Nig. J. Pure & Appl. Sci. Vol. 39 (Issue 1, 2026)
e-ISSN 2756-4045
(C) 2026 Faculty of Physical Sciences and Faculty of Life Sciences, Univ. of Ilorin, Nigeria
www.njpas.com.ng

Nutrient Composition and Sensory Evaluation of Bread Leavened with Natural Yeast from Fruit Peels

[2]Nebo, U.C., [3]Oriola, O.B., [2]Boboye, E.B. and [4]Agbo, S.O.

[1] Department of Microbiology, Federal University Oye-Ekiti, Ekiti State, Nigeria.

[2] Department of Microbiology, School of Life Science, Federal University of Technology Akure, Nigeria.

[3]Atiba University Oyo, Oyo State, Nigeria

[4] Environmental Toxicology and Ecotoxicology Unit, Department of Animal & Environmental Biology, Federal University Oye-Ekiti, Ekiti State, Nigeria.

Date Received: 20-09-2025
Date Accepted: 13-01-2026
DOI: https://doi.org/10.48198/NJPAS/25.B36

ABSTRACT

Fruits are rich in essential nutrients that promote yeast growth and proliferation; however, their peels are commonly discarded in the open environment where they constitute nuisance and serving as breeding ground for pathogen borne flies. Yeasts isolated from various fruits peels of pawpaw, pineapple, mango, watermelon and African wild mango from Akure metropolis, Ondo State, Nigeria were assessed for their leavening ability by inoculating wheat flour dough with 1.94 × 10^9 cells/mL of each of the ten different isolates. Two commercial Baker's yeasts (STK Royal and Saf Instant) served as positive control while un-inoculated doughs served as negative control. The doughs were baked at 200 ℃ for 1 h after which loaves weight, volume, specific volume and proximate compositions were determined. Sensory evaluations were conducted according to a nine-point hedonic scale. Specific volumes of bread loaves ranged from 1.92 to 3.22 cm^3/g, with *S. cerevisiae* EXF-6472 producing the highest loaf volume. Dough leavened by *S. cerevisiae* EXF-6472 was most preferred for texture (7.63) and leavening ability (8.3), while *Issatchenkia orientalis* YS16A produced the best aroma rating (7.6) compared to commercial yeasts and the un-inoculated control. Ash, moisture, fat, fibre, protein, and carbohydrate contents of the bread samples were 1.33–2.31%, 11.43–19.52%, 19.87–28.46%, 0.61–3.10%, 8.68–17.23% and 40.10–51.90%, respectively, with the un-inoculated dough yielding the poorest nutritional quality. On the whole, *S. cerevisiae* EXF-6472 produced bread with the highest specific volume, superior leavening performance and acceptable proximate values, demonstrating that fruit-peels-derived yeasts are viable, sustainable and competitive alternatives to commercial Baker's yeast.

Keywords: Bread quality, fruit peels, leavening ability, proximate analysis, *Saccharomyces cerevisiae*, waste valorization

Introduction

In recent times, recycling of solid wastes has become a major concern in environmental research mainly due to challenges associated with consequential effects of improper wastes disposal. Considerable quantity of peels originates from consumption of the edible parts of fruits however, most fruit peels occur as byproducts from food processing industries, juice processing plants, hotels and restaurants (Gebregergs *et al*., 2016; Rani *et al*., 2024). These peels, often discarded as wastes are abundant, thus leading to increasing

Corresponding Author: **Nebo Uchechukwu Chinwe**
Department of Microbiology, Federal University Oye-Ekiti, Ekiti State, Nigeria
Email: uchechukwu.nebo@fuoye.edu.ng

©2026 Creative Common License Attribution 4.0 International

challenges of waste disposal and potential environmental and health concerns (Gui-Fang *et al*., 2012; Yadav and Sirohi, 2023), hence the urgent need to recycle fruit wastes into useful products. Fruit peels, which are regarded as agricultural waste are rich repository of bioactive compounds including dietary fibers, phenolics, carotenoids, vitamins, and minerals (Joy *et al*., 2022; Patra *et al*., 2022; Hussain *et al*., 2023) and diverse microbial communities with significant potential for industrial applications. Notably, banana and mango peels are distinguished by their high polyphenols content and dietary fiber level (Khan *et al*., 2024; Ismail *et al*., 2024).

Among these, the yeasts associated with fruit peels present a particularly promising avenue for biotechnological exploitation. These microorganisms not only support waste valorization and environmental remediation but also opens new pathway for innovation in food and related industries. On the other hand, yeasts are unicellular eukaryotic microorganisms capable of fermenting sugars to generate carbon dioxide and ethanol (Maicas, 2020; Nebo *et al*., 2025). They have long been exploited in baking for dough leavening (Kogje and Ghosalkar, 2016; Dutta *et al*., 2024; Tesfaye *et al*., 2025) and their substantial contents of vitamins B, D2 along with high quality proteins, have also supported their use as nutritional supplements and feed additive in both humans and veterinary applications (Abbas *et al*., 2006; Thaler and Safferstein, 2014; Pang *et al*., 2022). This increasing awareness of the nutritional and functional potential of fruit peels has sparked considerable interest in their sustainable utilization.

