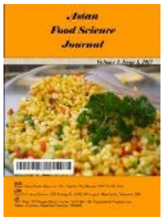

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Bread Production from Different Flours Using Strains of Baker's and Palm Wine Yeasts

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Authors' contributions

This work was carried out in collaboration between all authors. Authors RUBE, UOE and VBE designed the study. Authors UOE and IKA performed the statistical analysis. Authors RUBE, VBE and UOE wrote the protocol, and the first draft of the manuscript. All authors managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Bread is widely eaten across the world and the science of its baking has come a long way. This study was aimed at evaluating the effect of using Baker's and palm wine yeasts on the performance and sensory properties of bread baked with bean (*Phaseolus vulgaris*), corn (*Zea mays*), golden penny and wheat flours in addition to nutritional analysis of the flours and Baker's yeast. Collection of samples, processing of flours, palm wine yeast isolation, proximate and elemental analyses, and baking of the various breads were done using standard methodologies. Sensory evaluation was performed using Likert scale and replicate readings were analysed using analysis of variance. Baker's yeast had the highest amount of fat, ash and protein but lower than the rest in fiber and carbohydrate content. Amongst the flours examined for proximate composition, bean flours had higher amounts of moisture, ash and fiber, but not carbohydrate and fiber. Vitamins A, total and soluble vitamin C were present in all our sampled flours and Baker's yeast.

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Baker's yeast had the highest amount of these vitamins followed by corn and beans. Elemental composition analysis showed that the flours contained potassium, sodium, calcium, magnesium, iron, zinc, copper, manganese and phosphorus in varying amounts. Although Baker's yeast did slightly better than the isolated yeast with all the flour types, its sensory evaluation with maize and wheat flours samples were better than that of bean flour. The findings indicate that isolated yeast from palm wine compares favourably with Baker's yeast in the leavening of wheat bread, sensory properties and performance parameters.

Keywords: Bread; bean; maize; baker's yeast; palm wine; nutrient analysis; sensory properties.

1. INTRODUCTION

Bread is a staple food that is eaten not only in Nigeria and across Africa but all over the world [1]. Historically, the art of bread making and eating is as old as the history of human civilization, and evidence of cultivated and harvested wheat exist that is as old as 8,000BC [1-4]. Nutritional needs were not the target of early bakers of bread, however, with refinement over the millennia, bread making has gone a long way with a lot of varieties in order to meet different nutritional needs. Like all other foods produced from cereals, bread is eaten primarily as a cheap source of energy. It contains a valuable amount of protein, iron and vitamins. Due to the presence of gluten, flour is the basic ingredient in the production of bakery foods [2,3,4]. The elasticity of gluten makes it retains gas and supports the structure of the loaf. The dough is made by mixing together the flour, water, yeast, salt and other additional ingredients. Dough rising is via the production of carbon dioxide in the dough [5]. As a staple food, its production is vital and is not liable to seasonal fluctuation and can be made from varieties of flours. These flours can be obtained from beans, soya beans, cassava, wheat, corn and so on. Furthermore, the yeast used in baking can be isolated from various sources [3,6].

In Nigeria, especially the Southern part, palm wine is a popular beverage obtained from the fermented sap of oil palm tree (*Elaeis guineensis* and raffia palm (*Raphia hookeri*) [7-8]. It is a milky alcoholic beverage produced from the inflorescence of palm tree [7-8]. It is the most widely used and cherished natural traditional alcoholic beverage especially in the southern part of Nigeria and beyond [7-8]. The microbiology of this beverage is well documented [7,8]. *Saccharomyces cerevisiae* is a component of palm wine and many Nigerian workers have explored both biological and economic aspect of the species found in palm wine [7]. Studies have also shown that morphological, genetic and physiological variants affect organoleptic qualities of palm wine [9]. Isolated strains have been shown to have potentials useful as leavening agents or for production of wine, beer, and ethanol, and bread [3,10,11,12,13]. Yeasts isolated from palm wine are not widely accepted in commercial bread production despite its baking potentials [3,10]. Yeast strains isolated from Brukutu and Palm wine in an earlier study used to bake bread showed baking potential similar to commercial strains of baker's yeast [14]. Given the high cost of commercially available Baker's yeast, there is a need for locally available and more affordable strain of yeasts [15].

