Original Research Article

COMPARATIVE STUDY ON CONSUMER ACCEPTABILITY OF BREAD PRODUCED WITH COMPOSITE FLOUR FERMENTED BY YEAST ISOLATED FROM PALM WINE AND STALE BREAD

ABSTRACT

This study investigated the sensory acceptability of bread produced from composite flour (wheat, air potato and cassava) fermented using yeasts from palm wine and stale bread among 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 were formulated; proximate and mineral analysis of representative 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_1-F_1 were fermented by yeast isolated from palm wine while products A_2-F_2 were fermented by yeast from stale bread. Products A_1-C_2 were adjudged standard controls for Air potato flour (A), Wheat flour (B) and Cassava flour (C) while products D_1-F_2 were the test bread products of varying formulation blends of the composite flour. All the bread products (A_1-F_2) were evaluated and compared statistically at $p \leq 0.05$ level of significance. The Bread products D_2 and F_1 had the highest overall acceptability (99.90±0.10%) followed by E_1 (88.89±1.11%) while D_1, E_2, and F_2 stood (66.67±1.33%) acceptance respectively. The findings of this research revealed realistic

potentials of air potato flour supplemented with wheat and cassava flours respectively and the alternative sources of yeasts isolate clones that can be specifically used in fermenting different flour blends for production of widely accepted bread products in Nigeria.

.Keywords: Air potato, Composite flour, Yeast, Sensory evaluation, overall acceptability.

INTRODUCTION

Bread is an important 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 production in Nigeria is due to a variety of factors, chief amongst them been the importation of wheat flour, one of the major ingredients in bread production [2-5]. Wheat flour is suitable for bread production because of its gluten content; a protein which aids excellent formation of bread dough during fermentation, however, many locally made Nigerian flour products lacks adequate levels of gluten protein to enable them compete effectively as suitable alternatives to wheat flour [2-4]. There have been therefore lots of researches carried out to discover 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 [3-5]. While research efforts were originally geared towards blending several locally made flours from starch derived Nigerian crops with wheat flour to obtain appropriate blends suitable for bread production, efforts are now channeled towards supplementing wheat flour with locally made flours to improve the nutritive value and market acceptability of bread products in Nigeria [1, 3, 5]. There have been reports of bread made from flour of cereal grains such as rye, maize, barley, oats, and flours from root tubers like cassava and cocoyam have also been supplemented in blends with wheat flour for bread production [4, 5].

Cassava *(Manihot esculenta Crantz)* a common root tuber is consumed extensively in Nigeria as a major staple food [2, 6]. Nutritionally, cassava is a major source of dietary energy for low income consumers in many parts of Nigeria [1-3, 7]. Despite being a cheap source of food calories, cassava is nutritionally deficient in essential amino acids but rich in arginine [8]. Its use in the production of bread as composite flour has been reported in [1, 3, 4]. Air potato *(Dioscorea bulbivera)* is a true yam species in the family Dioscoreacea and it has attracted scientific interests owing to its numerous therapeutic applications which have been attributed to its unique phytochemistry [6, 8]. The yam species is highly underutilized in Nigeria and only consumed in some rural areas despite its immense health benefits [8]. *Discorea bulbivera* has been reported to be a good source of protein, lipids and crude fibers; making it an alternative suitable flour source for bread production [1-4, 8].

In Nigeria, baked products are fermented by Baker's yeast (*Saccharomyces spp*), however, findings have shown that yeasts from other natural sources can also effect qualitative fermentation processes of baked products for consumption [9, 10]. The use of composite flour and yeasts from different sources has 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, 3, 10]. Hence, this study investigated the sensory acceptability of bread produced from composite flour (wheat, air potato and cassava) fermented using yeasts isolated from palm wine and stale bread among prospective consumers at the Federal University of Technology (F.U.T), Akure, Nigeria.

MATERIALS AND METHODS

Production of Composite flour

The dried unfermented cassava and air potato flour was prepared by adopting the method of [11-13] as indicated in figure 1 and 2 below. Already prepared wheat flour was sourced from commercial vendors at the main market of the Akure metropolis.

