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Variations in the Nutritive Metal Contents of Cocoyam Flour and Quality Assessment of its Baked Products from Composite Flours

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Abstract
Variations in the nutritive metal contents of two cocoyam flours and the quality of their baked products from composite flours were assessed in this study. The two varieties of cocoyam (Colocasia esculenta and Colocasia antiquorum) used in this study were obtained from Egbeda Market Osogbo, Osun State, Nigeria. Wheat flour and other ingredients used were purchased at Orisunbare Market Osogbo, Osun State, Nigeria. Proximate, phytate, oxalate and hydrocyanic acid analyses were carried out by standard methods while the heavy metals content was done by the use of Atomic Absorption Spectrophotometer (AAS). All other parameters were carried out by standard methods. From the result, the values of proximate analyses of the two cocoyam varieties were not significantly different. Colocasia antiquorum having the values of 42.06mg±0.08/100mg for phytate, 0.39±0.01mg/100mg for oxalate and 1.26±0.02mg/100mg for hydrocyanic acid, had a higher toxicant value in the flour in all parameters determined. The elemental analyses of the flour from different species of cocoyam were significantly not different. The bread and cake samples produced from C. esculenta and C. antiquorum species of cocoyam flour were comparable to bread and cake produced from wheat flour under the same condition except for their binding properties, weight and shelf life. Thus, cocoyam can be used for the production of bread and cake if a suitable binder is incorporated into the ingredients.

Keywords: *Colocasia esculenta*, *Colocasia antiquorum*, Elemental analyses, Proximate analysis, Cake Maize

Introduction
Food is very essential to human body, as a source of nutrient. Food nutrients comprise carbohydrate, lipids, proteins, minerals, vitamins and water. Though food may be derived from plant and animals, plant is the only living organism that is capable of carrying out photosynthesis and is the major source of food in nature's chain (Byerlee and Sain, 1991). Food of plant origin may be classified into cereals, roots and tubers, sugars and syrups, legumes, pulses, nuts and oil seeds, vegetables and fruits (Eddy et al., 2007). Roots and tubers used as food include yams, cassava, potatoes, sweet potatoes and cocoyam (FAO, 1970). Roots and tubers have a high moisture content resulting in short storage life under ambient conditions and because of these, they are highly perishable and huge losses can occur after harvest (Akpan and Umoh, 2004). Roots and tubers contribute about 20-48% of the total calories and about 7.1% protein to the diets of the people of sub-Saharan Africa. In Nigeria, they are the main sources of calories accounting for over 50% of the caloric intake of the people of the south. Yam has less than 6% protein while cassava is a poor source of protein, less than 3%. Cocoyam is fair in protein, 7-9% and calcium (Eddy et al., 2012). Sweet potatoes are poor in protein but fair in their supply of the β-vitamins. Therefore, cocoyam has some nutritional advantages over the other root and tubers crops (Eddy et al., 2012). The most popular and widely consumed species of cocoyam are those of the genus Colocasia, Xanthosoma, Alocasia, Caryotosperma chamissonis and the Amophophallu scampanulatus and their chemical constituents vary with varieties (Eze and Okorji, 2003).

Colocasia esculenta, also known as "taro" (red cocoyam) is a well-known food plant that has a long history of cultivation. Its corms are an important source of starch. Cultivars of two species Colocasia esculenta, taro and Colocasia antiquorum (white cocoyam) are generally grown for food. It is consumed in homes, especially during periods preceding the yam harvest, which underscores its importance as a possible substitute for yam (Ajijola et al., 2003). It is used essentially the same way as yam, although it is not as highly valued. Taro is a perfect complementary element for all sorts of meals, as it offers vitamins and soluble fibres (Ndabikunze et al., 2011; Niba, 2003). Cocoyam ranks third in importance after

cassava and yam among the root and tuber crops that are cultivated and consumed in rural areas by the elderly in Nigeria. The crop is no longer favoured in urban homes due to poor information about its nutritive values (Onyeka, 2014). This widespread ignorance of the nutritive value and diversities of food forms of cocoyam is a major problem for the general acceptability and extensive production of the crop. Exploring the dietary nature of cocoyam and making awareness on the nutritive quality and conceivable industrial potential would intensify the use of cocoyam and its products locally and industrially (Okoye et al., 2006; Adejumo and Bamidele, 2012). The main nutrient supplied by cocoyam, as with other roots and tubers, is dietary energy provided by its carbohydrate content (Eze and Okorji, 2003).

