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ORIGINAL RESEARCH ARTICLE

COMPARATIVE EVALUATION OF THE QUALITY CHARACTERISTICS OF COMPOSITE FLOUR BREAD PRODUCED FROM WHEAT-ROOT TUBER AND WHEAT-GRAIN LEGUME FLOUR BLENDS

G. I. Agbara[1]*, A. C. Ige[2], N. H. Agbara[3], G. Ahmad[4], F. A. Masaya[1] and B. Aliyu[1]
[1]*Department of Food Science and Technology, University of Maiduguri, Maiduguri, Nigeria*
[2]*Department of Science Laboratory Technology, Ramat Polytechnic, Maiduguri, Nigeria*
[3]*Department of Home Economics, Lawan Mohamet College of Agriculture, Maiduguri Nigeria*
[4]*Department of Food Science, Bayero University Kano, Kano, Nigeria*
**Corresponding author's email address: giagbara@unimaid.edu.ng*

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ABSTRACT

Adoption of composite flours for baked and non-baked goods has been trending and the underlying reasons include economic consideration, nutritional enhancement and amelioration of noncommunicable diseases through consumption of functional foods. Comparative study of the performance of popular food crop flours in bread making is not well documented although a lot work abound in the literature concerning specific blends from wheat and crop flours studied separately. But in the present study, comparative effects of 30% substitution of wheat flour with two common root tuber flours: sweet potato (Ps) and cassava (Ca) and three common grain legume flours in Nigeria: soybean (S), cowpea (Co), bambara groundnut (B) on bread quality were studied. Soybean, cowpea, and bambara groundnut were soaked and decorticated, toasted mildly and milled to obtain flours. Cassava and sweet potato roots were peeled, chopped, oven dried, milled and sieved. All purpose wheat flour was used to form blends with non-wheat flours on a constant ratio of 70:30 replacement weight basis, a total of five flour blends were obtained while 100% wheat flour served as the control. Bread were prepared using straight dough method of AACC. Thereafter, standard procedures were used to evaluate the proximate composition of the blends and bread, as well as the bread physical and sensory properties. Data generated were subjected to analysis of variance and mean values ±SE were reported. Consistently, soybean and bambara groundnut flours had significant higher content of protein, ash, crude fat and crude fibre than cassava and sweet potato flours which contained higher level of carbohydrates. The moisture contents of the flours were low and comparable. The moisture, crude protein, crude fat, total ash, crude fibre and carbohydrate contents of the flour blends and the refined wheat flour varied significantly ($p<0.05$) from 8.08-10.27%, 7.52-13.93%, 2.08-4.06%, 0.81-1.85%, 2.11-4.51% and 67.75-76.66% respectively. The same trend was repeated in the proximate composition of the composite flour breads although the calorific values decreased due to decrease in carbohydrate contents (58.00-47.64%), protein (6.37-11.98%), and increase in moisture (26.71-29.75%), relative to the values observed in the flour blends. Bread weights (196-223g) were comparable but the bread volumes (429-988ml) and specific loaf volumes (2.24-4.82ml/g) varied significantly ($p<0.05$) and wheat bread had the highest and legume flour treated breads had the least. Organoleptic properties of the wheat bread were rated better in some attributes however not significantly ($p<0.05$) different from those of 30% sweet potato and cassava breads. It was concluded that although nutritional value of legume containing breads were greater yet their bread volumes were depressed more, the higher protein of grain legume flours not *withstanding confirming the fact that quality not quantity of the protein is the determinant factor in bread making potential of flours.*

