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Research Paper

Proximate Composition, Mineral Content and Functional Properties of Composite Flours and Microbiological/Sensory Analysis of Composite Flour Bread

Michael Sunday Abu*[1], Rufus Emamoge Aso[2], Job Itanyi Onuche[1], Roy Emochone Yohanna[1], RukaiyatLawal Mashi[3], Sa'ad, Hassanat Ahmad[1]
[1]*Department of Biochemistry, Faculty of Pure and Applied Sciences, Federal University Wukari, Nigeria*
[2]*Department of Microbiology, Faculty of Pure and Applied Sciences, Federal University Wukari, Nigeria*
[3]*Department of Biology, Federal College of Education, Kastina, Nigeria*

ABSTRACT
Composite flour is a mixture of several flours obtained from either roots, tubers, cereals and legumes with or without the addition of wheat flour. This study evaluated the proximate, some mineral compositions and functional properties of composite flour produced from potato, cassava and soybean and the effect of the fortification on microbial growth on the bread produced. The flour variations were prepared in 50:50 (%w/w) followed by the estimation of proximate composition, mineral contents and functional properties. Bread production was carried out using CP, CS and WC variants as well as whole wheat and cassava flours. Consequently, sensory evaluation and microbial load of the finished product were evaluated. The results showed that the CPF and CSF have highest moisture content (20%) and SF have lowest moisture content (2.85%), consequently, the SF have highest crude protein content (43.41%) and CF have the lowest crude protein content (4.34%), similarly, the percentage of the crude fibre showed that the CSF have the highest (27%) and WF have the lowest crude fibre content (3.06%), the lipid content of SF shows the highest (12.2%) and the CF shows the lowest (0.55 %), calcium content of the flours shows that the CPF have the highest (2.02g/100g) and the WF shows the lowest (0.25g/100g) and the phosphorus content showed that the CSF have the highest (1.58g/100g) and the CF have the lowest (0.01g/100g). The SWC showed that the wheat flour (WF) = 11.00 ± 1%is significantly ($p<0.05$) different from the cassava flour (CF) = 6.33 ± 0.58% and cassava-soybean flour (CSF) = 6.67 ± 0.58%. In the hand, water absorption capacity (WAC) revealed that the wheat flour (WF) = 1.74 ± 0.24(gH_2O/gflour)is significantly ($p<0.05$) different from cassava flour (CF) = 2.10 ± 0.08(gH_2O/gflour)and cassava-potato flour (CPF) =2.16 ± 0.07(gH_2O/gflour). Also, the oil absorption capacity (OAC) showed that wheat flour (WF) = 1.80 ± 0.15(goil/gflour)is significantly ($p<0.05$) different from cassava flour (CF) = 2.41 ± 0.07(gH_2O/goil), cassava-potato flour (CPF) = 2.21 ± 0.81(goil/gflour)and cassava-soybean flour (CSF) = 2.15 ± 0.10(goil/gflour). The microbial growth is higher on the wheat flour bread, WFB, followed by cassava flour bread, CFB, and there was a lower growth in cassava-potato flour bread, CPFB. The proximate composition and the functional properties of the composite flour bread identified through the study clearly substantiate the feasibility of using legume/tuber composite flours in bread formulations.

KEY WORDS: *Composite four, functional properties, proximate composition, cassava flour, microbial incidence*

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I. INTRODUCTION

Functional properties are intrinsic physico-chemical behaviours of food proteins that interact with other food constituents directly or indirectly thereby affecting food processing applications, quality and general acceptability (Berchie*et al.*, 2010). Proteins used in foods are expected to possess vital functional characteristics such as water and oil absorption capacities, nitrogen solubility, bulk density, emulsifying and foaming properties which will in turn govern the suitability of novel proteins as food supplement and ingredients for formulating new food products (Kiin-Kabari*et al.,* 2015). Thus in addition to functional properties, it is imperative to evaluate the proximate composition of food components intended to be used in novel formulation of food product to ascertain the nutritional content which would determine the general acceptability of such new product.

