

S/N	Foodstuff	Quantity
1.	Cocoyam	700 g
2.	Gari	150 g

Proximate Composition and Energy Contents of *Usung Ikpong* prepared from Cocoyam-Cassava Flour Blends

Results of proximate compositions and energy contents of samples are presented in Table 3. Sample A had significantly higher moisture (82.04%) and fat (0.16%) contents but lower fibre (0.13%), protein (1.38%), carbohydrate (16.09%) and energy (302.91%) values compared to samples prepared from cocoyam and cassava flour blends. For samples prepared from cocoyam and cassava flour blends, sample E had significantly lower value (65.89%) of moisture content than others. Ash content was significantly higher in sample C (0.37%) than in other samples except sample B (0.36%). Sample C (0.29%) had the highest value for fibre content, followed by sample B (0.23). Others had significantly lower values of fibre contents. Protein values were significantly higher in samples C (3.88%) and B (3.84%), while E had the lowest value of 2.09%. Carbohydrate and energy values increased progressively across the groups, with sample B having the lowest values while sample F had the highest values.

Table 3: Proximate Composition (%) and Energy Content (kj) of *Usung Ikpong* made from Cocoyam-Cassava Flour Blends (fresh weight basis)

	Sample					
Parameter	**A**	B	C	D	**E**	F
Moisture	82.04^{c}±0.02	70.57^{b}±0.01	68.09^{b}±0.02	67.43^{ab}±0.01	65.89^{a}±6.37	66.76^{ab}±0.01
Ash	0.20^{a}±0.01	0.36^{bc}±0.02	0.37^{cd}±0.01	0.32^{ab}±0.02	0.34^{b}±0.00	0.30^{a}±0.01
Crude Fiber	0.13^{a}±0.01	0.23^{c}±0.01	0.29^{d}±0.01	0.22^{b}±0.01	0.22^{b}±0.01	0.20^{b}±0.01
Crude Protein	1.38^{a}±0.17	3.84^{d}±0.17	3.88^{d}±0.04	2.44^{b}±0.17	2.58^{c}±0.10	2.09^{b}±0.20
Crude Fat	0.16^{e}±0.01	0.05^{b}±0.00	0.12^{c}±0.01	0.05^{b}±0.01	0.17^{d}±0.10	0.03^{a}±0.00
Carbohydrate	16.09^{a}±0.16	25.67^{b}±0.17	27.25^{c}±0.11	29.54^{d}±0.19	30.8^{d}±0.00	30.62^{e}±0.16
Energy	302.91^{a}±0.11	503.52^{b}±0.10	535.65^{c}±0.07	545.51^{d}±0.07	573.75^{e}±0.13	557.18^{d}±0.09

Mean of triplicate ± standard deviation. Values with different letters in the same row are significantly different ($p < 0.05$).

A: Usong Ikpong prepared from fresh cocoyam; B: Usung Ikpong prepared from 100% cocoyam; C: Usung Ikpong prepared from 94.34% cocoyam and 5.66% cassava flour blend; D: Usung Ikpong prepared from 89.29% cocoyam and 10.71% cassava flour blend; E: Usung Ikpong prepared from 84.75% cocoyam and 15.25% cassava flour blend; F: Usung Ikpong prepared from 80.65% cocoyam and 19.35% cassava flour blend.

Mineral Compositions of *Usung Ikpong* made from Cocoyam and Cassava Flour Blends

