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Proximate and Quality Evaluation of Cocoyam and Wheat Flour Blended Cake

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Abstract: *Consumption of pastry products is a time demand due to the change in the population's eating habits. Cake is one of the delicious snacks made from flour, sugar, shortening, baking powder, egg, and flavouring agent. The aim of the study was to conduct proximate composition and quality evaluation of cocoyam and wheat flour blended cake. Three different cake samples were produced in a ratio of 100:00, 70:30 and 60:40 and coded as MNO, PQR and STU. Proximate composition results of the cake samples indicated increasing level of moisture (g/100g), 13.79- 15.32%, Ash (g/100g), 1.71-2.17%, protein (g/100g), 7.076 - 8.86%, fat (g/100g), 31.12 - 32.43%, and carbohydrate (g/100g) 43.8 - 44.75% respectively. The sensory properties of cakes were evaluated using fifty untrained panelists comprising male and female petty traders. Cakes were evaluated for colour, flavour, texture, appearance and overall acceptability using nine point Hedonic scale (where= 9 liked extremely and 1= disliked extremely). Based on individual evaluation, cake sample made of (70% cocoyam flour and 30% cocoyam flour) was the most preferred in terms of overall acceptability. The sensory properties of the cakes showed no significant (p>0.05) differences between the control and composite cake samples in terms of overall acceptability. Data obtained were subjected to analysis of variance (ANOVA) and significance difference was accepted at 5% probability level. The study concluded that cocoyam (Xanthosoma sagittifolium) flour can be used for quality cake production with replacement of wheat flour up to 30% level without adversely affecting the sensory properties of the products.*

Keywords: cocoyam, wheat flour, cake, bakery product, snacks, proximate composition

1. Introduction

Cakes are used as snacks in many occasions and fast food industries [1]. Many cake recipes are classified according to their ingredients, accompaniments and cooking techniques [2]. They are produced using margarine, flour, eggs, baking powder and flavouring agent [1]. Wheat is mainly used as the grain of choice for production of this snack product, however, due to climatic conditions it is not grown in tropical regions of Ghana and therefore makes it very expensive. As demand increases, there is a tendency for wheat flour prices to increase, as well as an increase in the cost of importation [3].

This high cost is due to the fact that population growth has increased the consumption of processed food and baked goods thereby increasing the demand for imported products. The flour used to make baked goods is made from ordinary wheat, which is grown in many parts of the world, but is imported from countries with unfavorable climatic conditions for wheat cultivation. It is estimated that, in the year 2017 and 2018, Ghana imported 700,000 tons of wheat flour into the country which is about 5.4% increase in 2016-2017 [4]. Therefore, developing flour from local ingredients will help to cut down the cost of importing wheat flour into the country in order to save foreign exchange. The use of *Xanthosoma sagittifolium* in baked goods enhances cocoyam competitiveness with other root and tuber crops, extends its use in other food systems and improves economic efficiency. In addition, farmers need to grow more *Xanthosoma sagitifolium* as its consumption capacity increases, and this will increase their incomes and therefore increase the added value of cocoyam in pastry production [5].

Cocoyam represents a significant proportion of carbohydrate in the diet in many parts of developing countries and provides palatable starchy foods [5]. Cocoyam has nutritional benefits over other root and tubers [6]. It contains more crude protein than other roots and tubers, and also has digestible starch due to its small starch particle size, its vitamins, calcium, phosphorus, vitamins A and B [6]. Cocoyam is more important than other tropical roots such as yams, cassava and sweet potatoes due to its protein enhancement [7]; [8].

Using an indigenous crop to replace wheat flour will reduce production costs and save foreign exchange. Nevertheless, the properties of cocoyam flour have the same properties as wheat flour and can therefore partially replace wheat flour in many wheat-based products. According to [9], flour from other crops such as maize, millet, millet, cassava, potatoes and rice has been added to wheat flour to increase the use of local crops and reduce the cost of importing wheat. Blending different flours for pastry preparation is mainly practiced in tropical countries where the soil and climate are not conducive for commercial wheat production. The study was therefore undertaken to conduct proximate compositions and quality evaluation of cocoyam and wheat flour blended cake.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

The experiment was conducted at the Mycotoxin and Food Analysis laboratories, Department of Food Science and Technology, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Cocoyam, wheat flour, margarine, eggs, sugar, salt and baking powder) were purchased from the Kumasi central market (Ashanti Region), Ghana.

