

# Proximate and Sensory Properties of Wheat-Cocoyam (Colocasia Esculenta) Composite Bread

Bosede Adelola Orhevba and Yahaya Ndanaimi

## ABSTRACT

In this study, samples of composite breads were produced from wheat and cocoyam flour blends using D-optimal design mixture, in the following proportions: 95:5, 90:10, 85:15. Bread sample which contained 100% wheat flour was also produced and this served as the control. The bread samples obtained were subjected to proximate and sensory analysis. The following results were obtained for the whole wheat flour bread: moisture (27.65%), protein (11.33%), crude fibre (0.59%), ash content (0.78%), fat (8.19%) and carbohydrate content (53.69%), respectively. While the composite bread samples had the moisture, protein, crude, ash, fat and carbohydrate in the following ranges: 17.93-23.63%, 7.16-10.83%, 0.59-0.88%, 0.47-0.98%, 4.43-7.81% and 55.94-1.31%, respectively. The sensory tests carried out on the bread samples indicated that there was no significant difference between the whole wheat bread and the composite bread samples for flavour, crumb appearance and taste. However, for texture, overall preference and crust colour properties of the bread samples, significant differences were observed. From the study, it can be concluded that wheat flour can be substituted with cocoyam flour and bread samples made from this combination (up to 15% cocoyam flour inclusion) were acceptable. It was observed that the 100% wheat flour bread is the most acceptable, followed by the 5% cocoyam flour composite bread samples. Usage of cocoyam flours in bread baking can contribute significantly to enhancing nutrition and curbing the rising cost of bread.

**Keywords:** Cocoyam flour, composite bread, D-optimal design mixture, proximate composition.

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## I. INTRODUCTION

According to [1], bread is a fermented baked product gotten from wheat flour, water, yeast, and salt through processes which include mixing, kneading, proofing, shaping, and baking.

Wheat flour is one of the vital ingredients in bread production due to the gluten it contains. [2] reported that this gluten (in wheat flour) accounts for the elasticity of the dough which aids in trapping the carbon dioxide generated by yeast during fermentation. Nevertheless, wheat is a temperate crop and will not thrive under tropical conditions [3], [4]. Nigeria and many other developing nations (who are majorly in the tropics) therefore have to import wheat or wheat flour to meet their confectionary needs.

According to [5] and [6], the Food and Agricultural Organization (FAO) in the 1960s encouraged research on composite bread in a bid to reduce the import dependency of developing countries. [7] also reported on the unique baking properties of wheat which no other crop has, hence, the many studies being carried out on composite flour; as many as 1200 studies by the year 1993 according to [8]. Composite flour can be defined as a mixture of flours, starches and other ingredients used to totally or partially substitute wheat flour in confectionary [9]. [10] defined composite flour as combination of wheat flour with other flours like cassava, maize, and soybean. [7] also defined composite flour as a

combination of flours from starch tubers like cassava, potatoes, yam etc. or crops rich in protein like soybean and ground nut or cereals (maize, rice, millet, sorghum) with or without wheat flour.

In developing countries, composite flour is favourably considered due to the fact that it decreases the importation of wheat flour and boosts the use of locally available crops as flour [11]. In countries having crops other than wheat, it is considered economically beneficial to decrease or even abolish imports of wheat thereby meeting the needs of confectionary products by the utilization of locally grown crops [12].

Cocoyam (*Colocasia esculenta*) is highly nutritious and edible but underutilized. It belongs to the family, Araceae. According to [13], about 30–40 species of cocoyam have been identified, however, only 5–6 species produce edible parts. [14] reported that cocoyam is an under exploited and highly neglected crop in Nigeria, despite the fact that it is very nutritious.

Attempts are being made to investigate other sources of flour for combining wheat flour as well as enhance the nutritional value of baked foods. Thus, the need to identify nutritious, easily accessible, and underutilized crops like cocoyam. The result of this study would be a great relief to Nigerians in particular and Africans at large, who could not afford the high cost of wheat flour and its baked products.