Results on mineral compositions of samples are presented in Table 4. Sample A had significantly lower values for calcium (7.67 mg/100 g), magnesium (3.60 mg//100 g), potassium (0.71 mg/100 g), and sodium (2.95 mg/100 g) but significantly higher value for zinc content (0.07 mg/100g) compared to samples prepared from cocoyam and cassava flour blends. For samples prepared from cocoyam and cassava flour blends, calcium and phosphorus contents were significantly higher in sample B (14.93 mg/100 g and 8.08 mg/100 g respectively), followed by sample C (12.74 mg/100 g and 6.73 mg/100 g respectively) compared to others. Magnesium content decreased significantly and progressively across the group, with sample B (8.59 mg/100 g) and F (7.85 mg/100 g) having the highest and lowest values respectively. Sample B (3.53 mg/100 g), followed by C (2.32 mg/100 g) had significantly higher potassium values than others. Samples C (8.81 mg/100 g), followed by sample B (6.42 mg/100 g) had significantly higher sodium contents, though the lowest value was recorded for sample D and E. While zinc was not detected in samples D and E, Sample C (0.05 mg/100 g) had significantly higher values than others. Iron content was significantly higher in sample C (0.07 mg/100 g), followed by sample B (0.06 mg/100 g), while the lowest value was recorded for sample D (0.03 mg/100 g). Copper was not detected in any sample. Manganese was detected in only few samples, with sample F (0.02 mg/100 g) having significantly higher value than others.

Table 4: Minerals (mg/100g) and Anti-Nutrients (mg/100g) Compositions of *Usung Ikpong* prepared from Cocoyam and Cassava Flour Blends

			Sample			
Mineral Element	**A**	**B**	**C**	**D**	**E**	**F**
Calcium	7.67^{a}±0.00	14.93^{d}±0.13	12.74^{c}±0.01	12.32^{b}±0.02	12.22^{b}±0.01	11.52^{b}±0.01
Phosphorus	3.11^{a}±0.00	8.08^{e}±0.01	6.73^{d}±0.01	3.86^{b}±0.01	3.57^{ab}±0.00	4.76^{c}±0.00
Magnesium	3.60^{a}±0.00	8.59^{f}±0.00	7.85^{e}±0.06	7.57^{d}±0.02	7.33^{c}±0.01	6.63^{b}±0.03
Potassium	0.71^{a}±0.00	3.53^{d}±0.01	2.32^{c}±0.00	1.88^{b}±0.00	1.83^{b}±0.02	1.81^{b}±0.00
Sodium	2.95^{a}±0.00	6.42^{d}±0.02	8.81^{f}±0.01	4.15^{b}±0.01	4.95^{b}±0.01	5.27^{c}±0.02
Zinc	0.07^{d}±0.00	0.03^{b}±0.01	0.05^{c}±0.00	0.00^{a}±0.00	0.00^{a}±0.00	0.02^{b}±0.01
Iron	0.01^{a}±0.01	0.06^{bc}±0.00	0.07^{d}±0.00	0.03^{a}±0.00	0.05^{b}±0.00	0.05^{b}±0.01
Copper	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
Manganese	0.01^{b}±0.00	0.01^{b}±0.01	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00	0.02^{c}±0.00
Anti-Nutrients						
HCN	0.19^{a}±0.11	0.35^{c}±0.00	0.61^{e}±0.01	0.27^{b}±0.00	0.59^{d}±0.00	0.54^{d}±0.00
Saponin	1.33^{c}±0.11	0.85^{ab}±0.17	0.65^{a}±0.06	1.30^{c}±0.02	1.41^{cd}±0.01	2.07^{d}±0.01
Tannin	0.19^{a}±0.11	0.93^{c}±0.00	0.37^{b}±0.19	1.54^{d}±0.01	1.58^{d}±0.01	0.85^{c}±0.00
Oxalate	68.45^{a}±2.27	82.91^{bc}±1.60	92.03^{c}±1.37	79.79^{b}±3.08	71.67^{a}±2.26	79.80^{b}±3.08
Phytate	0.40^{a}±0.05	0.94^{d}±0.01	1.46^{e}±0.05	0.94^{d}±0.03	0.58^{b}±0.05	0.67^{c}±0.05

Mean of triplicate ± standard deviation. Values with different letters in the same row are significantly different ($p < 0.05$).
A: Usong Ikpong prepared from fresh cocoyam; B: Usung Ikpong prepared from 100% cocoyam; C: Usung Ikpong prepared from 94.34% cocoyam and 5.66% cassava flour blend; D: Usung Ikpong prepared from 89.29% cocoyam and 10.71% cassava flour blend; E: Usung Ikpong prepared from 84.75% cocoyam and 15.25% cassava flour blend; F: Usung Ikpong prepared from 80.65% cocoyam and 19.35% cassava flour blend.