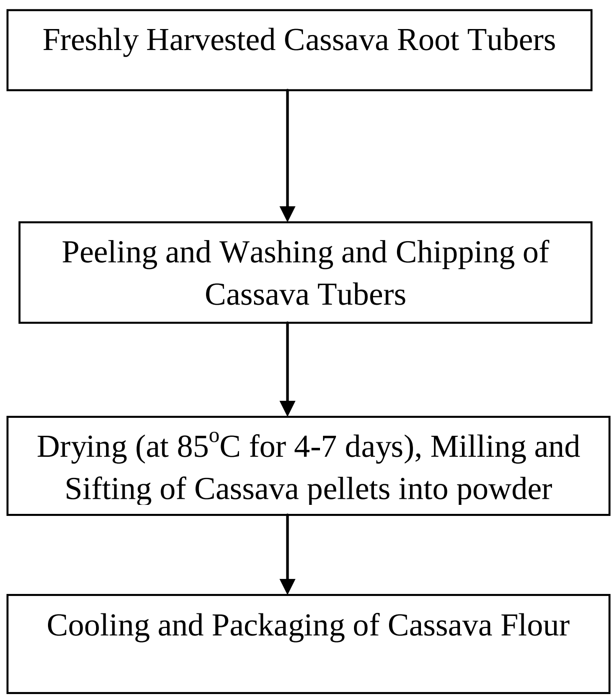

Figure 1: Flowchart for production of Cassava Flour [14]

Proximate analysis of composite flour

The Association of Official Analytical Chemist (A.O.A.C, 2012) protocols were adopted to determine the proximate and mineral compositions of the wheat flour, cassava flour and air potato flour respectively [14-16]. 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 as described in [13, 15, 17]. Moreso, mineral elements compositions of the composite flour were analyzed for calcium, iron, potassium, manganese, sodium and zinc contents respectively [16, 17].

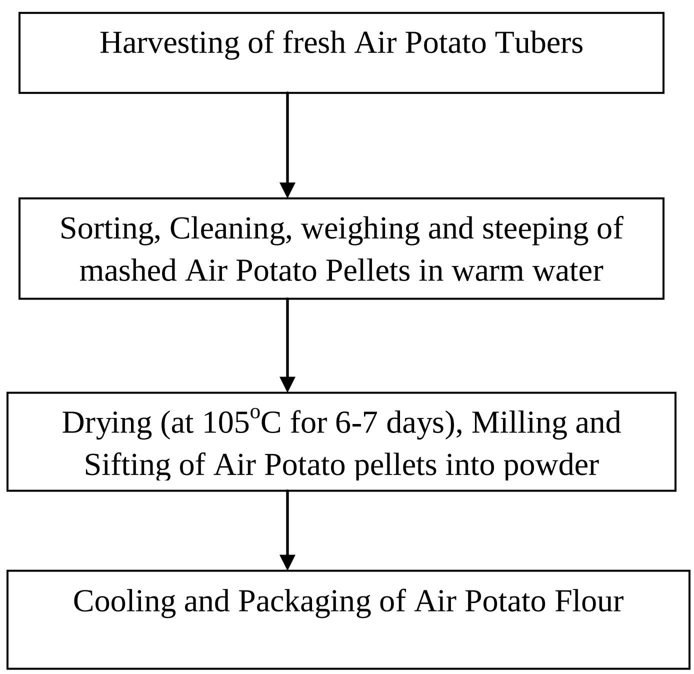

Figure 2: Flowchart for production of Air Potato Flour [13]

Isolation of Yeasts from Palm wine

Freshly trapped palm wine samples were obtained from local farmers at the F.U.T. Junction area of the Akure Metropolis into sterile labeled universal bottles and analyzed in the laboratory for mycological investigations within 6hr of collection. The methods described in [5, 7]were adopted for water sample preparation and Inoculum standardization in which sterile distilled water was used as diluents and a 1ml of the palm wine stock was taken aseptically into 9ml of sterile distilled water for serial dilution procedure in sterile test tubes under aseptic conditions. The third and fourth dilutions were estimated for yeast colony forming units on Potato Dextrose Agar (P.D.A) fortified with 0.1% lactic acid [5, 7]. The plates were incubated at 30^{o}C for 3-5 days for optimal growth and the fourth dilution plates were established as Inoculum standards for the isolation of yeasts due to easy numerical estimation of the colony forming units. Distinct colonies were identified by macro and microscopic morphology using cotton-blue-in-lacto phenol dye and viewed under high power oil immersion lens of the microscope, after which the identified yeast colonies were confirmed as *Saccharomyces spp* by sub-culturing on freshly prepared Yeast extract Agar and incubated at 30^{o}C for 3-5 days [5, 7]. The obtained pure isolates of the yeast were preserved on P.D.A slants and stored at 4^{o}C [5, 7].

