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QUALITY EVALUATION AND FUNCTIONAL PROPERTIES OF CAKE PRODUCED FROM BLENDS OF CASSAVA, WHITE AND RED COCOYAM FLOUR

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Abstract
Cakes are convenient food products prepared from flour basically wheat and other principal ingredients and often baked. The need to find alternatives to wheat flour for bakery applications has become crucial, especially in developing countries where wheat is neither grown nor cultivated. White and red cocoyam and cassava were collected for the study. Cake was produced using Ceserani and Kinton 2008 method with some slight modifications. The cake samples were produced from four formulations of flour blends of white, red cocoyam and cassava composite flours. Cake from 100% cassava flour is used as the control. The flour blends were analysed for functional and pasting properties, while the cakes samples were subjected to proximate, mineral and sensory evaluation. Results of the proximate, mineral and sensory analyses significantly increase with increase in the proportion of white and red cocoyam flour with sample D protein (78%), fat (54.23%), and fibre (2.3%) respectively. Major mineral contents in the composite flour were sodium, potassium, zinc and iron while sample D was having the highest mean values. Sensory evaluation indicated that Sample D was preferred in taste, colour, aroma, texture, and overall acceptability. Sample A which is 100% cassava flour was the least preferred. The study revealed that cake produced from white, red cocoyam and cassava flour blends possesses good nutrient quality comparable to the control sample.

Keywords: *Cakes, bakery applications, sensory evaluation, composite flour, functional properties*

Introduction

Cakes are convenient food products prepared from flour basically wheat and other principal ingredients and often baked. Cakes are baked deserts usually made from a good number of ingredients such as flour, sugar, shortening, baking powder, egg, flavourings, nuts, chocolate and dried fruits. Flour is one of the basic ingredients for cake making (Adegbanke and Ayomiposi, 2019). There are many cake recipes and can be classified based on their accompaniment such as coffee cakes, occasion cakes, primarily on ingredients and baking techniques.

Cassava (*Manihot esculenta Crantz*) has been used as a staple food of many nations. It is also known as manioc, yucca and tapioca. Its origins lie in Latin America, where it was discovered by the indigenous Indian population more than 4000 years ago (Akinpelu *et al.*, 2011). Among the starchy staples, cassava gives a carbohydrate production that is about 40% higher than rice and 25% more than maize (Tonukari, 2004). Cassava also consists of essential micronutrients, such as vitamins A, B and C, iron and Zinc, even though it is considered not having a limited nutritional value. It is a major source of carbohydrate for many populations, and it is the third

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largest source of carbohydrate in the world with Africa being the largest centre of production (Adenle *et al.*, 2012). The most promising areas of using cassava flour in food products are cookies, breakfast cereals, pastries or pies, cakes, breads, biscuits, noodles, muffins, and doughnuts (Aristizábal *et al.*, 2017). Cassava is increasingly popular with African farmers because of its agricultural advantages and potential to feed rapidly increasing populations.

The Red cocoyam (*Xanthosoma sagittifolium*) belongs to the *Xanthosoma* species which is generally refers to as Tannia, the white cocoyam (*Xanthosoma atrovirens)* belong to the family *Araceae* while Ede Anambra" (*Colocasia esculent avarantiquorum)* belongs to the *Colocasia* species and is commonly known as Taro. Cocoyam is an edible, highly nutritious and an underutilized crop. It is a staple food for millions of people living in the tropics and subtropics (Nwanekezi *et al.,* 2010; Ojinaka *et al.*, 2009). In Nigeria, cocoyam is one of the underexploited tropical root plants that are very nutritious but its utilization is still at the subsistence level and a highly neglected crop (Chukwu *et al.*, 2009). They have better nutritional qualities than other root and tuber crops such as cassava and yam, with higher protein, vitamin and mineral content. Processing cocoyam into flour for baking, baby food formula and other cocoyam recipes are recommended to reduce post-harvest losses of cocoyam and hence increase its utilization (Aniedu and Oti, 2008; Agbelomoge, 2013).

Composite flours have been shown to have great potentials in the production of high quality and nutritious food products and several researches have shown remarkable viability of up to 50% partial replacement of wheat flour with flours from other locally grown food crops such as roots, cereals and even nuts (Banua *et al*., 2021).