Wheat provides about 20 percent of the food calories requirement for the world's population that serves as a staple food in several countries around the globe and is the major ingredient in most breads, rolls, crackers, cookies, biscuits, cakes, doughnuts, macaroni, spaghetti, puddings, pizza, and many prepared hot and cold breakfast foods (Oppong*et al*., 2015). According to Nwanekezi (2013), the wheat imported into Nigeria translates to a huge monetary value of 635 billion naira per annum. "However, the recent data from the National Bureau of Statistics (NBS) trade report shows that Nigeria has spent N258.3billion on wheat importation in the first three months of this year, 2021, despite the government's continuous push to drive local production. Major staple foods such as semolina, bread, noodles, and pasta among others produced from wheat flour now form a regular part of meals in most urban and rural households across the country and this has driven the surge in wheat importation. Despite being a major market for wheat products, the country only produces 400,000 metric tons per annum, an amount that is 3.6 million short of total demand, according to data from the Federal Ministry of Agriculture. Efforts at boosting local wheat production in recent years have been obstructed by the Boko Haram insurgency in the North-Eastern region of the country, as wheat farmers in Borno, the country's major producing state had abandoned their farmlands and fled to other regions for safety, while some took residency at the Internally Displaced Person's (IDP's) camp" (Business day, 2021).

Thus, Nigeria and several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour. Composite flours may be considered as blends of wheat and other flours or wholly non-wheat blends of flours for the production of leavened breads, unleavened baked products, pastas, porridges, and snack foods, on the other hand, it could be seen as a mixture of flours from tubers rich in starch (e.g. cassava, yam, sweet potato) and/or protein rich flours (e.g. soy, peanut) and /or cereals (e.g. maize, rice, millet, buckwheat), plus or minus wheat flour (Suresh *et al.*, 2015). This study was therefore designed to fortify cassava flour with local non-wheat flours for the production of bread/other confectioneries products, and to further enhance the nutritional content of such products in Nigeria.

II. MATERIALS AND METHOD

Materials

Refined wheat (*Triticumaestivum* L.) flour, Full-fat soy (*Glycine max*) flour, Potato (*Solanum tuberosum)* flour and Cassava (*Manihotesculenta*) flour, Sugar, Yeast, Butter were sourced from a local market,.

METHOD

Preparation of sweet potato, full fat soybean and cassava flours

Sweet potato tubers or cassava tubers were washed, peeled and cut into thin slices, spread in a tray and was dried under the sun for 72 hours and was milled into flour. The flour was stored in a polyethylene bag until required for use.

Soybean grains were selected, washed and soaked in water for 6 hours and boiled in pressure cooker for 5 minutes. They were removed, dehulled and dried in the oven at 50^{o}c for 24 hours and ground into flour using an electric grinder. The flour was sieved through 80 mesh sieve. The flour samples were kept in airtight container before using. Notice, the packaging of flour samples differs between sweet potato and soybean, because of the higher fat content in soy flour, so it is necessary to be stored in an airtight container.

Determination of Proximate composition

Determination of crude fat, moisture content, total ash, crude fibre and crude protein were carried out by AOAC (2015) methods.

Determination of mineral contents

Determination of phosphorus and calcium were done ash titrimetric method as described by AOAC (2015).

Determination of Functional Properties

Swelling capacity

The swelling capacity was determined by the method described by Okaka and Potter (1977). 100 ml graduated cylinder was filled with the sample to 10 ml mark. The distilled water was added to give a total volume of 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 minutes and left to stand for a further 8 min. The volume occupied by the sample was taken after the 8th minutes.

Water absorption capacity (WAC) and oil absorption capacity (OAC)

WAC and OAC were determined according to the method described by Niba*et al.* (2000) as slightly modified. Two gram of each sample was weighed into a centrifuge tube and 50 ml of water was added. The content was shaken for about 5 minutes at room temperature. The mixture was kept in a water bath for about 15 minutes and centrifuged at 5000 rpm for 15 minutes. The supernatant was decanted and discarded, while the adhering drops of water/oil were removed and the resultant sediment was reweighed. WAC and OAC were calculated as the weight of the sediment (M2) divided by the initial weight of the sample (M1) (g/g).

