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Comparative Effects of Yeasts Sourced from Different Environments on Organoleptic Qualities of Bread Produced from Air Potato-Cassava-Wheat Composite Flour

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ABSTRACT

The prevention of illnesses at dietary level coupled with cost reduction in bread production, has spurred the needs to develop new varieties of low-cost quality bread. In this study, we assessed the relevance of air potato supplementation and yeasts from different sources in production of quality composite bread. Cassava and air potato flours were produced according to standard methods. Proximate and mineral composition of the flours was determined. Wheat-flour-blends and single-flour samples were leavened with strains of *Saccharomyces cerevisiae* sourced from different microenvironments for composite bread baking. Sensory evaluation was conducted on the bread. The proximate parameters (ash, fat, fibre, protein, moisture and carbohydrate) of the flour samples were significantly, different ($p \leq 0.05$). The ash content of air potato flour was highest (2.51%), followed by wheat (1.90%) and cassava (0.9%). Carbohydrate content was highest in cassava flour (82.35%) and least in air potato flour (32.77%). Fat content of wheat, air potato and cassava flours was 2.13, 1.90 and 0.46%, respectively. Wheat flour had highest fibre value (2.50%) compared to air potato (1.80%) and cassava (1.79%) flours. The moisture content of the flours ranged from 9.67% (wheat) to 20.40% (Cassava). Protein value of wheat flour was highest (11.37%), followed by air potato flour (3.09%) and cassava flour (2.96%). Mineral contents of the flours were different significantly ($p \leq 0.05$). Air potato flour had highest abundance of calcium (52.40 ppm) and sodium (29.81 ppm). Potassium was predominant in wheat flour which valued 87.79 ppm, followed by air potato flour (32.21 ppm) and cassava flour (29.72 ppm). The flours were generally less than 2.0 ppm in manganese and zinc contents. The organoleptic attributes (taste, colour, aroma and texture) of the bread samples was significantly different based on combinatorial effects of flour composition and/or yeast strain utilized in the bread preparation ($p \leq 0.05$). Overall acceptability score for single-flour bread category was 6.67±0.50 (DBTC3), 7.44±0.41 (DBTC1), 6.89±0.46 (DBTC1) leavened with *S. cerevisiae* BKR01, *S. cerevisiae* STLB6 and *S. cerevisiae* PWNE5, respectively. Of the composite bread loaves, DBTC123 (8.56±0.24), DBTC12 (7.78±0.22) and DBTC123 (8.33±0.17) dosed with *S. cerevisiae* BKR01, *S. cerevisiae* STLB6 and *S. cerevisiae* PWNE5, respectively, had highest overall acceptability. Findings from this study revealed suitability of air potato in composite flour and effect of yeast strains on its sensory quality.

Key words: Air potato, flour, composite bread, *Saccharomyces cerevisiae*, microenvironments, proximate, sensory

INTRODUCTION

In the recent years, there has been exponential increase in bread consumption in Nigeria, with the attending uprising price due to the fact that wheat, one of the major ingredients in bread is not cultivated in the tropics for climatic reasons (Edema *et al*., 2005). Efforts are now been geared towards promoting the use of composite flours in which flour from locally grown crops are used to supplement a portion of wheat flour and enhance functional improvement for bread baking, thereby decreasing demand for imported wheat and producing protein enriched bread (Giami *et al*., 2004). Apart from the aforementioned reason, wheat also compete for use in many baked goods such as biscuits, doughnuts and cakes, which are very popular now a days and the low protein content of wheat flour, which is the most vital ingredient used for the production of different kinds of baked produce has been a major concern in its utilization (Young, 2001).

In addition, with the increasing awareness on the need to eat superior quality and healthy foods, foods with ingredients that provide additional health benefits beyond basic nutritional requirements compel scientific search for sustainable sources. Hence, there is a shift towards composite bread technology and production of specialty breads from whole grain flour enhanced with flours from traditional crops and other functional ingredients yield product known as health breads or functional foods (Giami *et al*., 2004).

The uses of wheat, cassava and other flours have been well documented in many articles for composite flour or breading making (Khalil *et al*., 2000; McWatters *et al*., 2004). But the use of air potato in flour and bread production, has not been reported to the best of our knowledge. Air potato (*Dioscorea bulbifera* Linn.) is a member of the family Dioscoreaceae and native to Africa, Southern Asia and Nothern Australia, where it is widely cultivated. *Discorea bulbifera* is a perennial vine with broad leaves and two types of storage organs. The plant forms bulbis in the leaf axils of the twining stems and tubers beneath the ground. These tubers are like small, oblong potatoes. Some varieties are edible and cultivated as a food crop, especially in west Africa. The tubers of edible varieties often have a bitter taste, which can be removed by boiling and prepared in the same way as other yams, potatoes and sweet potatoes. The air potato is one of the most widely consumed yam species and can grow up to 150 ft tall (William, 2008).