Several studies have explored the use of cassava, white cocoyam, and red cocoyam flours in food product formulations. Cassava is better suitable to replace wheat flour compared to other root and tuber flours due to its high starch content, low production cost, and unique functional properties (Ayetigbo *et al.,* 2018). For instance, a study by Chavan *et al.,* (2017) investigated the quality of bread made from cassava and cocoyam flour blends. The study found that bread made from cassava and cocoyam flour blends had higher nutritional value than bread made from wheat flour. Another study by Arukwe (2020) examined the physicochemical properties of biscuits made from cassava, cocoyam, and wheat flour blends. The study found that biscuits made from cassava and cocoyam flour blends had higher dietary fibre content and lower fat content than biscuits made from wheat flour. The use of cocoyam flour for production of baked goods could be of help to lower the over-dependency of developing nations on imported wheat, thereby increasing the use of locally grown underutilized material 'cocoyam' varieties (white and red) and finally boosting the economy of the developing country. Therefore, this study was carried out to evaluate the nutritional quality (proximate and mineral) composition of the cake, functional properties of the flour and the acceptability of the cake made from the composite flour.

Materials and Methods

Raw Materials

Cassava, red cocoyam and white cocoyam tubers were purchased from Ago market in Ado Ekiti. Ekiti State. Other materials such as butter, sugar, milk, baking powder, salt, eggs and water were purchased from Oja-Oba in Ado Ekiti. Ekiti State.

Preparation of cassava flour

Cassava tubers were processed into flour using the processing methods of (Lagnika *et al*., 2019) with some modifications. Cassava tubers were sorted, peeled, washed with potable water, soaked in water for 15minutes to reduce the cyanogens, grated, pressing using manual hydraulic press to reduce the moisture and release the cyanogens into the liquid and the pressed cassava then sun dried for 4-6hrs followed by oven-drying at 55^{0}C for 24hrs. The dried cassava product was milled by attrition mill and sieved through 0.45mm aperture size to obtain the fine cassava powder.

Preparation of red and white cocoyam flours

The cocoyam samples were processed into flour (fermented and unfermented) using the method of Onimawo and Egbekun (1998) with a slight modification. Cocoyam corms were peeled with kitchen knife while chipping was done mechanically with a chipping machine (Crypto Peerless, Birmingham, England) which produced chips of approximately 4mm thickness. The chips were washed with potable water and were soaked in portable water for 24h. The fermented chips were drained and oven-dried at 65^{0}C for 9hr until crispy. The dried samples were subsequently milled into flour in laboratory hammer mill. The flour products were packaged in sealed polyethylene bags until required for analysis.

Sample formulation

Cassava flour, white cocoyam flour and red cocoyam flour were thoroughly mixed together in the proportions shown below in Table 1. The flour blends were thoroughly mixed in order to make it homogenized.

Table 1: Flour blend formulation Table (%)

Sample	Cassava Flour	White Cocoyam Flour	Red Cocoyam Flour
A	100	-	-
B	90	5	5
C	80	10	10
D	70	15	15

Key:
A-cassava flour 100%
B- Cassava flour 90%, white cocoyam 5%, red cocoyam 5%
C- Cassava flour 80%, white cocoyam 10%, red cocoyam 10%
D- Cassava flour 70%, white cocoyam 15%, red cocoyam 15%

Production of cake

The cake was produced the method described by Ceserani and kinton (2008) with slightly modification. The ingredients used were: flour (400g), butter (125g), sugar (200g), egg (300g), milk (200g), baking powder (0.5g), vanilla essence (5mL). The fat and sugar were creamed together until fluffy, mechanically in a bowl. The eggs were beaten for 5 minutes with the homogenizer, liquid milk and vanilla essence were added to the homogenized egg and then poured into the fluffy batter and thoroughly mixed. The sieved composite flours and baking powder were added into the mixture, thoroughly mixed to uniform texture and then poured into greased cake pans.

The cake mixture was baked in a pre-heated oven at 190°C for 15min. After baking, the cakes were cooled to room temperature,

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packaged in an aluminium foil and kept on the shelf for sensory evaluation.

Determination of proximate composition of cake samples produced from cassava, white and red cocoyam flour. The moisture, ash, crude fibre, crude fat, protein and carbohydrate contents were determined by the methods AOAC 2005.

Determination of mineral composition of cassava, white cocoyam and red cocoyam flour. Mineral content of each sample (sodium, calcium, potassium, zinc, iron and phosphorus) were determined by the methods of AOAC 2010.

Determination of functional properties of cassava, white cocoyam and red cocoyam flour. Bulk density and swelling index, were determined using AOAC (2000) methods while water and oil absorption capacities were determined according to the methods described by Onimawo and Akubor (2005).

Determination of sensory evaluation of cassava, white cocoyam and red cocoyam flour.

The method described by Iwe (2014) was adopted in the determination of sensory properties of the cake samples.