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1.0 Introduction

Bread is an important staple food, and its consumption is steady and increasing especially in urban centers of Nigeria. It is relatively expensive, however bread unit price in Nigeria depends on Dollar-Naira exchange rate because it is produced from an imported wheat, a crop that does not do well in humid tropics, its cultivation in northern Nigeria is hardly sustainable because of expensive irrigation regimen and vagaries of weather, usually cultivated during the cold period of the year. Bread is a fermented, spongy confection made with four basic ingredients: flour, salt, yeast and water, prepared through unit operations such as mixing, proofing, scaling, molding and baking. Bread formulation continue to change as food behaviors, nutritional consciousness and income change. Bread continue to attract worldwide consumption therefore has become the commonest food product that supply needed calorie, protein, vitamins and minerals to the greatest number of people in all climes and cultures world over (Pomeranz, 1987, Dewetterick, 2008). Wheat is the foremost grain of choice in the production of baked goods apparently due to uniqueness of its endosperm proteins: polymeric glutenins and monomeric gliadins, these two proteins constitute 75-85% of wheat endosperm proteins (MacRitchie, 1994); and on contact with water form what is commonly called gluten, a visco-elastic mass capable of retaining leavening gases during fermentation and baking process (Wieser, 2007). FAO (1971) initiated and promoted composite flour technology since 1970s, primarily to activate the use of non-wheat crops either partially or completely to replace wheat flour in the production of wheat-based goods such as bread, biscuit, cake, pastas, couscous, thin and thick porridges, etc. especially in wheat import-dependent countries like Nigeria and others not situated in the wheat belt of the world. However, the concept of composite flour tevhnology has been advanced further to the production of functional and nutritious foods perhaps arising from population explosion and increasing urbanization, and also the shift from consumption of coarse to refined cereals and the desire for ready-to-eat convenient foods, a hallmark of the new age man. Wheat importation represents an immense drain on the economy of Nigeria while at the same time suppressing and displacing indigenous crops with detrimental effects on agricultural development and food security. Since the diet of an average Nigerian is carbohydrate based, the need for strategic use of inexpensive high protein resources with superior amino acid profile to complement those of common staples and in so doing enhance their nutritive value, cannot be overstressed. New protein sources are being explored, protein quality of pulses or oil seeds occupy prominent place in this endeavour (Wang and Kinsella, 1976; Alimi et al.,2016). Agricultural crops such as cassava, sweet potato, cowpea, bambara groundnut, soybean are largely cultivated in different agro-climatic zones of Nigeria and transforming them into high quality flours, needed to formulate composite flours will induce commercial production of pastries, cookies, pastas, confections, biscuits, bread etc and thereby reduce hunger, malnutrition and food insecurity, and also reduce foreign exchange expenditure on wheat and other staple importation.

Corresponding author's e-mail address: giagbara@unimaid.edu.ng

Grain legumes contain 18-32% lysine-rich protein which naturally complement the nutritional profile of cereal or root based diet of resource poor families (Duranti and Guise, 1997). They are also known to contain high levels of non-nutrient phytochemicals, majority of which possess antioxidant activity (McIntosh and Topping, 2000), with the potential to obliterate oxidative stress which is responsible for increase of diseases which hitherto are rare.

Cowpea (*Vigna unguiculata* Walp) is the leading starchy pulse in Nigeria in terms of production and consumption (Alimi et al., 2016) closely followed by groundnut and bambara groundnut. It is a warm season annual crop with the greatest production in dry and moist savannah of sub-sahara Africa. Bambara groundnut on the other hand is regarded as a complete food because of high protein content (16-25%), caborhydrates (63-65%) and fat (6-8%) (Brough and Azam-Ali, 1992, Mazahib et al., 2013). Its lysine and methionine content are 6.82g/16g N and 1.85g/16g N respectively comparable to 6.24g/16g N and 1.14g/16g N for soy protein. Soybean, the wonder crop of the world, is an excellent source of high quality protein (35-40%) and the most important oil seed in the world in terms of production and utilization.

Cassava (*Manihot esculenta* Crantz) and sweet potato (*Ipomoae batata* L.) are cultivated for their tuberous roots which are cheap sources of dietary energy for peasants in tropical countries and according to Lebot (2009) people living in low land tropics of West and Central Africa depend on cassava for dietary energy. Nigeria is the leading producer of cassava since 1989 and production level continue to soar because of increased industrial demand for cassava starch and chips, an export commodity and also an important staple. Apart from its utilization as animal feed, cassava flour are incorporated into wheat flour for the production of baked or non baked goods in Nigeria. Sweet potato on the other hand, originated from the Central America and now grown in many countries and has the natural capability of surviving in wide range of farming systems and climates (Woolfe, 1992). The skin and flesh of the root have different colours and are good source of bioactive chemicals such as ascorbic acid, polyphenols and beta-carotene, a provitamin A (Kusumayanti et al., 2015). These to some extent are absent in cassava except in vitamin A biofortified cassava roots which is currently popularized. On the other hand, sweet potato does not contain toxic cynanogenic glucosides present in cassava roots yet cassava flour with its whitish clour and bland taste is therefore more suitable for blending with cream coloured wheat flour for composite flour formulations. Composite food products are noted for high nutritional value therefore able to mitigate high incidence of protein energy malnutrition with its high morbidity and mortality rate in developing countries like Nigeria. Therefore, the objective of the current study was to compare the physico-chemical and sensory properties of the blends and bread produced from wheat-grain legumes and wheat-root tubers flour blends.

2. Matrials and methods

2.1 Collection of raw materials and ingredients

Fresh roots of cassava and sweet potatoes, cowpea (Biu white variety), soybean and bambara nut (creamed coloured) were sourced at Gamboru vegetable market Maiduguri Custom area and materials such as All purpose flour (Flour mills Lagos, Nigeria), dried bakers yeast, salt & sugar (Dangote PLC, Lagos), baking fat (Simas, Indonesia), were purchased at the Maiduguri Monday market, Borno state, Nigeria. Processing and analysis of samples were carried out at the Food Processing Laboratory, Department of Food Science and Technology, University of Maiduguri, Borno state, Nigeria.

