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Comparative studies of the dough raising capacity of local yeast strains isolated from different sources

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ABSTRACT

Background: Fermentation by yeast is of primary importance for its leavening function and its possible contribution to the production of desirable flavoured compounds.
Objectives: This study focused on the isolation of local yeast strains from different sources: fresh pineapple juice, palm wine and orange juices and Burukutu.
Methods: Fresh pineapple juice, palm wine and orange juices and Burukutu were kept on a sterile workbench to be fermented at ambient temperature for 72 hours. Aliquots of the fermented samples were introduced into conical flasks containing yeast extract glucose peptone broth compounded for isolation and characterization. Yeast isolated from pineapple, burukutu, orange and palm wine were characterized. The morphological, cultural and biochemical characteristics of the yeasts were identified by using API20C AUX Kit (Bio Meriux), tested for markers characteristics such as sugars fermentation ability and starch hydrolysis. Biomass of each isolate tested was used to ferment flour dough to determine their fermentative abilities. Five out of the seven yeast isolates were compared with the commercial baker yeast (control) in terms of their dough raising capacity to confirm their baking potentials. Sensory evaluation of the baked fermented dough was carried out using these parameters: texture, aroma, taste and appearance.
Results: The yeasts were identified to be S*accharomyces cerevisiae, Saccharomyces exiguus, Saccharomyces kluyveri* and *Saccharomyces ludwigii***.** Catalase and Urease were found to be identical with the baker's yeast (Control). The results revealed that *Saccharomyces cerevisiae, Saccharomyces exiguus and Saccharomyces ludwigii* yeast isolates produced loaves that have sensory properties significant ($p \leq 0.05$) when comparable with baker's yeasts commonly used in many of the bakeries.
Conclusion: The findings in this study showed that it is possible to isolate a pure culture of *Saccharomyces species* from fermented fruits and local beverages for use in baking instead of importing the commercial baker's yeast that is expensive. These local isolates if used will economize our foreign reserve.

Keywords: Local yeast, Baker's yeast, *Saccharomyces* species, Dough raising

INTRODUCTION

Yeast fermentation is important for its leavening characteristics and its likely contributions to the production of needed flavour compounds in fermented products (Azmuda *et al*., 2006). The importance of yeast from early fermentation industries is widely documented. Today, baker's yeast is utilized for manufacturing bread throughout the globe at an industrial scale and is wholly imported from developed countries (Blakely, 2004).
Yeasts can execute three major functions in fermentation: it produces carbon dioxide in enough quantities to increase the dough; it produces a light spongy texture that results in palatable bread when correctly baked; it causes maturing of the bread and produces a complex mixture of chemical compounds that add to the flavor of the bread. In addition to producing carbon dioxide, the lactic acid-forming bacteria produce acids also.

While the acids contribute to the flavour of the finished bread and enhance the bread storage properties as reported by Azmuda, *et al*. (2006). The focus of this research is to develop local strains which may be used to serve as the bridging gap between importation and Nigeria's genuine quest to attain self-sufficiency in manufacturing. Yeast can be isolated from different food sources including

citrus juice with high sugar content, palm wine, Burukutu, pineapple, soil, nectar and compost (Savova and Nikolova, 2002). The capacity of yeast to ferment under conditions of high osmotic stress is essentially important to the baker. The purpose of this study was therefore to isolate and investigate the dough raising capacity of local yeast strains isolated from different sources.

MATERIALS AND METHOD

Samples Collection

Samples of fresh orange, pineapple, palm wine and burukutu were purchased from Bosso village in Minna, Niger State; collected in sterile containers and taken to the laboratory immediately.