Air potato can grow extremely quickly, roughly 8 inches per day and eventually reach over 60 ft long. It typically climbs to the tops of trees and has a tendency to take over native plants (William, 2008). New plants develop from bulbis that form on the plants and thus, serve as a means of dispersal and propagation. The smallest bulbis of air potato make its large scale production more easy due to their ability to sprout at a very small dissection (William, 2008).

At present, industrialists are in search for alternative products to wheat to reduce the cost of bread and baked products in Nigeria and thus serve as impetus for the use of composite flour for baking. This present study assessed the suitability of air potato in composite flour production and the effects of yeast from different sources on organoleptic qualities of the composite bread prepared from the flour.

MATERIALS AND METHODS

Raw materials and yeasts: Commercial wheat flour (Nigerian Flour Mills) was procured from Oja-Oba market in Akure. The cassava flour and air potato flour were prepared from air potato and cassava tubers cultivated in the Microbiology Experimental Field Plot and Research Farm of the Federal University of Technology Akure, Nigeria, respectively. Other ingredients used were fat, sugar and table salt (commercial grade). All chemicals used were of analytical grade. The baker's yeast was also sourced from local bakery in Akure. Other strains of *Saccharomyces cerevisiae* were isolated from stale bread and palm wine sourced from household and local tapper, respectively.

Production of unfermented cassava flour: Cassava flour was produced as described by Nwosu *et al*. (2014). Fresh cassava tubers were washed thoroughly, weighed and peeled manually

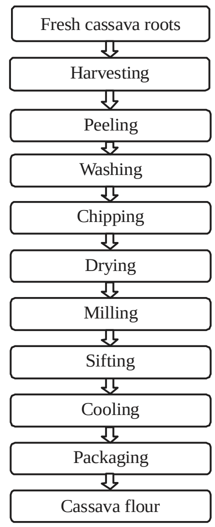

Fig. 1: Flow chart for the production of high quality unfermented cassava flour

with a stainless steel knife. The peeled cassava tubers were rewashed, reweighed on a balance to check the percentage yield after peeling and then cut into 0.5 cm thick slices. The slices were dried in an oven (Genlab, Britain) set at 105°C to a constant weight for 24 h and cooled before milling into flour using an electric milling machine. Finally, the milled cassava flour was sifted using sieves of aperture size (250 µm) to remove extraneous materials from the flour. The fine cassava flour obtained was packed in polyethylene bags and stored at 4°C for further use. The flow chart of the entire processes is presented in Fig. 1.

Production of air potato flour: Air potato flour was produced according to the modified method of Nwosu *et al*. (2014). The air potato tubers were harvested and thoroughly washed. The tubers were weighed and then peeled. The peeled air potato tubers were thereafter rewashed, cut into 0.5 cm thick slices and blanched with boiled water. Afterward, the chipps were fermented for 2 days in a plastic bioreactor, followed by drying in an oven (Genlab, Britain) at 105°C to a constant weight for 24 h and then milled into flour through an electric milling machine. Also, the milled air potato flour was sifted with sieves of aperture size (250 µm) to remove extraneous materials. The fine air potato flour thus obtained was packed into polyethylene bags, placed in an air tight covered plastic container and stored at 4°C for further use. The flow chart for the preparation of air potato flour is given in Fig. 2.

Determination of flour proximate composition: The methods of AOAC (2012) was employed to determine moisture content, protein content, fat content, crude fibre and ash contents of the wheat flour, cassava flour and air potato flour.

Moisture content was determined by drying samples in an oven (Genlab, Britian) at 105°C for 24 h. Crude protein percentage was determined by Kjeldahl method and the percentage nitrogen obtained was used to calculate the CP (%) using the relationship: CP = % N×6.25. Ether extract percentage was determined using Soxhlet system HT-extraction technique and percentage ash was determined by incinerating the samples in a muffle furnace at 550°C for 4 h. The ash was cooled in a desiccator and weighed. Crude fibre percentage was determined by dilute acid and alkali hydrolysis (AOAC., 2012) method. Carbohydrate was calculated by difference.

