QUALITY EVALUATION OF BREAD FROM WHEAT, COCOYAM AND ACHA COMPOSITE FLOUR BLEND

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ABSTRACT
Composite flours were produced from wheat supplemented with acha and cocoyam flour at varying proportions (A=100:0:0; B=90:5:5; C=85:10:5; D=80:10:10; E= 75:15:10). Proximate, mineral composition and functional properties were analysed using standard methods. Bread loaves were prepared from the composite flours and the sensory attributes evaluated. Results obtained revealed supplementation had a significant ($p \leq 0.05$) effect on the proximate composition. Higher quantities of acha and cocoyam flour resulted in an increase in moisture, crude protein and ash content while there was a decrease in the crude fibre and carbohydrate content. Functional properties was significantly ($p \leq 0.05$) different among the flour blends with the exception of bulk density. Increase in iron and zinc in the flour blends was also observed as the supplementation increases. Bread loaves from C (85:10:5) were the most acceptable to the panellists.

Key words: Bread, Wheat, Cocoyam, Acha, Composite Flour

INTRODUCTION
The use of cereals, tubers with or without legumes and fibers as viable sources of functional composite flours keeps on increasing (Bamigbola *et al*., 2016; Awolu *et al.,* 2016). Bread is one of the most important staple foods and the second most widely consumed non-indigenous food products after rice in Nigeria. It isa low cost processed food consumed by people in every socio- economic class and is acceptable to both adults and children. Bread is a fermented confectionary product mainly made from wheat flour and a mixture of yeast, salt, sugar and water by unit operations involving mixing, kneading, proofing, shaping and baking. Wheat grains are relatively low in total protein and generally low in lysine and certain other amino acids, which could be supplemented by the use of acha (Dabels *et al*., 2016).

Cocoyam is nutritionally superior to other roots and tubers in terms of digestibility, crude protein and the following minerals (calcium, magnesium and phosphorus) content (Eze *et al*., 2015). This makes it suitable for potentially allergic infants (gluten allergy), persons with gastro intestine disorders, diabetes patient among others (Eze *et al*., 2015). Acha, *Digitaria exilis*) is also known as Fundi, fonio, hungry rice, Fonio blanc and Petit mil (Ayo and Gidado, 2017), It is believed that acha may have nutraceutical properties, as it is used in some areas for managing diabetes (Jideani and Jideani, 2011). Acha is known to be easy to digest but does not sharply increase the blood sugar level. It is traditionally recommended for children, old people and for people suffering from diabetes or stomach diseases (Ayo and Gidado, 2017). It is commonly eaten as a porridge, couscous or non-alcoholic beverage (Glew *et al*., 2013).

The use of cocoyam and acha composite flour in the production of low cost and generally accepted food products would create an avenue to reduce over dependency of confectionary factories on wheat flour and also provide an alternative towards nutritionally richer and cheaper bread products. Moreover, it will provide essential phytochemicals in bread, ensure food security and improve the health of the consumers in addition to improving the purchasing power of the farmers. Therefore, this study was aimed at producing low-calorie, high-biological value dietary bread by producing protein rich gluten free bread using the composite flour comprising of wheat, cocoyam and acha.

METHODOLOGY
Source of materials and material preparations:
Hard wheat flour (Golden penny), bakers' yeast, butter, sugar table salt and cocoyam corms were purchased from King's market, Ikole Ekiti, Ekiti State, Nigeria. Acha seeds were purchased at the central market, Kaduna in Kaduna State. Wheat grains, cocoyam tubers and acha grains were processed into flour with slight modification to the method described by Agiriga (2014), Akinlua *et al*.(2018) and Olapade and Oluwole (2013) respectively. Wheat, acha and cocoyam flours were formulated in the proportion 100:0:0 (A), 90:5:5 (B), 85:10:5 (C), 80:10:10 (D) and 75:15:10 (E). Bread loaves were prepared using the straight dough method as described by Nwosu *et al*. (2014).

Analysis
Proximate, mineral compositions, and pasting properties were carried out on the samples using the

AOAC (2010) methods. The bulk density, water and oil absorption capacity, foam capacity and stability and least gelation concentration were determined using the method described by Onimawo and Akubor (2012). Swelling power was determined by the method described by Oladele and Aina (2007).