Anti-Nutrients Contents of *Usung Ikpong* Prepared with Cocoyam-Cassava Flour Blends

Results on anti-nutrients are presented in Table 4. Sample A had significantly lower values for HCN, saponin, (except sample C), tannin, oxalate, (except sample D) and phytate. For samples prepared from cocoyam and cassava flour blends, sample C (0.61 mg/100 g), followed by sample B (0.35 mg/100 g) had significantly higher values for HCN compared to others. Sample C (0.65 mg/100 g), followed by sample B (0.85 mg/100 g) had significantly lower saponin values than others. Sample C had significantly lower value for tannin (0.37 mg/100 g) but the highest values for oxalate (92.03 mg/100 g) and phytate (1.46 mg/100 g) than all other samples, $p < 0.05$.

Sensory Characteristics of *Usung Ikpong Prepared* from Cocoyam-Cassava Flour Blends

Results of sensory evaluations are presented in Table 5. All samples scored similarly in appearance. Sample F scored significantly higher than all others in texture. Although, samples B and E scored a little higher than others in taste, the differences were not statistically significant. Sample D scored a little higher (2.70 ±1.56) in flavor than samples B (2.50±1.08), C (1.50±0.84), E (2.30 ±1.25) and F (2.00 ±1.24), but significantly lower than sample A (3.80 ±1.39). For overall acceptability, sample A scored significantly higher than others.

Table 5: Sensory Characteristics of *Usung Ikpong* with Cocoyam-Cassava Flour Blends

	Sensory Attribute				
Sample	**Appearance**	**Texture**	**Taste**	**Flavour**	**Overall Acceptability**
A	3.30^{a}±1.70	2.00^{a}±1.24	3.60^{b}±1.34	3.80^{b}±1.39	7.30^{b}±2.35
B	2.00^{a}±0.82	2.50a±1.84	2.50^{ab}±1.90	2.50^{a}±1.08	2.00^{a}±1.15
C	3.40^{a}±2.31	2.60^{a}±0.96	2.20^{a}±0.91	1.50^{a}±0.84	2.60^{a}±0.84
D	2.40^{a}±0.96	2.30^{a}±1.05	2.20^{a}±1.03	2.70^{ab}±1.56	2.00^{a}±0.94
E	2.60^{a}±0.96	2.80^{a}±1.39	2.50^{ab}±1.35	2.30^{a}±1.25	2.10^{a}±1.28
F	3.40^{a}±2.06	7.00^{b}±2.62	2.30^{a}±1.05	2.00^{a}±1.24	2.20^{a}±1.54

Mean of triplicate ± standard deviation. Values with different letters in the same column are significantly different ($p < 0.05$). Mean of triplicate ± standard deviation. Values with different letters in the same row are significantly different ($p < 0.05$).
A: Usong Ikpong prepared from fresh cocoyam; B: Usung Ikpong prepared from 100% cocoyam; C: Usung Ikpong prepared from 94.34% cocoyam and 5.66% cassava flour blend; D: Usung Ikpong prepared from 89.29% cocoyam and 10.71% cassava flour blend; E: Usung Ikpong prepared from 84.75% cocoyam and 15.25% cassava flour blend; F: Usung Ikpong prepared from 80.65% cocoyam and 19.35% cassava flour blend.

DISCUSSION

This study was carried out to evaluate the nutritional and sensory properties of *Usung Ikpong* produced from cocoyam and cassava flour blends. Generally, it was observed that, products prepared with fresh cocoyam had higher moisture but lower nutrient contents than products prepared with flour blends. This was probably due to the fact that, the fresh cocoyam has more moisture which contributed to the weight of the raw material than flours (which have less moisture but more of food material). Higher nutrient values of both macro and micronutrients in *Usung Ikpong* prepared from flour blends is a positive outcome that can encourage and convince consumers about the nutritional benefits of *Usung Ikpong* produced from either cocoyam flour or the combination of cocoyam and cassava flour blends, compared with that produced from fresh pounded cocoyam. Increasing moisture contents of products with lower proportion of cassava flour in samples can be taken advantage of when swallow with softer consistency is desirable.