2.2 Production of Cocoyam Flour (CF)

Fresh cocoyam was carefully washed with tap water, peeled using a stainless steel knife, rewashed and cut into 0.5 cm thick slices. The slices were dried in a gas oven at 60°C for seven hours before milling into flour using Philip blender. The ground flour was sifted through a sieve until fine textured flour was obtained. It was then packed in a labeled food container and stored at room temperature ready for preparation of composite flours [8].

2.3 Formulation of Blends

Three different cake samples were produced in a ratio, 100:00, 70:30 and 60:40 and coded as MNO, PQR and STU. Sample with 100% wheat flour labeled MNO served as control whilst composite samples PQR and STU contained 70% wheat flour, 30% cocoyam flour and 60% wheat flour and 40% cocoyam flour respectively. Akai food mixer was used for mixing wheat- cocoyam composite flours to achieve uniform mixing.

Table 1: Formulation of ingredients for cake making

INGREDIENTS	MNO	PQR	STU
Soft wheat flour (g)	100	70	40
sugar (g)	60	60	60
Margarine (g)	150	150	150
Eggs (large size)	5	5	5
Baking powder (g)	10	10	10
Salt (g)	1	1	1
Vanilla essence (ml)	5	5	5

Control sample MNO, 100% wheat flour, PQR, 70% wheat flour, 30% cocoyam flour) and STU, 60% wheat flour, 40% cocoyam flour.

2.5 Method of preparation

The method adopted by [10] was used to make the cake with slight adjustment. The margarine together with sugar was creamed manually until it became light and fluffy in a mixing bowl 40 minutes. The eggs were beaten for three minutes using a rotary whisk and 5 ml of vanilla essence was incorporated. It was slowly added to the creamed mixture. Flour samples from different mixtures were sifted through a separate sieve, with salt and baking powder, and gradually turned into a mixture with a metal spoon. The batter was transferred to a greased cake tins and baked in a preheated oven at 200˚C for 50 minutes A dagger was placed in the middle of the cake to find out about it doneness. When cooked, the cake was removed from the tin and allowed to cool in a wire rack and packaged for evaluation and proximate analysis.

Proximate composition

The cake samples were assessed to determine their nutritional quality. The parameters determined according to standard methods [11] were moisture, ash, protein, fat and carbohydrate contents

Moisture content and total solids: Oven Drying Method

Five grams (5g) of the sample was transferred to the previously dried and weighed dish. The Dish was placed in an oven and thermostatically controlled at 105 degrees for 5 hours. Dish was removed and placed in a desiccator to cool to room temperature and weighed. It was then dried again for 30 minutes, cooled down again and weighed. Drying, cooling and weighing were repeated until a constant weight was reached. (Alternatively, sample could be dried in a thermostatically controlled oven for at least 8 hours where a constant weight would be achieved). The determinations were duplicated and the average found [12].

Calculations

$$\%\ \text{Moisture (wt/wt)} = \frac{\text{wt } H_2O \text{ in sample}}{\text{Wt of wet sample}} \times 100$$

$$\%\ \text{Moisture (wt/wt)} = \frac{\text{wt of wet sample-wtof dry sample}}{\text{Wt of wet sample}} \times 100$$

$$\%\ \text{Total solids (wt/wt)} = \frac{\text{wt of dried sample}}{\text{Wt of wet sample}} \times 100$$

