Asian Journal of Advances in Agricultural Research

4(1): 1-9, 2017; Article no.AJAAR.36899
ISSN: 2456-8864

Sensory Evaluation Assessment of Bread Produced with Composite Flour Fermented by Baker's Yeast in Akure, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author DJA designed and supervised the study. Author TB wrote the protocols and managed the analyses of the study. Authors OIA and OFF performed the statistical analysis, wrote the first draft of the manuscript and managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/AJAAR/2017/36899
Editor(s):
(1) Bing-Lan Liu, Department of Applied Chemistry, Chaoyang University of Technology, Taiwan.
Reviewers:
(1) Uttara Singh, Government H. Sc. College, Panjab University, India.
(2) Karen Breshears, University of Central Missouri, USA.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/22198

Original Research Article

Received 21st September 2017
Accepted 27th October 2017
Published 8th December 2017

ABSTRACT

This study investigated the functional properties of bread produced from composite flour (Wheat, Air potato and cassava) and comparatively evaluated the sensory acceptability of bread products fermented using Baker's yeast amongst prospective consumers at the Federal University of Technology (F.U.T), Akure, Nigeria. Different blend ratios (A-F) of composite flour containing Wheat, Cassava and Air potato flours respectively were formulated for production of bread fermented using Baker's yeast. Proximate and mineral analysis of cassava, Wheat and Air potato flours were carried out according to standard procedures set by A.O.A.C., 2012. A descriptive sensory evaluation was carried out to assess bread products (A-F) produced from the different composite flour blends as sensory evaluators were selected by cross sectional simple random sampling techniques. The organoleptic parameters accessed for the bread products include taste, aroma/texture, appeal/appearance and overall consumer acceptability index respectively. Bread products A-C were adjudged standard controls for Air potato flour (A), Wheat flour (B) and Cassava flour (C) while

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products D-F were the test bread products of varying formulation blends of the composite flours. All the bread products (A-F) were evaluated and compared statistically at p≤ 0.05 level of significance. Bread product F had the highest overall acceptability (99.90±0.10%) followed by E (88.89±1.11%) and D (55.56±1.44%). The findings of this research revealed realistic potentials of Air potato flour supplemented with Wheat and Cassava flours respectively to produce widely accepted bread products in Nigeria.

Keywords: Air potato; composite flour; Baker's yeast; sensory evaluation; overall acceptability.

1. INTRODUCTION

Bread is a staple food in Nigeria and all over the world, with an exponential increase in consumption over recent years [1-3]. The rising cost of bread products in Nigeria is chief due to the importation of Wheat flour, one of the major ingredients used in local bread production [2-4]. Wheat flour is suitable for bread production because it contains high levels of sugar and fiber, high content of gluten: A protein which aids excellent formation of bread dough during fermentation, and moderate mineral elements constituents [2-5]. However, many locally made Nigerian flours from tuber crop products such as Cassava and Cocoyam lacks adequate levels of gluten protein to enable them compete effectively as suitable alternatives to Wheat flour [4-6]. There have been therefore lots of research efforts centered on discovering suitable alternatives to Wheat flour that can be used to bake bread, thereby reducing the demand for Wheat and also improve the economic value of locally made flour products in Nigeria [3-6]. While research efforts in the past were originally tailored towards total substitution of Wheat flour by several locally made flours from starch derived Nigerian crops suitable for bread production, efforts are now channeled towards supplementing Wheat flour with these same locally derived flours in different blends and formulations in a bid to improve the nutritional value and consumer acceptability of these bread products in Nigeria [6-9].