Values obtained for nutrients (especially macronutrients) in *Usung Ikpong* produced from cocoyam and cassava flour blends in this study were somewhat comparable to those of gari (eba), fufu and pounded yam (common swallows consumed in Nigeria) (Sanusi *et al*., 2017). The moisture, carbohydrate, ash and calcium contents of *Usung Ikpong* produced from cocoyam and cassava flour blends all had similar values with those reported for the common swallows (gari, fufu and pounded yam); fat, crude fibre and most micronutrients contents were lower while protein value was higher than other swallows (Sanusi *et al*., 2017). Cocoyam is known for its comparatively higher nutrient profiles in terms of protein digestibility and mineral composition than other tubers (Wada *et al*., 2019). *Xanthosoma Spp* in particular serves as appreciable source of dietary energy, proteins, vitamins and mineral elements including potassium and zinc (Boakye, 2018). Lower nutrient contents, especially those of micronutrients reported in this study can be attributed to a diluting effect from added cassava components in the product, as cassava is a starchy root with minimal micronutrient profile (Salvador *et al*., 2014). However, the nutrient contents (both macro and micronutrients, except zinc, copper and manganese) of samples in this study were within the ranges that can make significant contributions to the daily nutrient recommendations when and if used as part of an overall adequate diet (Institute of Medicine, 2001). Low sodium content of samples in this study is of advantage to enhance minimal intake of sodium among consumers.

Cassava is a starchy root crop, known for its high carbohydrate content, but low in other macro- and micro-nutrients except vitamin C which is usually found in relatively high amount (Salvador *et al*., 2014). Nutrient compositions tended to decrease with increasing proportions of cassava flour in the samples, with samples prepared with either 100% cocoyam flour or that prepared from 94.34% Cocoyam and 5.66% cassava flour blend having higher values. This implies that, cocoyam (*Xanthosoma Spp*), if processed into flour with minimal quantity of a gelling agent can still confer its maximum nutritional benefits and subsequently increase its utilization.

The range of values obtained for anti-nutrients in this study (except oxalate) were relatively low. Usually, foods with high level of anti-nutrients are often regarded to be of low nutritive value due to detrimental effects of anti-nutrients on both nutrient bioavailability and general well- being of consumers. It has been shown in previous studies that, processing can lead to significant reductions in anti-nutrient levels in cocoyam based products (Lewu *et al*., 2010; Ukom and Okerue, 2018). The low profile of anti-nutrients in cocoyam products observed in this study may be due to the various processing activities including blanching, drying and eventual cooking. Also, the cassava flour which had undergone the process of grinding, fermentation and dehydration could have lent some diluting effect to the final products produced from cocoyam and cassava flour blends. Lower levels of anti-nutrients in samples give some assurance of nutrients bioavailability from the products as well as consumer safety from harmful side effects from such food components.

There were similarities in sensory properties of samples in this study. All samples had similar appearance. Preference for texture in sample prepared with the highest proportion of cassava flour was probably due to the gelling effect of cassava in the product; the very reason most consumers add gari to fresh cocoyam when pounding. Lower ratings for taste in samples prepared from flour blends can be attributed to changes resulting from processing, especially the dehydration process. Sun drying had been implicated in poorer organoleptic ratings for color, aroma, taste, and overall acceptability in okra (Falade and Omojola, 2008).

CONCLUSIONS AND RECOMMENDATIONS

Usung Ikpong prepared from cocoyam and cassava flour blends particularly that prepared from 94.34% cocoyam and 5.66% cassava flour blend, (product with minimal gelling agent) can serve as a nutritious dish, especially when used as part of an overall adequate intake. It can be consumed without undue concerns over consumer safety and issues of nutrient bioavailability from anti-nutritional factors. It can also serve as a convenient replacement (with better nutrient density and comparative sensory attributes) for fresh pounded cocoyam which is usually associated with drudgery in preparation and acridity from consumption. Increased consumption of *Usung Ikpong* prepared from flour blends should therefore be encouraged to increase the utilization of cocoyam, especially *Xanthosoma atroviren.*

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