Notably, the use of indigenous yeast strains for dough leavening provides dual advantages; enabling the production of staple foods using locally sourced, natural fermentative cultures, while simultaneously advancing circular economy practices through the valorization of agro-industrial waste (Amara *et al*., 2023; Dhiman *et al*., 2025). Despite the vast diversity of yeasts associated with fruit wastes, their leavening potential remains largely underexplored, particularly within the emerging framework of sustainable food systems and microbial resource valorization.

Therefore, this study aims to evaluate the leavening capacity of yeasts strains isolated from fruit peels, assess the sensory attributes and nutritional compositions of the resulting baked bread. In doing so, it seeks to advance food security and environmental sustainability by promoting the innovative utilization of bioresources that are commonly regarded as wastes. However, this study did not assess the influence fruit-peel-derived yeasts on the shelf-life the baked product.

2.0 Materials and Method

Study Area

Fruit peels were sourced from major dumpsites, located on campus and at various points across the metropolis, particularly known with high accumulation of fruit wastes.

Collection of Samples

Ten different fruit peels including pawpaw, pineapple, banana, mango, watermelon, lemon, lime, apple, African wild mango and soursop were collected into sterile bags and transported to Microbiology Laboratory, Federal University of Technology, Akure, Ondo State.

Isolation and Identification of Yeasts from Fruit Peel Samples

Yeasts cells were isolated from fruit peels following the method of Thapa *et al*. (2015). Peels from each fruit were first manually homogenized into paste using a pre-washed surface sterilized mortar and pestle. One gram of the resulting paste was serially diluted and the 10^{-3} dilution was pour-plated in triplicate. The Rose Bengal agar (RBA) was prepared according to manufacturer's instruction and sterilized in an autoclave at 121 ℃ for 15 min. The plates were incubated at 28 ℃ for 48 h, after which yeast loads were enumerated as colony forming units per gram (CFU/g). Distinct colonies were further purified by streaking onto fresh RBA using sterile inoculating loop under aseptic conditions. The plates were incubated at 28 ℃ for 48 h and the resulting pure isolates were subsequently maintained on agar slants for further analysis. A total of thirty yeast isolates were identified using biochemical indices and sequencing of the D1/D2 domain of the 26S rDNA (Nebo *et al*., 2024). The

ten most active sugar fermenting strains from the previous investigation were selected for use in this study.

Preparation of the Inoculum of Commercial Yeasts

One gram of each commercial yeast (Saf Instant, China and STK Royal, China) was activated in 10 mL of sterile distilled water to prepare stock solutions. These were serially diluted and inoculated onto Rose Bengal Agar (RBA) plates, then incubated at 28 ℃ for 48 h. The resulting colonies were used to prepare the starter cultures.

Preparation of Yeast Starter Culture

Different yeast isolates were inoculated separately into sterilized peptone broth containing 25% (w/v) glucose in 100 mL conical flasks and incubated at 30 °C in a water bath shaker at 50 rpm for 72 h. The cells were harvested by centrifuging the culture at 12,000 rpm for 10 min. The pellets of yeast cells were washed three times in sterile distilled water and thereafter re-suspended in 10 mL sterile distilled water (Ma'aruf *et al*., 2011).

Standardization and Determination of Yeast Cells Population

Cells population was determined by diluting 1 µL of each re-suspended yeast starter culture with 99 µL of normal saline. A 10 µL of the cell suspension was carefully dropped underneath the coverslip on counting Burker chamber of a hemocytometer (Freshney, 2015). The cells were counted using a microscope (10 × objective).

$$Total\ cells/ml = \frac{\text{Total cells counted x dilution factor}}{\text{No of Squares}} \times 10,000\ \text{cells/mL} \quad \text{(i)}$$

The number of cells inoculated = cell concentration × original sample volume used (ii)

Bread Production

The straight dough method was used for bread production following the procedure of Cauvian (2015) with slight modification. Accordingly, all ingredients including wheat flour (200 g), sugar (25 g), solid fat (40 g), salt (5 g), milk (25 g) and water (100 mL) were mixed thoroughly, after which the mixture was kneaded using a wooden rolling pin to obtain the dough (Balarabe *et al*., 2017). Yeast cells of 1.94×10^9 cells/mL from each of ten different yeast isolates were inoculated separately into a single dough. Additionally, two brands commercial Baker's yeast (Saf Instant, China and STK Royal, China) were used separately as positive control, while another formulation of dough without yeast served as the negative control.

Each of the dough samples was placed in a separate baking pan smeared with vegetable oil and covered for 1 h at 30±2℃, in order for the yeast to ferment the dough. Subsequently, the doughs were proofed for 90 min at 30 ℃ prior to commencement of baking in an oven temperature of 200 ℃ for 1 h.