2.2 Raw materials preparation

Sweet potatoes and cassava roots were manually peeled, sliced (<5mm thick) immersed in hot water (>90°C), 5 min, then air dried and finally dried in a cabinet dryer 60°•C±2°C, 12 h. Cooled dried chips were separately ground in a laboratory hammer mill and manually sieved using 300μm mesh. Grain legumes (cowpea, bambaranut, soybean) were sorted, winnowed, separately soaked in tap water (1:3W/V) for 2 h, manually dehulled, parboiled for 10 min, then air dried, and mildly roasted on a hot pan until lightly browned, cooled grains were separately ground and sieved and packaged.

2.3 Formulation of the flour blends

The blends were made by replacing 30% of wheat flour (WF) with either sweet potato(P), cassava(Ca), cowpea(Co), soybean(S) or Bambara groundnut(B) flour giving a total of five blends, code named: WP, WCa, WCo, WB, WS and WF served as experimental control. Each blend was placed in a blender and mixed for 2 min, then separately packaged for analysis and bread preparation.

2.4 Preparation of composite flour bread

Straight dough method of AACC (2000) for bread preparation was applied with the recipe shown in Table 1. The flour and all ingredient were mixed in a mixer, Master Chef (MC B180, China) medium speed, the dough was covered and placed in a fermentation chamber for 90 min, 37±2°C, relative humidity, 80-85%, thereafter degassed, scalled 250g, molded and placed in a greased pan and proofed again 60 min, 37±2°C, RH 80-85%, later baked in a preheated oven 220°C, 30 min. Cooled loaves of bread were left in polyethylene bags at room temperature prior to use next day.

Table 1: Recipe for the composite flour bread preparation

Wf	WP	WCa	WCo	WS	WB	yeast	salt	sugar	fat	water(ml)
1000	-	-	-	-	-	15	10	55	50	550 - 600
700	300	-	-	-		15	10	55	50	650 - 700
700	-	300	-	-	-	15	10	55	50	650 - 700
700	-	-	300	-	-	15	10	55	50	650 - 700
700	-	-	-	300	-	15	10	55	50	650 - 700
700	-	-	-	-	300	15	10	55	50	650 - 700

W: wheat, p: potato (sweet), ca: cassava, co: cowpea, s: soybean, b: bambara groundnut

2.5 Proximate composition of blends and bread

The composite flours and breads were analyzed for the proximate composition (moisture, crude protein, total ash, total lipids, crude fiber using the established ptocedures of AACC (2000). Carbohydrate was determined by difference and calorific values were calculated as shown below. Moisture contents were determined by drying the samples at 150°C for 1h, Protein contents (% N x 6.25) were determined by the micro-Kjedahl method. Crude fat were determined using solvent extraction in a Soxhlet apparatus with petroleum ether (boiling point: 40 - 60°C). The ash contents were determined by dry ashing in a muffle furnace at 550°C, 5 h. Dietary fiber was determined using alternate digestion of 1g sample with dilute sulphuric acid (1.25%) and dilute sodium hydroxide (1.25%)solutions, washing, drying and finally ashing in a muffle furnace, 550°C, 5 h. Caloric values (kcal) were obtained by multiplying the values of carbohydrate, protein, ash, and fat with the Atwater conversion factors, then summing up: E = [4x(protein) + 4x(CHO) + 9x(fat)]

2.6 Physical characteristic of the composite breads and the wheat bread

The physical characteristics of the bread samples (loaf weight, loaf volume and specific volume) were determined: loaf weight was measured after cooling to room temperature using a laboratory weighing scale and the readings were recorded in grams. The loaf volume was measured using seed (Fonio seeds) displacement method, a mofification of Giami et al. (2004). While the specific volume was calculated as loaf volume divided by loaf weight V/(cm^3/g) (Araki et al., 2009).

2.7 Sensory Evaluation of loaves of bread produced from flour blends of wheat-legume and wheat-root tuber flour blends

The sensory properties of the bread were evaluated using the 9-point hedonic scale as described by Larmond (1977) where 9 represents like extremely, 1 dislike extremely and 5 neither liked nor disliked. Twenty (20) semi-trained judges (12 females and 8 males) comprising students and staff of the Department of Food Science and Technology, University of Maiduguri. Panelists (age, 23-55 years) were asked to assess the coded samples based on the following attributes (crumb, taste, aroma, colour and symmetry). Panelists were provided with drinking water to rinse thier mouth after tasting each sample. The assessment was conducted only in one session.