Yeast Isolation

Visible spoilage microorganisms growing on the specimen were scooped with a sterile wire loop and inoculated into Yeast Extract Glucose Peptone Broth (YEGB) incubated at room temperature for 24hours. The turbid suspension was further streaked on Sabouraud Dextros Agar SDA (supplemented with chloramphenicol) and subsequently incubated for 24hours at room temperature. Well-formed colonies were isolated and subculturing done to get pure culture which was maintained on SDA slants for further studies according to the method described by Jahan *et al*. (2007)

Yeasts Identification

The yeasts were characterized based on cultural, morphological and biochemical characteristics on SDA plates. The cultural properties of the yeast isolates were determined by observing the distinct colonies on SDA.

The cultural characteristics considered were colony shape, size and colour; morphological characteristics were cell shape and bud while biochemical characterization of the yeasts was done using the API20C AUX KIT (BioMeriux) according to the method described by Soliman, *et al* (2011).

Yeast Biomass Production

Yeast isolates were inoculated in 100ml of Yeast Extract Glucose Peptone Broth (YEGPB) broth separately, incubated at an ambient temperature of 300 revolutions per minute (300rpm) in shaking incubator for 7 days to observe the flocculation formed. After incubation, the culture broth was centrifuged at 6000 rpm for 10 minutes, the supernatant was decanted. The pellets were weighed to determine biomass production in shake culture according to the method described by Thais, *et al*., (2006).

Dough raising capacity (DRC) of the yeast strain isolates

Flour (Golden penny brand) purchased from Bosso market in Minna, Niger state was used for the dough fermentation test using the following recipe: flour (50g), salt (0.5g), sugar (5g), a teaspoonful of butter (2.0), egg (1g), yeast biomass (1.0g) (from each isolate) and water (30ml), using 0.5 Mc Fraland standards. The kneaded dough was transferred to the measuring cylinder whose inner surface had been oiled and the initial volume noted by leveling the surface lightly.

The set up was left at room temperature and the dough raising capacity determined at an interval of 30mins for a period lasting 180minutes and the results compared with the commercial baker's yeast. The initial and final dough volumes were recorded from the graduated surface cylinder and the net increase in volume was calculated according to the method described by Ramachandra *et al*., (2009).

The dough raising capacity (DRC) was computed as:

$$DRC = \frac{V_2 - V_1}{V_1} \times 100$$

Where V_1 = Initial volume, V_2 = Final volume

Kilning of Dough

Doughs obtained from the kneaded flour with each yeast sample were baked in a cooker oven at 200^{o}C for 20minutes in a container made of aluminium.

Baked Bread Sensory Property

The bread baked was subjected to sensory analysis by using a panel of twelve judges to assess the texture, aroma, taste and appearance using a five-point hedonic scale as Excellent = 5, Very good = 4, Good = 3, Satisfactory = 2 and Poor = 1. The panellists were made up of people familiar with bread consumption and were provided with water to rinse their mouth before proceeding to the next baked product for assessment according to the method described by Boboye and Dayo-Owoyemi, 2009.

Statistical Analysis

The data obtained from the sensory assessment of the baked products were subjected to statistical analysis using Analysis of Variance (ANOVA) and student T-test. The significance of variations in the analyzed data was tested at a 95% confidence limit using SPSS version 16.0.

RESULTS AND DISCUSSION

The results of the morphological, cultural and biochemical characterization of the yeast strains isolated from the different sources: Burukutu, Palm wine, Pineapple and Orange juice are presented in Table 1. The morphological, cultural and biochemical characteristics of the yeasts strain isolated from different sources and the control (Baker's yeast) reveal that the yeasts are facultative anaerobes, smooth, flat, cream or cream-white with a circular or oval shape that are in clusters. Macroscopically and culturally, the yeasts from palm wine presented cream white colour and burukutu presented cream white colour isolates. Characteristically, they showed moderate circular colonies, while the colonies of the isolate from palm wine presented cream colour and burukutu presented a cream colour with large-raised flat cells or colonies and alcoholic odour on Sabouraud dextrose agar. This result is similar to the findings of Peu, *et al*. (2012) who reported that typical yeast colonies were creamy and regular colony shape.