Isolation of Yeasts from Stale Bread

Stale bread samples of about 5-10 days after baking were obtained from local food vendors at the Akure South Local Government Area of the Akure Metropolis into sterile containment packs and analyzed in the laboratory for investigations within 6hr of collection [5, 7]. Inoculum standardization, sample preparation, identification and confirmation of the distinct colonies of *Saccharomyces spp* were done in similar manner as described above for isolation of yeasts from palm wine samples [5, 7]. The obtained pure isolates of the yeast were also preserved on P.D.A slants and stored at 4^{o}C [5, 7].

Formulation of Composite Flour Blends

Different composite flour blends were obtained using different ratios of Air Potato flour, Cassava flour and Wheat flour respectively by modifying the blend ratios of composite flour described in [1-3, 12-14, 18]. The six flour ratios obtained were 100% Air Potato Flour (A), 100 % Cassava flour (B), 100 % Wheat 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, 200g of Cassava flour for blend B, 200g of Wheat flour for blend C, 100g each of Air potato flour and Wheat flour for blend D, 100g each of Air potato flour and Cassava flour for blend E and 80g of Air potato flour, 80g of Wheat flour and 40g of Cassava flour for blend F respectively.

Production of Bread from different composite flour combinations

The different composite flour combinations A, B, C, D, E and F 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 as described separately in the findings of [11-14, 17, 18]. The products were labeled (A_1 –F_1) for bread products fermented by yeasts isolated from palm wine while bread products fermented by yeasts isolated from stale bread were denoted (A_2- F_2) respectively.

Description of Study Area used for Sensory Evaluation

The Federal University of Technology, Akure is found in Ondo State, Nigeria with coordinates $7^o16'$ N $7^o18'$ N/ $5^o9'$ E $5^o11'$ E [17, 19]. It is located at the extreme southern region of the Akure South Local Government Area of Ondo state, Nigeria [17, 19].

Sensory Evaluation of Bread samples

A simple random sampling method was adopted to obtain 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 (A-F). The organoleptic properties assessed include the taste, the aroma/texture, appeal/appearance of the products and overall acceptability by the consumers [1-7]. The authors made the evaluators assess the bread products separately at different interval of time to avoid bias, a method adopted and described in the findings of [10-14]. Each evaluator rated the bread products independently of the authors on a hedonic scale ranging from 7 (moderately liked) to 9 (extremely liked) [2-5, 18]. The bread samples A (A_1, A_2), B (B_1, B_2), and C (C_1, C_2) served as controls while bread products D_1, D_2, E_1, E_2, F_1 and F_2 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 using the method described in [17, 18].

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 [10-14].

RESULTS

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≤ 0.05 levels of significance as represented in figures 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 with (2.51±0.28%) while the ash contents of wheat and cassava flours respectively are not significantly different at the specified level of confidence. While the fat contents of the three flours are however not significantly different at P≤ 0.05 level of significance, wheat flour has the highest fiber content (2.50±0.25%) while the fat contents of air potato and cassava flours are not significantly different at the specified level of significance. 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% concentration.

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 concentration at 87.50±2.50% and cassava has the lowest at 30.2±1.80% concentration. On the other hand however, the sodium concentration of air potato flour was the highest (89.40±1.69%) while wheat has a comparatively low concentration 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 cassava flour 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_1 –F_1) fermented by yeasts isolated from palm wine are represented in Tables 1 with respect to the organoleptic properties (taste, appeal/appearance, texture/aroma) and overall acceptability of the bread products. Alternatively, the evaluation indexes of the bread products (A_2 –F_2) fermented by yeasts isolated from stale bread are represented in Tables 2 with respect to the organoleptic properties (taste, color/appearance, texture/smell) and overall acceptability of the bread products.