Cassava *(Manihot esculenta Crantz)* a common root tuber is consumed extensively in Nigeria [5-9]. Nutritionally, Cassava is a major source of dietary energy for low income citizens in many parts of Nigeria because of its cheap availability [7-9]. Despite being a cheap source of food, Cassava is nutritionally deficient in essential amino acids but rich in arginine [8,9]. Its use in the production of bread as composite flour has been reported [1,4-6,8], although the bread products obtained generally had low acceptability [1,6,8]. Air potato *(Dioscorea bulbivera)* is a root tuber crops in the family Dioscoreacea found in many Nigerian settlements but hardly consumed due to several cultural considerations and customs despite its immense health benefits [8, 10]. Moreover, this yam specie has attracted scientific interests owing to its numerous therapeutic applications which have been attributed to its unique phytochemistry in many research findings [6,10]. Air potato has been reported to be a good source of protein (gluten), lipids and crude fibers; making it an alternative suitable flour source for bread production [4-6,8, 10].

In Nigeria, baked products are fermented by Baker's yeast (*Saccharomyces cervisiae*) as different findings have shown its effectiveness in qualitative fermentation of baked products for consumption [1-3,4-8]. The use of composite flour containing flour blends of cassava, Air potato and Wheat for production of bread products fermented by Baker's yeast have the potential to conserve the foreign exchange spent on Wheat importation and also add value to indigenous crops like Air potato and Cassava locally grown in Nigeria [1,4-10]. Hence, this study investigated the functional properties of bread produced from composite flour (Wheat, Air potato and cassava) and comparatively evaluated the sensory acceptability of bread products fermented using Baker's yeast amongst prospective consumers at the Federal University of Technology (F.U.T), Akure, Nigeria.

2. MATERIALS AND METHODS

2.1 Production of Composite Flour

The methods described in the findings of [11-14] were adopted for preparing dried unfermented Cassava and Air potato flours as indicated in Figs. 1 and 2. Already prepared dried Wheat flour was obtained from commercial vendors at the main market of the Akure metropolis.

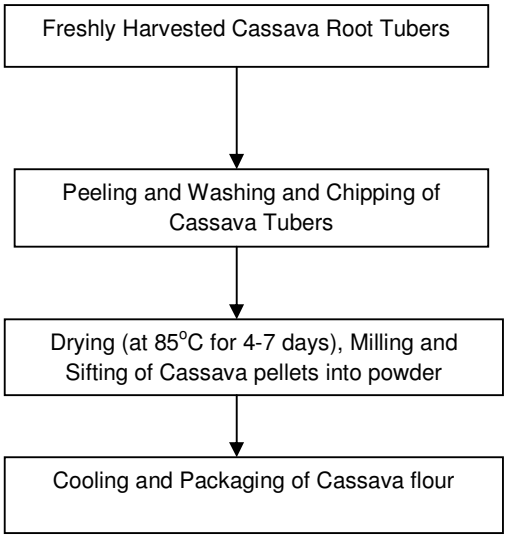

Fig. 1. Flowchart for production of cassava flour [13]

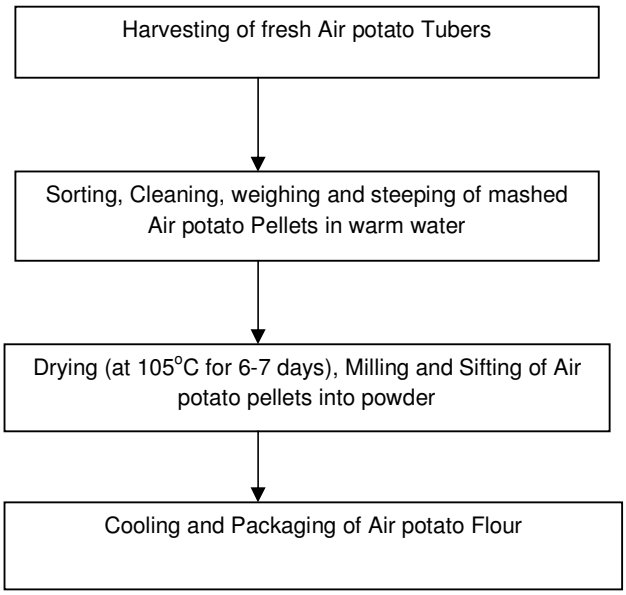

Fig. 2. Flowchart for production of air potato flour [14]