WAC/OAC = $\frac{M2}{M1}\ g/g$

Determination of bread weight or baking loss

Weight loss was determined by weighing dough of each sample before bake (M1) and weighing of the bread sample after sufficient cooling (M2). Weight loss was expressed as a percentage.

Weight Loss = $\frac{M1-M2}{M1}x100$

Determination of microbial load

Serial Dilution

Accurately 1 g of the sample was weighed into a test tube containing 9 ml of distilled water. The test tubes were arranged in ascending order from 1 to 10 each with 9 ml of distilled water. The first test tube containing the sample was shaken vigorously for homogenous mixture. One ml was picked and transferred to the second test tube. It was shaken and 1ml was also transferred to the third test tube it continues to the last test tube. All the test tubes were labelled from 1^1 to 1^{10} respectively.

Preparation of media

Accurately 28 g of the N.A was weighed and dissolved in 1000 ml of distilled water and pre-heated. It was sterilized in an autoclave for 15 minutes at 121°C for 15psi and allowed to cool to a temperature bearable to the skin.

Inoculation of the sample

From the test tubes prepared for serial dilution, 1 ml of the sample was poured into a petri dish. About 15-20 ml of the N.A was measured into the petri dish containing the sample. The petri dish was rogue for proper mixture. It was allowed to set on the bench and incubated for 24 hours in an incubator. After 24 hours, the colonies were observed for colour, shape, size and numerical count. The counting of the colony was done with colony counter.

Colony forming unit (C.F.U) = $\frac{No\ of\ count}{100} \times unit\ factor$

Preparation of composite flours and bread production

The composite flours were produced in the ratio of 1:1 WCF = 400 g of wheat flour + 400 g of cassava flour. CPF = 400 g of cassava + 400 g of sweet potatoes. CSF = 400 g of cassava + 400 g of soybean. The dry ingredients, 800 g flours/composite flours and 100 g butter were well mixed. One egg was added and the content was mixed properly followed by the addition of warm water, 100 g of sugar and 5 g of yeast and the resultant mixture was thoroughly mixed to obtain the dough. Exactly 110 g of the dough was placed inside the baking pan and kept at room temperature for 20 minutes to ripe. The ripe dough was taken to the oven and baked for 15 minutes. The bread was brought out from the oven and allowed to cool for further analysis.

Sensory Evaluation of Bread

A five point Hedonic scale (Derek and Richard, 1982), where 5 represented the highest score and 1 the lowest was employed to evaluate the product for flavour, texture (crumb, crust), colour (crumb, crust) and general acceptability. Each judge (panel member) was seated in an individual compartment free from noise and distraction. The breads were properly coded and served to the panelists for evaluating of taste, flavour, colour (crumb, crust), texture (crumb, crust) and general acceptability. Each judge was presented with a glass of water after each tasting session to rinse mouth so as to prevent carryover effect

III. RESULT

Proximate Composition

The proximate composition of the flours/composite flours evaluated and is shown in Table 1. The individual flours showed that the wheat flour (WF) has the highest moisture content (9.90 %) as compared with cassava, sweet potatoes and soybean flours. Meanwhile, among the composite flours (WCF, CPF and CSF), CPF and CSF showed higher moisture content (20 % both) as compared with WCF (10 %).

There was a difference in the protein level across the flour samples. The protein level was highest in soybean (SF) (43.41 %) while the cassava flour (CF) showed the least protein content (4.34 %).

The crude fibre content of cassava-soya bean flour (CSF) and wheat flour (WF) content showed highest and lowest value (27 % and 3.06 %) respectively.

There was high variation in crude fat content among samples collected in Table 1. The soybean flour (SF) was higher in percentage of crude fat while cassava flour (CF) was lowest.