Determination of Physical Properties of Bread

Weight of bread loaf

At the elapse of 1 h of baking, weight of each bread loaf produced was determined on an electronic weighing balance (CE- 410I, Camry Emperors, China) after removal from an oven.

Volume of the bread loaf

Each bread loaf produced was assessed for volume 1 h after removal from an oven (Balarabe *et al*., 2017). Volume of bread loaf was determined using seed displacement method according to Dabels *et al*. (2016).

Volume of bread loaf (cm^3) = $V_2 - V_1$ (iii)

Where V_1 = Volume of seed that filled the container

V_2 = Volume of seeds displaced by the bread sample

Specific volume of the bread loaf

The specific volume of the bread loaf was determined according to Ayo *et al*. (2008) as follows:

$$\text{Specific volume } (cm^3/g) = \frac{\text{Volume of bread loaf}}{\text{Weight of bread loaf}} \quad \text{(iv)}$$

Proximate Analysis of Bread Loaf

Proximate analysis of each bread loaf obtained from the freshly baked dough was conducted to determine moisture, protein, fat, ash, fibre, and carbohydrate contents, according to Association of Official Agricultural Chemists (AOAC 2012).

Determination of bread moisture content

Petri dishes were thoroughly washed, labelled, oven-dried and weighed to obtain the initial weight (W_1). Precisely 2 g of each bread sample (W_2) was placed into the pre-weighed dishes, evenly distributed, and immediately transferred to a desiccator to prevent atmospheric moisture uptake. The samples were then dried in a hot-air oven at 105 °C for 3 h, after which it was cooled in a desiccator for 30 min, and reweighed. The drying–cooling–weighing cycle was repeated until a constant weight (W_3) was achieved. Moisture content (%) was calculated using the standard gravimetric relation:

$$\text{Moisture content (\%)} = \frac{\text{loss in weight during drying (W2-W3)}}{\text{Weight of sample taken (W2-W1)}} \times 100 \quad \text{(v)}$$

Determination of bread protein content

Protein content was quantified using the micro-Kjeldahl method, following standardized digestion, distillation, and titration procedures.

(i) *Digestion*

One gram of homogenized sample was transferred into a 50 mL micro-Kjeldahl flask, followed by 1.6 g selenium oxide catalyst and 15 mL concentrated H_2SO_4. The mixture was digested in a block digester at 105 °C for 2 h until the initial green coloration disappeared and a clear, colourless digest was obtained.

(ii) *Distillation*

After cooling, the digest was diluted to 50 mL with distilled water. A 5 mL aliquot was introduced into the distillation unit. The receiving flask contained 5 mL of 2% boric acid and mixed indicator (methyl red–bromocresol green). The digest was rendered alkaline by adding 15 mL of 4% NaOH, and steam distillation was performed with the delivery tube submerged below the acid level. Liberation of ammonia was confirmed by the colour shift of the receiving solution from pink to blue. Distillation proceeded until 50 mL distillate was collected.

(iii) *Titration*

The distillate was titrated with 0.1 M HCl to a pink endpoint. Total nitrogen content was calculated using the AOAC (2012) formula:

$$\text{Nitrogen content (\%)} = \frac{\text{N.F} \times \text{M} \times \text{V1} \times \text{T} \times \text{PF}}{\text{V2} \times \text{W}} \times 100 \quad \text{(vi)}$$

$$\text{Protein content (\%)} = \text{Nitrogen (\%)} \times 6.25 \text{ (protein conversion factor)} \quad \text{(vii)}$$

Where: N.F. = conversion factor of nitrogen atom to standard volume (0.014)

M = Morality of HCl (0.01), V_1 = Final volume of digest (50ml), V_2 =Volume of digest used (10ml), T = Titre volume of distillate, W = Weight of sample used, PF = Protein conversion factor for foods containing nitrogen (6.25)

Determination of bread fat content

The weight of the empty Whatman No. 1 filter paper was recorded (W_1), after which 1 g of each sample was placed in the paper, wrapped neatly with thread, and reweighed (W_2). Petroleum ether (boiling range 40–60 °C) was added to a round-bottom flask to three-quarters of its volume, and the Soxhlet extractor was assembled with a reflux condenser. The wrapped sample was inserted into the extraction chamber, and continuous reflux extraction was performed for 6 h. After extraction, the filter paper and residual sample were dried at 100 ℃ for 1 h, cooled in a desiccator, and weighed to obtain the final weight (W_3).

$$\text{Fat content (\%)} = \frac{\text{Weight loss by the sample (W2-W3)}}{\text{Weight of the sample (W2-W1)}} \times 100 \quad \text{(viii)}$$

Determination of bread ash content

Ash content, representing the inorganic residue remaining after complete combustion of organic material, was determined using the dry-ashing method. Clean, oven-dried crucibles were weighed (W_1), and 1 g of each sample was added and reweighed (W_2). The samples were incinerated in a muffle furnace at 530 ℃ for 3 h, with heating continued until a light grey or white ash was obtained. Crucibles were cooled in a desiccator to room temperature and weighed (W_3). Cooling and reweighing were repeated until a constant weight was achieved, following AOAC (2012) guidelines.