The evaluation scores of the test bread products represented in Tables 1 and 2 are expressed in percentages of the 18 evaluators at $p \leq 0.05$ level of significance and the evaluation scores of the hedonic scale 7-9 represents the acceptability of the bread products by the evaluators; a standard described in [1-7, 10-14, 17, 18]. Products F_1 and D_2 have the highest evaluation score 99.90±0.10% for taste of the test bread products followed by E_2 and F_2 77.87±1.23%, E_1 66.67±1.33% and D_1 55.57±1.47% respectively (Table 1 and 2). The evaluation score for the appeal/appearance of the bread products were also similar to that of the taste as products F_1 and D_2 have an evaluation score of 77.87±1.23% followed by F_2 at 44.44±1.56%, E_2 and E_1 at 33.33±1.67% while D_1 had a very low evaluation score of 11.11±1.89% (Table 1 and 2).

Conversely, the evaluation score of the texture/aroma of the test bread products also followed the same pattern as bread products F_1 and D_2 had the highest evaluation score in this category too at 99.90±0.10% while E_2 had a score of 77.87±1.23%, F_2 and E_1 had the same score at 66.67±1.33% while product D_1 had its score at 55.57±1.47% respectively (Table 1 and 2). The overall acceptability of the test bread products were also estimated by the evaluators and analyzed at $p \leq 0.05$ levels of significance as bread products F_1 and D_2 had excellent acceptability at an overall score of 99.90±0.10% while the test product E_1 had an overall acceptability at 88.78±1.12% and products D_1, F_2 and E_2 had the same overall acceptability index at 66.67±1.33% respectively as represented in Table 3