Where wt= Weight of sample/spread

Ash content

5g sample was weighed into a tarred crucible and was pre-dried. Crucibles were placed in cool muffle furnace using tongs, gloves and protective eyewear. The crucibles Ignited for 2 hours at about 600 degrees Celsius. Muffle furnace was turned off and opened when temperature dropped to at least 250°C preferably lower. The door was carefully opened to avoid losing ash that may be fluffy. Safety tongs was used to transfer crucibles to a desiccator with a porcelain plate and desiccant. Desiccator was closed and allowed crucibles to cool prior to weighing

Calculations

$$\%Ash = \frac{\text{wt of ash}}{\text{Wt of sample}} \times 100$$

$$\%Ash = \frac{(\text{wt of crucible+ ash}) - \text{wt of empty crucible}}{(\text{wt of crucible+ sample}) - \text{wt of empty crucible}} \times 100$$

Where wt= Weight of sample/spread

Fat content: soxhlet extraction

Previously dried (air oven at 100°C) 250 ml round bottom flask was weighed accurately. 5.0g of dried sample to 22 ×80mm paper thimble or a folded filter paper was weighed. A small of cotton or glass wool was placed into the thimble to prevent loss of the sample. 150ml of petroleum spirit B.P 40-60°C was added to the round bottom flask and assembled the apparatus. A condenser was connected to the soxhlet extractor and reflux for 4 - 6 hours on the heating mantle. After extraction, thimble was removed and recovered solvent by distillation. The flask and fat/oil was heated in an oven at about 103°C to evaporate the solvent. The flask and contents were cooled to room temperature in a desiccator. The flask was weighed to determine weight of fat/oil collected.

$$\%\ \text{Fat (dry basis)} = \frac{\text{fat/oil collected}}{\text{Weight of sample}} \times 100$$

$$\%\ \text{Fat (dry basis)} = \frac{(\text{wt of flask + oil}) - \text{wt. of flask}}{\text{Weight of sample}} \times 100$$

Crude fibre determination

Two grams (2g) of the sample from crude fat determination was weighed into a 750ml Erlenmeyer flask. Two hundred milliliters (200ml) of 1.25% H_2SO_4 was added and immediately flask was set on hot plate and connected to the condenser. The contents were boiled within 1 minute of contact with solution. At the end of 30 minutes, flask was removed and immediately filtered through linen cloth in funnel and washed with a large volume of water. Filtrate (containing sample from acid hydrolysis) was washed and returned into the flask with 200ml 1.25% NaOH solutions. Flask was connected to the condenser and was boiled for exactly 30 minutes. It was then filtered through Fischer's crucible and washed thoroughly with water and added 15ml 96% alcohol. Crucible and contents was dried for 2 hour at 105 °C and cooled in desiccator and it was weighed. Crucible was ignited in a furnace for 30 minutes and after that it was cooled and reweighed.

$$\%\ \text{Crude fibre} = \frac{\text{weight of crude fibre}}{\text{Weight of sample}} \times 100$$

$$\%\ \text{Crude fibre} = \frac{\text{wt of crucible + sample (before – after) ashing}}{\text{Weight of sample}} \times 100$$

Where wt= Weight of sample/spread

Protein Determination

Digestion Method

Two grams (2g) of sample and a half of selenium – based catalyst tablets and a few anti-bumping agents were added to the digestion flask. Twenty five milliliters (25ml) of concentrated H_2SO_4 was added and the flask was shaken for the entire sample to become thoroughly wet. Flask was placed on digestion burner and heated slowly until boiling ceased and the resulting solution was clear. The sample was then cooled to room temperature and digested sample solution was transferred into a 100ml volumetric flask and made up to the mark.

Distillation Method

To flush out the apparatus before use, distilled water was boiled in a steam generator of the distillation apparatus with the connections arranged to circulate through the condenser, for at least 10 minutes. The receiving flask was lowered and continued to heat for 30 seconds in order to carry over all liquid in the condenser. 25 ml of 2% boric acid was pipetted into 250ml conical flask and 2 drops of mixed indicator added. The conical flask and its contents were placed under the condenser in such a position that the tip of the condenser is completely immersed in solution. 10ml of the digested sample solution was measured into the decomposition flask of the Kejdahl unit, fixed it and add excess of 40% NaOH (about 15-20ml) to it. The ammonia produced was distilled into the collection flask with the condenser tip immersed in the receiving flask till a volume of about 150ml– 200ml is collected. Before distilling another sample and on completion of all distillations, the apparatus was flushed as in step 1 above. Steam was allowed to pass only until 5ml of the distillate is obtained.