$$\text{Ash content (\%)} = \frac{\text{Weight loss by the sample (W3-W1)}}{\text{Weight of the sample (W2-W1)}} \times 100 \quad \text{(ix)}$$

Determination of bread fibre content

Crude fibre content was determined following the AOAC (2012) protocol. One gram of each sample was placed into a clean, labelled 250 mL conical

flask and weighed (W_1). A 200 mL aliquot of 1.25% H_2SO_4 was added, and the mixture was boiled for 30 min before filtration and thorough rinsing with hot water to remove soluble components. The residue was transferred back into the flask, treated with 200 mL of 1.25% NaOH, and boiled for another 30 min. After filtration through muslin cloth, the residue was washed sequentially with hot distilled water, 10% HCl, and industrial methylated spirit. The residue was then transferred to a crucible, dried at 105 °C, cooled in a desiccator, and weighed (W_2). The dried residue was subsequently ashed at 500 °C for 90 min, cooled, and weighed to obtain W_3.

$$\text{Ash content (\%)} = \frac{(W2-W3)}{(W1)} \times 100 \qquad \text{(x)}$$

Determination of bread carbohydrate content

The Nitrogen-Free Extractive (NFE), representing the soluble carbohydrate fraction, was not measured directly but calculated by difference. The percentage carbohydrate content was derived using the proximate composition values according to the standard expression:

Carbohydrate (%) = 100 – (Ash + Protein + Fat + Fibre + Moisture) % (xi)

Sensory Evaluation of Bread Loaves

Thirty (30) panelists were recruited through simple random selection from individuals who had no known allergies to wheat-based products. Prior to the evaluation, the panelists participated in a short training/orientation session. During this session, they were informed about the purpose of the assessment, the sensory attributes to be evaluated (taste, colour, aroma, texture, and overall acceptability), and the correct use of the 9-point hedonic scale according to Fadahunsi *et al*. (2013). The scale descriptors were explained in detail as follows: Like extremely (9), Like very much (8), Like moderately (7), Like slightly (6), Neither like nor dislike (5), Dislike slightly (4), Dislike moderately (3), Dislike very much (2), and Dislike extremely (1). Sample presentation was randomized, and panelists were instructed to evaluate each bread sample independently under uniform environmental conditions to minimize.

Statistical Analysis

All experiments in this study were conducted in triplicates and numerical data were subjected to one way Analysis of Variance (ANOVA) using Statistical Package for the Social Science (SPSS) version 22. The differences between mean values of treatment groups were separated using Duncan's New Multiple Range Test at $p \leq 0.05$ level of significance.

Results

Weight, Volume, Specific Volume and Appearance of Bread Baked with Most Active Sugar Fermenting Yeasts

Physical properties of bread loaves leavened with each of the ten yeasts isolates from different fruit peels are shown in Table 1. Specific volume of the bread loaves ranged from 1.92 to 3.22 cm^3/g, while *Saccharomyces cerevisiae* EXF-6472 recorded the highest value. Values from positive control tested with yeasts (STK Royal and Saf Instant) were 3.00 cm^3/g and 2.38 cm^3/g respectively. However, specific volume measurement of bread loaf from the negative control (dough without yeast) had the least value of 1.92 cm^3/g (Table 1). On the other hand, weight measurement obtained from bread loaf not leavened by yeasts (419.69 g) was higher than values obtained from loaves leavened with yeasts and the two positive controls (344.00 g and 408.01 g). The highest volume of bread loaves was recorded from dough leavened by *Saccharomyces cerevisiae* EXF-6472 (1092.03 cm^3), which was followed by *Saccharomyces cerevisiae* EXF-6498 (1087.33 cm^3). In contrast, bread loaf from the negative control recorded the least bread volume of 807.16 cm^3 (Table 1). Plate 1 shows bread loaves obtained from dough leavened by selected yeasts isolates from the various fruit peels. Carbon (II) oxide was produced from sugar fermentation by the yeast on a sliced sample (Figure 1).

Table 1: Weights and volumes of bread loaves produced with best sugar fermenting yeasts isolated from fruit peels