The result of the biochemical tests carried out on local yeast strain isolates indicated that all the isolates were urease positive and catalase-positive. Starch hydrolysis test of the yeast isolates from BK(cw), PA(cw), PW(cw), OJ(cr) and control were positive and yeast isolate from BK(cr), PA (cr) and PW(cr) were negative.

The initial and final dough volumes were recorded from the graduated surface of the measuring cylinder and the net increase in volumes of dough inoculated with yeast isolates is presented in Table 2.

Fig 1 reveals the result of the sensory assessment of the baked bread and parameters investigated showed that PA(cw), PW(cw), BK(cr), BK(cw) and OJ(cr) are significant at ($p<0.05$). Yeast isolates from OJ(cr) and BK(cw) baked bread had the best texture and aroma than the control; followed by PA(cw), BK(cw), BK(cr) and OJ(cr). The appearance of the baked product with yeast isolates from PA(cw), PW(cw) and OJ(cr) were better rated than the control although the taste of the bread from PW(cw), BK(cw) and OJ(cr) compared well with control.

Table1. Morphological, Cultural and Biochemical Characteristics of Yeast Isolated from Different Sources

Characteristics Isolates	BK(cr) *S.l udwigii*	BK(cw)	PW *S. kluyveri*	PA *S. exiguus*	OJ *S. cerevisiae*	Control *S. cerevisiae*
Surface	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Margin	Circular	irregular	Irregular	Irregular	Circular	Circular
Catalase	+	+	+	+	+	+
Glucose	+	+	+	+	+	+
Sucrose	+	+	+	+	+	+
Mannitol	-	-	-	-	-	-
Sorbitol	-	-	-	-	-	-
Lactose		-	-	-	-	-
Galactose		+	+	+	+	+
Fructose	+	+	+	+	+	+
Maltose	+	+	V	_	+	+
Urease	+	+	+	+	+	+
Starch test		+	-	-	+	+

Keys: += Positive (Acid production), ‑ = negative (No acid production), V=Variable
Burukutu(cream) = BK(cr); B urukutu(cream white) = BK(cw); Palm wine(cream) = PW(cr); Palm wine(cream white) = PW(cw); Pine apple (cream) = PA(cr); Pine apple (cream white) = PA(cw); Orange juice(cream) = OJ(cr)

Table 2: Dough Raising Capacity of Yeast Isolates from Different Sources

	Yeast Isolates Sourses					
Dough Volume (cm)	PA(cw)	PW(cw)	BK(cr)	BK(cw)	OJ(cr)	Ctrl
Initial volume at 0 min	2.0	2.0	2.0	2.0	2.0	2.0
Final volume at 180 min	4.5	2.8	3.2	3.3	4.2	8.0
Dough rise (V_2-V_1)	2.5	0.8	1.2	1.3	2.2	6.0
DRC (%)	125	40	60	65	110	300

V_1 = Initial volume; V_2 = Final volume; DRC = Dough raising capacity; Burukutu (cream): BK (cr); Burukutu (cream white) : BK (cw); Palm wine(cream):PW(cr); Palm wine (cream white) : PW (cw); Orange juice(cream): OJ(cr); Control :Ctrl