Titration Method

The Distillate with 0.1N HCL solution was titrated. The acid was added until the solution became colourless. Any additional acid added made the two solutions become pink. The nitrogen content was determined in duplicate, and a blank determination was run using the same amount of all reagents as used for the sample. The blank was meant to correct for traces of nitrogen in the reagents and included digestion as well as distillation methods.

Calculation:

$$\% \text{ Total nitrogen} = \frac{100 \times (Va-Vb) \times NA \times 0.01401 \times 100}{W \times 10}$$

Where:

Va- volume in ml of standard acid used in titration

Vb- volume in ml of standard acid used in blank

NA- normality of acid

W- Weight of sample taken

Carbohydrate content

The calculation of available carbohydrate (nitrogen-free extract-NFE) was made after completing the analysis for ash, crude fibre, ether extract and crude protein. The calculation was made by adding the percentage values on dry matter basis of these analysed contents and subtracting them from 100%.

Calculation:

Carbohydrate (%) = % crude fibre + % NFE

OR

Carbohydrate (%) =100 - (% moisture +% fat +% protein +% ash)

x. Calculation for dry basis = $\frac{(100-\% \text{ moisture}) \times \text{wet basis}}{100}$

2.9 Sensory Evaluation

The sensory properties of cakes were evaluated using fifty untrained panelists comprising male and female petty traders. Cakes were evaluated for crust colour, flavour, texture, appearance and overall acceptability using nine point Hedonic scale (where 1 = liked extremely and 9 = disliked extremely). A slice of cake from each blend was presented to panelists. Each panelist was provided with a glass of tap water to rinse the mouth between evaluations.

2.10 Statistical Analysis

Data obtained was subjected to analysis of variance (ANOVA) and Significance difference was accepted at 5 % probability level

3. RESULTS AND DISCUSSION

Table 2 presents the proximate composition of the various cake products. The moisture content of the samples ranged from 13.79-15.32%. The control sample (MNO) had the highest moisture content while the least was sample STU (60% wheat flour and 40% cocoyam flour). As a result, it can be deduced that some moisture will be found in the samples as observed during the study [13]; [14]; [15]. The insignificant increase in the moisture content in the control sample could be due to the different ingredients used. There were no significant differences ($p>0.05$) among the composite samples, however, sample MNO (100% wheat flour) differed ($p<0.05$) significantly from the other samples. The low moisture contents in samples PQR (70% wheat flour, 30% cocoyam flour) and STU, (60% wheat flour and 40% cocoyam flour) suggest that the cake products would have a long shelf-life since lower moisture content of baked products is critical for prolonging the shelf life [16] whereas the control sample may have a shorter shelf-life since high moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that lead to spoilage [17]; [18]. The moisture content of all samples was similar to that produced by [19].

The ash content of the cakes ranged from 1.71± 0.16 to 2.17± 0.03. Sample STU (70% wheat flour, 30% cocoyam flour) had the highest ash content of 2.17% whereas the least was the control (100% wheat flour) with 1.71%. This study recorded a significant difference ($p<0.05$) between the control MNO (100% wheat flour) and the composite samples (PQR, 70% wheat flour, 30% cocoyam flour) and STU, 60% wheat flour and 40% cocoyam flour). This study is in line with [20] who reported ash contents of 2.20 to 2.57%. The presence of ash is an indication of minerals present in the cake samples [21]. The ash content of composite cakes increases as the level of supplementation increases indicating that the inorganic nutrients in the composite cake is richer than that of wheat cake. The increase in ash content of composite cakes could be ascribed to the high level of ash content in cocoyam flour comparable to wheat flour.