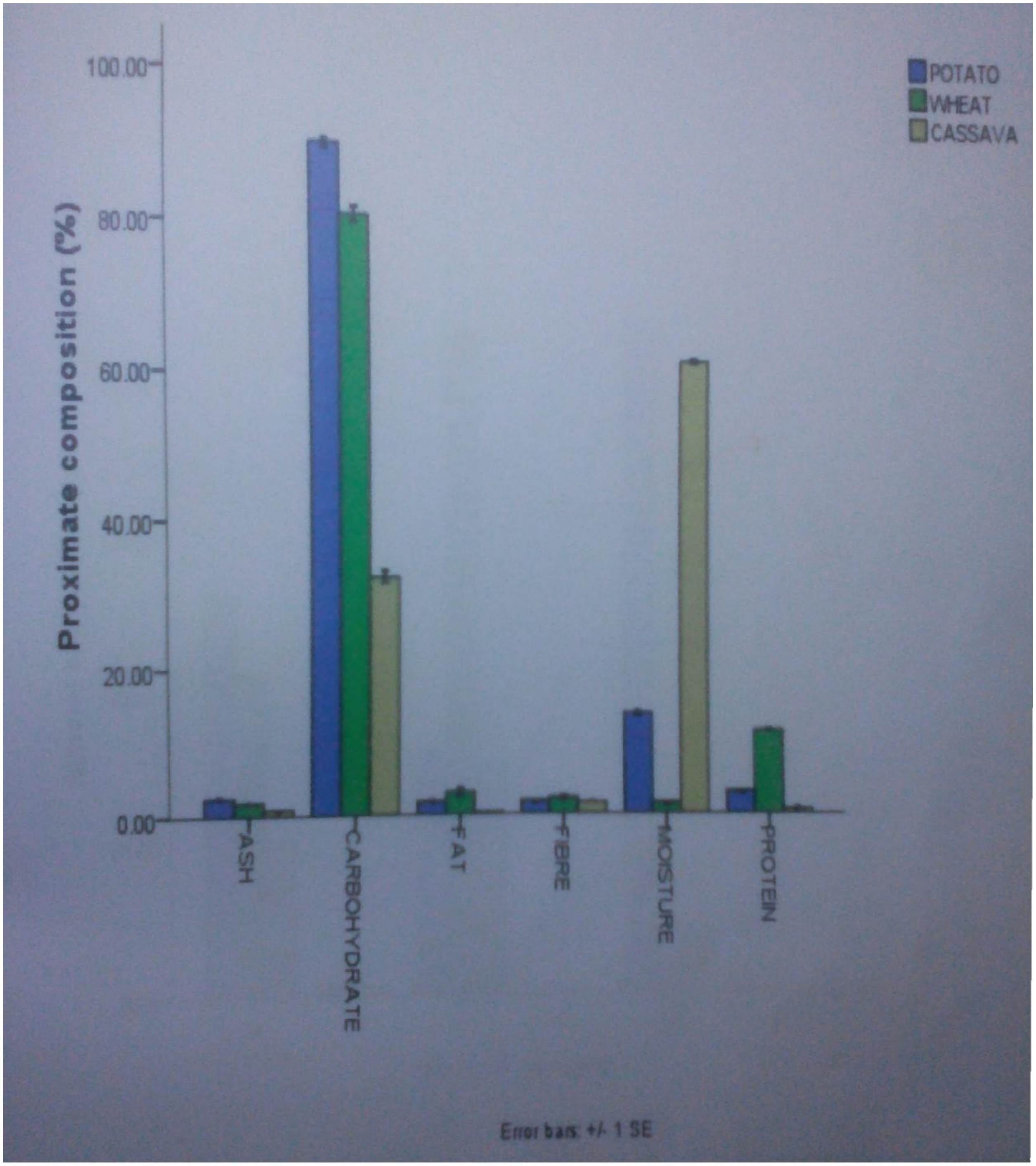

Figure 3: Comparative proximate composition of Air potato flour, Wheat flour and Cassava Flour used in composite bread production