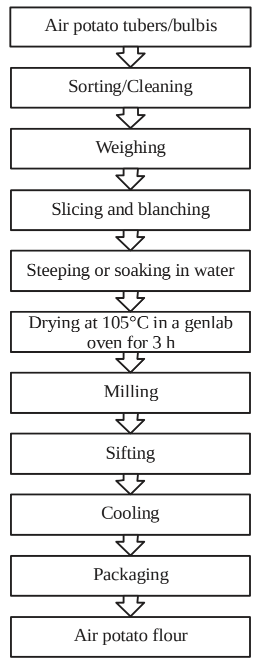

Fig. 2: Flow chart for the production of air potato flour

Table 1: Formulation of samples

Flour	Composition (g)
DANETC1	100% A.P (200)
DANETC2	100% W.F (200)
DANETC3	100% C.F (200)
DANETC12	50% A.P (100): 50% W.F (100)
DANETC13	50% A.P (100): 50% C.F (100)
DANETC123	40% A.P (80): 40% W.F (80): 20% C.F (40)

W.F: Wheat flour, C.F: Cassava flour and A.P: Air potato

Table 2: Items used for composite bread baking

Constituents	Percentage
Flour (1, 2, 3, 12, 13, 123)	100
Water	Variable
Sugar	5.0
Fat	3.5
Yeasts (a, b, c)	1.5
Salt	1.0

1: DANETC1, 2: DANETC2, 3: DANETC3, 12: DANETC12, 13: DANETC13, 123: DANETC123, a: *Saccharomyces cerevisiae* BKR01, b: *Saccharomyces cerevisiae* PWNE5, c: *Saccharomyces cerevisiae* STLB6

Preparation and formulation of composite flours: Different composite flours were formulated with blends of wheat flour, air potato flour and cassava flour. The details of the blend preparation are presented in Table 1.

Baking procedure of composite breads: Composite breads were baked with ingredients listed in Table 2. The proportions were expressed as percentage of flour used. The various composite flour brand used in the baking were portions of DANETC12, DANETC13 and DANETC1 formulated in Table 1. The ratios of the other constituents were fixed. Bread baked with DANETC2 (100% wheat flour) served as control, while DANETC1 (100% air potato flour) and DANETC3 (100% cassava flour) were compared. All the flour brands were mixed into dough, kneaded for 20 min, molded into loaves and proofed for 1 h at room temperature. The loaves were baked

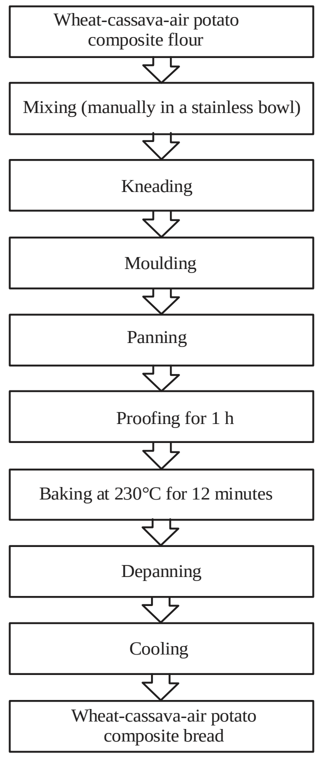

Fig. 3: Flow chart for the production of bread samples from wheat-cassava-air potato composite flour

in an oven at 230°C for 12 min. Figure 3 shows the flow chart for the production of bread samples from wheat-cassava-air potato composite flour.

Sensory evaluation of bread samples: Sensory evaluation was carried out on the samples within 3 h after production using a 9 man panelist. The organoleptic parameters considered were taste, aroma, texture, colour/appearance and overall acceptability of the composite bread. The panelists were selected randomly from the students of the University. They were made to carry out the organoleptic assessment under controlled environment to avoid biased results. The bread samples wrapped with transparent polyethylene bags were presented in small sliced and coded identical white papers. The panelists were instructed to rate the breads based on 9-point hedonic scale ranging from 1 = disliked extremely to 9 = liked extremely according to Ihekoronye and Ngoddy (1985).

Statistical analysis: Data obtained from triplicate determinations were subjected to statistical analyses of variance (ANOVA) of SPSS software version 17 (Microsoft Corporation, USA) at 95% confidence interval. Means were separated using Duncan's New Multiple Range Test and differences were considered significant at $p \leq 0.05$.