Cocoyam is rich in some micro elements including P, Mg, Zn, etc., fairly high in crude proteins, carotene, ascorbic acid, thiamin, riboflavin and nicotinic acid, rich in ash, low in fibre and is not a fair source of oils and fats (Eddy et al., 2012). Observing the dietary nature of cocoyam, the high starch content and its quality (i.e. fine starch grains), the degree of utilization of cocoyam and its products when contrasted with other root and tubers crops both locally and industrially is pretty low (Eddy et al., 2012). The idea that cocoyam is a "poor man food" has been established in most Nigerian homes such that some are not comfortable to be found in the act of consuming cocoyam. Malnutrition in Nigeria and other developing nations is traced to the consumption of low quality and quantity of food (Shittu et al., 2007).

Lately, attempts have been made by the Federal Government of Nigeria (through its agencies such as Raw Materials Development and Research Institute, Abuja) towards the improvement of composite bread utilizing a blend of wheat flour and cocoyam flour (Eddy et al., 2012) as an alternatives to whole wheat bread consumption by diabetic patients. The combination of cocoyam-wheat flour could be used in the industrial production of baked foods, noodles, and weaning foods. It is well documented in the literature that blends of cocoyam and wheat flour will improve the nutritive quality of the protein (Davidson et al., 1979; Bradbury and Singh, 1986). The dietetic value of cocoyam-wheat flour blends is enormous in many hospitals, especially in Nigeria. Dieticians in Africa will find the combination of cocoyam and wheat highly valuable in the treatment of malnutrition and other chronic diseases that depend on vegetable proteins. The production of this type of blend will increase the consumption of cocoyam and wheat for better nutritional status of all age groups.

According to Apotiola and Fashakin (2013), the food industries are faced with the challenge of producing food products containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges, hence, there is a large demand for healthier food and not just empty food. Cocoyam has shown itself as an integral part of the African food with its large reservoir of nutrients, it is estimated that cassava provided about 40% of the calories consumed in Africa (UNICEF, 1991). In view of this, it is important to know the percentage at which cocoyam composite flour is acceptable to the public when used as a baking ingredient and its nutritional value. Knowledge of this can ensure healthier foods for consumers and in turn create a market for cocoyam in a developing nation such as Nigeria and lead to diversification of the major food crops in Nigeria. Also, this work intends to explore the nutrients present in the flours obtained from two varieties of cocoyam and the level of acceptance of their products when mixed with whole wheat by a selected group of people.

Materials and Methods

Procurement of Experimental Materials

The two varieties of cocoyam (Colocasia esculenta and Colocasia antiquorum) used in this study were obtained from Egbeda Market Osogbo, Osun State, Nigeria. Wheat flour and other ingredients used were purchased at Orisunbare Market Osogbo, Osun State, Nigeria

Chemical Analyses

Samples for determination of wet analysis (moisture content) were used immediately after harvest while those for dry weight analysis were washed, peeled, sliced and allowed to dry in the sun for ninety-six hours till they became brittle. They were then blended to powder using Moulinex blender, stored in air-tight bottles labeled and kept in a cool dry place. De-ionized water was used wherever applicable. The ground samples comprised whole corms and cormels in fairly equal proportions.

Preparation of Cocoyam Flour

The cocoyam flour was prepared by peeling and slicing the corms and cormels of the cocoyam and then washed thoroughly in water so as to remove as much mucilaginous materials as possible. After

washing, the sliced cocoyam was soaked in water overnight, it was then rewashed and finally immersed for three hours in 0.25% bisulphate solution. They were blanched in boiling water for 4-5 minutes, later drained and sun dried for 72hours. The dried slices were ground, sieved to 40 – 50 mesh and then stored.

Proximate Analysis on Sample

The moisture, fat, protein, ash, and crude fibre contents were determined using Association of Official Analytical Chemists (AOAC 2005) methods. The carbohydrate content was determined by the difference between 100 and the total sum of the percentage of fat, moisture, ash, crude fibre, and protein content (Birt et al., 2005).