2.2 Proximate Analysis of Composite Flour

The protocols described by the Association of Official Analytical Chemist (A.O.A.C, 2012) were adopted to determine the proximate and mineral compositions of the Wheat flour, Cassava flour and Air potato flour respectively [1,4,15]. The moisture content, ash content, crude fiber content, crude protein content, fat content, carbohydrate content, water and oil absorption capacity and swelling index were all determined using the A.O.A.C, 2012 protocols [14,15]. The three flour types were also analyzed for mineral elements compositions (calcium, iron, potassium, manganese, sodium and zinc contents) [1,8,12-14].

2.3 Formulation of Composite Flour Blends

Modifications of the methods described in [4,5, 8,10,14] were adopted as different composite flour blends were obtained using simple ratios of

Air potato flour, Cassava flour and Wheat flour respectively to obtain different composite flour blends. The six flour ratios obtained were 100% Air potato Flour (A), 100 % Wheat flour (B), 100 % Cassava flour (C), Air potato flour/Wheat flour (50%/50%) (D), Air potato flour/Cassava flour (50%/50%) (E) and Air potato flour/Wheat flour/Cassava flour (40%/40%/20%) (F) respectively. The blend ratios are: 200g of Air potato flour for blend A, 200 g of Cassava flour for blend B, 200 g of Wheat flour for blend C, 100 g each of Air potato flour and Wheat flour for blend D, 100 g each of Air potato flour and Cassava flour for blend E and 80 g of Air potato flour, 80 g of Wheat flour and 40 g of Cassava flour for blend F respectively.

2.4 Production of Bread from Different Composite Flour Combinations

The different composite flour combinations were all baked into bread products by yeasts isolated from both palm wine and stale bread following standard procedures of dough mixing, fermentation, punching, scaling, moulding, proofing, baking, cooling and de-panning respectively [1,2,4-6,13,16]. The products were labeled (A–F) and lyophilized Baker's yeast (*Saccharomy cescerevisiae*) was obtained from commercial Bakeries in Akure metropolis for fermentation of the flour blends (A-F).

2.5 Description of Study Area Used for Sensory Evaluation

The Federal University of Technology, Akure is located in Ondo State, Nigeria with coordinates $7^{o}16^{'}$ N $7^{o}18^{'}$ N/ $5^{o}9^{'}$ E $5^{o}11$ E. It is located at the extreme southern region of the Akure South Local Government Area of Ondo state, Nigeria [17].

2.6 Sensory Evaluation of Bread Samples

Simple random sampling techniques were adopted for obtaining 18 students as evaluators in the study area (Federal University of Technology, Akure Campus) to assess the organoleptic properties and the overall consumer acceptability of the different bread samples produced. The organoleptic properties assessed include the taste, the aroma/texture, appeal/appearance of the products and overall acceptability by the consumers [1-8,13,14,16, 18]. The evaluators assessed the bread products separately at different time intervals to avoid bias. Each evaluator rated the bread products independently on a hedonic scale ranging from 7 (moderately liked) to 9 (extremely liked) [13,14, 16]. The bread samples A, B, and C served as controls while bread products D, E, and F were the test products of interest. All bread products were nevertheless rated by the evaluators. The raw scores were expressed in percentages and analyzed statistically [4-8,18].

2.7 Data Analysis

Analyzed bread products were in triplicates; data means obtained for evaluation ratings of the organoleptic properties of the bread products were subjected to a 2-way analysis of variance and the means were separated using Duncan's New Multiple Range test at $P \leq 0.05$ level of significance [4-8,16,18].