RESULTS

Proximate composition of air potato, wheat and cassava flours: Figure 4 shows the comparative proximate composition of air potato, wheat and cassava flours used in composite bread

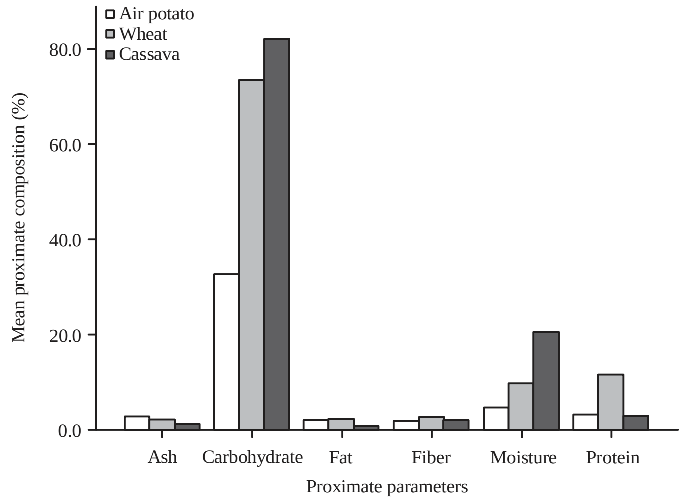

Fig. 4: Comparative proximate contents of air potato, wheat and cassava flours used in composite bread making

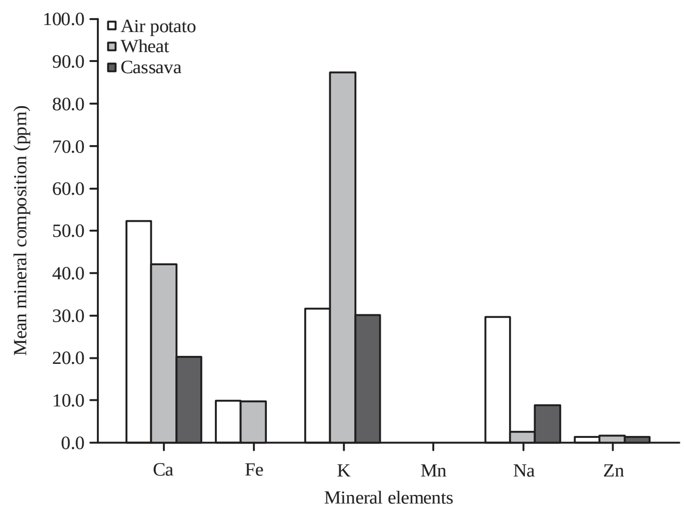

Fig. 5: Comparative mineral composition of air potato, wheat and cassava flours used in the composite bread making

preparation. Significant differences were observed in proximate parameters (ash, fat, fibre, protein, moisture and carbohydrate) of all flour samples ($p<0.05$). It was found that ash content of air potato flour was the highest (2.51%), followed by wheat (1.90%) and the least was cassava (0.9%). While, the highest (82.37%) carbohydrate content was found in cassava flour, but the lowest (32.77%) was found in air potato flour. The fat content of wheat, air potato and cassava flour were 2.13, 1.90 and 0.46%, respectively. Wheat flour had highest fibre value (2.50%), as compared to air potato (1.80%) and cassava (1.79%) flour. The moisture values of the flour ranged from 4.72% (air potato) to 20.40% (Cassava). It was observed that protein value for wheat flour was highest (11.37%), followed by air potato flour (3.09%) and then least in cassava flour (2.96%).

Mineral composition of air potato, wheat and cassava flours: The relative mineral contents of the three flours used in composite flour formulation is shown in Fig. 5. There were significant

Table 3: Assessment of taste parameter of air potato-cassava-wheat composite bread produced with different yeast strains

Bread	BKR01	STLB6	PWNE5
DBTC1	5.56 ± 0.72^{aA}	8.11 ± 0.56^{Ca}	6.56 ± 2.19^{aA}
DBTC2	5.67 ± 0.44^{aA}	5.89 ± 0.75^{aA}	8.67 ± 0.19^{aB}
DBTC3	6.56 ± 0.50^{bA}	5.89 ± 0.51^{bA}	6.11 ± 1.90^{aA}
DBTC12	7.33 ± 0.37^{bA}	7.56 ± 0.18^{bA}	6.11 ± 0.92^{aA}
DBTC13	6.67 ± 0.53^{bA}	7.11 ± 0.46^{bA}	7.00 ± 0.87^{aA}
DBTC123	8.33 ± 0.37^{cAB}	7.22 ± 0.36^{bA}	8.33 ± 0.71^{aB}

Data was presented as Mean±SE of three replicate determinations. Mean with the same superscript letter(s) along the same row (lowercase) or column (uppercase) are not statistically different at p≤0.05. DBTC1: 100% air potato, DBTC2: 100% wheat, DBTC3: 100% cassava, DBTC12: 50% air potato+50% wheat, DBTC13: 50% air potato+50% cassava, DBTC123: 40% air potato+40% wheat+20% cassava BKR01, PWNE5 and STLB6: *S. cerevisiae* strains