Sensory Evaluation

Sensory evaluation was carried out using the method as described by Ihekoronye and Ngoddy (1985). Twenty (20) trained sensory panelists consisting of members' students from the students of Food Science and Technology, Federal University Oye Ekiti, Ekiti State. The purposive sampling technique was adopted in the selection of the panel of judges because the students have better knowledge of food than other students and would therefore give better interpretation on what would be required of them. The samples were coded and validated questionnaire made up of quality evaluation for appearance, flavour, crust and crumb colour, texture and overall acceptability were used. Quality ratings were based on a 9-point descriptive hedonic scale with 9 (like extremely) being the highest score and 1(dislike very much) as the least score.

Statistical Analysis:

Means were compared using test of significant difference (Steel and Torrie, 1980). Test of significant (P<0.05) difference among the reatments were determined by Analysis of Variance (ANOVA) as described by Steel *et al*. (1997).

RESULTS AND DISCUSSION

The results of proximate composition of bread produced from wheat, cocoyam and acha composite flour blend is presented in Table 1. The moisture content ranged from 36.64 to 38.62% with sample A having the least value while sample E had the highest value. The moisture content of the breads produced from composite flour increased with increasing acha and cocoyam flours substitution into the wheat flour. This agrees with the report given by Ayo and Nkama (2004) who reported an increase in the moisture content of bread with increasing proportion of acha flour substituted into wheat flour. High moisture content in flours encourages the proliferation of micro-organisms and consequently microbial spoilage. However, bulky bread is desirable to hungry consumers because it is stomach filling and satisfying.

The crude protein content ranged from 11.29 to 14.32% with sample C having the least value while sample E had the highest value. This is in line with Olapade and Oluwole (2013) who reported an increase in the protein content of bread with increase in the proportion of acha flour substituted into wheat flour. The fat content ranged from 15.32 to 16.92% with sample E having the lowest value while sample C had the highest value. The sample with the highest acha content contains the least fat content. High fat content is not a desired attribute in flour as this could readily increase the oxidation rate thereby leading to rancid flavour and off-color. Tubers store energy in the form of starch rather than lipids. It is believed that increase in the quantity of cocoyam flour in the composite flour blends will amount to the reduction in fat contents of the blends which gives longer shelf life to the products. This study corresponds with Igbabul *et al*. (2014) who reported a decrease in the fat content of bread samples produced as the quantity of wheat flour reduces.

The crude fibre content ranged between 3.53% and 4.29% more non- digestible component therefore providing bulk for proper peristaltic action in the intestinal tract.

The ash content ranged from 1.76 to 2.71% with sample B having the least value while sample E had the highest ash content. This results obtained in this study are in line with values reported by Olapade and Oluwole (2013) and Igbabul *et al*. (2014) who reported that there was an increase in the ash content of the bread samples produced with increase in the proportion of acha flour substituted into wheat flour.

The carbohydrate content of the flour blend varied between 26.08% and 29.35% with sample A having the highest value while sample E had the least value. Carbohydrates are good sources of energy In this regard therefore these flour blends can be applicable where a high concentration of it is desirable This study. is in line with Olapade and Oluwole (2013) and Igbabul *et* al. (2014) who reported a decrease in the carbohydrate content of bread samples produced with decrease in the quantity of wheat flour substitution.

The results of functional properties of bread produced from the composite flour blends is presented in Table 2. The water absorption capacity (WAC) ranged from 150.50 to 172.45% with sample A having the lowest value while sample E had the highest value. Increase in WAC is useful in baked products, which requires hydration to improve paste handling

Table 1: Proximate Composition of Wheat, Cocoyam and Acha Composite Flour

Sample	Moisture content (%)	Fat content (%)	Crude fibre (%)	Crude protein (%)	Ash content(%)	Carbohydrate (%)
A	36.64±0.25^{e}	16.64±0.39^{b}	4.29±0.11^{a}	11.29±0.07^{e}	1.79 ±0.21^{c}	29.35±0.32^{d}
B	37.20±0.05^{d}	16.50±0.05^{c}	3.94±0.02^{b}	12.12±0.09^{d}	1.76 ±0.02^{c}	28.48±0.06^{c}
C	37.71±0.08^{c}	16.44±0.01^{d}	3.79±0.01^{c}	12.74±0.04^{c}	1.81±0.10^{c}	25.95±0.16^{a}
D	38.24±0.11^{b}	16.42±0.02^{a}	3.69±0.01^{d}	13.48±0.37^{b}	2.04±0.55^{b}	26.13±0.16^{b}
E	38.62±0.09^{a}	15.32±0.02^{e}	3.53±0.01^{e}	14.32±0.10^{a}	2.13±0.09 ^{a}	26.08±0.17^{e}

Values are mean ± standard deviation of triplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)
characteristics.