A few studies have shown that wide variations exist in properties of bread made from various flours and yeast strains in terms of nutrient, texture, volume, appearance and taste [12,16]. Few studies exist on the effect of bread variation with different flours and yeast sources. Therefore, the aim of this study was to evaluate the variations of bread using different flours with Baker's and palm wine yeast strains in addition to nutrient analysis of the various flours.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Flours

Locally available wheat (*Triticum aestivum*), beans (*Phaseolus vulgaris*), and corn (*Zea mays*) were bought from Watt market, Calabar, Cross River State, Nigeria. The wheat and corn were washed and spread on a clean surface and allowed to sun-dry while the beans were soaked, washed thoroughly, deshelled and then sun dried for twenty-four (24) hours. The samples (wheat, beans and corn) were oven dried at 70℃ for another twenty-four (24) hours. Thereafter, they were then blended separately, dry sieved and stored in separate polythene bags for further analysis. Collection were done as previously described [14,16,17,18].

2.2 Collection of Palm Wine

Fresh palm wine samples obtained from oil palm (*Elaesis guineensis*) were collected from a palm wine taper in Obong Ntak, Etim Ekpo Local Government Area, Akwa Ibom State, Nigeria within 30-60 minutes of tapping in sterile 500 ml screw-capped plastic bottles and were immediately transported to laboratory for further analysis.

2.3 Isolation and Characterisation of Yeast

The palm wine was shaken vigorously and used to carry out a ten-fold serial dilution. All dilutions were plated onto triplicate potato dextrose agar (PDA) plates supplemented with 0.05 mg/ml of chloramphenicol and gentamicin each to inhibit bacteria growth. Plates were incubated at room temperature (25 ± 2°C) for a maximum of 48 hrs. Representative colonies (confirmed to be yeasts by microscopy) were purified by re-streaking on PDA plates and isolates were stored on PDA slopes. Yeast isolates were identified by standard morphological and biochemical methods [19,20,21,10].

2.4 Proximate Composition Analysis

The wheat, beans, corn and Baker's yeast samples were analysed for proximate composition according to the methods of Association of Official Analytical Chemists (AOAC) (1990) [22]. These included moisture, crude fiber, ash, crude protein, crude fat, and carbohydrate.

2.5 Determination of Vitamins

Vitamins A, E, and C were determined according to methods previously described [23,24].

2.6 Determination of Mineral Elements

The mineral elements were determined by the dry ash extraction method of AOAC (1990) [22] at the Central Laboratory of Faculty of Agriculture, Wildlife and Forestry, University of Calabar, Calabar, Nigeria.

2.7 Estimation of Anti-nutrients

The anti-nutrients examined were hydrocyanic acid, phytic acid and oxalate. These were done as previously described [25,26,27].

2.8 Baking of the Various Bread Sample

The baking of the various bread samples was done following the procedures of a popular Bakery (Hi-quality Bakery) located in Calabar, Cross River State. All the mixings and proportion measurements of all the ingredients were done as instructed. Briefly, 500 g of each of the sieved flours were first weighed out onto a clean working bowl. Exactly 200 g of Topper butter were then added to each of the various weighed flour samples and manually mixed together. Using another clean bowl, 50 ml of water, 150 g of sugar, 10 g of salt, desired milk quantity, and yeasts (5 g) were measured and weighed out accordingly. These ingredients were then mixed properly until a balanced taste was obtained. The mixture was then added to each of the flour samples to obtain the dough. The resulting dough was then weighed (each weighed 1.3kg) and divided into 3 equal parts weighing 433.33 g each. The dough was placed in a clean, oiled and milked washed pan and kept to rise for an hour. They were then placed in an electric oven with the temperature maintained 290ºC for 35 to 45 minutes, and 250ºC for 30 minutes. The baked breads were then removed from the oven, allowed to cool for 5 minutes before being removed from the pans, weighed and dimensions recorded for each baked sample.