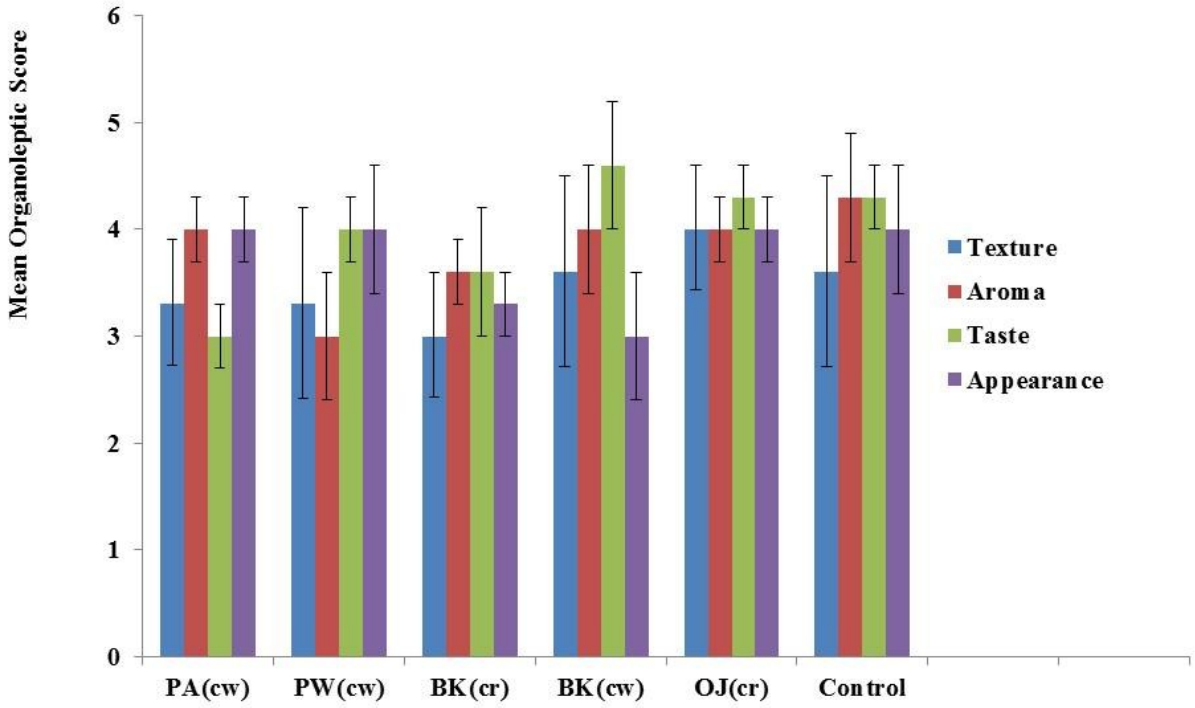

Fig 1: Sensory evaluation of baked bread prepared with the various yeast isolates

An extensive screening procedure was performed to find suitable yeast capable of replacing baker's yeasts from local drink sources and four yeast isolates were obtained, purified and selected for evaluation of their baking property. Positive reactions were detected by the production of turbidity and colour change in the medium from red to yellow with gas production determined by the presence of bubbles in the Durham tube. Most of the yeast isolates can ferment glucose, fructose and sucrose with gas production that indicated positive result. All the yeast isolates fermented galactose with gas production except BK(cr) isolate that did not ferment nor produce gas. D-mannitol, sorbitol and lactose were not fermented. According to the findings of Jimoh, *et al*. (2012), galactose is a non-conventional yeast nutrient, which can be used as the sole source of carbon when the medium does not contain glucose. This infers that yeast isolates that could not assimilate galactose do not possess GAL genes.

The yeast strain isolates from BK(cr), BK (cw), PA(cw), PW(cw) OJ(cr) and the control were positive for maltose because they utilized

sugar with gas production, changing its initial colour from red to yellow with yeast growth while PW(cr) and PA(cr) were negative with no fermentation nor gas production; hence, no colour change was observed. Isolates PA(cr) and PW(cr) were not able to ferment or produce gas in the maltose fermentation test within the seven days, hence they are identified as poor maltose utilizers. However, yeasts from PA (cw) and PW(cw) showed a different pattern in the utilization of maltose on the fourth day. They exhibited strong maltose fermentation with gas production from the fourth through the seventh day of evaluation. These results conform with the work of Sobia *et al*. (2007) that reported the isolation and taxonomic characterization of yeast strains based on maltose utilization with yeast having high capacity adjudged as good in baking.