2.8 Statistical Analysis

Determinations were conducted in duplicates and data generated were subjected to one-way analysis of variance (ANOVA). Means were separated using Duncan multiple range test and a p-value of less than 0.05 accepted as significant ($p < 0.05$).

3. Results and discussion

Proximate compositions of the various flours are presented in Table 2. Lower moisture or higher dry matter content of the flours (7.24-9.83%) reflects the low relative humidity of the environment this time of the year (dry season). Therefore, it is reasonable to conclude that finer granulation of the root flours might be responsible for slightly higher moisture content due to greater exposure than observed in legume flours. Soy and cassava flours had the least and the highest moisture contents. Crude protein (4.04-37.48%), crude fat (1.14-19.20%), total ash (2.59-5.89%), crude fibre (2.81-4.24%) and carbohydrates (25.06-79.21%) were higher in the legume flours expectedly than observed in the root tuber flours. According to De Almeida et al. (2006) food legumes contain more protein (17-40%) than in cereals (7.5-12%), the later have protein far more higher than in root or stem tubers. The same trend applies to fat content of legumes which is in general greater in most cereal and root tuber flours. Higher nutrtive value of legumes enhance the diet in which they are incorporated. Processing conditions, varietal differences, location and agronomical practices as well as storage and handling influence greatly the chemical composition of crops or their flours (Kaur et al., 2007). In addition, decortication, grinding and sieving processes make comparative evaluation of reported results by different workers difficult especially with respect to ash and dietary fibre contents of different flours. For instance, Apprinnita et al. (2014) reported lower moisture and protein content in sweet potato and cassava flours than observed in this study. Black eye bean, the commonest bean in Nigeria is reported by Shuang-Kui et al. (2014) to contain 1.56% oil against 5.20% recorded for Nigerian grown cowpea, however other parameters reported by the same authors for black eye bean are comparable with values obtained here. Soy flour had superior higher protein, fat, fibre, ash contents than other flours and the least carbohydrates and moisture contents, greater dry matter. Bambara groundnut flour had better balance of the nutrients, therefore regarded as a complete food (Mazahib et al., 2013). The proximate values recorded for cassava and sweet potato flours in this study were comparable except significant higher total ash and crude fat of cassava flour, their protein and carbohydrate (78.65% and 79.21%) contents were not significantly different. Diofanor et al. (2018) reported higher protein (10.25%) and lower fat (1.48%), ash (1.32%) and moisture (4.41%) for sweet potato flour

Table 2: Proximate composition (%) of the various flours used for blend formulations

Flours	Moisture	Crude protein	Crude fat	Total ash	Crude fibre	CHO
S	7.24±0.47^{b}	37.48±5.23^{a}	19.20±0.43^{a}	5.89±0.67^{a}	4.24±0.26^{a}	25.06±0.16^{d}
B	8.66±1.25^{ab}	18.10±1.20^{c}	5.80±0.74^{b}	3.01±1.03^{bc}	3.60±1.39^{ab}	60.83±1.21^{b}
Co	8.19±0.57^{b}	22.59±0.87^{b}	5.20±0.16^{b,c}	3.17±0.10^{bc}	4.17±0.08^{a}	56.14±0.22^{c}
Ca	9.83±0.07^{a}	5.04±0.40^{d}	2.77±0.72^{c}	4.37±0.06^{b}	3.50±0.36^{ab}	78.65±0.23^{a}
Ps	8.94±1.87^{ab}	5.31±0.72^{d}	1.14±0.49^{d}	2.59±0.68^{d}	2.81±0.33^{b}	79.21±0.31^{a}

Results are Mean±SE (n=2). Values in the same column with the same superscript are significantly not different at p-value of 5% ($p<0.05$). S: soy flour, B: bambara groundnut flour, Co: cowpea flour, Ca: cassava flour, Ps: sweet potato flour