2.9 Sensory Evaluation

This was done using the Likert five-point scale and scored as follows: AS= Agree strongly, AG= Agree, N= Neutral, D= Disagree and DS=Disagree strongly. The parameters were coded as thus A =taste, B=palatability and attractiveness, C= Appealing colour, D= Would you buy this bread? E= Similarity of taste to other bread, F= Is the colour good enough? G= Similar texture to commercial bread, H= confidence in ingredients, I= Odour and J= Recommendation to other.

2.10 Statistical Analysis

Replicate readings obtained were analysed for significance using Analysis of Variance (ANOVA) at 95% significance level. All the analyses were done using Microsoft Excel 2007 Version.

3. RESULTS

The results of the study are as presented in the tables. Table 1 shows the proximate composition of the various flour samples in g/100g dry matter. Table 2 shows the estimation of anti-nutrients in the various samples in mg/100g dry matter. Table 3 shows the various vitamins present in the flour samples. Table 4 is an estimation of the elemental composition of the samples. Table 5 shows the biochemical test results for the isolated yeast. Tables 6 -8 show the sensory evaluation test of isolates. Tables 9 and 10 show the performance of bread baked with both Baker's and palm wine yeast.

From Table 1, it can be seen that the bean flour types had the highest amount of moisture 21.70 g/100g dry matter. The flour sample with the least amount of moisture was corn flour with a moisture content of 12.54 g/100g dry matter. Results of the ash content of the flours indicate that Baker's yeast again had the highest amount of ash (6.72 g/100g dry matter) and corn the least amount of 1.52 g/100g dry matter. Similar results were also seen for crude protein as Baker's yeast again had the highest amount of protein (24.70 g/100g dry matter) while bean flour was the second most abundant (23.20 g/100g dry matter) and the least was corn (10.41 g/100g dry matter). Similar results were seen with fat as Baker's yeast had the highest amount of fat 14.52 g/100g dry matter followed by corn with 4.47 g/100g dry matter while bean flour had the least amount of fat 1.73 g/100g dry matter. However, fibre contents were lower in Baker's yeast and corn than the rest of the flour samples. As expected corn and wheat flour had the highest amount of carbohydrate 81.34 and 78.74 g/100g dry matter, respectively. Analysis of variance showed a significant difference in the mean readings.

From Table 2, Baker's yeast had the least amount of all the anti-nutrients examined except for tannin. It had the least amount of hydrocyanic acid (1.65 mg/100g dry matter), total oxalate (14.43 mg/100g dry matter), soluble oxalate (4.70 mg/100g dry matter) and phytate (0.09 mg/100g dry matter). Hydrocyanic content was highest in bean flour (2.63 mg/100g dry matter) while total and soluble oxalates were most abundant in wheat flour with readings of 35.72 and 18.50 mg/100g, respectively. Phytate and tannin were most abundant in maize flour with values of 0.53 and 0.41, respectively.

From the results in Table 3, it can be seen that the all the flour samples were rich in vitamins A and also in total and soluble vitamin C. However, these vitamins were most abundant in Baker's yeast. Bean flours had the least amount of the vitamins examined.