Yeast isolates	Bread weight (g)	Bread volume (cm^3)	Bread Specific Volume (cm^3/g)
Saccharomyces cerevisiae EXF-6472	338.73±1.37^{i}	1092.03±2.01^{a}	3.22±0.11^{a}
Issatchenkia orientalis YS16A	344.67±0.67^{g}	936.00±0.71^{i}	2.72±0.20^{g}
Pichia kudriavzevii C105	348.03±1.03^{e}	1018.57±1.03^{f}	2.69±0.91^{g}
Hanseniaspora uvarum HCF4317	351.67±3.18^{d}	1064.49±1.32^{c}	2.99±0.07^{d}
Saccharomyces cerevisiae EXF-6498	342.00±1.31^{h}	1087.33±3.17^{b}	3.18±0.30^{b}
Lachancea fermentati	354.00±0.08^{d}	1051.36±1.65^{d}	2.97±0.81^{e}
Pichia kudriavzevii NWB5-1	346.01±1.09^{f}	936.01±0.91^{i}	2.71±0.11^{g}
Pichia fermentans YM26567	363.01±2.02^{c}	1007.99±0.62^{g}	2.78±0.10^{f}
Pichia cecembensis NRRLY	344.01±1.51^{g}	936.01±1.03^{i}	2.72±0.12^{g}
Saccharomyces cerevisiae YCR034	340.33±1.34^{i}	1050.01±0.83^{d}	3.09±0.20^{c}
Saf Instant	408.01±3.01^{b}	972.00±1.03^{h}	2.38±0.09^{i}
STK Royal	344.00±0.57^{g}	1032.01±1.26^{e}	3.00±0.13^{d}
Negative Control	419.69±2.32^{a}	807.16±1.34^{j}	1.92±0.06^{j}

Values are mean ± SD; values in the same column with the same alphabet superscript are not significantly different
Legend: Saf Instant and STK Royal = Commercially available yeast used as positive control to leaven dough
Negative Control = Dough not leaved by yeast

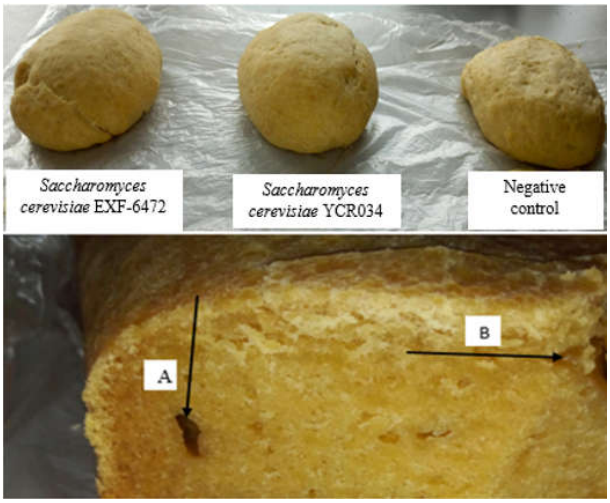

Figure 1: Bread loaves obtained from doughs leaved by selected yeast isolates from various fruit peels

Legend: A and B are the areas of CO_2 production during fermentation by yeast

Sensory Properties of Bread Loaves

Sensory parameters (texture, taste, colour, aroma, leavening and overall acceptability) of the bread loaves produced from leavening of dough with yeast isolates obtained from fruit peels were compared with the positive control (two commercially available yeasts, STK Royal and Saf Instant) and the negative control (dough without yeast). The texture of bread produced from dough leavened by *Pichia cecembensis* was rated highest (7.63) ahead of *Saccharomyces cerevisiae* EXF-6472 (7.6) while the negative control scored the least value of 7.13 (Figure 2). The taste of the bread produced from dough leavened by *Saccharomyces cerevisiae* EXF-6472 was preferred (7.7) ahead of other yeast isolates, followed by *Issatchenkia orientalis* YS16A (7.6) (Figure 3). The colour of bread produced from dough leavened *Saccharomyces cerevisiae* EXF-6472 was rated highest (7.5), followed by *Saccharomyces cerevisiae* EXF-6498 and STK Royal that ranked the same (7.47) (Figure 4). Furthermore, bread loaves produced from loaves leavened by *Issatchenkia orientalis* YS16A was rated highest (7.6) in aroma, while the least ranking of 6.2 was attributed to the negative control (Figure 5). Similarly, leavening ability of *Saccharomyces cerevisiae* EXF-6472 was ranked best (8.3) followed by *Saccharomyces cerevisiae* EXF-6498 (8.07) which rated the same with Saf Instant (8.07), one of the commercially available yeasts that served as positive control (Figure 6). Taken together, the perception of the different qualities of bread under review revealed that bread loaves produced without leavening yeast (negative control) was rated ahead of some others

leavened by yeast isolates in taste including the positive controls. Despite this, loaves produced without any leavening yeast ranked least in texture, aroma and leavening (Figures 2 - 6).