3. RESULTS

The protocols adopted for the preparation of the different composite flour constituents are represented by Figs. 1 and 2. Moreso, the percentage composition by mass of the different composite flour combinations are represented also in Table 1. The comparative proximate compositions (Carbohydrate, Ash, Fat, Fiber, Moisture and Protein contents) and mineral compositions (Calcium, Iron, Potassium, Manganese, Sodium and Zinc contents) of the different flours (Air potato flour, Wheat flour and Cassava flour) used in composite flour formulations were analyzed separately and reported at $P \leq 0.05$ levels of significance (Figs. 3 and 4). Air potato flour has the highest carbohydrate content (90.35±1.58%) while Cassava flour has the lowest content (37.58±1.64%); The Ash contents of Air potato flour was also the highest (2.51±0.28%) while Wheat and Cassava flours respectively are not significantly different at the specified level of confidence. Cassava flour has the highest moisture content (61.40±2.20%) while Wheat flour has the lowest moisture content (3.67±1.10%); alternatively, Wheat flour has the highest protein content of 11.37±1.21% while Cassava flour is very low in protein content with just 1.97±0.28%.

Moreover, the comparative mineral compositions of the flour samples also gave an insight into their nutritive suitability for bread production. Air potato was discovered to have the highest calcium content at 52.30±2.20% while Cassava has the least concentration at 20.00±1.50%. The iron, zinc and manganese concentrations of all

the three flours were not significantly different at the specified level of significance while Wheat flour has the highest potassium content at 87.50±2.50% and Cassava has the lowest at 30.2±1.80%. On the other hand, the sodium concentration of Air potato flour was the highest (89.40±1.69%) while Wheat has a comparatively low at 1.73±0.24%. The results above signified an important edge that Air potato flour possess as a suitable alternative for bread production compared to Wheat flour while Cassavaflour is comparatively a poor alternative for Wheat flour.

Furthermore, the sensory evaluation results gave useful information on the preferences of consumers to both the control bread products (A-C) and the test bread products (D-F). The evaluation indexes of the bread products (A–F) fermented by Baker's yeast are represented in Table 2 with respect to the organoleptic properties (taste, appeal/appearance, texture/aroma) and the overall acceptability of the bread products are represented in Table 3 by adopting the methods described in [4-6, 8].

Table 1. Composite flour combinations of different bread types

Bread Type	Flour composition (percentage by mass)
A	100% Air potato flour (200 g)
B	100% Wheat flour (200 g)
C	100% Cassava flour (200 g)
D	50% Air potato flour (100 g) + 50% Wheat flour (100 g)
E	50% Air potato flour (100 g) + 50% Cassava flour (100 g)
F	40% Air potato flour (80 g) + 40% Wheat flour (80 g) + 20% Cassava flour (40 g)