Inclusion of cocoyam flour into wheat flour for confectionary purposes will help to decrease reliance on imported wheat flour, reduce cost of confectionary products, increase affordability, and enhance the nutritional value of the products.

## II. MATERIALS AND METHODS

### A. Materials

Fresh tubers of cocoyam (*Xanthosoma sagittifolium*) used for the study were obtained from a farm in Minna. Wheat flour and other bread ingredients used for the study were obtained from a market in Minna, Niger State, Nigeria.

### B. Methods

The cocoyam tubers were sorted to remove impurities. They were peeled with knife and washed. They were then cut into uniform sizes of 5 mm and divided into twenty equal samples. Each sample was weighed, labelled, and blanched in water bath maintained at constant temperature of 100 °C for 5 mins as reported by [15]. The blanched chips were spread on trays and dried in an oven at 77 °C for 14 hours. The dried samples were ground into fine flour using a milling machine. The experimental design used for the study was the optimal mixture design of the response surface methodology (RSM). This generated 28 experimental runs (Table I). The independent variables were wheat flour, cocoyam flour, baking temperature and baking time, while the responses were moisture, fat, carbohydrates, protein, ash, and fibre contents.

TABLE I: EXPERIMENTAL DESIGN FOR THE WHEAT-COCOYAM BLENDS

Samples	Run	Wheat (%)	Cocoyam (%)	Baking Temp (°C)	Baking Time (mins)	Responses (%)
A	1	87.52	12.48	235	35	
B	2	85	15	265	35	
C	3	85	15	265	40	
D	4	85	15	235	35	
E	5	93.74	6.26	265	45	
F	6	90	10	265	35	
G	7	85	15	265	45	
H	8	92.48	7.52	250	35	
I	9	85	15	242.5	37.5	
J	10	90	10	250	45	
K	11	90	10	265	35	
L	12	95	5	235	45	
M	13	95	5	235	45	
N	14	95	5	235	35	
O	15	91.2	8.77	265	35	
P	16	95	5	235	40	
Q	17	90	10	265	35	
R	18	95	5	235	45	
S	19	95	5	250	40	
T	20	90	10	235	35	
U	21	95	5	235	35	
V	22	85	15	250	40	
W	23	95	5	250	45	
X	24	90	10	265	45	
Y	25	86.26	13.74	265	45	
Z	26	90	10	265	40	
A <sub>1</sub>	27	85	15	250	40	
B <sub>1</sub>	28	85	15	235	40	
Control		100		235		

Wheat and cocoyam flours were combined based on the experimental design as shown in Table II.

TABLE II: DESIGN MATRIX FOR WHEAT-COCOYAM BLENDS

Variables	Unit	Levels	
		Low	High
Cocoyam flour	%	5	15
Wheat flour	%	85	95
Baking Temperature	°C	235	265
Baking Time	Min	35	45

The methods employed for the preparation of the bread samples were according to the methods described by [15] with little modification (Table III).

TABLE III: INGREDIENTS USED FOR THE FORMULATION OF DOUGH PER LOAF

Ingredients	Composition (g)	Composition (%)
Flour	300	60
Water	165	33
Sugar	18	3.6
Butter	8	1.6
Yeast	5	1
Vitamin C	2	0.4
Salt	2	0.4

### C. Bread Baking Process

All the ingredients (Table III) were initially dry mixed in a bowl and later mixed with water until soft dough that can easily be handled was produced. During the mixing of ingredients for dough formulation, the flour composition ratio varied while other ingredients were kept constant. The straight dough method described by [16] was followed. The dough was baked in an electric oven at different temperatures and time as specified on Table II. After baking, the bread samples were cooled at room temperature. Dough proofing and composite bread samples are shown in Plates 1-4.



Plate 1. 95:5 (Wheat-Cocoyam) 235 °C, 45 mins.



Plate 2. 95:5 (Wheat-Cocoyam) 235 °C, 35 mins.



Plate 3. 85:15 (Wheat-Cocoyam) 265 °C, 35 mins.