3.1 Proximate composition of the blends and refined wheat flour.

Moisture contents (8.08-10.27%) of the composite flours and wheat flour were generally within the safe level for effective storage, wheat flour had significant higher moisture content than the blends (Table 3). Blending higher moisture wheat flour with non-wheat flour led to reduction in moisture content of the resulting blends, perhaps due to reduction in the surface aera of flour particles exposed to the environment, refined wheat flour is reported to have finer granulation (Belorio et al., 2019). Similar reduction in moisture and increase in ash, ptotein, fat and fibre were reported by Otegbayo et al. (2018) for wheat-soy blends, Dhaka and Sangeeth (2017) for wheat-sweet potato blends, and Dabels et al. (2016) for wheat-Acha-Mungbean blends. The higher dry matter indicates higher water absorption during reconstitution therefore higher dough yield and reduced bread stalling rate on storage. Protein contents of the blends containing food legume flours were higher expectedly (12.81-13.93%) and those containing root tuber flours (wheat-sweet potato (Wp70:30) and wheat-cassava (Wca70:30) had the least protein content (7.52-8.27%) especially, Wp70:30. The protein contents of the wheat flour was enhanced with inclusion of grain legume flour but decreased with the addition of tuber flour. The obvious reason is legumes generally contain approximately 2-3 times the protein of cereals, 4-5 times that of root tubers on dry weight basis. This is the single reason legumes are used for food fortification since they are cheap sources of inexpensive dietary nitrogenous substrates for peasants depending on starchy staples only for protein and calorie. Fat contents of the blends ranged between 2.55 and 4.06% the wheat flour had the least (2.08%) and wheat-soybean Ws (70:30) the highest (4.06%). Wheat and root tubers are not good sources of lipids, relative to root tubers, wheat contain higher fat but in general high amounts of lipids are found in most food legumes than in root or wheat flour. Added fat during dough formation provides tender crumb, therefore better mouthfeel in addition to highten flavor and enhanced calorie, however fat rancidification is a problem with overly fat-enriched foods during storage. The ash contents of Ws (70:30) and Wc (70:30) were significantly ($p<0.05$) higher respectively 1.81 and 1.85% and they were not significantly different, this was closely followed by the ash content of Wb70:30. Ash which represents the inorganic material is often indicative of the extent of flour refining, a repetitive process of grinding, milling and sieving. For wheat flour, ash content measures the amount of brany particles in the flour although beneficial to health but higher level is injurious to gluten strands and gas cells during dough mixing and fermentation (Anil, 2007; Rhemane et al., 2007). Ash also is a determinant of flour colour and blending with higher ash nonwheat flours not only enhances nutrient density of blends but also changes the colour profile of resulting blends. The crude fiber contents of the blends (2.11-4.59%) followed the same trend as the ash and protein contents. The indigestible dietary fibre content of flours mainly originate from the outer coverings which are also the main source of ash, and blending with low fibre (2.11%) refined wheat flour with non-wheat flour increased the crude fiber content of the blends more in wheat-legume blends than in wheat-tuber blends, a range of 2.11-4.59% was obtained. Carbohydrate contents of the wheat-legume flour blends were lower because of higher content of protein, fat, ash and crude fiber while higher carbohydrate contents were observed in Wca (70:30) and Wp (70:30) respectively 75.68% and 76.66%, higher than 73.99% for wheat flour. Similar observations were made by previous researchers who blended wheat flour with legume or root tuber flour. Ndife et al. (2011) and Otegbayo et al. (2018) separately worked on wheat-soybeans flour bread; Olaoye et al. (2018) studied wheat-bambaranut composite flour bread, Ahmed and Campbell (2012) worked on wheat-cowpea flour bread, in each case the reocurring observation was increase in protein, ash, fiber and fat contents of the flour blends with simultaneous slight decrease in moisture and carbohydrate contents depending on the level of wheat flour replacement. On the other hand, addition of root or stem tuber flour to wheat flour in blend formulation led to protein decrease, slight increase or decrease of fat in the blends and the simultaneous increase in total ash, dietary fiber and carbohydrate. This trend was similarly observed by Dhaka and Sangeeth (2017) and Oluwalana et al. (2012) for wheat-sweet potato flour blends, Amandikwa et al. (2015) for wheat-yam flour blends and Lagnika et al. (2019) for wheat-cassava flour blends.

Table 3: Proximate composition (%) of wheat flour and the different flour blends

Formulation	Moisture	Protein	Fat	Ash	Fibre	CHO	Calorie(Kcal)
W(100:00)	10.27 ± 0.09^{a}	10.78 ± 0.90^{b}	2.08 ± 0.05^{bc}	0.81 ± 0.02^{c}	2.11 ± 0.38^{c}	73.89 ± 0.16^{b}	357.80 ± 1.14^{a}
WB(70:30)	8.31 ± 0.14b	12.81 ± 0.33^{a}	3.51 ± 0.05a	1.65 ± 0.31^{ab}	3.65 ± 0.29^{b}	70.27 ± 0.09^{c}	363.11 ± 1.11^{a}
WS(70:30)	8.08 ± 0.07^{bc}	13.93 ± 0.67^{a}	4.06 ± 0.04^{a}	1.81 ± 0.51^{a}	4.18 ± 0.07^{ab}	67.94 ± 0.06^{d}	364.02 ± 1.39^{a}
WCo(70:30)	8.29 ± 0.11^{b}	11.85 ± 0.71^{b}	3.74 ± 0.07^{a}	1.85 ± 0.19^{a}	4.59 ± 0.07^{a}	67.75 ± 0.12^{d}	360.06 ± 1.08^{a}
WP(70:30)	9.36 ± 0.08^{ab}	7.52 ± 0.39^{c}	2.85 ± 0.03^{b}	1.07 ± 0.11^{bc}	2.55 ± 0.13^{bc}	76.66 ± 0.31^{a}	362.37 ± 1.72^{a}
WCa(70:30)	9.48 ± 0.31^{ab}	8.27 ± 0.22^{c}	2.64 ± 0.11^{b}	1.21 ± 0.09^{b}	2.79 ± 0.10^{bc}	75.68 ± 0.23^{a}	359.56 ± 1.33^{a}