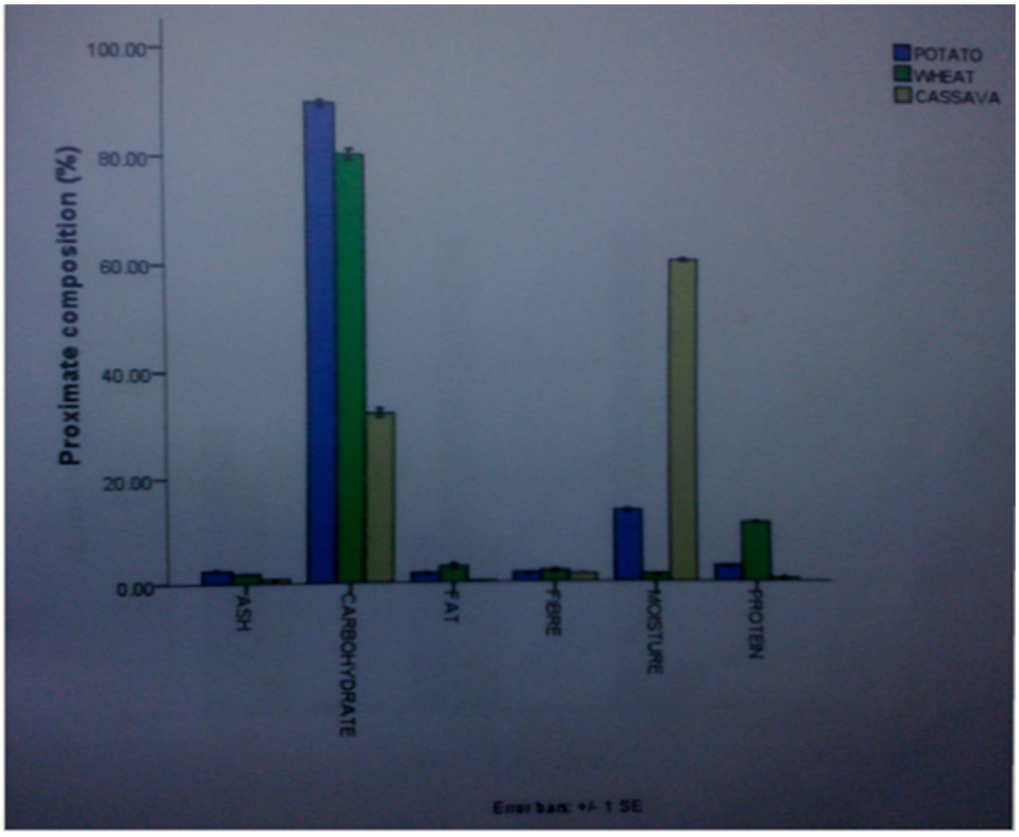

Fig. 3. Comparative proximate composition of air potato flour, wheat flour and cassava flour used in composite bread production [28]