Table 4: Assessment of colour parameter of air potato-cassava-wheat composite bread produced with different yeast strains

Bread	BKR01	STLB6	PWNE5
DBTC1	$6.78^{ab}\pm0.66^{AB}$	$7.56^{c}\pm0.24^{B}$	$6.11^{a}\pm0.56^{A}$
DBTC2	$6.78^{ab}\pm0.36^{B}$	$6.67^{bc}\pm0.68^{B}$	$5.56^{a}\pm0.38^{A}$
DBTC3	$7.67^{c}\pm0.53^{B}$	$7.44^{bc}\pm0.38^{B}$	$6.11^{a}\pm0.46^{A}$
DBTC12	$7.22^{bc}\pm0.32^{B}$	$7.33^{bc}\pm0.29^{B}$	$5.56^{a}\pm0.50^{A}$
DBTC13	$6.22^{a}\pm0.32^{A}$	$5.78^{a}\pm0.55^{A}$	$5.33^{a}\pm0.69^{A}$
DBTC123	$8.00^{c}\pm0.29^{B}$	$6.56^{ab}\pm0.50^{A}$	$7.67^{b}\pm0.33^{B}$

Data were presented as Mean±SE of three replicate determinations. Mean with the same superscript letter(s) along the same row (lowercase) or column (uppercase) are not statistically different at p≤0.05. DBTC1: 100% air potato, DBTC2: 100% wheat, DBTC3: 100% cassava, DBTC12: 50% air potato+50% wheat, DBTC13: 50% air potato+50% cassava, DBTC123: 40% air potato+40% wheat+20% cassava BKR01, PWNE5 and STLB6: *S. cerevisiae* strains

differences in mineral contents of various flours (p<0.05). Air potato flour had highest abundance of minerals such as calcium (52.40 ppm) and sodium (29.81 ppm). Potassium was predominant in wheat flour, which valued 87.79 ppm, followed by air potato flour (32.21 ppm) and then cassava flour (29.72 ppm). The flours were generally less than 2.0 ppm in manganese and zinc contents. The iron composition was 9.71 ppm in air potato and wheat flours.

Organoleptic features of composite bread produced with *Saccharomyces cerevisiae* strains from different sources: Data presented in Table 3 summarized the mean score of 9-scale hedonic sensory evaluation for tastes of whole flour bread and composite bread samples. The loaves baked with baker's yeast and 100% air potato (DANETC1) had hedonic score of 5.56±0.72 and 100% wheat (DANETC2) scored 5.67±0.44, but were not significant difference (p<0.05) in term of tastes. Bread DBTC1 (100% A.P) produced with *Saccharomyces cerevisiae* STLB6 scored 8.11±0.56 and scored highest in term of taste among its variants. *Saccharomyces cerevisiae* STLB6 and *S. cerevisiae* PWNE5 showed appreciable influence on the tastes of bread made from 100% air potato (DANETC1) and 100% wheat (DANETC2) (p<0.05) whereas, strain *S. cerevisiae* BKR01 had no effect on the tastes of breads from either flours (DANETC1, 5.56±0.72; DANETC2, 5.67±0.44). The hedonic mean scores of loaves baked from DANETC3 (100% C.F), DANETC12 (50% A.P:50% W.F) and DANETC13 (50% A.P: 50% C.F) regardless of the yeast strains employed were not statistically different in tastes (p≤0.05). Among all the breads baked from different flours formulated, highest preference recorded as hedonic score (8.33±0.71) in term of tastes was obtained in DANETC123 (40% A.P: 40% W.F: 20% C.F). The composite breads made with DANETC123 (40% A.P: 40% W.F: 20% C.F) obtained a significantly higher score for taste attribute than other bread samples especially when baked with *S. cerevisiae* STLB6 and *S. cerevisiae* PWNE5. In addition, yeast strain has significant influence on the tastes of composite breads made from 40% air potato+40% Wheat+20% cassava flour (p≤0.05).