Determination of Toxicants

Phytate determination was carried out by method described by Latta and Eskin (1980), the oxalate determination was carried out by the modified method described by Adeniyi et al., (2009), which was previously described by Oke (1966): 2 g of the sample was digested with 10 ml 6 M HCl for one hour and made up to 250 ml in a volumetric flask. The pH of the filtrate was adjusted with conc. NH4OH solution until the colour of solution changed from salmon pink colour to a faint yellow colour. Thereafter, the filtrate was treated with 10 ml of 5% CaCl2 solution to precipitate the insoluble oxalate. The suspension is now centrifuged at 2500 rpm, after which the supernatant was decanted and precipitate completely dissolved in 10 ml of 20% (v/v) H2SO4. The total filtrate resulting from the dissolution in H2SO4 is made up to 300 ml. An aliquot of 125 ml of the filtrate was heated until near boiling point and then titrated against 0.05 M of standardized KMnO4 solution to a faint pink colour which persisted for about 30 s after which the burette reading was taken. The oxalate content was evaluated from the titre value. The hydrocyanic acid determination was carried out by the method described by Anhwange et al., (2011).

Elemental Analysis

The mineral content in each sample was analysed using atomic absorption spectrophotometer (AAS) fitted with a hollow cathode lamp and a fuel-rich flame (air-acetylene) following the AOAC (2005) procedure.

Determination of Carotenoids

The carotenoids extraction and determination was carried out by following the method as described by (Takagi, 1985).

Bread Making

The straight dough method was used in the baking operation. This involved the mixing of the paste (cocoyam and wheat flour) with other ingredients at different proportions namely; sugar (6%), yeast (1%), baking powder (1.5%) and water. This was closely followed by kneading process which was done by the kneading machine to ensure better crumb quality of the bread. After the kneading, the dough was cut into the required weights and then moulded into the pans, allowed to rest and then leavened by the yeast in a warm room. This is called fermentation stage which determines good or poor rising of the dough. With good formulation, mixing, kneading and favourable condition at the fermentation/proofing stage, the loaves surely turned out good at the baking stage. The dough at the fermentation stage was allowed to stay for six hours and the oven temperature was set at 600℃ for forty minutes before taking out the bread. The different flour mixture ratios include: 100% wheat, 95% wheat and 5% cocoyam, 90% wheat and 10% cocoyam, 85% wheat and 15% cocoyam, 80% wheat and 20% cocoyam.

Physical Properties of Bread

Bread characteristics were evaluated by measuring the loaf weight, loaf volume and specific loaf volume. Loaf weight was measured 30 minutes after the loaves were removed from the oven using a weighing balance whereas loaf volume was measured using the rapeseed displacement method as modified by (Giami et al., 2004) as follows: (The pearled barley was used in place of rapeseed). A box of fixed dimensions (23.00 x 14.30 x 17.21 cm) of internal volume 5660.37 cm3 was put in a tray, half filled with pearled barley, shaken vigorously 4 times, then filled till slightly overfilled so that overspill fell into the tray. The box was shaken again twice, and then a straight edge was used to press across the top of the box once to give a level surface. The seeds were decanted from the box into a receptacle and weighed. The procedure was repeated three times and the mean value for seed weight was noted (C g). A weighed loaf was placed in the box and weighed seeds (3500 g) were used to fill the box and levelled off as before. The overspill was weighed and from the weight obtained, the weight of seeds around the loaf and volume of seed displaced by the loaf were calculated using the following equations by AACC method 10-05.01 (AACC, 2002):

Seeds displaced by loaf (L) = C g + overspill weight – 3500 g.

Volume of loaf (V) = (L ×5660.37 〖 cm〗 ^3)/C

The specific loaf volume was determined by dividing the loaf volume by its corresponding loaf weight (cm3/g) as described by (Araki et al., 2009).

Cake Making

This involved the mixing of the paste (cocoyam-wheat flour) with other ingredients namely; fat (62.5%), sugar (37.5%), baking powder (2.5%), egg (75%) at different proportions. The fat and sugar were mixed first so as to ascertain a level of uniformity followed by the other ingredients. After the mixing, the dough was cut into required weights and moulded into the pans. The dough was baked in the oven at a temperature of about 500C before taking out the cake.