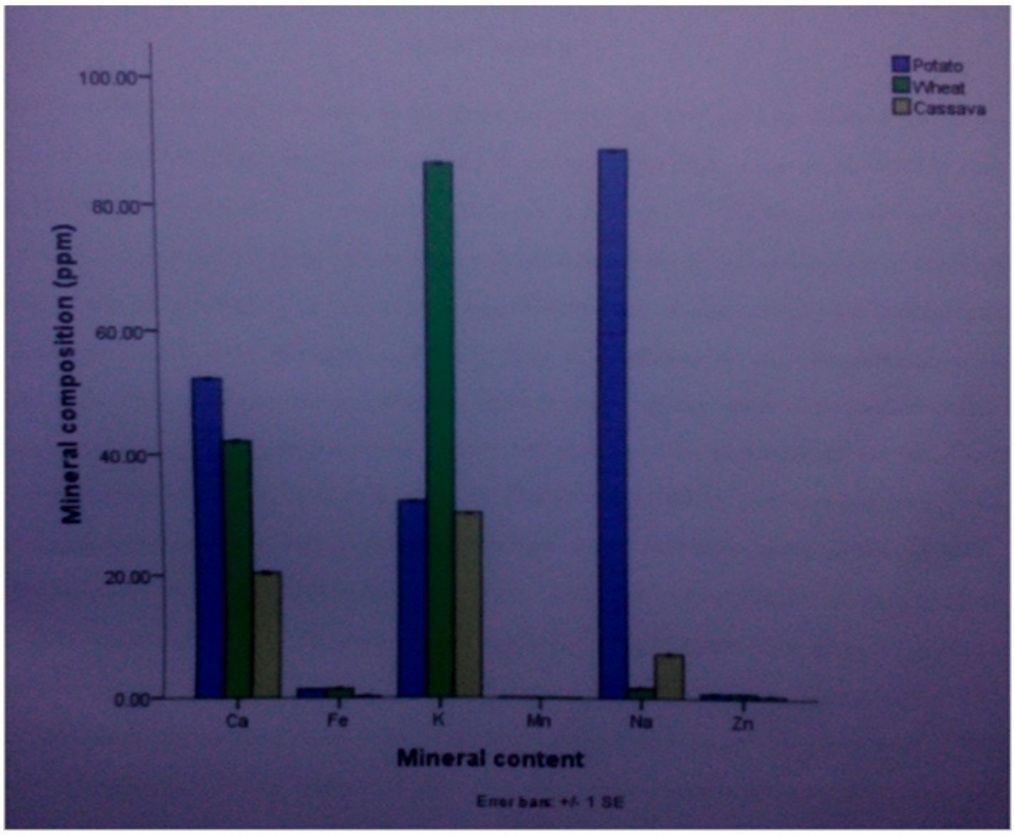

Fig. 4. Comparative mineral composition of air potato flour, wheat flour and cassava flour used in composite bread production [28]

Table 2. Sensory evaluation scores of the bread products A- F fermented by Baker's yeast

H. scale	Sensory evaluation scores of bread products for taste (%)					
	A	**B**	**C**	**D**	**E**	**F**
7	00±00^{a}	33.33±1.69^{d}	55.56±1.44^{f}	11.11±1.89^{b}	44.45±1.55^{e}	11.11±1.89^{b}
8	33.33±1.69^{d}	00±00^{a}	22.22±1.78^{c}	44.45±1.55^{e}	33.33±1.69^{d}	11.11±1.89^{b}
9	00±00^{a}	00±00^{a}	00±00^{a}	11.11±1.89^{b}	00±00^{a}	66.67±1.33^{g}
H. scale	**Sensory evaluation scores of bread products for appeal/appearance (%)**					
	A	**B**	**C**	**D**	**E**	**F**
7	22.22±1.78^{c}	11.11±1.89^{b}	11.11±1.89^{b}	00±00^{a}	66.67±1.33^{g}	33.33±1.69^{d}
8	22.22±1.78^{c}	00±00^{a}	44.45±1.55^{e}	44.45±1.55^{e}	00±00^{a}	33.33±1.69^{d}
9	00±00^{a}	00±00^{a}	00±00^{a}	11.11±1.89^{b}	00±00^{a}	33.33±1.69^{d}
H. scale	**Sensory evaluation scores of bread products for texture/aroma (%)**					
	A	**B**	**C**	**D**	**E**	**F**
7	11.11±1.89^{b}	22.22±1.78^{c}	22.22±1.78^{c}	11.11±1.89^{b}	44.45±1.55^{e}	33.33±1.69^{d}
8	22.22±1.78^{c}	11.11±1.89^{b}	33.33±1.69^{d}	55.56±1.44^{f}	00±00^{a}	33.33±1.69^{d}
9	22.22±1.78^{c}	11.11±1.89^{b}	33.33±1.69^{d}	00±00^{a}	00±00^{a}	33.33±1.69^{d}

Keys: H. Scale- Hedonic scale, 7- moderately liked, 8- like very much, 9- liked extremely, A- 100% Air potato flour fermented by Baker's yeasts, B- 100% Wheat flour fermented by Baker's yeasts, C- 100% Cassava flour fermented by Baker's yeasts,, D- 50% Air potato flour + 50% Wheat flour fermented by Baker's yeasts, E- 50% Air potato and 50% Cassava flour fermented by Baker's yeasts, F- 40% Air potato flour + 40% Wheat flour + 20% Cassava flour fermented by Baker's yeasts, values with the same superscript have no significant difference at p≤0.05 level of significance. Bread A- C is control bread products respectively while D- F are test bread products

Table 3. Overall acceptability of bread products A to F

A	B	C	D	E	F
11.11±1.33a	11.11±1.33a	77.78±1.22c	55.56±1.44b	88.89±1.11d	99.90±0.10e