Data on colour/appearance evaluation of whole flour bread and air potato-cassava-wheat composite bread samples produced with three yeast strains is presented in Table 4. The mean hedonic scores for the colour/appearance of the breads were statistically different based on flour

Table 5: Evaluation of aroma parameter of air potato-cassava-wheat composite breads produced with different yeast strains

Bread	BKR01	STLB6	PWNE5
DBTC1	$6.00^{a}\pm0.56^{A}$	$7.56^{cd}\pm0.17^{B}$	$6.33^{a}\pm0.53^{AB}$
DBTC2	$6.11^{a}\pm0.11^{A}$	$6.00^{a}\pm0.47^{A}$	$6.56^{a}\pm0.34^{A}$
DBTC3	$7.00^{b}\pm0.33^{A}$	$6.56^{ab}\pm0.44^{A}$	$6.22^{a}\pm0.49^{A}$
DBTC12	$6.78^{b}\pm0.57^{A}$	$8.00^{d}\pm0.17^{A}$	$6.44^{a}\pm0.63^{A}$
DBTC13	$6.44^{ab}\pm0.34^{A}$	$6.78^{b}\pm0.40^{A}$	$7.00^{a}\pm0.29^{A}$
DBTC123	$7.00^{b}\pm0.29^{A}$	$7.22^{bc}\pm0.32^{A}$	$8.22^{b}\pm0.22^{B}$

Data was presented as Mean±SE of three replicate determinations. Mean with the same superscript letter(s) along the same row (lowercase) or column (uppercase) are not statistically different at $p\leq0.05$. DBTC1: 100% air potato, DBTC2: 100% wheat, DBTC3: 100% cassava, DBTC12: 50% air potato+50% wheat, DBTC13: 50% air potato+50% cassava, DBTC123: 40% air potato+40% wheat+20% cassava BKR01, PWNE5 and STLB6: *S. cerevisiae* strains

composition and yeast strain used in the baking process ($p\leq0.05$). Generally, the colour of all breads scored at least 6.22±0.32 (like slightly) out of a total 9-scale evaluation. Of all bread leavened with *S. cerevisiae* BKR01 and *S. cerevisiae* PWNE5, DBTC123 recorded highest score of 8.00±0.29 and 6.7±0.33, respectively. Whereas, bread DBTC3 had highest score of 7.44±0.38 and bread DBTC13 the lowest (5.78±0.55) among bread prepared with *S. cerevisiae* STLB6.

The comparative study on the aromas of bread made from whole/composite flours leavened with different yeast strain is shown in Table 5. The aroma of all bread crusts was at least rated like slightly by panelists. Out of the bread made from the three whole flours (DANETC1, DANETC2 and DANETC3), highest mean hedonic score of 7.00±0.33 for aroma was obtained by DBTC3 among bread dosed with *S. cerevisiae* BKR01. Also, bread DBTC1 received the highest score of 7.56±0.17 and 6.33±0.53 for aroma among loaves baked from whole component flours dosed with *S. cerevisiae* STLB1 and *S. cerevisiae* PWNE5, respectively. The aroma characteristic of the dough of 100% air potato, 100% wheat and 100% cassava flours was statistically different based on combinatorial effects of flour composition and/or yeast strain utilized in the bread preparation ($p\leq0.05$). Whereas the influence of yeast strains on aroma formation in 100% air potato bread samples (DBTC1) were pronounced. Also, the effect of yeast strains on loaves made from 100% wheat flour and 100% cassava flour was inconsequential. For the composite bread, highest mean hedonic score of 8.00±0.17 was attained by DBTC12 dosed with *S. cerevisiae* STLB1 compared with its variants leavened with other yeast strains. The bread DBTC123 leavened with *S. cerevisiae* BKR01 and *S. cerevisiae* PWNE5 exhibited mean hedonic score of 7.00±0.29 and 8.22±0.22, respectively and were mostly desired among composite bread samples prepared with similar yeast strain in term of aroma. The role of yeast strains was not significantly different on the aromas of the composite bread samples except in DBTC123 ($p\leq0.05$).

The substitution effects of various flours on textural characteristics of composite bread samples contrasted with whole flour bread sample is shown in Table 6. The textural attributes of whole flour bread samples baked with *S. cerevisiae* BKR01 were rated 5.56±0.71 (DBTC1), 5.67±0.29 (DBTC3) and 6.67±0.58 (DBTC2). The bread DBTC1 (100% air potato flour) leavened with *S. cerevisiae* STLB6 and *S. cerevisiae* PWNE5 received highest preference in term of texture and scored 7.22±0.32 and 7.22±0.60, respectively. The yeast strains used had effects on the textural properties of DBTC1, DBTC3, DBTC12 and DBTC123 appreciably ($p\leq0.05$). Out of the three brands of composite bread samples produced, DBTC123 (40% A.P: 40% W.F: 20% C.F) was the most preferred in term of texture regardless of yeast strain employed.