The different flour mixture ratios include: 100% wheat, 95% wheat and 5% cocoyam, 90% wheat and 10% cocoyam, 85% wheat and 15% cocoyam, 80% wheat and 20% cocoyam.

Sensory Analysis of Bread and Cake from Wheat and Cocoyam Flour. All baked breads and cakes were evaluated using a panel judges consisting of 5 people. A 5-point hedonic scale as recommended by (Amerine et al., 2013) was used for the assessment to evaluate the colour, texture, odour, taste and the overall acceptability of products. In this scale, 5 represents extremely liked, 4 represents partially liked, 3 represents extremely disliked, 2 represents partially disliked while 1 represents neither liked nor disliked for the evaluation of taste, odour, texture, colour and overall acceptability.

Statistical Analysis

The proximate composition, toxicants and elemental analysis were carried out in triplicate. Data obtained was analysed statistically using analysis of variance (ANOVA) at 5% probability level as described by Steel and Torrie (Steel & Torrie, 1960).

Results and Discussion

Table 1 represents the results obtained from the proximate analysis of two (2) cocoyam flour samples obtained from Colocasia esculenta (CE) (red cocoyam) and Colocasia antiquorum (CA) (white cocoyam). Based on the analysis, the two flour samples had relatively high amounts of moisture content, indicating that the samples were prone to microbial attack in the course of storage. It has been reported (Ndabikunze et al., 2011) that the moisture content of C. esculenta obtained from Tanzania and Uganda \were 68.36% and 69.045% respectively. C. esculenta (CE) had moisture content of 70.89% and CA had moisture content of 70.02%. There is no significant difference between the reported cocoyam flour and the estimated cocoyam flour from this study. Moisture content is the amount of water present in a material. Cocoyam like other root crops has high water content. The values of moisture content record for the various species explain the texture and shelf life features. Colocasia antiquorum with less water content keeps longer than the C. esculenta which contains relatively high amount of moisture. So many factors including environmental conditions, age, storage, extent of drying and time of harvest of the samples affect the moisture content of tuber crops (Adegunwa et al., 2011). Some of these factors might have contributed to the difference between the estimated moisture content and values reported by some other authors.

Table 1: Proximate Composition of Two Varieties of Cocoyam Flour

S/N	Parameters	*Colocasia esculenta*	*Colocasia antiquorum*
1	Moisture Content (%)	70.89±0.03[a]	70.02±0.01[a]
2	Ash Content (%)	1.93±0.02[a]	2.02±0.02[a]
3	Crude Protein (%)	5.35±0.01[a]	6.06±0.01[b]
4	Crude Fat (%)	1.28±0.01[a]	1.14±0.00[a]
5	Crude Fibre (%)	1.82±0.03[a]	1.94±0.04[a]
6	Carbohydrates (%)	18.73±0.20[a]	18.82±0.30[a]

Values are means ± standard deviation of triplicate determinations.

The ash content of the two cocoyam varieties (CE and CA) were 1.93% and 2.02%, respectively. Ash content is an indication of the potential source of mineral elements which might be of nutritional importance. Report (Alinnor and Akalezi, 2010) have shown that the ash content of Colocasia esculenta was 1.60%. The observed ash content of CA is somewhat correlated to the reported value. There is a direct proportionality between ash content and mineral element composition and the result obtained were consistent with this trend. According to Sanful and Darko (Sanful and Darko, 2010), roots and tubers are estimated to contain about 8% of protein. (Ciacco and D'Appolonia,

1978), also stated that among the root crops, cocoyam shows better performance in terms of protein. However, the result of the analysis showed that the protein content of CA (6.06%) is higher than that of CE (5.35%) which is closer to the protein value of actual cocoyam flour. The fat contents of the cocoyam species CE and CA are 1.28% and 1.14%, respectively used in this study is relatively higher than the reported value for cocoyam flour which is 1.05% (Alinnor and Akalezi, 2010). Fat serve as a potential source of energy in the body. It can be broken down in the body to release glycerol and fatty acids. The glycerol can be converted to glucose by the liver and used as a source of energy. It can be deduced that cocoyam is not an excellent source of fat.
Perssini and Sensidoni (2009) observed that there is a relatively low yield of dietary fibre in cocoyam. The result of this work shows that the fibre content of CE (1.82%) was lower than the fibre content of CA (1.94%) which was higher than the reported fibre content (1.00%) of CE (Alinnor and Akalezi, 2010). Of the solid nutrient content in roots and tuber crops, carbohydrates predominate (Eddy et al., 2007). The two cocoyam varieties (CE and CA) used for this work have carbohydrate content of 18.73% and 18.82%, respectively. These values are lower than the reported Colocasia esculenta obtained from Tanzania and Uganda which are 24.43% and 21.65%, respectively (Ndabikunze et al., 2011).