Some mineral and energy content of flours/composite flours

The mineral and energy content of flours/composite flours were investigated and shown in Table 2. In the mineral content, the individual flours showed that the soybean flour (SF) have the highest %ash content (4.45 %) as compared with wheat flour (WF) (0.6 %), cassava flour (CF) (2.3 %), and potatoes flour (PF) (2.7 %).

Meanwhile among the composite flours (WCF, CPF and CSF), cassava-potato flour (CPF) (16.5 %) showed higher ash content compared to WCF (4.1 %) and CSF (7.5 %).
Also, in the nitrogen free extract (NFE) the individual flours (WF, CF, PF and SF) showed that the potato flour (PF) (76.4 %) has the highest NFE content. Meanwhile among the composite flours (WCF, CPF and CSF) wheat-cassava flour (WCF) (37.52 %) showed higher NFE content as compared to cassava-potato flour (CPF) (27.79 %) and cassava-soybean flour (CSF) (12.75 %).
The energy content of the individual flours (WF, CF, PF and SF), soybean flour (SF) (365.48 cal) showed the highest energy that is the M.E cal content. While among the composite flours (WCF, CPF and CSF) cassava-soybean flour (CSF) (401.67 cal) showed higher energy content compared to wheat-cassava flour (WCF) (385.110 cal) and cassava-potato flour (CPF) (316.32 cal).
Also, part of the mineral content, in calcium, the individual flours (WF, CF, PF and SF) the soybean flour (SF) (0.35g/100g) has the highest calcium content. While in the composite flours (WCF, CPF and CSF) cassava-potato flour (CPF) (2.02g/100g) showed higher calcium content than wheat-cassava flour (WCF) (1.25g/100g) and cassava-soybean flour (CSF) (0.99g/100g).
The phosphorus content of the individual flours (WF, CF, PF and SF) wheat flour (WF) (0.05g/100g) has the highest phosphorus content. While among the composite flours (WCF, CPF and CSF) cassava-soybean flour (CSF) (1.58g/100g) showed higher phosphorus content compared to wheat-cassava flour (WCF) (1.33g/100g) and cassava-potato flour (CPF) (0.85g/100g).

Functional properties of flours/composite flours
The functional properties of flours/composite flours such as the swelling capacity (SWC), the water holding/water absorption capacity (WHC/WAC) and the oil absorption capacity (OAC) were evaluated as represented in Table 3. The SWC showed that the wheat flour (WF) = 11.00 ± 1%is different from the cassava flour (CF) = 6.33 ± 0.58% and cassava-soybean flour (CSF) = 6.67 ± 0.58%.
The water holding/water absorption capacity (WHC/WAC) showed that the wheat flour (WF) = 1.74 ± 0.24(gH_2O/gflour)is different from cassava flour (CF) = 2.10 ± 0.08(gH_2O/gflour)and cassava-potato flour (CPF) =2.16 ± 0.07(gH_2O/gflour).
Also, the oil absorption capacity (OAC) showed that wheat flour (WF) = 1.80 ± 0.15(goil/gflour)is different from cassava flour (CF) = 2.41 ± 0.07(gH_2O/goil), cassava-potato flour (CPF) = 2.21 ± 0.81(goil/gflour)and cassava-soybean flour (CSF) = 2.15 ± 0.10(goil/gflour).

Moisture lost on finished product
Moisture loss of the samples is presented in Table 4. The result shows that wheat flour bread, WFB, lost the highest moisture while the cassava-potato flour bread, CPFB, lost the lowest moisture.

Bacterial growth of raw materials of flours and finished product after cooling
The growth of bacterial on raw material as presented in Table 5 demonstrated that there was a higher growth on cassava flour, CF, and lower growth on cassava-potato flour, CPF.
Also, the growth on the bread showed that there was a higher growth on wheat flour bread, WFB, and lower on cassava-soya bean flour bread, CSFB.

Bacterial growth on the bread after 3 days
The microbial growth on the bread is presented in Table 6 in which there was a higher growth in the wheat flour bread, WFB, followed by cassava flour bread, CFB, and there was a lower growth in cassava-potato flour bread, CPFB.