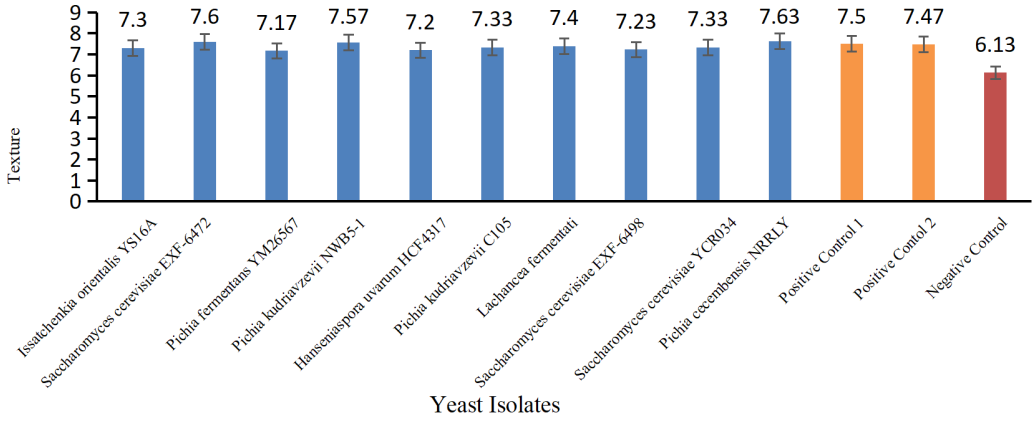

Figure 2: Texture of bread produced from dough leavened by yeast isolates from different fruit peels

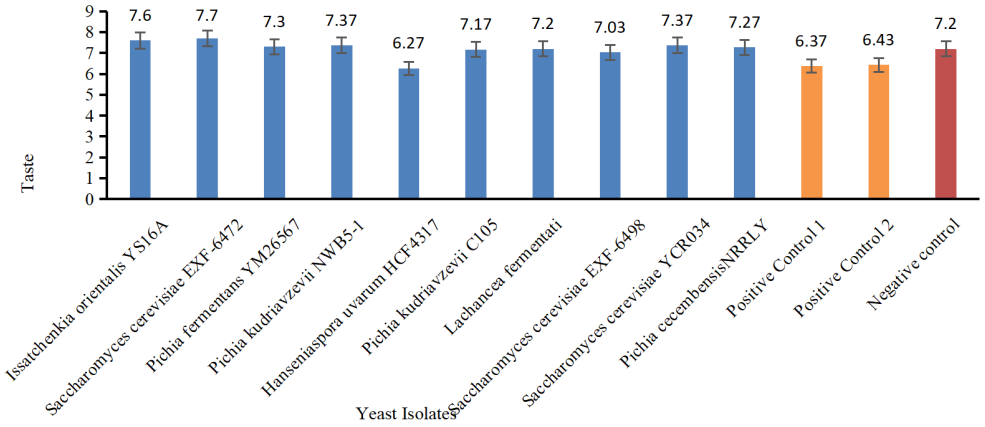

Figure 3: Taste of bread produced from dough leavened by yeast isolates from different fruit peels

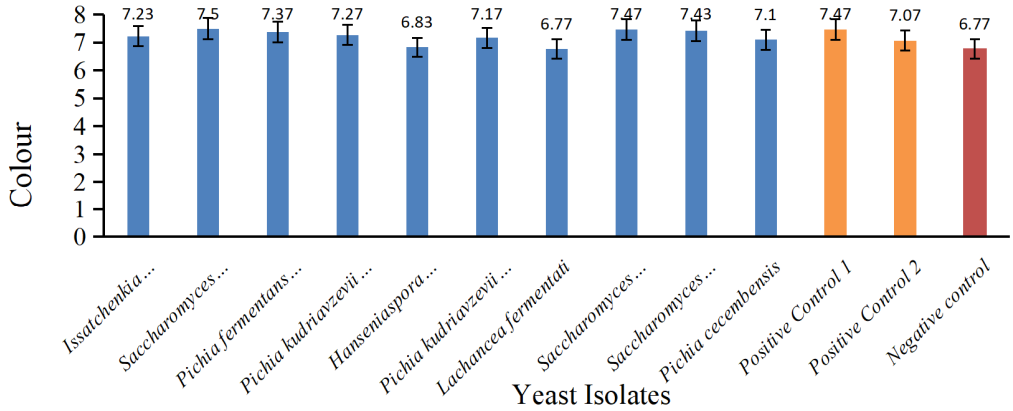

Figure 4: Colour of bread produced from dough leavened by yeast isolates from different fruit peels

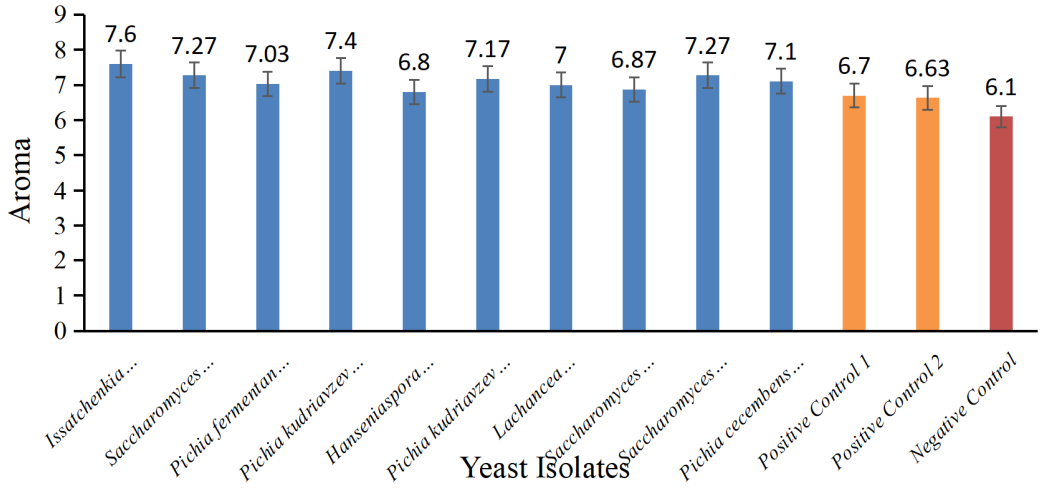

Figure 5: Aroma of bread produced from dough leavened by yeast isolates from different fruit peels