Yeast biomass of the yeast isolates identified as *Saccharomyces cerevisiae* and *Saccharomyces ludwigii* that can produce gas were used for dough leavening while those without the capacity to produce gas were screened out. The quantity of the yeast biomass yield during the production differed; this could be as a result of their adaptation to the medium from where they were grown or the source. Yeast biomass production is influenced by the Pasteur's effect which suppressed fermentation for respiration thereby allowing more of the cells to be produced. This study showed that local isolates could be considered as a potential source of bakers' yeasts and is in conformity with the report of Yabaya and Jatau (2009) whose work revealed that wild yeast of *Saccharomyces cerevisiea* isolated from local beverages could be used in baking industries. Yeast biomass is a complete additive that can fortify a diet with different nutritional components and proteins as reported by Jahan *et al*., (2007). Yeast is an excellent food additive that contributes polyunsaturated fatty acids, different vitamins, glutathione, lysine, methionine and threonine rich proteins to the diet.

Dough raising capacity test with isolate: The yeast *Saccharomyces cerevisiae* from PA(cw) indicate high dough raising performance because the yeast showed the best dough leavener obtained in this study. Followed closely was *Saccharomyces cerevisiae* from OJ(cr), BK(cw), BK(cr) and PW (cw) in that order. The sugar metabolism derived from flour and sucrose added as ingredients to the dough may be in charge of the evolution of carbon dioxide by the yeast leading to dough expansion. These results conform with the work of Rosada (1998) who reported that yeasts' leavening performance can be dependent on their sugar fermentative abilities. The yeast *Saccharomyces cerevisiae* from PW (cw) performed least in the dough raising test implying that they are poor dough leavening.

The technological role of yeast in flour dough is a strong alcoholic fermentation with extensive carbon dioxide liberation. The gassing power of yeast depends on the zymase enzyme complex of the yeast cells with available fermentable carbohydrates (Stear, 1990). The difference in the gassing power produced by yeasts used in this work is due to the various maltase and zymase content activities of these yeasts.

Sensory Evaluation of the baked dough

The product gotten from baked bread with isolates compared with baker's yeast (control) indicated that sensory parameter of the yeast *Saccharomyces cerevisiae* from PA(cw), PW (cw), *Saccharomyces cerevisiae* from BK(cw) and *Saccharomyces cerevisiae* from OJ(cr) produced dough with textures rated between 3.0 and 4.0. This range corresponded to good texture ratings in the sensory scale used.

Yeast activities affect the texture of dough they fermented apart from dough raising which confirms the report made by Corriher (2001) that expansion of dough is due to the carbon dioxide produced by yeast which leads to the texture of baked dough. The isolates from PA (cw), BK(cw), BK(cr) and OJ(cr) indicated that their baked bread products were comparable in aroma with the baker's yeast (control) which is significant at $p<0.05$; PW(cw) is not significant. The aroma rating of baked dough compared inferred that five out of the seven yeasts can produce compounds that imparted appealing flavours to the baked fermented doughs. The baked dough fermented with PA(cw) rates was not significantly low ($p<0.05$) in taste when compared to the taste of baked dough's fermented with isolates from PW(cw), BK(cr), BK (cw), OJ(cr) and control. This implies that all the yeasts used improved the taste of the dough they fermented making it more palatable after baking. However, the baked dough fermented with the yeast isolates from PA(cw), PW(cw) and OJ(cr) had an appearance that is significantly ($p< 0.05$) comparable to that of the control, while BK (cw) is insignificant. This implies that the appearance of dough fermented after baking was greatly influenced by the activities of the yeast strain.

CONCLUSION

The necessity to produce this resource locally and consistently to avoid its importation from other countries is the thrust of this work. The

local yeasts strain isolated from fruits and local beverage used in this work indicated that local isolates gave good baking property comparable to that of baker's yeasts (control). It shows that the use of local isolates as a substitute for baker's yeast could result in excellent dough property in baking which will help in the transformation agenda of the government and keying into the NEES (National Economic and Empowerment Strategy) empowerment program in Nigeria.

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