Fungal growth on bread after 3 days
There was a higher fungal growth in the wheat-cassava flour bread, WCFB, followed by wheat-flour bread, WFB, whereas, there was no growth on the cassava-potato flour bread, CSPB as showed in Table 6.

Sensory evaluation on bread
The sensory evaluation on bread was evaluated and presented on Table 7. The individual flour bread (WFB and CFB) wheat flour bread (WFB) showed the highest in colour (5), flavour (5), taste (5), texture (5) and acceptability (5) compared to the cassava flour bread (CFB). Meanwhile the composite flour bread (WCFB, CPFB and CSFB) wheat-cassava flour bread (WCFB) showed the highest in colour (4), flavour (4), taste (4), texture (4) and acceptability (5) compared to the cassava-potato flour bread (CPFB) (4,3,4,4 and 4) and cassava-soybean flour bread (CSFB) (4,4,4,4 and 3).

Table 1: Proximate Composition of Flours/Composite Flours

Sample	M.C %	Crude protein%	Crude fibre %	Lipids %
WF	9.9	15.11	3.06	1.15
CF	9.5	4.34	8	0.55
PF	8.55	7.05	4.6	0.7
SF	2.85	43.41	16.58	12.2
WCF	10	28.38	20	0.6
CPF	20	35.29	25	0.65
CSF	20	5.29	27	0.7

WF = 100 % wheat flour; CF = 100% cassava four; PF = 100% sweet potatoes flour; SF = 100% soybean flour; WCF = 50% wheat flour; 50% cassava flour; CPF = 50% cassava flour: 50% sweet potatoes; CSF = 50% cassava flour: 50% soybean flour

Table 2: Some Mineral and Energy Content of flours/composite flours

SAMPLES	Ash (%)	NFE (%)	M.E (cal)	Calcium (g/100g)	Phosphorus (g/100g)
WF	0.60	70.18	351.51	0.25	0.05
CF	2.30	75.31	323.55	0.28	0.01
PF	2.70	76.40	340.10	0.33	0.03
SF	4.45	20.51	365.48	0.35	0.02
WCF	4.10	37.52	385.10	1.25	1.33
CPF	16.50	27.79	316.32	2.02	0.85
CSF	7.50	12.75	401.67	0.99	1.58

WF = 100 % wheat flour; CF = 100% cassava four; PF = 100% sweet potatoes flour; SF = 100% soybean flour; WCF = 50% wheat flour; 50% cassava flour; CPF = 50% cassava flour: 50% sweet potatoes; CSF = 50% cassava flour: 50% soybean flour

Table 3: Functional Properties of Flours/composite Flours

Sample	SWC (%)	WHC (gH_2O/gflour)	OAC (goil/gflour)
WF	11.00 ± 1^{b}	1.74 ± 0.24^{a}	1.80 ± 0.15^{a}
CF	6.33 ± 0.58^{a}	2.10 ± 0.08^{b}	2.41 ± 0.07^{b}
WCF	10.00 ± 1^{b}	1.83 ± 0.05^{a}	2.03 ± 0.07^{a}
CPF	12.33 ± 1.15^{b}	2.16 ± 0.07^{b}	2.21 ± 0.81^{b}
CSF	6.67 ± 0.57^{a}	1.98 ± 0.05^{a}	2.15 ± 0.10^{b}

n= 3; values in mean ±STD, means with different superscript varies significantly at $p<0.05$ down the column. WF = 100 % wheat flour; CF = 100% cassava four; PF = 100% sweet potatoes flour; SF = 100% soybean flour; WCF = 50% wheat flour: 50% cassava flour; CPF = 50% cassava flour: 50% sweet potatoes; CSF = 50% cassava flour: 50% soy bean flour

Table 4: Moisture Loss of Bread

Sample	Moisture Lost (%)
WF	29 ± 0.05^{d}
CF	27 ± 0.09^{cd}
WCF	23 ± 0.01^{c}
CPF	5.64 ± 0.05^{a}
CSF	17.82 ± 0.01^{b}