High WAC is also useful in product bulking and consistency. High water absorption capacity may be as a result of the flours having more hydrophilic constituents such as polysaccharides. Also, protein has both hydrophilic and hydrophobic nature and therefore they can interact with water in food. The WAC increased with increasing quantity of cocoyam and acha flours in the blends. This work corresponds to Akonor *et al*. (2017) who reported that water absorption of composite flours of wheat and cocoyam increased significantly with increase in the quantity of cocoyam flour substituted into wheat flour.
The oil absorption capacity (OAC) varied between 140.00% and 146.50% with sample A having the lowest value while sample D had the highest value. The relatively higher values of the composite blends could be due to the variations in the presence of non-polar side chain, which might bind the hydrocarbon side chain of the oil among the flours. Similar findings were observed by Chandra *et al*. (2015). OAC of sample D suggests that it could be useful in food formulation where oil holding capacity is needed.

The bulk density of the flours ranged from 0.76to 0.79 g/ml with E having the least value while sample A and B had the highest bulk density. The slight variation in bulk density could be as a result of the variation in starch content, particle size and moisture content of the flours (Chandra et al 2015). Olapade and Oluwole (2013) reported a decrease in the bulk densities of wheat and acha composite flours with increase in the quantity of acha. Bulk density reflects the relative volume of packaging material required. The higher the bulk density, the denser the packaging material required.

The foaming capacities ranged from 11.04 to 11.51% with sample A having the lowest value while sample E had the highest value. Similar trend was observed by Mepba (2007) who reported the foaming capacities of wheat and plantain composite flour increasing with decrease in the quantity of wheat flour. Swelling capacity values ranged between 15.30% and

Table 2: Functional Properties of Wheat, Cocoyam and Acha Composite Flour

Samples	Bulk density (g/ml)	Water absorption (%)	Oil absorption capacity (%)	Foaming capacity (%)	Swelling capacity (%)	Foaming stability (%)
A	0.79 ± 0.14^{a}	150.50 ± 0.00	140.00 ± 0.14^{e}	11.04 ± 0.01^{c}	17.61 ± 0.01^{a}	1.93 ± 0.05^{e}
B	0.79 ± 0.14^{a}	152.00 ± 0.00	$141.00\beta\pm0.00^{d}$	11.16 ± 0.02^{b}	15.80 ± 0.01^{b}	2.29 ± 0.01^{d}
C	0.78 ± 0.00^{a}	160.00 ± 0.07^{c}	144.45 ± 0.00^{b}	11.20 ± 0.14^{b}	15.60 ± 0.03^{c}	2.49 ± 0.00^{c}
D	0.77 ± 0.07^{a}	165.35 ± 0.00^{b}	146.50 ± 0.14^{a}	11.21 ± 0.00^{b}	15.50 ± 0.00^{d}	2.64 ± 0.03^{b}
E	0.76 ± 0.14^{a}	172.45 ± 0.00^{a}	144.10 ± 0.07^{c}	11.51 ± 0.07^{a}	15.30 ± 0.03^{e}	2.84 ± 0.00^{a}

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

17.61% with sample E having the lowest value while sample A had the highest value. The swelling capacity decreased as the quantity of cocoyam flour and acha flour increased.

The results of mineral content of flours produced from wheat, cocoyam and acha composite flour blend is presented in Table 3. The sodium content of the composite flour varies from 8.91 to18.71 mg/100g with sample E having the least value while sample A had the highest value. The potassium content of the composite flour varies in value between 32.83 mg/100g and 50.75 mg/100g with sample A having the highest value while sample D had the least value. Onoja *et al*. (2011) reported a decrease in iron and potassium contents of composite flour blends with a corresponding increase in acha flour and decrease in wheat flour.
Calcium contents of the flour blends varied between 9.96 and 14.56 mg/100g with sample A having the least value while sample E had the highest value. Dabels *et al*. (2016) reported that there was an increase in calcium content of composite flour blends with a corresponding increase in plantain flour and decrease in wheat flour.
The iron content of the flour blends varied in value between 0.37 mg/100g and 0.61 mg/100g with sample A having the least value while sample E had the highest value. The iron content of the bread samples increased with increase in the proportion of acha flour and cocoyam flour. Ameh *et al*. (2013) reported a

similar increase in iron content of bread loaves with increase in the proportion of rice bran being substituted into wheat flour.