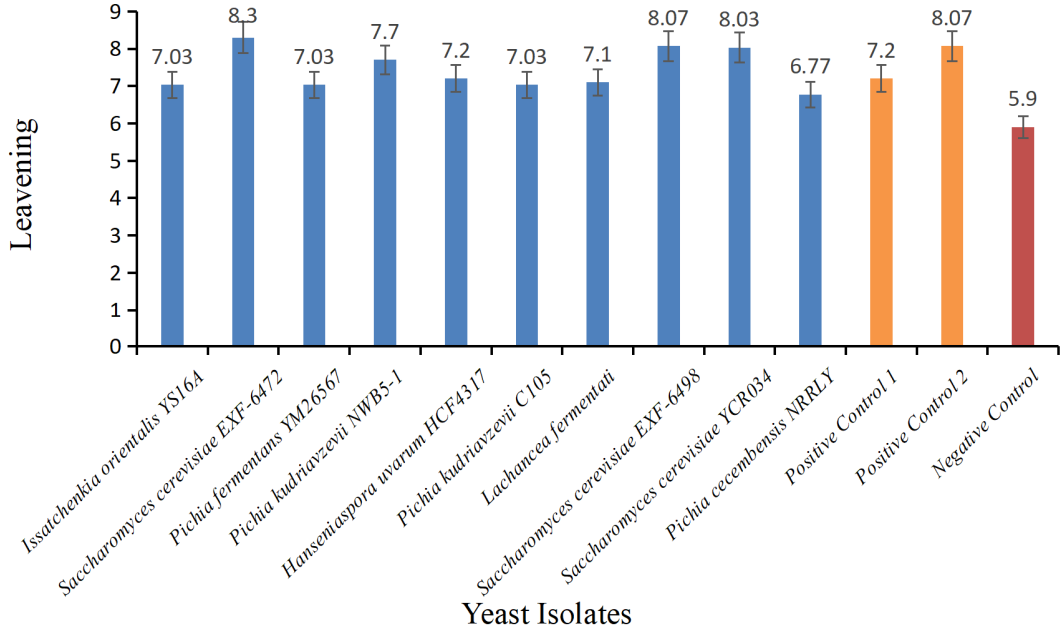

Figure 6: Leavening ability of bread produced from dough leavened by yeast isolates from different fruit peels

Proximate Composition of Bread Samples Produced with Most Active Carbon Dioxide Producing Yeasts Isolated from Fruit Peels in Akure Metropolis

Proximate composition of bread samples produced from dough leavened with ten most active CO_2 producing yeast isolates were compared with two commercially available yeasts (Saf Instant and STK Royal) and a corresponding unleavened bread sample is shown in Table 2. The compositions showed that ash, moisture, fat, fibre, protein and carbohydrate contents of the bread samples corresponds to1.33% - 2.31%, 11.43% - 19.52%, 19.87% – 28.46%, 0.61% – 3.10%, 8.68% – 17.23%, and 40.10% – 51.9%, respectively. Saf Instant that served as positive control yielded the highest amount of ash and moisture (2.31±0.01% and 19.52±0.02%) from the bread sample assessed, followed by *Pichia fermentans* YM26567 and *Lachancea fermentati* with similar quantities (2.29±0.00% and 2.27±0.00%). On the other hand, *Pichia*

kudriavzevii C105 produced the highest amount of fibre (3.10±0.01%) followed by *Lachancea fermentati* (3.03±0.00%) and did not differ significantly ($p \geq 0.05$) from bread produced from *Hanseniaspora uvarum* HCF4317 (3.02±0.01%). The highest amount of protein was obtained from bread leavened by *Saccharomyces cerevisiae* EXF-6498. In contrast, bread baked without yeast (negative control) yielded loaves with lowest quantities of ash, moisture, fibre, and protein but with high fat and carbohydrate content (Table 2). Protein content of bread samples produced from dough leavened by yeast isolates varied significantly compared to negative control. Notably, there was no significant difference ($p \geq 0.05$) in protein contents of both commercially available yeasts (STK Royal and Saf Instant) that served as positive control.