N=3, $p<0.05$; WFB = 100 % wheat flour bread; CFB = 100% cassava four bread; WCFB = 50% wheat flour: 50% cassava flour; CPFB = 50% cassava flour: 50% sweet potatoes; CSFB = 50% cassava flour: 50% soybean flour

Table 5: Bacterial Growth on Raw Material and Bread Product

Sample	Bacterial growth on flours (cfu/g)	Bacterial growth of bread after some hours (cfu/g)
WF	10×10^6	29×10^6
CF	15×10^6	3×10^6
WCF	15×10^6	112×10^6
CPF	7×10^6	35×10^6
CSF	10×10^6	19×10^6

WF = 100 % wheat flour; CF = 100% cassava four; WCF = 50% wheat flour: 50% cassava flour; CPF = 50% cassava flour: 50% sweet potatoes; CSF = 50% cassava flour: 50% soybean flour

Table 6: Bacterial and Fungal Growth on Bread after 3 days

Sample	Bacterial Growth (cfu/g)	Fungal Growth (cfu/g)
WF	36×10^6	2.8×10^6
CF	27×10^6	2×10^6
WCF	6×10^6	4×10^6
CPF	1×10^6	0
CSF	8×10^6	2×10^6

WFB = 100 % wheat flour bread; CFB = 100% cassava four bread; WCFB = 50% wheat flour: 50% cassava flour; CPFB = 50% cassava flour: 50% sweet potatoes; CSFB = 50% cassava flour: 50% soybean flour

Table 7: Sensory Evaluation of Bread

Sample	Colour	Flavour	Taste	Texture	Acceptability.
WFB	5	5	5	5	5
CFB	4	4	4	4	3
WCFB	4	4	4	4	5
CPFB	4	3	4	4	4
CSFB	4	4	4	4	3

WFB = 100 % wheat flour; CFB = 100% cassava four; WCFB = 50% wheat flour: 50% cassava flour; CPFB = 50% cassava flour: 50% sweet potatoes; CSFB = 50% cassava flour: 50% soybean flour

IV. DISCUSSION

The low moisture content of these flours blends would enhance their storage stability by preventing mould growth and other biochemical reactions (Singh *et al.*, 2005) and this assertion can possibly explain why they may have longer shelf life and could be suitable in both bakery and noodles products (Ocheme*et al.*, 2018).

The protein content enhancement of the flours by combination of different flours in this study suggests that composite flours made from cassava, sweet potatoes and soybeans may be useful in production of protein enriched bakery products such as bread. The crude protein content and quality of cassava flour can be improved by blending cassava flour with soybeans and sweet potatoes flours and used as composite flours. The improved protein values of the test (WCF, CPF and CSF) may be as a result of type of supplements present, and as well, it could be attributable to synthesis of new protein from hydrolysed free amino acids during fermentation by microflora enzymes. It is known that when legumes such as soybeans supplement cereals and tubers they provided a protein quality comparable to or higher than that of animal protein (Hotz and Gibson, 2007). This assertion was in line with the present study where the protein quality of cassava flour was enhanced by the present of soybean flour. Similarly, the higher protein content observed for the CPF blend over the WCF and CSF blends showed that it was superior to other blends and may possibly increase the nutritional supplication in the body as compared to the other blends.

Crude fibre contributes to the wellbeing of the gastrointestinal tract and metabolic processes in man because it comprises cellulose and lignin which have capacity to raise intestinal mobility causing increased transit time for bile salt derivatives such as deoxycholate, which are chemical carcinogen, hence reducing incidence of carcinoma of the colon (Schneeman, 2002; Eddy *et al*., 2007).Wheat flour would not be a better source of fibre content since it had significantly lower crude fibre content. Therefore, it will be useful if flour of sweet potatoes, soybean or cassava is added to boost its fibre content as seen in this study. However, cassava flour and whence mixed with soybean and sweet potatoes flours showed improved crude fibre content.