The protein content of the composite cake samples were 7.07 – 8.86% with sample STU (60% wheat flour, 40% cocoyam flour) having the highest protein content of 8.86 followed by PQR (70% wheat flour, 30% cocoyam flour) with 7.70%. The lowest was MNO with 7.07% protein content. The protein content increased as the amount of cocoyam flour increased. The results disagreed with [22] and [23] whose works were composite rock cake from wheat, cassava and cocoyam; they recorded relatively low protein content from all the rock cake samples produced. Based on the proximate analysis results, it can be said that there was a significant difference ($p<0.05$) from between all the cake samples produced. Protein in food is very vital as it is responsible for body building and repair of worn out tissues. Proteins are important food components, especially for children since they are needed as building blocks for the body, necessary for growth and for the repair of damaged tissues.

The fat content ranged from 31.12± 0.38 to 32.43± 0.30 with sample PQR (70% wheat flour, 30% cocoyam flour) having the highest fat content of 32.43% and MNO (100%

Wheat flour, having the lowest. There were significant differences (p<0.05) between the control sample MNO (100% wheat flour) and the composite sample PQR (70% wheat flour, 30% cocoyam flour). These differences could be attributed to the variation of ingredients used. It was observed that the fat content increasing as the level of 30% cocoyam flour was incorporated into the wheat flour. The finding agrees with [24] and [25] on their reports for the increasing trend in the fat content of cookies produced from wheat-defatted cashew nut and wheat-brewers spent grain (2.52–4.80%) flour blends respectively. The presence of high fat content in the cookies means high calorific value and also serves as a lubricating agent that improves the quality of the product, in terms of flavour and texture. Fat is very important in food as it helps in the absorption of vitamins and it also fills fat cells and insulates the body to keep it warm.

The carbohydrate content of the various cake products ranged from 43.80± 0.24 to44.85± 1.00 with sample PQR containing 70% wheat flour and 30% cocoyam flour having the highest carbohydrate content of 44.85% followed by the control sample MNO made of 100% wheat flour with 44.75% whilst the least was STU (60% wheat flour, 40% cocoyam flour) having 43.80%. This observation may be attributed to the high content of carbohydrate in cocoyam. The finding is in line with [26], who recorded higher carbohydrate content from baked products prepared from cocoyam and cassava. The results revealed no significant differences (p>0.05) between the composite samples.

Table 2 Proximate composition of various cakes

Sample	**Moisture**(g/100g)	**Ash**(g/100g)	**Protein**(g/100g)	**Fat**(g/100 g)	**CHO**(g/100 g)
MNO	15.32± 0.03	1.71± 0.16	7.076± 0.29	31.12± 0.38	44.75± 0.10
PQR	13.79± 1.05	1.93± 0.06	7.70± 0.18	32.43± 0.30	44.14± 1.00
STU	13.96± 0.25	2.17± 0.03	8.86± 0.50	31.15± 0.04	43.8± 0.24

Control sample MNO, 100% wheat flour, PQR, 70% wheat flour, 30% cocoyam flour) and STU, 60% wheat flour, 40% cocoyam flour.

Sensory Qualities of cake

The result of analysis of the sensory properties of cakes produced is shown in Table 3. The Colour is a very important parameter when evaluating well-cooked cakes. It depicts the appropriate raw materials used for preparation, and also provides information about the composition and quality of the product [27]. In terms of colour, cakes made from a blend of wheat flour (70%) and cocoyam flour (30%) had significantly higher colour than 100% wheat flour [28]. The study agrees with the findings of [29], they prepared sponge cakes from locally grown rice and defatted soybean blends and had an acceptable inclusion level of 20% defatted soybean for colouring. A similar study report indicated that colour sensory scores of cookies made from millet and cowpea increased as the level of guarpitha increased [30]. This result shows that both samples MNO (100% wheat flour) and PQR (70% wheat flour, 30% cocoyam flour) were equally accepted in terms of colour. Conversely, the control sample and sample PQR were significantly (p≤0.05) different from sample STU (60% wheat flour, 40% cocoyam flour).