Table 1. Proximate composition of the various flour samples (g/100g dry matter)

Proximate components	Baker's yeast	Corn	Wheat	Bean
Moisture	17.30±0.10[a]	12.54±0.02 [a]	13.54±0.02 [a]	21.70±0.10 [a]
Ash	6.72±0.02	1.52±0.02	2.80±0.02	3.80±0.10
Protein	24.70±0.02	10.41±0.01	12.92±0.02	23.20±0.02
Fat	14.52±0.02	4.47±0.01	2.06±0.02	1.73±0.01
Fibre	1.83±0.01	2.18±0.02	3.30±0.10	4.70±0.10
Carbohydrate	34.74±0.02	81.34±0.02	78.74±0.02	66.32±0.02

[a]*Represents significant Mean±SD values across all columns (p < 0.05)*

Table 2. Estimation of anti-nutrients in the various flour samples (mg/100g dry matter)

Anti-nutrients	Baker's yeast	Corn	Wheat	Bean
HCN	1.65±0.02[a]	2.23±0.02 [a]	2.31±0.01 [a]	2.63±0.01 [a]
Total oxalate	14.43±0.02	18.43±0.01	35.72±0.02	26.96±0.01
Soluble oxalate	4.70±0.10	7.20±0.10	18.50±0.10	14.43±0.02
Phytate	0.09±0.01	0.53±0.01	0.52±0.02	0.36±0.01
Tannin	0.20±0.01	0.41±0.01	0.31±0.01	0.14±0.02

[a]*Represents significant Mean±SD values across all columns (p<0.05)*

Table 3. Estimation of vitamins in the various flour samples

Vitamins	Baker's yeast	Corn	Wheat	Bean
Vitamin A (mg/dl)	133.92±0.02[a]	4.28±0.02 [a]	0.30±0.10	9.42±0.02
Total vitamin C (mg/100g)	18.49±0.01	15.90±0.10	10.40±0.10	11.42±0.01
Soluble vitamin C (mg/100g)	8.43±0.02	7.83±0.01	2.35±0.01	4.18±0.02

[a]*Represents significant Mean±SD values across all columns (p<0.05)*

Table 4 shows the results of the various elements analysed in the various flour samples. The results indicates that potassium, sodium, calcium, manganese, iron, zinc, copper, magnesium, and phosphorus were present in all the flours except manganese and phosphorus which were not detected in Baker's yeast and not done for wheat flour. Corn flour had the highest amount of potassium 363.20 mg/100 dry matter and wheat flour had the least of 5.20 mg/100 dry matter. Sodium levels in wheat and Baker's yeast were higher than in the rest of the flours. The top two flours abundant in calcium were wheat and corn flours with values of 40.30 and 11.70 mg/100 dry matter, respectively. Bean flours recorded the highest levels of iron, manganese and zinc while magnesium was more abundant in corn and Baker's yeast.

Table 4. Elemental composition in the various samples (mg/100 dry matter)

Elements	Baker's yeast	Corn	Wheat	Bean
K	31.84	363.20	5.20	13.90
Na	10.74	3.75	15.94	0.07
Ca	64.966	11.70	40.30	0.83
Mg	28.58	73.40	9.40	2.20
Fe	4.91	3.40	3.94	74.10
Zn	0.24	2.64	3.72	34.60
Cu	0.08	2.08	0.38	3.16
Mn	ND	0.38	-	8.10
P	ND	317.10	-	22.80

ND= Not detected and "'-" = Not done

The carbon source assimilation test shows that the isolated yeast was negative to the nitrogen sources which were lysine and urea. It was also negative to lactose, melibiose and mannitol but was positive for glucose, sucrose, maltose, xylose, galactose, raffnose and trehalose.

From the results presented in Table 6, wheat bread baked with Baker' yeast outperformed bread baked with yeast isolated from palm wine. All the participants agreed strongly and or agreed to its taste, colour and readiness to buy and recommend to others while only 8 agreed strongly and or agree to the taste of wheat baked with palm wine.