Plate 4. 85:15 (Wheat-Cocoyam) 250 °C, 40 mins.

#### D. Sensory Evaluation

The sensory evaluation of the bread samples was carried out for consumer acceptance and preference using a 20-man trained panel (drawn from the university community). The following sensory properties were assessed: taste, flavour, crumb colour, crust colour, texture, and overall acceptability with the use of a nine-point Hedonic scale. On this scale, 1 represents “extremely dislike” while 9 represents “extremely like” respectively. Responses from the panellists were then analysed statistically.

### III. RESULTS AND DISCUSSION

#### A. Results

The moisture, fat, carbohydrates, protein, ash, and fibre contents (proximate composition) and the mean sensory evaluation of the bread samples are shown in Tables IV and V.

TABLE IV: RESULTS OF PROXIMATE COMPOSITION OF BREAD SAMPLES

Samples	Moisture (%)	Protein (%)	Crude (%)	Ash (%)	Fat (%)	Carbohydrate (%)
A	21.07	8.32	0.66	0.85	5.25	65.47
B	23.63	8.82	0.69	0.89	5.74	71.31
C	21.09	7.16	0.65	0.96	5.8	69.17
D	18.31	8.33	0.82	0.95	4.95	71.31
E	22.65	10.72	0.6	0.49	5.08	67.54
F	20.06	9.44	0.69	0.69	6.82	59.15
G	17.97	8.34	0.83	0.95	5.05	70.84
H	24.87	10.26	0.69	0.52	5.72	60.32
I	19.51	8.42	0.78	0.98	4.43	67.13
J	21.06	9.25	0.65	0.73	6.54	64.95
K	20.54	8.794	0.66	0.73	7.02	65.34
L	20.84	10.71	0.59	0.57	6.35	60.46
M	18.82	10.75	0.6	0.49	7.15	55.94
N	23.57	10.79	0.58	0.48	6.92	58.56
O	19.74	9.52	0.65	0.58	6.68	60.05
P	25.26	8.96	0.59	0.48	7.24	59.56
Q	22.86	9.54	0.66	0.89	5.74	64.95
R	21.66	10.03	0.65	0.48	7.81	54.6
S	21.45	9.74	0.63	0.48	7.24	59.5
T	20.05	9.16	0.76	0.65	6.72	64.33
U	20.25	10.08	0.59	0.57	7.59	57.63
V	21.66	8.62	0.85	0.89	4.49	67.54
W	22.92	10.83	0.53	0.74	6.74	58.56
X	21.79	10.33	0.67	0.86	6.14	62.95
Y	22.87	8.85	0.86	0.78	5.15	68.54
Z	18.54	8.97	0.66	0.73	6.92	60.27
A <sub>1</sub>	18.23	8.46	0.86	0.96	5.62	70.84
B <sub>1</sub>	15.19	8.2	0.88	0.96	5.15	70.79
Control	27.65	11.33	0.58	0.47	8.19	53.69