Taste is the main factor that determines the acceptance of any product which has the greatest impact as far as the market success of its product is concerned. The taste of the various cakes ranged from 7.19 - 8.15%. Cake prepared from 70% wheat flour, 30% cocoyam flour had the best score for taste followed by 100% Wheat flour. The results is similar to that of [31] whose work was biscuits made from sprouted lima bean, sprouted syrup and wheat flour and recorded better taste than wheat flour biscuits. Based on the results, it can be said that there were significant difference ((p≤0.05) between the composite sample PQR7 (0% wheat flour, 30% cocoyam flour) and the control MNO (100% wheat flour).

The flavour score of the various cake products ranged from 7.82 ± 1.00 to 7.96 ± 0.82. The composite sample made of 70% wheat flour, 30% cocoyam flour had the highest flavour and was preferred by panelists followed by the control sample (100% wheat flour). The acceptance of the flavour follows a similar pattern. The mean flavour score of the food product is significantly affected by blend proportion. Flavour score of cake formulated from cocoyam and wheat flour was increased as the level of cocoyam complementation increased by 30%. This could be due flavour cocoyam flavour. The differences in the means of samples MNO (100% wheat flour) and PQR (70% wheat flour, 30% cocoyam flour) are significantly different (p<0.05).

Texture score of the cakes ranged from 7.48 ± 1.21 to 8.12 ± 1.18 with cake sample PQR with 70% wheat flour and 30% cocoyam flour having the highest score of 8.12% and was “very much liked” in texture. Sample PQR (70% wheat flour, 30% cocoyam flour) was significantly (p≤0.05) different from the rest of the cake samples. Texture score of biscuit produced from AYBF and wheat composite flour was increased as the proportion of AYBF incorporation increased [32]. According to [33] texture score of biscuit formulated from millet and cowpea was higher than that of 100% millet biscuits.

A cake sample made of 70% wheat flour and 30% wheat flour did not show a significant difference from 100% wheat flour cake in terms of overall acceptability [32]. Replacing wheat flour (WF) with 30% cocoyam flour in cake production provides good results in terms of sensory sensitivity [34]. Based on individual evaluation, cake sample made from (70% cocoyam flour and 30% cocoyam flour) was the most preferred in terms of overall acceptability [35]. Overall, the acceptability of cake made from 30% cocoyam and 70% wheat flour was accepted by the panelists [36]. Similar research reports have shown that the overall acceptability of biscuits made from chickpeas and wheat mixtures decreased as gram levels increased. But the average acceptable score for inclusion of chickpea flour by 20% did not differ significantly from that of control cookie (100% wheat) [37]

Table 3 Sensory Qualities of cake

Sample	Colour	Taste	Flavour	Texture	Overall Acceptability
MNO	8.63 ± 0.95	8.04 ± 1.13	7.82 ± 1.17	7.79 ± 0.98^{ab}	8.10 ± 0.88
PQR	7.81 ± 0.72	8.15 ± 0.97	7.96 ± 0.82	8.12 ± 1.18a	8.58 ± 0.90
STU	7.61± 0.70	7.19 ± 0.72	7.83 ± 1.00	7.48 ± 1.21bc	7.88 ± 0.80

Control sample MNO (100% wheat flour), PQR (70% wheat flour, 30% cocoyam flour) and STU (60% wheat flour, 40% cocoyam flour).

Conclusion

Results from this work showed that cocoyam flour could be used in the production of quality cakes. The flour blends has influenced the colour and good flavour of the cakes, helping to increase its overall acceptability. The use of cocoyam *(Xanthosoma sagittifolium)* flour to produce a favourable baked product like cakes increases its production, consumption and farmers' incomes and reduces the pressure on the use of wheat flour for biscuit production. The results of this work have shown that cocoyam (*Xanthosoma sagittifolium*) flour can be used for quality cake production with replacement of wheat flour up to 30% level without adversely affecting the sensory properties of the products.

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