Presented in Table 7 are data on the overall sensory acceptability evaluation of air potato-cassava-wheat composite/single flour bread samples produced with different yeast strains. The overall acceptability of bread samples were significant ($p\leq0.05$). In the whole flour bread category leavened with bakers' yeast (*S. cerevisiae* BKR01), 100% cassava bread (DBTC3) received

Table 6: Assessment of textural parameter of air potato-cassava-wheat composite bread produced with different yeast strains

Bread	BKR01	STLB6	PWNE5
DBTC1	$5.56^{a}\pm0.71^{A}$	$7.22^{b}\pm0.32^{B}$	$7.22^{b}\pm0.60^{B}$
DBTC2	$6.67^{ab}\pm0.58^{A}$	$7.00^{b}\pm0.55^{A}$	$6.78^{b}\pm0.57^{A}$
DBTC3	$5.67^{a}\pm0.29^{A}$	$5.33^{a}\pm0.73^{A}$	$6.44^{b}\pm0.63^{A}$
DBTC12	$6.22^{a}\pm0.72^{AB}$	$5.11^{a}\pm0.68^{A}$	$7.00^{b}\pm0.37^{B}$
DBTC13	$6.56^{a}\pm0.48^{A}$	$5.11^{a}\pm0.68^{A}$	$5.00^{a}\pm0.78^{A}$
DBTC123	$8.00^{b}\pm0.24^{B}$	$6.22^{ab}\pm0.49^{A}$	$7.22^{b}\pm0.43^{B}$

Data was presented as Mean±SE of three replicate determinations. Mean with the same superscript letter(s) along the same row (lowercase) or column (uppercase) are not statistically different at $p\leq0.05$. DBTC1: 100% air potato, DBTC2: 100% wheat, DBTC3: 100% cassava, DBTC12: 50% air potato+50% wheat, DBTC13: 50% air potato+50% cassava, DBTC123: 40% air potato+40% wheat+20% cassava BKR01, PWNE5 and STLB6: *S. cerevisiae* strains

Table 7: Evaluation of overall acceptability of air potato-cassava-wheat composite bread produced with different yeast strains

Bread	BKR01	STLB6	PWNE5
DBTC1	$3.78^{a}\pm0.94^{A}$	$7.44^{bc}\pm0.41^{B}$	$6.89^{b}\pm0.46^{B}$
DBTC2	$6.00^{b}\pm0.17^{AB}$	$6.78^{ab}\pm0.52^{A}$	$5.33^{a}\pm0.82^{B}$
DBTC3	$6.67^{bc}\pm0.50^{A}$	$6.67^{a}\pm0.44^{A}$	$6.33^{b}\pm0.44^{A}$
DBTC12	$7.33^{c}\pm0.44^{AB}$	$7.78^{c}\pm0.22^{B}$	$6.67^{b}\pm0.29^{B}$
DBTC13	$6.89^{c}\pm0.51^{A}$	$6.78^{ab}\pm0.40^{A}$	$6.67^{b}\pm0.33^{A}$
DBTC123	$8.56^{d}\pm0.24^{B}$	$6.89^{ab}\pm0.35^{A}$	$8.33^{c}\pm0.17^{C}$

Data was presented as Mean±SE of three replicate determinations. Mean with the same superscript letter(s) along the same row (lowercase) or column (uppercase) are not statistically different at $p\leq0.05$. DBTC1: 100% air potato, DBTC2: 100% wheat, DBTC3: 100% cassava, DBTC12: 50% air potato+50% wheat, DBTC13: 50% air potato+50% cassava, DBTC123: 40% air potato+40% wheat+20% cassava BKR01, PWNE5 and STLB6: *S. cerevisiae* strains

highest overall acceptability with a mean sensory score of 6.67±0.50 while the least was 100% air potato bread with 3.78±0.94. The air potato bread DBTC1 dosed with *S. cerevisiae* STLB6 and *S. cerevisiae* PWNE5 scored a mean of 7.44±0.41 and 6.89±0.46 respectively and had highest overall acceptability among other bread made from single flour brand. The overall acceptability of composite bread samples were substantially influenced by yeast strain used in their production ($p\leq0.05$). Among bread leavened with *S. cerevisiae* BKR01, DBTC123 had highest desirability. Also, DBTC12 had 7.78±0.22 and was generally preferred above other composite bread produced with *S. cerevisiae* STLB6. The score obtained for overall acceptability of DBTC123 leavened with *S. cerevisiae* PWNE5 was 8.33±0.17 corresponding to a degree of "like very much". Thus, indicated that the bread sample was generally appreciated by the panelists.