Table 5. Biochemical identification test for the isolate yeast

Biochemical tests	Results
Glucose	+
Sucrose	+
Maltose	+
Xylose	+
Galactose	+
Lactose	-
Raffnose	+
Melibiose	-
Mannitol	-
Trehalose	+
Urea hydrolysis	-
Lysine	-
Isolate	***Saccharomyces cerevisiae***

Tables 7 and 8 shows the various sensory evaluations of bean and corn baked breads, respectively. The sensory evaluation of bean flour bread showed that Baker's yeast again was

Table 6. Sensory evaluation test for wheat flour bread leavened with Baker's and palm wine yeast

Sensory properties	Baker's yeast					Palm wine yeast				
	AS	AG	N	D	DS	AS	AG	N	D	DS
A	10	0	0	0	0	7	1	1	1	0
B	5	5	0	0	0	6	3	0	1	0
C	8	2	0	0	0	5	0	0	2	3
D	9	1	0	0	0	0	0	0	0	0
E	2	4	0	0	4	0	1	2	3	4
F	7	3	0	0	0	6	1	2	1	0
G	1	4	1	0	4	2	0	0	4	4
H	5	4	1	0	0	2	2	3	1	2
I	2	4	0	3	3	1	0	1	4	4
J	8	2	0	0	0	5	2	0	1	2

Keys: AS= Agree strongly, AG= Agree, N= Neutral, D= Disagree and DS=Disagree strongly. A =taste, B=Palatability and attractiveness, C= Appealing colour, D= Would you buy this bread? E= Similarity of taste to other bread, F= Is the colour good enough? G= Similar texture to commercial bread, H= Confidence in ingredients, I= Odour and J= Recommendation to other better than yeast isolated from palm wine. Over half of the respondents agreed to and or strongly agreed to the taste, colour, palatability and attractiveness, texture, and odour. The situation was almost reversed in bread baked with yeast as over half of the respondents disagree and or disagreed completely with all the sensory parameters evaluated except for confidence in ingredients.

Corn flour bread baked with both yeasts showed similar results in terms of taste, palatability and attractiveness and appealing colour as over half of the respondents agreed and or strongly agreed to the listed parameters. Furthermore, all respondents disagreed or strongly disagreed with the texture.

Tables 9 and 10 show the performance of the various bread samples using palm wine and Baker's yeast strains. The volumes were almost similar with for wheat flour baked bread with volumes of 714.18 and 658.36 cm^3, respectively for Baker's yeast and palm wine yeast. Smaller volumes were seen for bean and corn flour baked breads.

Table 7. Sensory evaluation test for bean flour bread leavened with Baker's and palm wine yeast

Sensory properties	Baker's yeast					Palm wine yeast				
	AS	**AG**	**N**	**D**	**DS**	**AS**	**AG**	**N**	**D**	**DS**
A	10	0	0	0	0	5	0	0	1	4
B	3	1	1	0	5	2	1	2	1	4
C	8	2	0	0	0	4	0	1	0	5
D	0	0	2	0	8	1	0	3	1	5
E	1	3	0	0	6	0	0	2	2	6
F	6	3	1	0	0	3	1	2	0	4
G	1	5	1	0	4	2	0	0	5	4
H	3	3	2	2	0	1	3	2	1	3
I	1	4	1	1	3	1	0	1	4	4
J	3	1	1	0	6	1	0	3	1	5

Keys: AS= Agree strongly, AG= Agree, N= Neutral, D= Disagree and DS=Disagree strongly. A =taste, B=palatability and attractiveness, C= Appealing colour, D= Would you buy this bread ? E= Similarity of taste to other bread, F= is the colour good enough, G= Similar texture to commercial bread, H= confidence in ingredients, I= Odour and J= recommendation to other

Table 8. Sensory evaluation test for corn flour bread leavened with Baker's and palm wine yeast