TABLE V: MEANS OF SENSORY SCORE BASED ON 9-POINT HEDONIC SCALE

Sample	Taste	Flavour	Crust colour	Crumb colour	Texture	Overall acceptability
A	8.33	7.33	8.33	6.67	6.33	7.50
B	6.33	7.67	6.33	6.33	6.67	7.33
C	6.00	7.33	7.33	7.33	6.67	6.83
D	6.00	8.00	7.67	7.33	6.67	6.50
E	8.67	6.67	7.00	6.33	6.33	7.33
F	8.33	7.00	6.33	6.33	8.00	8.17
G	6.00	7.33	7.33	7.33	6.50	6.83
H	7.00	6.67	6.67	5.67	7.33	6.50
I	6.00	7.33	7.33	7.33	6.50	6.83
J	7.67	5.67	6.33	6.67	7.67	8.17
K	7.67	7.33	6.67	6.67	7.67	8.17
L	8.00	7.67	7.00	7.00	8.00	8.50
M	8.00	6.33	5.67	6.67	7.67	8.33
N	8.00	8.00	7.67	7.67	7.67	8.33
O	7.87	7.67	7.00	7.00	8.00	8.50
P	8.67	7.67	7.00	6.67	7.67	8.33
Q	8.67	8.33	7.67	7.33	7.00	7.67
R	9.00	7.00	7.33	7.67	7.33	8.17
S	9.00	6.67	5.67	5.67	7.00	8.00
T	8.00	7.33	7.67	7.33	6.67	7.50
U	7.67	7.67	7.33	7.33	7.00	7.17
V	8.00	8.00	6.67	8.00	7.00	8.00
W	8.00	7.33	6.67	7.00	7.00	8.00
X	7.33	7.67	7.67	7.67	7.33	7.67
Y	6.67	7.67	7.33	7.33	6.82	7.17
Z	8.33	7.00	7.33	7.33	7.33	7.50
A <sub>1</sub>	6.00	7.33	7.33	7.33	6.82	6.83
B <sub>2</sub>	7.00	6.67	6.67	5.67	6.00	6.50
Control	10.00	9.00	8.50	8.67	8.33	9.67

#### B. Discussion

##### 1. Proximate compositions of composite bread samples

The moisture content of the bread samples decreased significantly as the substitution of the cocoyam flour level increased. The highest value of moisture content was obtained in bread sample P, with 95-5% wheat- cocoyam composite flour, while the lowest value was observed in bread sample G, of 85-15% wheat-cocoyam flour (Table IV). This finding agrees with that reported by [2] and [17] but differs from studies reported by [18] and [19]. They reported that moisture content of their composite breads increased with increase in levels of non-wheat flour. This phenomenon can be linked to the higher water holding ability of the non-wheat flour as compared to the wheat flour according to [20].

The reduction observed in the protein content of the samples as the cocoyam flour substitution level (Table IV) may be attributable to the fact cocoyam has low protein content. The lowest protein content was observed in sample C, processed from 85%-15% wheat- cocoyam flour blend; while the highest protein content was observed in sample W, processed from 95%-5% wheat-cocoyam flour blend, respectively. Roots and tubers have been reported to be low in protein contents thus limiting their extensive utilization.

The rise observed in the crude fibre content could be as a result of the fact that the 100% wheat flour bread had the lower fibre content values (0.58%) when compared with the wheat-cocoyam composite flour breads. Fibre is a source of roughage which helps digestion [21].

There was a noticeable increment in the ash content of the composite bread samples from 0.48 to 0.96% with increase in the levels of cocoyam flour substitution (from 5 to 15%). This rise in ash content could be attributed to the higher quantities of ash in the cocoyam flour as compared to wheat flour. This agrees with the findings of [22] who reported an increase in the ash content of wheat-cassava bread.

Samples I and R contained the lowest (4.43%) and highest (7.81%) fat contents which were produced from 85%-15% wheat-cocoyam flour blend and 95%-5% wheat-cocoyam

flour blends, respectively. The fat content decreased with increase in the wheat and cocoyam flour formulation (Table 4), this could be due to their low-fat contents as reported by [17]. Fat bestows tenderness, moistness, flavour, colour, and anti-staling qualities in confectionary products.

The highest carbohydrate content (71.31%) was observed in sample D, with a proportion of 85% wheat and 15% cocoyam flour while the least value of carbohydrate was observed in bread sample M, with the proportion of 95% wheat and 5% cocoyam flour (Table IV). According to [23], cocoyam contains carbohydrate in the form of starch. [17] also reported an increase in carbohydrate content due to blending with cocoyam flours. Carbohydrate pre-dominates all solid nutrients in roots and tubers [24].

## 2. Sensory evaluation

The sensory properties of the bread samples are presented in Table 5. The evaluation was based on a nine-point hedonic scale. The properties: taste, crust colour, crumb colour, flavour, texture, and overall acceptability of the composite breads were compared with the control bread (100% wheat). Significant statistical differences were observed within each attribute. This shows that these differences observed were as a result of the substitution levels of the wheat and cocoyam flours as observed by the panellists and as it affected their preferences.