Results and Discussion

Proximate composition of cassava, white cocoyam and red cocoyam flour

The result of proximate composition is shown in Table 2. The protein contents ranged from 7.44 to 7.87% for all samples. Sample D having (70:15:15) ratio had the highest protein value while the lowest protein value 7.44% was observed in the control sample. The increase in the proportion of white and red cocoyam flour significantly increases the protein content and this confirms cocoyam having protein and amino acid than many other roots and tubers (Sefa-Dede and Sackey 2002). The moisture content of the cake samples decreased with increased proportion of both white and red cocoyam flour. This is evidence that cake sample with high proportion of white and red cocoyam flour would have longer shelf life stability since they have lower moisture content. High moisture content in food samples is of great disadvantages as it encourages microbial activities that lead to food spoilage (Anno *et. al.* 2016). The values obtained for the fat content ranged from 46.65% to 54.24% and the cake sample A which is the control sample had the highest value of 54.24% while the cake sample D with (70:15:15) ratio had the least fat values among the composite flours. The high level of fat is due to the incorporation of fat for cake production. Fat content of the samples decreased as the proportion of white and red cocoyam flour increased. Similar observation was reported by Etong *et al.* (2014) and Ayo-Omogie and Adekunle (2015). Crude fiber value ranged from 2.02 to 2.33% and the cake prepared from (70:15:15) ratio had the highest value. Cocoyam contains some dietary fiber, which helps in regulating bowel health, lowering cholesterol levels and controlling blood sugar levels. Cocoyam flesh of about 100g provides 4.1 g or 11% of recommended daily dietary fibre (Adeyanju *et al*., 2019). The ash content of the cake samples increased from 1.05 to 1.72% with an increased in the proportion of white and red cocoyam flour. Iwe *et al*. (2016) affirmed that the ash content of food gives an idea of the total quantity of the mineral elements in the food. Based on this fact, high ash content as observed in cake sample D with high proportions of white and red cocoyam flour would possess high mineral content than the control sample (100% cassava). This implies that such samples would serve as good sources of mineral.

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Table 2
Proximate composition (%) of the cake samples produced from cassava, white and red cocoyam flour

Sample	MoistureContent	Protein	Fat	CrudeFibre	Ash	Carbohydrate
A	28.61	7.44	54.24	2.02	1.05	18.22
B	28.41	7.87	52.42	2.23	1.15	16.12
C	25.37	7.71	46.96	2.11	1.22	8.14
D	23.97	7.87	46.65	2.33	1.72	6.31

Key:
A-cassava flour 100%
B- Cassava flour 90%, white cocoyam 5%, red cocoyam 5%
C- Cassava flour 80%, white cocoyam 10%, red cocoyam 10%
D- Cassava flour 70%, white cocoyam 15%, red cocoyam 15%

Mineral composition of cassava, white cocoyam and red cocoyam flour

The results of the mineral composition of flour blends are shown in Table 3. Calcium content ranged between 244.55 – 315.40 (mg/100g). While sample D had the highest calcium content (315.40 mg/100g) than other samples. Cocoyam contains vitamin, thiamin, riboflavin, and niacin) and minerals (calcium, phosphorus) in reasonable amount (Ojinnake *et al*., 2009). These nutrients give cocoyam nutritional advantages over other numerous roots and tubers. Appreciable amount of calcium is good for bone and good teeth formation most especially among infants and young adult.

The iron content ranged between (0.75 to 0.91 mg /100g). Sample D had the highest value of iron while sample A 100% cassava flour had the least value (0.740 mg/100g). The highest value obtained in sample C and D could be as a result of ratio of the mixture of white and red cocoyam flour used. This is an indication that both red and white cocoyam flour increases the amount of iron content. Iron is necessary for growth and reproduction.

Phosphorus content ranged between (60.95 to 72.19 mg/100g). Sample D had the highest Phosphorus content while sample A had the least. Zinc content in the samples ranged between (0.68 to 0.84 mg/100g). It was observed that sample D had the highest mineral content among the samples.

Table 3: Mineral composition of cake from cassava, white cocoyam and red cocoyam flour

Sample	Sodium mg/100g	Calcium mg/100g	Potassium mg/100g	Zinc mg/100g	Iron mg/100g	Phosphorus mg/100g
A	98.45	244.55	261.25	0.68	0.75	60.95
B	102.60	277.25	285.75	0.81	0.81	65.31
C	110.75	296.45	293.50	0.73	0.84	68.35
D	135.45	315.40	309.35	0.83	0.91	72.19

Key:
A-cassava flour 100%
B- Cassava flour 90%, white cocoyam 5%, red cocoyam 5%
C- Cassava flour 80%, white cocoyam 10%, red cocoyam 10%
D- Cassava flour 70%, white cocoyam 15%, red cocoyam 15%

Functional properties of cassava, white cocoyam and red cocoyam flour

The results of the functional properties of flour blends are shown in Table 4. The water absorption capacity ranged from 160.65 – 180.06 g/100g. The water absorption capacity (WAC) of flour blends decreased with an increased in white and red cocoyam flour. The cakes prepared with whole cassava flour had the highest carbohydrate content. The lower carbohydrate values obtained in cakes could be due to the inclusion of white and red cocoyam flour blends. The values obtained for water absorption capacity could be useful in bakery products such as bread, cakes and cookies that require hydration to improve dough handling characteristics (Ohizua *et.al*. 2017). Water absorption capacity is an important processing parameter in the development of ready-to-eat foods; high absorption capacity assures product cohesiveness (Houson and Ayenor, 2002).