Sensory properties	Baker's yeast					Palm wine yeast				
	AS	**AG**	**N**	**D**	**DS**	**AS**	**AG**	**N**	**D**	**DS**
A	10	0	0	0	0	9	0	0	1	0
B	5	2	2	0	1	6	1	2	0	1
C	6	3	1	0	0	7	1	1	0	1
D	2	1	4	0	3	2	0	3	2	3
E	1	3	1	0	5	0	0	3	4	3
F	5	4	1	0	0	6	1	2	1	0
G	0	5	10	0	4	0	0	0	5	5
H	3	2	3	0	2	1	3	2	2	2
I	4	1	1	3	1	0	1	3	6	0
J	2	1	4	0	3	2	0	3	1	4

Keys: AS= Agree strongly, AG= Agree, N= Neutral, D= Disagree and DS=Disagree strongly. A =taste, B=Palatability and attractiveness, C= Appealing colour, D= Would you buy this bread? E= Similarity of taste to other bread, F= Is the colour good enough? G= Similar texture to commercial bread, H= Confidence in ingredients, I= Odour and J= Recommendation to other

Table 9. Performance of bread baked with Palm wine yeast

Types of flours	Height (cm)	Width (cm)	Length (cm)	Weight (cm)	Volume (cm^3)
Wheat	5.30±0.71	9.00±0.00	13.80±0.00	350.00±0.00	658.26
Beans	4.40±0.14	7.40±0.85	13.80±0.00	350.00±0.00	449.32
Corn	3.40±0.01	4.50±0.00	4.00±0.00	250.00±0.00	61.20

Table 10. Performance of bread baked baker's yeast

Types of flours	Height (cm)	Width (cm)	Length (cm)	Weight (cm)	Volume (cm^3)
Wheat	6.35±0.21	8.15±0.49	13.80±0.00	450.00±0.00	714.18
Beans	4.30±0.32	6.73±0.61	13.80±0.00	350.00±0.00	399.36
Corn	3.40±0.01	5.50±0.00	6.00±0.00	265.00±0.00	112.20

4. DISCUSSION

From the proximate composition results, Baker's yeast had the highest amount of moisture, ash and protein but lower than the rest in fibre and carbohydrate. Amongst the flours examined for proximate composition, bean flours have higher amounts of moisture, ash, protein, fat and fibre but not carbohydrate. Ameh et al. [28], in their study showed that proximate composition of wheat to be moisture (21.07%), crude protein (11.04%), crude fat (1.57%), crude fibre (1.76%) and carbohydrate (63.10%). When compared to our findings, our moisture content was less but all other parameters were higher. Corn as expected had the highest amount of carbohydrate and least amount of protein. Shah et al. [29] showed maize flour to contain carbohydrate (71.88g), protein (8.84g), fat (4.57g), fibre (2.15g), ash (2.33g) and moisture (10.23g). When compared to our findings, it shows that our carbohydrate and protein contents were slightly higher.

Bean flour used in this study had the least amount of carbohydrate and the highest amount of protein. Eshun [30], showed the proximate composition of bean flours of three soya bean flours from Ghana to be 1.02% - 1.80%, 1.01% - 1.67%, 36.94% - 40.01%, 16.82% - 19.30%, 2.97% - 3.01%, 34.97%, respectively for moisture, ash, crude protein, crude fat, crude fibre, carbohydrate, and these were slightly different from our findings. Elsewhere in another study, the crude protein content was in the range of 20.69–23.08 %, crude fat, 0.59–1.14 %, crude fibre, 4.06–6.86 %, ash, 4.39–5.61%, moisture 9.19-11.83 %, carbohydrate 54.31-59.64 % for five Lima beans accession [31]. Apart from moisture and carbohydrate in our study that were out of range, other parameters were within range of their findings.