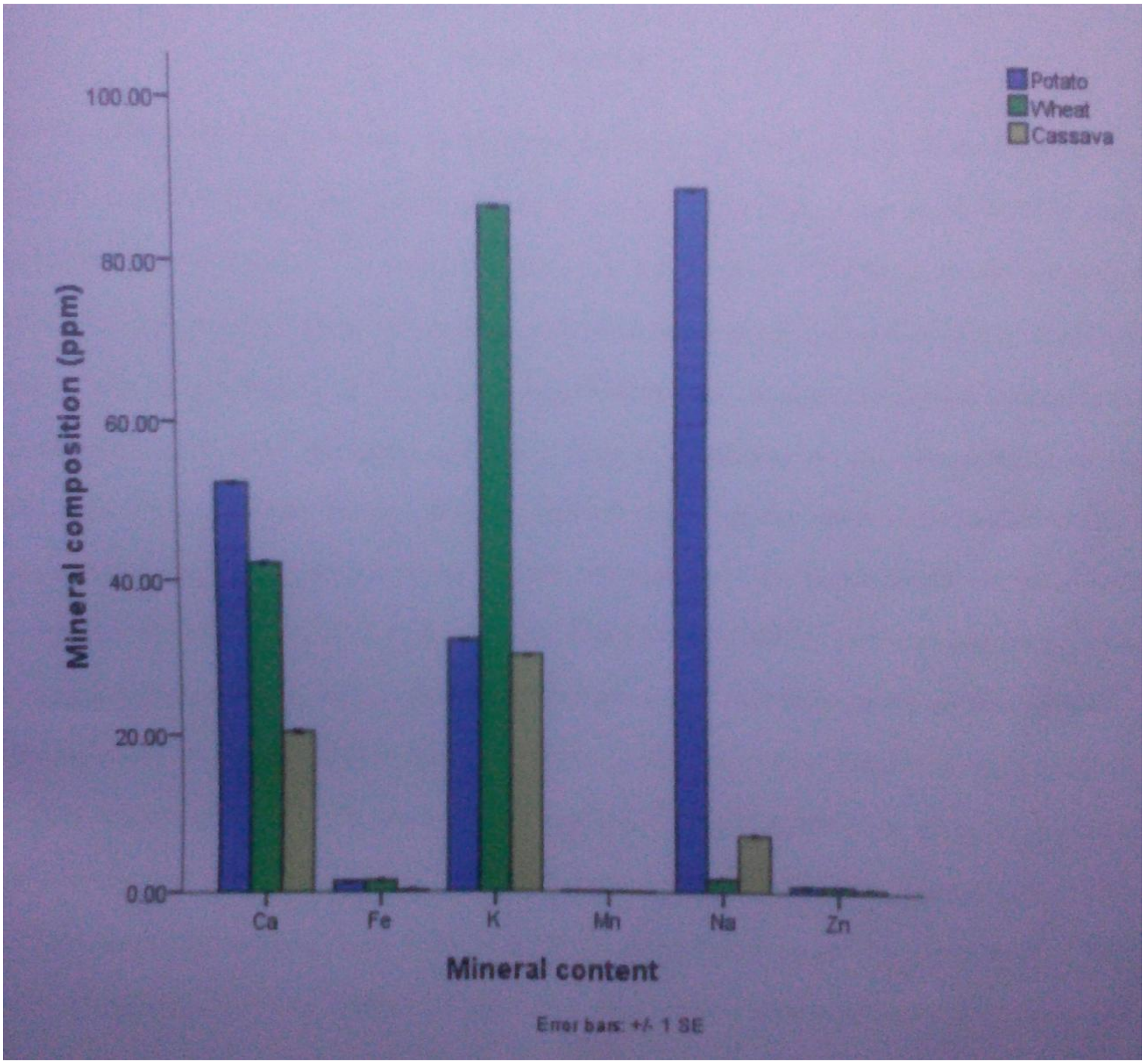

Figure 4: Comparative Mineral composition of Air potato flour, Wheat flour and Cassava Flour used in composite bread production

Table 1: Sensory evaluation scores of the bread products A_1- F_1 fermented by yeast from palm wine

H.Scale	Sensory Evaluation Scores of Bread Products for Taste (%)					
	A_1	B_1	C_1	D_1	E_1	F_1
7	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}	33.33 ± 1.69^{d}	33.33 ± 1.69^{d}	33.33 ± 1.69^{d}	11.11 ± 1.89^{b}
8	11.11 ± 1.89^{b}	00 ± 00^{a}	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}	00 ± 00^{a}	44.44 ± 1.56^{e}
9	22.22 ± 1.78^{c}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	33.33 ± 1.69^{d}	44.44 ± 1.56^{e}
H.Scale	Sensory Evaluation Scores of Bread Products for Appeal/Appearance (%)					
	A_1	B_1	C_1	D_1	E_1	F_1
7	11.11 ± 1.89^{b}	22.22 ± 1.78^{c}	33.33 ± 1.69^{d}	00 ± 00^{a}	11.11 ± 1.89^{b}	33.33 ± 1.69^{d}
8	11.11 ± 1.89^{b}	00 ± 00^{a}	11.11 ± 1.89^{b}	00 ± 00^{a}	22.22 ± 1.78^{c}	33.33 ± 1.69^{d}
9	11.11 ± 1.89^{b}	00 ± 00^{a}	00 ± 00^{a}	11.11 ± 1.89^{b}	00 ± 00^{a}	22.22 ± 1.78^{c}
H.	Sensory Evaluation Scores of Bread Products for Texture/Aroma (%)					
Scale	A_1	B_1	C_1	D_1	E_1	F_1
7	11.11 ± 1.89^{b}	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}	11.11 ± 1.89^{b}	33.33 ± 1.69^{d}	11.11 ± 1.89^{b}
8	33.33 ± 1.69^{d}	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}	44.44 ± 1.56^{e}	33.33 ± 1.69^{d}	55.57 ± 1.43^{f}
9	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	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_1- 100% air potato flour fermented by yeasts from palm wine, B_1- 100% wheat flour fermented by yeasts from palm wine, C_1- 100% cassava flour fermented by yeasts from palm wine, D_1- 50% air potato flour + 50% wheat flour fermented by yeasts from palm wine, E_1- 50% air potato and 50% cassava flour fermented by yeasts from palm wine, F_1- 40% air potato flour + 40% wheat flour + 20% cassava flour fermented by yeasts from palm wine, values with the same superscript have no significant difference at $p\leq0.05$ level of significance. . Bread products A_1- C_1 are control bread products respectively while D_1- F_1 are test bread products

Table 2: Sensory evaluation scores of the bread products A_2- F_2 fermented by yeast from stale bread