Table 2 shows the results obtained from the toxicant analysis of two cocoyam (CA and CE) flour samples. All roots and tubers contain oxalate as calcium oxalate and soluble oxalate (Eka, 1978). The oxalates have been implicated as mechanical defence mechanism, storage reserves and stores of excess calcium (Khattak et al., 1974). Consumption of large doses of oxalic acid causes corrosive gastroenteritis, shock, convulsive symptoms, low plasma calcium, high plasma oxalates and renal damage (Passmore and Eastwood, 1986). Oxalate binds with calcium and prevents its absorption in the alimentary canal. The oxalate bound calcium from other foods to give calcium oxalate which is excreted in the faeces (Goesaert et al., 2005). The peels of tubers contain more oxalate than the peeled tubers; thus, supporting the role of oxalate as allelochemicals. Oxalates are responsible for the formation of kidney stones (Coe et al., 2005). This result showed that the oxalate content of CA is higher than that of CE which are 0.3853 mg/100 g and 0.3156 mg/100 g, respectively.

Table 2: Toxicants in Two Varieties of Cocoyam Flour

S/N	PARAMETER	*Colocasia esculenta*	*Colocasia antiquorum*
1	Phytate (mg/100g), Defatted	35.62±0.12[a]	42.06±0.08[b]
2	Oxalate (mg/100g)	0.32±0.01[a]	0.39±0.01[a]
3	HCN (mg/100g)	0.86±0.02[a]	1.26±0.02[b]

Values are means ± standard deviation of triplicate determinations.

Colocasia antiquorum shows a higher composition of Phytate which was 42.0642 mg/100 g than Colocasia esculenta which was 35.6244 mg/100 g. Phytates have been described as complexes with dietary minerals, especially iron and zinc, and causes mineral-related deficiency in humans. It also negatively impacts protein and lipid utilization (Kumar et al., 2009). However, phytates have also been shown to have some health benefits such as protection against a variety of cancers mediated through anti-oxidation properties, interruption of cellular signal transduction, cell cycle inhibition and enhancement of natural killer (NK) cells activity. It has therapeutic use against diabetes mellitus, atherosclerosis and coronary heart disease and reduces kidney stone formation (Kumar et al., 2009).

Hydrocyanic acid in both CE and CA were low. The values were 0.8636 mg/100 g and 1.2642 mg/100 g, respectively. The lethal dose of cyanide was reported to be 35.0 mg/100 g. This gives cocoyam a safe margin. Goesaert et al., (2005) reported that hydrocyanic acid exerts inhibitory effect at the cytochrome oxidase level in the electron transport chain.

Table 3 shows the elemental analysis of both CE and CA. Consumption of either of the two varieties was beneficial for a normal health. The presence of nutritive metals in both CE and CA has shown that the cocoyam varieties were beneficial for normal health to ensure proper functioning of the cardiovascular system, eye health, and reduces the risk of prostate cancer,

Table 3: Elemental Analysis of Two Varieties of Cocoyam Flour

S/N	SAMPLE IDENTITY	CE	CA
1	Iron (mg/100g)	1.217±0.010	1.265±0.020
2	Manganese (mg/100g)	4.856±0.130	5.126±0.070
3	Zinc (mg/100g)	8.532±0.210	6.668±0.300
4	Lead (mg/100g)	0.001±0.010	0.001±0.020
5	Calcium (mg/100g)	42.985±0.020	39.775±0.030
6	Magnesium (mg/100g)	58.985±0.010	61.144±0.020
7	Potassium (mg/100g)	475.367±0.029	474.046±0.120
8	Sodium (mg/100g)	16.527±0.210	18.043±0.170
9	Nickel (mg/100g)	0.648±0.010	0.595±0.020
10	Cadmium (mg/100g)	0.001±0.001	0.0001±0.00

Values are means ± standard deviation of triplicate determinations.