Zinc is one of the essential micronutrients given consideration in food product fortification needed for the immune system and the body to function appropriately. It is also involved in cell division, cell growth, and wound healing (Navarre, 2009). Zinc value ranged from 0.50 to 0.62 mg/100g with sample A had the least value while sample E having the highest value. The zinc content increased with increase in the proportion of acha flour and cocoyam flour. Onoja *et al*. (2011) reported that there was an increase in zinc content of composite flour blends with a corresponding increase in acha flour and decrease in wheat flour. This implies that the composite flour samples could potentially be used to augment zinc status in aged people or those taking medications such as hormone replacements or diuretics. (Roberts-Nkrumah and Badrie, 2008)

Table 3: Minerals Contents of Wheat, Cocoyam and Acha Composite Flour

Samples	Na (mg/100g)	K (mg/100g)	Ca (mg/100g)	Fe (mg/100g)	Zn (mg/100g)
A	18.71 ± 0.01^{a}	50.75 ± 0.21^{a}	14.56 ± 0.04^{a}	0.37 ± 0.00^{d}	0.50 ± 0.00^{e}
B	13.00 ± 0.00^{b}	39.08 ± 0.04^{c}	12.72 ± 0.01^{b}	0.43 ± 0.00^{c}	0.55 ± 0.01^{d}
C	10.61 ± 0.01^{c}	36.61 ± 0.01^{d}	10.28 ± 0.01^{c}	0.50 ± 0.00^{b}	0.56 ± 0.00^{c}
D	10.43 ± 0.04^{d}	32.83 ± 1.06^{e}	10.23 ± 0.01^{c}	0.55 ± 0.01^{b}	0.59 ± 0.01^{b}
E	8.91 ± 0.01^{e}	41.05 ± 0.71^{b}	9.96 ± 0.01^{d}	0.61 ± 0.00^{a}	0.62 ± 0.01^{a}

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

The sensory scores of the bread produced from wheat, cocoyam and acha composite flour blend are shown in Table 4. There was no significant ($p<0.05$) difference among all the five samples in all the sensory parameters measured. Texture of the bread ranged from 7.07 – 7.47 with sample B having the highest score. Aroma ranged from 6.87 (B) –7.47 (E). While the appearance ranged from 6.93 -7.90 with sample E the lowest and A recorded the highest value. Sample C was the most acceptable in term of crust, crumb appearance and overall acceptability.

CONCLUSION

From this study, it may be inferred that composite flour of wheat with acha and cocoyam flour has shown good potential which could be beneficial as the protein and ash content were improved in addition to the functional properties of the flour having wide application in food products. Acha and cocoyam could be added to wheat to produce bread up to levels of 15 and 10 % respectively without significant adverse effects regarding the crust colour, crumb structure and appearance. However, composite flours with ratio of 85: 10:5 (wheat: acha: cocoyam) flours was the most accepted. Further study on the shelf life and antinutrients of the composite flours and bread required.

Table 4: Mean Sensory Scores of Bread Samples Produced from Wheat, Cocoyam and Acha Composite Flour

Samples	Texture	Aroma	Taste	Crumb	Crust	Appearance	Overall acceptability
A	$7.27^{c}\pm0.80$	$7.27^{c}\pm1.03$	$7.33^{c}\pm1.45$	$7.20^{d}\pm1.15$	$7.73^{a}\pm1.10$	$7.90^{a}\pm0.12$	$7.27^{c}\pm1.44$
B	$7.07^{d}\pm0.88$	$6.87^{e}\pm1.06$	$7.07^{d}\pm1.22$	$6.40^{e}\pm1.35$	$6.67^{e}\pm1.72$	$7.77^{b}\pm0.08$	$7.13^{d}\pm1.64$
C	$7.33^{b}\pm0.72$	$7.33^{b}\pm0.82$	$8.07^{a}\pm0.46$	$7.67^{a}\pm0.82$	$7.67^{b}\pm0.72$	$7.73^{bc}\pm0.88$	$8.27^{a}\pm0.03$
D	$7.07^{d}\pm1.39$	$7.00^{d}\pm1.25$	$6.93^{e}\pm1.62$	$7.47^{b}\pm1.13$	$6.80^{d}\pm1.47$	$7.13^{bc}\pm0.25$	$8.00^{b}\pm0.54$
E	$7.47^{a}\pm0.99$	$7.47^{a}\pm1.25$	$8.00^{b}\pm1.69$	$7.33^{c}\pm0.82$	$7.07^{c}\pm1.10$	$6.93c^{d}\pm0.80$	$7.07^{e}\pm1.22$

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

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