DISCUSSION

The suitability of air potato in production of composite flour for supplementation of wheat and cassava flours in bread baking was investigated. The ash content of air potato flour suggests that air potato flour is high in minerals and could improve mineral intake, when combine with cassava and wheat flour. The moderate crude fibre composition of air potato flour could signify its potential usefulness in functional food formulation. Crude fibre is essential in the control of oxidative processes in food products and functional food ingredient (Mandalari *et al*., 2010). Relatively low level of carbohydrates found in air potato flour could make it find application in production of composite bread and food products for the diabetics and hypertensive patients that required low sugar diet. Ajani *et al*. (2012), reported that food substances that are low in carbohydrate could find application, as soup thickeners and health diets requiring low sugar contents. The low carbohydrate content of air potato flour could have negative effects on the water absorption capacity of its composite flours. Ogunlakin *et al*. (2012) revealed that water absorption capacity is important in the development of ready-to-eat foods and that high carbohydrate content is usually associated with high absorption capacities, which assure product cohesiveness. The low fat content of air potato flour would play a significant role in prolonging its shelf life and storability and that of other food products formulated from it. Ihekoronye and Ngoddy (1985) showed that relatively high fat content could be undesirable in baked food products. This is because fat can promote rancidity in foods, leading to development of unpleasant and odorous compounds. Its low fat content could be exploited and be of benefit in functional food preparations (composite bread) for patients suffering from atherosclerosis or related problems. The moderately low moisture content of air potato flour would enhance its shelf life characteristics and prevent chances of deterioration from microbes. For prevention of chances of microbial deterioration and chemical changes during storage, Shahzadi *et al*. (2005) established that moisture content should be below 14%. High moisture content of flour usually predisposes them to high prevalence of microbial attack unless properly dried (Eleazu and Ironua, 2013). Composite flours from air potato and cassava and/or wheat could have better storage value. The low protein content of air potato flour obtained in this study is similar to the report of Igyor *et al*. (2004) who obtained value as low as 1.2%. This suggested that air potato might not be a good source of dietary proteins.

Air potato has high abundance of calcium and sodium. It could therefore serve, as dietary source of these essential elements to improve mineral intake. Incorporating air potato in composite products will go a long way to reduce malnutrition and calcium deficiency health challenges especially osteoporosis and blood clotting. It may also be suitable in prevention of neurodegenerative disorders in human population.

The consumption of foods and beverages is inseparably linked to the stimulation of the human chemical senses, odour and taste (Ralf, 1995). The observed differences in hedonic scores for tastes of bread samples could be attributed to differential capabilities of the yeast strains to produce metabolites, such as; amino acid, lactic acid, diacetyl and glycerol that have taste-enhancing effects on the bread. More so, it might be due to distinct ability of strains to produce enzymes required in conversion of components, such as; glutamine to glutamic acid and other taste enhancers. The desirability of the colour and appearance of the bread samples might be due to blanching of air potato slices. Blanching inactivates polyphenolase that is responsible for enzymatic browning and therefore, prevented phenol oxidation that usually resulted to undesirable colour (Akissoe *et al*., 2003).

The textural variation of the bread may possibly be due to fermentative potential and volume of carbon (IV) oxide produced by different yeast strains and gluten level of the flour blends. The baking parameters of temperature and time variables; bread components state, such as fibre, starch and protein (gluten), weather damaged or undamaged and the amounts of absorbed water during dough mixing, all contribute to the final texture of the bread (Joel *et al*., 2011). In addition, carbon (IV) oxide retention ability of blended dough and gluten fraction which is responsible for the elasticity of the dough and the volume of carbon (IV) oxide trapped during yeast fermentation also affects texture of bread (Mongi *et al*., 2011).

The combinatorial effects of flour composition and/or yeast strain utilized revealed significant difference on aroma desirability of the bread. This could be attributed to the flour constituents available as aroma precursors for conversion to volatile flavour compounds. Furthermore, strain competence in bioconversion of precursors to volatile or flavour elements might be responsible for differences observed in sensory scores for bread from different flour blends.

CONCLUSION

The study has revealed suitable supplementation ratio of air potato flour in production of composite products when blended with wheat and cassava flours (40% air potato+40% wheat+20%

cassava). Also, *S. cerevisiae* PWNE5 had desirable effects on the organoleptic quality of the composite bread and thus could serve as alternative to the commercial strain. The overall acceptability of the composite bread showed that air potato could compete favourably with other crops in formulation of functional foods. Its composite bread could contend with existing bread market suitably. The relatively low carbohydrate and fat contents of its flour could make it useful in designing specialty foods targeted toward specific health requirements such as the diabetics, hypertensive, atherosclerosis or related health conditions.

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