Values are means±SE (n=2), Means in the same column bearing similar subscripts are not significantly different ($p>0.05$). W=wheat (100:00), Wb=wheat-bambaragroundnut, Ws=wheat-soybean, Wco=wheat-cowepa, Wp=wheat-sweetpotato; Wca=wheat-cassava.

3.2 Proximate composition of composite flour breads and wheat bread

Moisture contents were higher in the composite breads, it increased from 26.71% in the control to 29.75% in WS (70:30). **(Table 4)**. Similar trend was observed by Adebayo-Oyetoro et al., (2016) for wheat-fermented banana bread (28.94-36.85%) wherein bread moisture increased with increased replacement of wheat flour, similar observation was reported by Amandikwa et al. (2015) for wheat yam bread. Apart from blends formed by partial replacement of wheat flour, baking time and temperature affects moisture content of bread (Shittu et al., 2007). The protein contents of 30% pulse flour treated breads (10.68-11.98%) were higher, 30% soybeans flour bread was slightly higher (11.98%) among them and 30% sweet potatoes and 30% cassava bread had the least amount of protein 6.89% and 6.37% respectively which were significantly different. Yusuf and Ejeh (2018) reported progressive increase in moisture, protein and other nutrients of bread with increased replacement of wheat flour with Bambara nut flour; Otegbayo et al. (2018) similarly observed the same trend in wheat-soybean bread. Blending wheat flour with tuber flour leads to reduction in the protein content of the resulting blend or the food product, however dietary fiber and total ash are enhanced as observed here and similarly reported by Oluwalana et al. (2012), Dhaka and Sangeeth (2017) and Lagnika et al. (2019). Kidane et al. (2013) reported increase in bread moisture, ash, fibre and decrease in protein and fat with increasing replacement of wheat flour with sweetpotato flour. The fat content of the wheat bread and composite flour breads ranged from 3.31% (wheat bread) to 5.81% (WS 70:30) slightly less than the range of 2.37-3.24% fat reported by Igbabul et al. (2019) for wheat wateryam-hamburger beans bread. Equally, the ash (1.50-2.97%) and crude fiber (1.19-2.57%) contents were also enhanced more in the composite breads. Similar observation were made by Oluwalana et al. (2015); Olaoye et al. (2018) for wheat Bambara nut bread and Ahmed and Campbell (2012) for wheat-cowpea bread, Ndife et al. (2011) for wheat-soybean bread. Higher level of protein and fat in pulse treated bread decreased the carbohydrate content which ranged from 47.64% (WS70:30) to 58.00 (W100%), the carbohydrate content of the 30% sweet potato and 30% cassava bread were not significantly different from that of the wheat bread as well as the calorific values of the breads which varied from 285.23 to 298.95 kcal/100g indicating that these bread are good for those conscious of body weight.

Table 4: Proximate composition (%) of bread from different composite flour bread

Formulation	Mc	Protein	Fat	Ash	Fibre	CHO	Calorie(Kcal)
W(100:00)	26.71±0.10^{b}	9.29±0.34^{b}	3.31±0.25b^{c}	1.5±0.14^{c}	1.19±0.38^{c}	58.00±0.43^{a}	298.95±4.94^{a}
WB(70:30)	28.45±0.04^{ab}	10.68±0.29^{ab}	5.40±0.19^{a}	2.09±0.11^{b}	2.27±0.29^{ab}	51.11±0.022^{b}	295.76±3.76^{a}
WS(70:30)	27.75±0.07^{ab}	12.21±0.41^{a}	5.81±0.09^{a}	2.68±0.08^{a}	2.19±0.07^{ab}	46.64±0.17^{d}	287.69± 3.32^{a}
WCo(70:30)	30.39±0.13^{a}	11.98±0.46^{a}	4.19±0.39^{ab}	2.97±0.02a	2.57±0.07^{a}	49.90±o.33^{c}	285.23±2.10^{a}
WP(70:30)	29.47±0.28^{a}	6.37±0.59^{c}	3.77±0.20^{b}	1.50±0.07^{c}	1.85±0.13^{b}	57.34±0.09^{a}	288.77±4.12^{a}
WCa(70:30)	29.22±0.13^{a}	6.89±0.30^{c}	3.91±0.46^{b}	1.81±0.01^{c}	1.89±0.21^{b}	56.44±0.23^{ab}	288.31±4.07^{a}