Type 2 Diabetes and Other Ailments.

Table 4 presents the Carotenoid profile of both the CE and CA. The table shows that a total of about 10 components, in which CE had a higher value in all parameters determined and that of the values where significantly different: Carotene ranged from 404.99 in CE to 50.68 to CA. (Mayne, 1996) described carotene to protect against photo-induced tissue damages, it as well quench highly reactive singlet oxygen. Carotene has been described as a Provitamin A. It protects against photo-induced tissue damage, quenches highly reactive singlet oxygen under certain conditions and can block free radical-mediated reactions (Mayne, 1996). The author further described βeta-Cryptoxanthin as responsible for reducing risk of lung cancer and for proper cardiovascular functioning.

Table 4: Determination of Carotenoids (mg/100 g) in Two Varieties of Cocoyam Flour

S/N	COMPONENTS	*Colocasia esculenta*	*Colocasia antiquorum*
1	Malvidin	2.76×10^{-3}	1.24×10^{-3}
2	Beta-cryptoxanthin	171.11	28.07
3	Lycopene	4.54×10^{-2}	2.12×10^{-3}
4	Carotene	404.99	50.68
5	Lutein	160.77	25.71
6	Xanthophylll	5.59×10^{-4}	2.36×10^{-4}
7	Anthera-xanthin	10.58	2.72
8	Asta-xanthin	11.57	1.83
9	Viola-xanthin	4.61	6.21×10^{-1}
10	Neo-xanthin	1.34×10^{-1}	6.66×10^{-3}

Values are means ± standard deviation of triplicate determinations.

Fiedor and Burda (2014) described Lutein as an oxygen containing carotenoid that plays an important role in eye health by absorbing high energy UV radiation. This shows that a regular meal of Colocasia esculenta ensures a good health far more than Colocasia antiquorum. Asta-xanthin has been described as a helpful carotenoid in treating cardiovascular disorders (Johnson et al., 2009; Polyakov et al., 2001). Lycopene has been described as the most potent agent against prostate cancer (Giovannucci et al., 2002). Malvidin has been described as a carotenoid that protects the cardiovascular system, has a role in tumour cell inhibition. Malvidin acts as a post-conditioning agent being able to elicit cardio-protection against chemical damage (Quintieri et al., 2013).

The result of the physical properties of bread baked at different substitution ratios of wheat to cocoyam is as shown in Table 5. The best bread in terms of loaf weight, loaf volume and specific volume was given by the 100% wheat flour (control) with a specific volume of 3.48cm3/g. This was closely followed by CE with specific volume of 3.16 cm3/g; than CA with specific volume of 3.14 cm3/g. Colocasia esculenta has a better specific volume than CA because it is closer to the 100% wheat flour.

Table 5: Physical Properties of Bread Baked at Different Levels of Wheat and Cocoyam Flours Substitution

Parameters	Loaf Weight (g)		Loaf Volume (cm^3)		Specific Volume (cm^3/g)	
	Colocasia esculenta	*Colocasia antiquorum*	*Colocasia esculenta*	*Colocasia antiquorum*	*Colocasia esculenta*	*Colocasia antiquorum*
100 % Wheat (Control)	185.65		646.32		3.48	
95% W and 5 % C	140.35	137.76	443.15	432.63	3.16	3.14
90% W and 10 % C	144.43	140.20	447.26	434.62	3.10	3.10
85% W and 15 % C	138.80	136.40	433.06	422.84	3.12	3.10
80% W and 20 % C	138.60	134.10	428.27	414.37	3.09	3.09

W = Wheat, C = Cocoyam

The sensory analysis of the baked breads also shows that the control was superior in all sensory characteristics compared with the cocoyam-wheat flour (Table 6). In terms of odour, the 100% wheat flour performed better than any other samples. Wheat-CE had a closer value to the control compared to CE which makes it better. In terms of taste, the control still performed better than the cocoyam substitution. Colocasia antiquorum had better taste compared to CE. Colocasia antiquorum was closer to the value of the 100% wheat flour. In terms of texture, the control has the highest value. Colocasia antiquorum has a closer value to the control compared to CE which makes it better.