Keys: A- 100% Air potato flour fermented by Baker's yeasts, B- 100% Wheat flour fermented by Baker's yeasts, C- 100% Cassava flour fermented by Baker's yeasts,, D- 50% Air potato flour + 50% Wheat flour fermented by Baker's yeasts, E- 50% Air potato and 50% Cassava flour fermented by Baker's yeasts, F- 40% Air potato flour + 40% Wheat flour + 20% Cassava flour fermented by Baker's yeasts, values with the same superscript have no significant difference at p≤0.05 level of significance. Bread A- C is control bread products respectively while D- F are test bread products

The evaluation scores of the test bread products represented in Table 2 are expressed in percentages of the 18 evaluators at p≤ 0.05 level of significance and the evaluation scores of the hedonic scale 7-9 represents the acceptability of the bread products by the evaluators. Products F has the highest evaluation score 88.89±1.11% for taste of the test bread products followed by E at 77.87±1.23%, and D at 66.67±1.33% respectively (Table 2). The evaluation scores for the aroma/texture of the bread products were also similar to that of the taste as products F has an evaluation score of 99.90±0.10% followed by E at 66.67±1.33% and D has a moderate evaluation score of 55.56±1.44% (Tables 2 and 3).

Conversely, the evaluation scores of the appeal/appearance of the test bread products also followed the same pattern as bread product F had the highest evaluation score in this category at 99.90±0.10% while D had a score of 66.67±1.33%, while E had a score of 44.45±1.54% respectively (Table 2). The overall acceptability of the test bread products were also estimated by the evaluators and analyzed at p≤0.05 levels of significance as bread product F had excellent overall acceptability at a score of 99.90±0.10% while the test product E had an overall acceptability at 88.89±1.11% and product D had its overall acceptability index at 55.56±1.44% respectively as represented in Table 3.

4. DISCUSSION

It was generally observed that variations in the nutritional constituents of the different flour blends used had a direct relationship on the quality of bread products produced since all the bread products were fermented by (*Saccharomyces cerevisae*); this was also similar in [4-8]. Several recent Nigerian literature texts have revealed that different species of Saccharomyces ferment different carbohydrate substrates and produce varying degrees in textures, appeal and aroma of the products fermented [1,4,6,9,10,14].

Products fermented by the Baker's yeast (isolates of *Saccharomyces carlsbengensis* and *Saccharomyces cerevisae*) generally possess better dough qualities, better impacted taste flavors and favorable overall acceptability indexes; this mainly because these yeast species are highly osmophilic and hydrophilic [2,4,13, 19].

Consequently, the bread products F and E were the most acceptable of the test bread products and a closer observation at the composite flour blends of these two products (composite blends E and F) reveals that the two blends (E and F) contains high sugar rich contents with blends E (50% Air potato/50% Cassava) and F (40% Air potato, 40% Wheat, 20% cassava) having high combined levels of sugar, fibers and protein levels; hence encouraging optimal dough formation of the bread products F and E by *Saccharomyces cerevisae*; as justified in the findings of [10,14,20-23].

Similarly, the product D also had a moderate overall acceptability index, the composite blend D is composed of 50% Air potato and 50% Wheat flour. However, since Wheat flour has moderate levels of some essential mineral elements and fiber [24-27], and since Air potato is supplemented in the blend, a moderate dough quality is justified as reflected in the result. Interestingly, the composite blend C (100% Cassava flour) which is rich in high mineral element and fiber content levels as reflected in the proximate and mineral elements evaluation in the results section had also had a high overall acceptability index compared to flour blends A and B respectively; this further highlights the nutritional preferences of the Baker's yeast used in fermenting the bread products [1,2,4,6,24-26].

5. CONCLUSION

The high acceptability indexes obtained from the different bread products containing Air potato and Cassava flours in the findings of this research consolidated recent efforts directed at discovering other locally processed flours that can compete favorably with Wheat flour in the Nigerian baking industry. The findings of this research however revealed realistic potentials of Air potato flour supplemented with Wheat and Cassavaflours respectively to produce widely accepted bread products in Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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