Values are means±SE (n=2), Means in the same column bearing similar subscripts are not significantly different (p>0.05). W=wheat (100:00), Wb=wheat-bambaragroundnut, Ws=wheat-soybean, Wco=wheat-cowepa, Wp=wheat-sweetpotato; Wca=wheat-cassava. Mc=moisture

3.3 Physical properties of the composite breads and the wheat bread

Bread weights (196.45g (WS70:30)- 220.47g WP70:30) were comparable and not significantly different although numerically 30% cassava and 30% sweet potato breads had higher bread weights.(**Table 5)** Significantly higher bread volume (988ml/g) and specific volume (4.82ml//g) were recorded for wheat bread, those of composite breads were lower especially the legume flour treated breads with volumes 429-578ml, and loaf specific volumes(SLV) 2.24-2.85ml/g indicating that dilution of wheat gluten through blending with non wheat flours led to bread volume reduction, more in legume treated composite breads especially WS70:30 despite having higher protein content than starchy root tuber flours. Bread volumes and SLV of 30% sweet potato was the second highest followed by 30% bambara groundnut bread. Previous studies observed that the decrease in available gluten as a result of blending with non-wheat flour was responsible for reduced bread volume and specific volume (Shittu et al., 2007, Ndife et al., 2011, Otegbayo et al., 2018, Dhaka and Sangeeth, 2017, Oluwalana et al., 2012, Ahmed and Campbell, 2012, Amandikwa et al., 2015) among others, similarly reported reduced bread volume or specific volume and higher bread weight as the main negative effect of using composite flour for bread manufacture, however enhanced nutrient density is reported as the positive effect. Eriksson et al. (2014) reported a decline in SLV from 3.43ml/g in wheat bread to 2.40ml/g as the graded level (10-30%) cassava flour replaced wheat flour. Oluwole et al. (2017) reported SLV range of 2.09-3.81ml/g for wheat-cassava-soybean breads. Dhaka and Sangeeth (2017) reported a SLV of 2.43ml/g for 25% sweet potato bread and Nwosu et al. (2014) reported SLV of 2.35ml/g for 50% cassava bread with soybean improver.

Table 5: Physical characteristics of bread from different composite flour

Flour/Blend	Loaf Weight (g)	Loaf Volume(ml)	Specific Loaf Volume(ml/g)
W(100:00)	205.14± 2.87^{c}	988±10.38^{a}	4.82±0.14^{a}
WB(70:30)	204.13±1.90^{c}	578±7.49^{c}	2.85±0.05^{c}
WS(70:30)	196.45±2.15^{d}	429±11.29^{f}	2.24±0.06^{d}
WC(70:30)	209.50±3.47^{b}	525± 10.67^{d}	2.59±0.07^{bc}
WP(70:30)	220.47±5.07^{a}	743.75±9.05^{b}	3.44±0.29^{b}
WCo(70:30).	. 217.83±1.09^{a}	497.65±8 32^{d}	2.29±0.11^{d}

Values are mean±SE.(n=2), Means in the same column bearing similar subscripts are not significantly different (p>0.05). W=wheat (100:00), Wb=wheat-bambaragroundnut, Ws=wheat-soybean, Wco=wheat-cowepa, Wp=wheat-sweetpotato; Wca=wheat-cassava.