Most foods with high fat content contribute essentially to the energy requirement for humans and animals. High fat flours are also good for flavour enhancers and useful in improving palatability of foods in which it is incorporated (Oppong*et al.*, 2015). However, the low lipid level observed in the samples was expected because legumes, cereals, roots and tubers store energy in form of starch rather than lipids. The low lipid values are beneficial as it guarantees longer shelf life for the breads because it is a common knowledge that the higher the lipid content of a given food, the higher are the chances for rancidity. Also, the low level of lipid is an indication that such flours would be good source of flour for people with cardiovascular diseases.

Ash content is an indication of mineral content of food as it was evident with the present of calcium and phosphorus. This therefore suggests that cassava flour in association with soybean and sweet potatoes flours could be important sources of minerals (Oppong*et al.*, 2015) and as such wheat flour can further be enhanced through composite flour by in-cooperation of cassava, sweet potatoes or soybeans flours. The improved ash content for the CF, WCF, CPF and CSF flours and the control when compared with the control flour, WF, was an indication that the composite flours were of good sources of mineral.

The increased energy levels for the flours might be ascribed to either individual food materials or microflora enzyme hydrolysis that led to the synthesis of complex carbohydrates from other nutrients carbon skeletons. These energy levels of variant flours suggests that they could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy (Butt and Batool, 2010).

The high swelling capacity observed with WF as compared with the CF could be due to the ability of the gluten in wheat flour to form continuous network of strand when in water whereas the low CF swelling capacity could be as result large particle size or increased decrease interaction of the granules (Camel *et al.*, 2019). However, there was an improvement when cassava flour was mixed with soybeans and sweet potatoes flours.

Water absorption capacity is the ability of the flour or starch to hold or retain water against gravity that can comprise of bound water, hydrodynamic water, capillary water and physically entrapped water (Andres*et al.*, 2006).This effect could be attributed to the loss interaction between amylose and amylopectin in the native starch granules and the weak binding forces that hold the starch particles together (Ajatta*et al.,* 2016)and is essential for rapid dough formation during processing of bakery products such as bread.

Oil absorption capacity is a process that involves physical entrapment of oil by food products or materials when mixed with oil. It is an indication of the rate at which protein sticks to fat in food fortifications and is useful since fat acts as flavour retainer and increases the taste of food. As composite flours were compared, (WCF, CPF and CSF) with WF, it was found out that CPF and CSF resisted oil absorption better.It has been reported by Althea-ann and Shuryo(1983) that the higher the amount of heat treatment given to a protein, the more hydrophobic the protein becomes, as a result of a higher number of hydrophobic groups exposed through the unfolding of the protein molecules.

Baking loss was analysed in terms of moisture loss from the bread. The moisture content of the control bread was more than the composite flour breads. During baking, the loss of moisture content decreases with an increased proportion of composite flour and thus baking loss also decreases with composite flour bread as it was in the case with the present study.

After some hours, all the samples had some microbial growth but the composite of wheat-cassava flour bread have more growth compared to other samples. These values gradually increased during the 3 days of storage probably due to hydrolysis of fat. This is in agreement with the report of Sewald and DeVries (2003) that hydrolysis of glycerides account for the increased of microbial growth stored bread. The low growth observed in the cassava-potato flour bread (CPFB) after 3 days of storage relative to the other mixes could be attributed to low fat content. This implied that cassava-potato flour bread (CPFB) would have a longer storage quality because long shelf life is associated with low microbial growth of a food/product.

The organoleptic properties as well as the sensory evaluation scores of the standard and experimental breads were observed to be satisfactory. Sensory evaluation scores revealed that the composite flour breads obtained lower scores compared to the standard bread in terms of colour, flavour, taste, texture and acceptability. There were no significant difference in the values of standard and the three composite flour bread variants in terms of colour, flavour, taste, texture and acceptability.

V. CONCLUSION

The study made an attempt to identify bread formulations using legume/tuber composite flours. The proximate composition and the functional properties of the composite flour bread identified through the study clearly revealed the feasibility of using legume/tuber composite flours in bread formulations. Similarly, the organoleptic evaluation of the experimental and control formulations clearly showed that the experimental variations were all acceptable by the panellists.

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