H.Scale	Sensory Evaluation Scores of Bread Products for Taste (%)					
	A_2	B_2	C_2	D_2	E_2	F_2
7	11.11 ± 1.89^{b}	22.22 ± 1.78^{c}	55.57 ± 1.43^{f}	44.44 ± 1.56^{e}	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}
8	11.11 ± 1.89^{b}	33.33 ± 1.69^{d}	00 ± 00^{a}	55.57 ± 1.43^{f}	55.57 ± 1.43^{f}	55.57 ± 1.43^{f}
9	33.33 ± 1.69^{d}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}
H.Scale	Sensory Evaluation Scores of Bread Products for Appeal/Appearance (%)					
	A_2	B_2	C_2	D_2	E_2	F_2
7	22.22 ± 1.78^{c}	22.22 ± 1.78^{c}	00 ± 00^{a}	22.22 ± 1.78^{c}	11.11 ± 1.89^{b}	00 ± 00^{a}
8	66.67 ± 1.33^{g}	00 ± 00^{a}	55.57 ± 1.43^{f}	55.57 ± 1.43^{f}	22.22 ± 1.78^{c}	44.44 ± 1.56^{e}
9	00 ± 00^{a}	33.33 ± 1.69^{d}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}
H. Scale	Sensory Evaluation Scores of Bread Products for Texture/Aroma (%)					
	A_2	B_2	C_2	D_2	E_2	F_2
7	44.44 ± 1.56^{e}	11.11 ± 1.89^{b}	11.11 ± 1.89^{b}	11.11 ± 1.89^{b}	55.57 ± 1.43^{f}	11.11 ± 1.89^{b}
8	55.57 ± 1.43^{f}	22.22 ± 1.78^{c}	33.33 ± 1.69^{d}	77.78 ± 1.22^{g}	22.22 ± 1.78^{c}	55.57 ± 1.43^{f}
9	00 ± 00^{a}	00 ± 00^{a}	00 ± 00^{a}	11.11 ± 1.89^{b}	00 ± 00^{a}	00 ± 00^{a}

Keys: H. Scale- Hedonic scale, 7- moderately liked, 8- like very much, 9- liked extremely, A_2- 100% air potato flour fermented by yeasts from stale bread, B_2- 100% wheat flour fermented by yeasts from stale bread, C_2- 100% cassava flour fermented by yeasts from stale bread, D_2- 50% air potato flour + 50% wheat flour fermented by yeasts from stale bread, E_2- 50% air potato and 50% cassava flour fermented by yeasts from stale bread, F_2- 40% air potato flour + 40% wheat flour + 20% cassava flour fermented by yeasts from stale bread, values with the same superscript have no significant difference at $p\leq0.05$ level of significance. Bread products A_2- C_2 are control bread products respectively while D_2- F_2 are test bread products

Table 3: Overall acceptability of bread products A_1 to F_2

Overall acceptability Bread Products fermented by yeasts from palm wine (%)					
A_1	B_1	C_1	D_1	E_1	F_1
66.67 ± 1.33^b	33.33 ± 1.69^a	66.67 ± 1.33^b	66.67 ± 1.33^b	88.89 ± 1.11^c	99.90 ± 0.10^d
Overall acceptability Bread Products fermented by yeasts from stale bread (%)					
A_2	B_2	C_2	D_2	E_2	F_2
77.78 ± 1.22^c	66.67 ± 1.33^b	55.57 ± 1.43^a	99.90 ± 0.10^d	66.67 ± 1.33^b	66.67 ± 1.33^b

Keys: A_1- 100% air potato flour fermented by yeasts from palm wine, B_1- 100% wheat flour fermented by yeasts from palm wine, C_1- 100% cassava flour fermented by yeasts from palm wine, D_1- 50% air potato flour + 50% wheat flour fermented by yeasts from palm wine, E_1- 50% air potato and 50% cassava flour fermented by yeasts from palm wine, F_1- 40% air potato flour + 40% wheat flour + 20% cassava flour fermented by yeasts from palm wine, A_2- 100% air potato flour fermented by yeasts from stale bread, B_2- 100% wheat flour fermented by yeasts from stale bread, C_2- 100% cassava flour fermented by yeasts from stale bread, D_2- 50% air potato flour + 50% wheat flour fermented by yeasts from stale bread, E_2- 50% air potato and 50% cassava flour fermented by yeasts from stale bread, F_2- 40% air potato flour + 40% wheat flour + 20% cassava flour fermented by yeasts from stale bread, values with the same superscript have no significant difference at $p \leq 0.05$ level of significance. Bread products A_1- C_1 and A_2- C_2 are control bread products respectively while D_1- F_1 and D_2- F_2 are test bread products respectively.