3.4 Sensory attributes of the composite breads visavis the wheat bread.

Sensory attributes of the test breads (Table 6) were evaluated on a 9-point hedonic scale, the scores for crust colour (4.09-8.49), symmetry (4.41-8.30), crumb texture (5.90-8.19), taste (6.18-8.07) and aroma (5.86-7.55) revealed the wheat bread had higher scores than the composite breads, the next on the line was wheat-bambaranut bread (WB70:30) and declined further in 30% sweet potato and cassava breads. Bambara groundnut flour has equivalent carbohydrate with cowpea and both are more starchy than soybean, meaning starchy flours perform better bread making potential than high protein flours as found in legumes flours perhaps due to higher water absorption of legume flours occasioned by higher protein content. Poor symmetric shapes in the composite bread is linked to loss of or reduced viscoelasticity of the dough and reduced leavening gas retention capacity that accompany blending wheat with non wheat flour. With the exception of WB70:30, the other two legume flour treated breads had the worst rating for symmetry 4.43 for (WS70:30) and 4.41 for (WC70:30). Bread symmetry has something to do with flour strenght which is dependent on protein content, not quantity but quality of protein, because at 30% replacement of the wheat flour with legume flour, the protein of the treated blends were enhanced. Higher flour particlce size in legumes than in wheat and root tuber or cereal flours (Oladunmoye et al., 2010) might be responsible for poor quality of legume treated breads. Bourre et al. (2019) and Sakhare et al. (2015) reported better bread scores with finer pulse flours, that higher flour partcle size as found in legume flours adversely affect sensory properties more than the volume.The colour and symmetry of WB(70:30) were not significantly different from wheat bread but significant variation existed between 30% Bambara nut bread and wheat bread in terms of crumb texture, taste and aroma. The crust color of WP (70:30) was the poorest perhaps due to greater sugar availability for increased maillard reaction or caramelization and the same was responsible for its high taste score (7.36) although not higher than that of the wheat bread (8.05). However, Ijah et al. (2014) reported 5% potato bread had more preference than wheat bread. Collade et al. (1997) produced bread with good volume, crust and crumb with 15% sweet potato inclusion and Otegbayo et al. (2018) with less than 15% soybean. The aroma of 30% soybean flour bread was the poorest (5.86) perhaps due to strong beany flavor despite heat treatment yet not significantly different from the aroma of 30% sweet potato (5.91) and cassava bread (5.89) however the aroma of these breads were not rejected. Yusuf and Ejeh (2018) did not observe clear cut differences in the attributes of wheat bread and wheat- bambara nut bread except at higher substitution levels. Amandikwa et al. (2015) reported that less than 25% yam inclusion was able to yield acceptable wheat-yam bread which was not significantly different from wheat bread. Similar observation was made by Trejo-Gonzalez (2014) who incorporated 5-10% sweet potato flour to produce bread that had sensory properties not different from the wheat bread. Olaoye et al. (2018) reported the production of acceptable bread with 10% substitution of Wheat flour with bambara groundnut flour. On the basis of the foregoing, the way 30% inclusion of wheat less flour especially legume flour would yield bread with better physical and sensory properties is the addition of improvers or use of flour that has the same finer granulation as wheat flour Belori et al. (2019) or use of native or better modified starch (Iwe et al.,2014).

Table 6: Sensory attributes of composite breads and the wheat bread

Attributes	W100:00	WB70:30	WS70:30	WCo70:30	WCa70:30	WP70:30
Colour	8.30 ± 0.27^{ab}	8.49 ± 0.23^{a}	5.64 ± 0.53^{b}	5.27 ± 0.67^{bc}	5.56 ± 0.53^{b}	4.09 ± 0.11^{d}
Symmetry	8.30 ± 0.31^{a}	8.17 ± 0.80^{a}	4.43 ± 0.19^{c}	4.88 ± 0.32^{bc}	4.41 ± 0.6^{c}	5.39 ± 0.37^{b}
Crumb	8.19 ± 0.45^{a}	7.65 ± 0.31^{ab}	6.37 ± 0.11^{b}	6.09 ± 0.41^{bc}	6.32 ± 0.28^{b}	5.90 ± 0.07^{c}
Taste	8.07 ± 0.51^{a}	6.88 ± 0.37^{bc}	6.74 ± 0.17^{bc}	6.69 ± 0.19^{bc}	6.18 ± 0.47^{c}	7.36 ± 0.21^{b}
Aroma	7.55 ± 0.29^{a}	6.63 ± 0.51^{ab}	5.86 ± 0.08^{d}	5.45 ± 0.42^{d}	6.39 ± 0.61^{bc}	6.21 ± 0.31^{c}

Values are means±SE (n=2), Means in the same column bearing similar subscripts are not significantly different (p>0.05). W=wheat (100:00), Wb=wheat-bambaragroundnut, Ws=wheat-soybean, Wco=wheat-cowepa, Wp=wheat-sweetpotato; Wca=wheat-cassava.

Conclusion

Protein quality is demostrable an important factor for better bread physical properties. Therefore, flour with their high protein and 30% wheat flour replacement performed poorly in both sensory and physical properties of bread. Proximate composition of the blends depend which flour involve blend formulation. The same pattern is reflected on the proximate composition of the composite flour breads. Depression of the bread volume or specific loaf vo!ume or higher bread weight is influenced by the extent of flour water absorption greater in legume treated blends.Wheat bread out-scored composite flour breads on the investigated sensory attributes, however wheat-bambara nut bread surprisingly compared favorably with wheat bread on some of the sensory attributes such as colour and symmetry. Beany flavor was pronounced with bread treated with legume flour especially soybean flour which induced poor assessment of other attributes. Nutritional value of composite flour breads was greater and despite higher protein, legume flours have the poorer bread volume than thestarchy root tuber flours. Bambara nut flour is a promising better alternative to soybean and cowpea flours for better bread quality while sweet potato and cassava flour had comparable effects on bread quality. Less than 30% incorporation of non-wheat flours is suggested for better bread volume and sensory properties.

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