Table 6: Sensory Analysis of Bread Baked at Different Levels of Wheat and Cocoyam Flours Substitution

Parameters	Odour		Taste		Texture		Colour		Overall Acceptability	
	RC	*WC*	*RC*	*WC*	*RC*	*WC*	*RC*	*WC*	*RC*	*WC*
100 % Wheat (Control)	5.0		5.0		5.0		5.0		5.0	
95% W and 5 % C	4.8	4.6	4.6	4.8	4.2	4.4	4.8	4.6	4.6	4.8
90% W and 10 % C	4.8	4.8	4.2	4.4	4.0	4.2	3.8	4.6		
85% W and 15 % C	3.8	3.8	3.4	4.0	3.6	4.8	3.6	3.4	3.6	3.8
80% W and 20 % C	4.8	4.8	4.2	4.4	4.0	4.2	3.8	4.6		

W = Wheat, C = Cocoyam

The colour of CE was closer to the control sample implying that in terms of colour rating, this sample is preferred. The change in colour of cocoyam may occur as a result of browning reaction. It was observed that as soon as the peeled raw cocoyams were sliced, they started darkening due to oxidation. This darkening effect is carried into the mixed dough and finally into the bread. The overall acceptability result indicates that the control sample was significantly more acceptable than any other bread samples. This was followed by CA

The sensory analysis of the baked cakes also showed that the control was superior in all sensory characteristics compared with the cocoyam- wheat flour (Table 7). In terms of odour, the 100% wheat flour performed better than any other samples. Colocasia antiquorum had a closer value to the control sample compared to Colocasia esculenta which makes it better. In terms of taste, the control still performed better than the cocoyam substitution. Colocasia antiquorum had better taste compared to Colocasia esculenta. Colocasia antiquorum was closer to the value of the 100% wheat flour. In terms of texture, the control has the highest value. Colocasia esculenta has a closer value to the control compared to Colocasia antiquorum which makes it better. The colour of Colocasia esculenta was closer to the control sample implying that in terms of colour rating, this sample is preferred. The change in colour of cocoyam may occur as a result of browning reaction. It was observed that as soon as the peeled raw cocoyams were sliced, they started darkening due to oxidation. This darkening effect is carried into the mixed dough and finally into the cake.

The overall acceptability result indicates that the control sample (100% wheat flour) was significantly more acceptable than any other cake samples. This was followed by Colocasia antiquorum

Table 7: Sensory Analysis of Cake Baked at Different Levels of Wheat and Cocoyam Flours Substitution

Parameters	Odour		Taste		Texture		Colour		Overall Acceptability	
	RC	*WC*	*RC*	*WC*	*RC*	*WC*	*RC*	*WC*	*RC*	*WC*
100 % Wheat (Control)	5.0		5.0		5.0		5.0		5.0	
95% W and 5 % C	4.4	4.6	4.4	4.6	4.6	4.4	4.8	4.6	4.6	4.8
90% W and 10 % C	4.0	4.0	4.2	4.4	4.6	4.4	4.0	4.6		
85% W and 15 % C	4.6	4.2	4.0	4.8	4.6	4.8	4.8	4.2	3.8	4.0
80% W and 20 % C	4.0	4.0	4.2	4.4	4.6	4.4	4.0	4.6		

W = Wheat, C = Cocoyam

Conclusion

The aim of the study was to analyze samples of Colocasia esculenta and Colocasia antiquorum species of cocoyam for their proximate composition and to utilize the samples for the production of bread and cake. The bread and cake samples produced from Colocasia esculenta and Colocasia antiquorum species of cocoyam flour were comparable to bread and cake produced from wheat flour under the same condition except for their binding properties, weight and shelf life.

Thus, cocoyam can be used for the production of bread and cake if a suitable binder is incorporated into the product. The use of additives that can improve the shelf life of the products shall also offer a promising alternative. The carbohydrate, minerals, protein, fats and oils and vitamins composition of cocoyam bread and cake were quite acceptable and comparable to that of wheat bread and cake produced under similar condition. This study, therefore, recommends that future research should be aimed toward improving the quality of bread and cake produced from cocoyam flour. Research into the utilization of the other species of cocoyam in bread and cake making should be encouraged.

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