DISCUSSION

Recent efforts described in many findings are geared towards supplementing wheat flour with other flours from different crops locally produced in Nigeria for cost effective production of bread and improvement of its nutritive value [3, 5, 20]. It was generally observed that variations in the species of the yeast isolate clones used in the fermentation of the different composite flour blends had a direct relationship on the quality of bread products produced; this was also similar in the findings of [20, 21]. However, since the identification of the yeast isolates used was only done at the genus level (*Saccharomyces spp)*, several recent Nigerian literature texts from research findings in [2-5, 20, 21] have revealed that different species of Saccharomyces ferment flour blends and other carbohydrate substrates differently and hence produce varying degrees of textures, appeal and aroma of the products fermented.

Moreso, the findings of [5, 7] revealed that the variations in the population of the different isolates in the genus *Saccharomyces spp* in Palm wine and Stale bread isolated across different Nigerian states effected a wide range array of products produced in fermentation of carbohydrate substrates used. In similar findings that agrees with the assertion above, high populations of *Saccharomyces carlsbengensis* and *Saccharomyces cerevisae* were abundant in palm-wine while *Saccharomyces globusus* was the most abundant specie of Saccharomyces isolated from stale bread; this explains differences in dough formation, fermentation time and arrays of by-products formed in the fermented products of these findings [7, 17].Therefore, since palm wine and stale bread were the sources of yeasts used in the fermentation of different flour blends adopted in this study, the variations in the taste, aroma, appeal and texture of the bread products is justified as the recent findings cited above suggests that the yeasts isolated in this study has varying population clones of Saccharomyces [5, 7, 17].

In the findings of [21-23], the yeast isolated from stale bread *Saccharomyces globusus* was discovered to less osmophilic (less sugar loving affinity) and less hydrophilic; hence products fermented by this yeast had poor dough qualities, less impacted taste flavors and less acceptability. The same finding in [21-23] also suggests that products fermented by isolates of *Saccharomyces carlsbengensis* and *Saccharomyces cerevisae* had better dough qualities, better impacted taste flavors and a favorable acceptability; this mainly because palm wine contains high sucrose levels (10-12%) and these yeast species are highly osmophilic and hydrophilic.

Consequently, the bread products F_1 and E_1 are the most acceptable of the bread products fermented by yeasts from palm wine, 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 proportionate amount by mass of high sugar rich flour 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_1 and E_1 by the yeast isolates from palm wine (*Saccharomyces carlsbengensis* and *Saccharomyces cerevisae*). This was justified in the findings of [12-14, 24].

Similarly, the product D_2 was the most acceptable test product fermented by yeasts from stale bread; in a recent finding cited earlier [23], it was also discovered that asides been less osmophilic, the yeast from stale bread (*Saccharomyces globusus*) requires higher concentrations of mineral elements (particularly calcium and sodium) and mild protein levels for its metabolism. Interestingly, the composite blend D (50% Air potato/ 50% wheat) is rich in high mineral element levels and has mild protein concentrations as reflected in the proximate and mineral elements evaluation in the results section. This explains the excellent acceptability of the bread D_2 fermented by yeast from stale bread as described also in the findings of [21-23, 25]. A closer look at the acceptability of the control bread products will reveal that bread A_2 also had a favorable acceptability index due similar reasons as blend A is composed of 100% Air potato [24-26].

CONCLUSION

The high acceptability indexes obtained from the different bread products containing air potato flour in the findings of this research consolidated the recent research efforts channeled towards discovering other alternative flour sources to wheat flour. The findings of this research has given an insight into the enormous potential of air potato flour supplemented with wheat and cassava flours respectively to produce widely accepted bread products. These findings also reveal the potential alternative sources of yeasts isolate clones that can specifically used in fermenting different flour blends for commercial production of widely accepted bread products by prospective consumers in Nigeria.

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