For taste, it was observed that the 100% wheat flour bread, 5% and 10% cocoyam flour substituted bread, respectively, were the most preferred (Table V). Bread with higher proportion of wheat (95%) and lower proportion of cocoyam flour (5%) scored the highest, which agrees with the findings of [11] and [25]. Nevertheless, increasing cocoyam flour from 5 to 15% did not show any significant difference in the taste of the bread as this reflects the bland taste associated with cocoyam flour. [1], [26] and [27] all reported similar findings.

Flavour contributes greatly to the acceptability or otherwise of a product according to [28]. The sensory evaluation revealed that the most preferred bread samples were the 100% wheat flour bread, 5%, 10% and 15% cocoyam flour substituted breads respectively (Table VI). Food flavour results from subtle interactions between taste and aroma, which gives a favourable or unfavourable sensory experience to a consumer [29]. It is the flavour of a food that majorly determines whether it will be accepted or rejected, despite the fact that its appearance elicits the initial response.

For the bread crust colour, the 100% wheat flour bread and the 5% cocoyam flour substituted bread were the most preferred. As the quantity of cocoyam flour in the bread, baking temperature and time increased, the bread became very dark brown in colour. Table V shows that higher ratings were given to the bread products having lower proportions of cocoyam flour. It was observed that the crust colour of the following bread products: 100% (wheat flour bread), N (5% cocoyam flour bread), U (5% cocoyam flour bread), A (12.48% cocoyam flour bread), T, (10% cocoyam flour) and D (15 cocoyam flour bread) were given high rating at baking temperature of 235 °C and time of 35 min, respectively. The brownish bread appearance could be attributed to the high fibre content in the bread [30]. According to [28], colour is an important parameter when assessing baked bread.

For crumb colour, it was observed that 100% wheat flour bread is the most acceptable (Table V) followed by 5% substitution of cocoyam flour composite bread samples, while samples with higher proportion cocoyam flour showed the least preference in terms of crumb colour. As the proportion of cocoyam flour increased, the acceptance of crumb colour decreased.

The texture of the composite bread samples decreased as the proportion of cocoyam flour in the composite flour blend increased. This may be attributed to the high fibre content of the bread. It was observed that higher proportions of cocoyam flour (15%) gave low scores on texture (Table V). [13] reported that high substitution levels of other flours to wheat flour reduces the elastic properties of wheat flour dough which leads to low gas retaining properties during fermentation which in turn reduces the texture quality of the final bread.

A similar trend as observed in the other sensory attributes was observed for the overall rating; 100% wheat flour bread, 5%, 10% and 15% cocoyam flour substituted breads were the most desired products overall respectively.

The results obtained from this study agrees with the findings reported by [31] in which they partially replaced wheat flour with flours from tubers. It was observed that at substitution levels with cocoyam flour beyond 15%, preference decreased. The use of cocoyam starch in cookies production at 5 and 10% levels respectively were reported by [32] has having desirable sensory attributes. [31], equally reported that blending sweet potato flour with wheat flour up to 20% substitution level, produced confectionaries with improved functional properties. [33] reported that cassava and cocoyam flour can be used to replace wheat flour up to 30% in the production of rock cakes.

## IV. CONCLUSIONS

Studies were conducted using Central composite design for the production of cocoyam flour. Response surface methodology (RSM) was used in estimating the effect of three independent variables namely, blanching time(X1), drying temperature(X2) and drying time (X3) on the proximate, functional, and ant-nutritional properties of cocoyam flour.

In this study, partial substitution of wheat flour with cocoyam flour was possible and bread samples produced from this combination up to 15% supplementation with cocoyam flours were acceptable. Consequently, the utilization of cocoyam flour as partial substitution with wheat flour should be further investigated for confectionary purposes. This will help to expand the utilization options for this underutilized crop and make it more popular. Thereby reducing the dependence on wheat flour which will invariably lead to reduced cost of confectionary products in the long run.

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