The bulk density of the samples ranged from 0.13 to 0.64 g/ml. Bulk density of the flour blends increased as the ratio of white and red cocoyam flour blends increased. The high bulk density of flour blends suggests their suitability for use in food preparations in terms of machinery and packaging. This might be because particle size and the true density of flours are generally affected by bulk density. Cocoyams are known to have a high content of tiny, easily digestible, starch grains (Adane *et al*., 2006). Bulk density is a measure of heaviness of solid samples, which is important for determining packaging requirements, material handling and application in the food industry. Flours with high bulk densities (>0.7 g/ml) are used as thickeners in food products (Akubor and Badifu 2004), therefore the sample D (0.64 g/ml) in this study could be suitable as thickeners. The values obtained for the dispersibility ranged from 70.01 to 76.03%. Dispersibility decreased as the ratio of white and red cocoyam increased. High dispersibility observed in this study will aid the reconstitution of batter to a fine consistency during mixing (Adebowale *et al.,* 2008). Swelling capacity is an index of protein functionality such as denaturation and its potential applications. The higher the solubility, the higher the functionality of the protein in a food (Adebowale *et al*., 2008). The higher swelling power of flours compared to others indicates that the protein component of the samples are still intact. Swelling power is also a quality criterion in some good formulation such as bakery products; it indicates the amount of water that can be absorbed by the flour granules during heating (Osungbaro *et al*., 2010). Swelling power ranged from 6.38 – 8.01% with sample D having highest and A the lowest. Swelling power increased as the ratio of white and red cocoyam flour increased. Also from this study, sample D had the highest protein value recorded.

Table 4

Functional properties of cassava, white cocoyam and red cocoyam flour

Sample	Water absorption (g/100g)	Swelling power (%)	Bulk density (g/ml)	Dispersibility (%)	Wettability (secs.)
A 100/0/0	180.06	6.38	0.13	76.03	66
B 90/5/5	170.89	7.38	0.16	72.04	53
C 80/10/10	160.76	7.56	0.58	71.02	47
D 70/15/15	160.65	8.01	0.64	70.01	34

Key:
A-cassava flour 100%

B- Cassava flour 90%, white cocoyam 5%, red cocoyam 5%
C- Cassava flour 80%, white cocoyam 10%, red cocoyam 10%
D- Cassava flour 70%, white cocoyam 15%, red cocoyam 15%

Sensory evaluation of cake made from cassava, white and red cocoyam flour blend

The results of sensory evaluation of cake samples produced from flour blends are shown in Table 5. The cake sample produced from sample A from 100:0:0 were least rated by the panellists. The result revealed that the cake containing 70% cassava, 15% white and 15% red cocoyam flour blend were most preferred for colour, taste, aroma, texture and overall acceptability than the cake having the 100% cassava flour, sample A.

Table 5

Sensory evaluation of the cakes sample produced using cassava, white and red cocoyam flour.

Samples	Colour	Taste	Aroma	Texture	Overall Acceptability
A	6.20	6.00	6.80	6.15	6.10
B	6.50	6.25	6.85	6.90	6.65
C	6.70	6.45	6.95	6.95	6.55
D	7.40	7.30	7.20	7.55	8.10

Key:
A-cassava flour 100%
B- Cassava flour 90%, white cocoyam 5%, red cocoyam 5%
C- Cassava flour 80%, white cocoyam 10%, red cocoyam 10%
D- Cassava flour 70%, white cocoyam 15%, red cocoyam 15%

Conclusion

This study revealed that the nutritional values of cakes produced cassava/cocoyam flour blends are higher in (protein, ash, and crude fibre) content and were enriched. The mineral contents in the cake samples were notably increase in sodium, calcium, potassium, zinc, iron and phosphorus respectively, with samples C and D having the highest values, this could also enhance the nutritional status of consumers. These nutritional qualities make cocoyam a functional food ingredient. Flour blends from cassava, white and red cocoyam had significant increase on the functional properties of the flour. Increased ratio of white and red cocoyam flour blends, samples C and D had increased swelling capacity values of composite flours 7.38, 7.56 and 8.01 g/ml respectively and bulk density values 0.16, 0.58,and 0.64 g/ml respectively. This makes the flour blends a quality criteria in some good food formulation such as bakery products. Cake samples containing high ratio of white and red cocoyam flour blends were generally accepted than the control sample. Therefore, this implies that sample D (70:15:15) is acceptable for the production of cake a nutritious snacks.

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