Anti-nutrient analysis showed that hydrocyanic acid, total oxalate, soluble oxalate, phytate and tannins ranged from 1.65-2.62, 14.43-35.72, 4.70-18.50, 0.09-0.83 and 0.12-0.41 mg/100 g dry matters, respectively. When compared with edible vegetables and mushroom previously examined, these were found to be within the same range and lower than world maximum allowable limits in foods [18,25,27,32,33]. Furthermore, all examined anti-nutrients were lower than those reported earlier for *Citrus paradis* peels [24], test and seeds of *Dacryodes eludis* and *Garcinia kola* [32], and as well as pod and seeds of *Cola rostada* and *Cola nitida* [34].

Vitamins A, total and soluble C were present in all our sampled flours and Baker's yeast. Baker's yeast had the highest amount of these vitamins followed by corn and beans. Ameh et al. [28] also showed the presence of some vitamins (thiamine 0.15 mg/100g, riboflavin 0.06 mg/100g and niacin 3.31mg/100g.) in their study. Our findings were also agreeable with those of Shah et al. [29] who reported thiamine 0.42mg, riboflavin 0.10mg, vitamin C 0.12mg in maize flour.

Elemental composition analysis showed that the study flours contained potassium, sodium, calcium, magnesium, iron, zinc, copper, manganese and phosphorus in the studied flour samples. However, manganese and phosphorus were not detected in Baker's yeast and corn. In another study, Eshun [30] reported calcium, magnesium, iron and phosphorus in the range of 62.93 mg/100g - 217.38 mg/100g, 8.39 mg/100g - 8.53 mg/100g, 3.86 mg/100g - 11.51 mg/100g and 0.88 mg/100g - 2.33 mg/100g respectively. These were also agreeable to our findings. In an earlier study, reported mineral content ranged from 2.45–172.77 mg/100g, for iron and phosphorus, respectively in bean [31]. Our findings were within range for the bean flour sample.

Shah et al. [29] reported levels of phosphorus to be 348mg, sodium 15.9mg, calcium 10mg, iron 2.30mg, potassium 286mg, magnesium 139mg and copper 0.14mg in maize. All these minerals were detected in our study maize flour sample.

Isolation and evaluation of local microbial strain with defined or special commercial ability is a common and desirable aspect of industrial and foods microbiology [35]. The biochemical results of the yeasts isolated from palm wine showed that the isolated palm wine yeast was *Saccharomyces cerevisiae.* It is commonly isolated from sugary foods and alcoholic beverages including local ones such as palm wine and has been shown to be better than other species of yeasts [12,36]. In an earlier study, it was shown that *Saccharomyces cerevisiae species* from palm wine gotten from different sites in Enugu did not have high leavening ability like their control. However, they influenced the aroma and flavour more than the control (Baker's yeast) [3]. This is in line with our findings as the taste received an agreeable or strongly agreeable rating. In a recent study, Nwakwu et al. [37] showed that yeasts isolates play an important role in the odour of palm wine during its fermentation. Furthermore, this was slightly different from the findings of Nwakanna et al. [3] who found out that enhanced strains did better than those that were not in baking of bread. Although Baker's yeast did better than the isolated yeast with all the flour types, its sensory evaluation with maize and wheat flours samples were better than that of bean flour. These findings were in line with a recent study that revealed that Palm wine yeasts are best leavening agents of wheat [13]. Yahaya and Jatau [14] showed that two isolates of yeast from Palm wine and Burukutu compared favourably with the commercial Baker's yeast strain (control), thus confirming their baking potentials. The performance of the baked bread with the commercial and the isolated yeast shows that Baker's yeast baked breads did much better than that of isolated yeast but it was very comparable to those Palm wine yeasts with wheat bread.

5. CONCLUSION

From the findings in this study, it can be deduced that the various samples used in this study are very rich in proximate nutrients, vitamins, minerals and allowable levels of anti-nutrients. The isolated yeast from Palm wine did compare favourably with Baker's yeast in the leavening of wheat bread, sensory properties and performance parameters. There is a need for further studies aimed at evaluating the nutrients levels in the baked bread samples with both yeast types and strain improvements of the Palm wine yeast.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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