Table 2: Proximate composition of bread samples produced from dough leavened by the most active carbon dioxide producing yeast isolates from fruit peels

Yeast isolates	Ash (%)	Moisture (%)	Fat (%)	Crude fibre (%)	Protein (%)	Carbohydrate (%)
*Saccharomyces cerevisiae*EXF-6472	1.53±0.02^{i}	14.81±0.01^{h}	22.42±0.01^{j}	2.10±0.01^{g}	16.11±0.01^{c}	43.02±0.01^{g}
Pichia cecembensis NRRLY	1.98±0.01^{f}	12.73±0.01^{k}	26.43±0.01^{c}	0.66±0.02^{k}	16.09±0.01^{d}	40.10±0.01^{m}
Pichia kudriavzevii NWB5-1	1.56±0.02^{h}	19.09±0.02^{c}	24.79±001^{d}	1.89±0.01^{i}	12.11±0.01^{h}	40.57±0.01^{k}
*Pichia fermentans*YM26567	2.29±0.03^{b}	17.78±0.02^{d}	24.21±0.02^{e}	2.24±0.01^{d}	10.20±0.01^{i}	43.29±0.02^{f}
Lachancea fermentati	2.27±0.01^{b}	13.02±0.01^{j}	19.87±0.02^{m}	3.03±0.02^{b}	9.93±0.03^{k}	41.02±0.01^{j}
*Issatchenkia orientalis*YS16A	2.15±0.01^{e}	15.81±0.01^{g}	23.10±0.01^{h}	2.32±0.03^{c}	12.31±0.04^{g}	44.31±0.05^{e}
Hanseniaspora uvarum HCF4317	2.20±0.01^{d}	12.50±0.01^{l}	23.47±0.00^{g}	3.02±0.01^{b}	16.21±0.01^{b}	42.62±0.01^{h}
*Saccharomyces cerevisiae*YCR034	1.99±0.01^{f}	19.39±0.01^{b}	20.87±0.02^{k}	2.20±0.01^{e}	15.93±0.02^{e}	47.58±0.01^{b}
Pichia kudriavzevii C105	1.41±0.01^{j}	16.57±0.03^{f}	27.14±0.01^{b}	3.10±0.01^{a}	14.20±0.01^{f}	40.19±0.05^{l}
Saccharomyces cerevisiae EXF-6498	1.59±0.02^{g}	13.86±0.01^{i}	23.49±0.00^{f}	1.80±0.04^{j}	17.23±0.03^{a}	42.03±0.03^{i}
STK Royal (Positive Control 1)	2.25±0.01^{c}	16.65±0.01^{e}	22.61±0.01^{i}	2.01±0.01^{h}	10.13±0.01^{j}	46.32±0.05^{c}
Saf Instant (Positive Control 2)	2.31±0.01^{a}	19.52±0.02^{a}	19.92±0.01^{l}	2.12±0.01^{f}	10.12±0.02^{j}	46.09±0.02^{d}
Negative Control	1.33±0.01^{k}	11.43±0.02^{m}	28.46±0.03^{a}	0.61±0.01^{l}	8.68±0.01^{l}	51.90±0.01^{a}

Values are Mean ± SD; Values with different superscript within the columns are significantly different ($p<0.05$) by Duncan multiple range test

4.0 Discussion

The high specific volume yields by *Saccharomyces cerevisiae* EXF-6472 *Saccharomyces cerevisiae* EXF-6498 and *Saccharomyces cerevisiae* YCR034 is comparable with that of the commercial yeast, STK Royal and suggest a highly efficient leavening process, potentially due to their robust sugar metabolism and elevated CO_2. This aligns with the earlier findings that identified indigenous yeasts from fruit peels as strong leavening agents (Ma'aruf *et al.*, 2011; Balarabe *et al.*, 2017; Tesfaye *et al*., 2025). The enhanced leavening observed in this study is likely be driven by multiple factors, including strain-specific enzymatic activities, osmotic stress tolerance, and efficient utilization of fermentable sugars within the dough matrix (Dong and Karboune, 2021; Dong, 2022). The differences in specific volume recorded among treatments may further reflect the variable capacities of individual yeast strains to hydrolyze sucrose and other complex sugars into fermentable monosaccharides (Struyf *et al*., 2017; Rodrigues *et al*., 2021; Timmermans *et al*., 2023). The tendency of isolates to ferment sucrose with corresponding elevated CO_2 may have facilitated expansion of the dough to improve the texture of bread (Müller *et al*., 2021). The superior texture ratings may be attributed to improved gas retention and gluten matrix development resulting from consistent CO_2 release during fermentation, which promotes a

softer and more uniform crumb structure. These observations align with earlier reports by Corriher (2001) and Rathnayake *et al*. (2018) who demonstrated that CO_2 mediated expansion results in characteristic porosity and texture of fermented baked products (Sahlström *et al*., 2004; Sun *et al*., 2023). These findings reinforce the critical role of yeast-mediated gas production in determining final bread quality. Notably, dough fermented with *Issatchenkia orientalis* YS16A, isolated from pineapple peel, received the highest aroma rating. This observation suggests that fermentation with *Issatchenkia orientalis* YS16A facilitated the synthesis of desirable volatile aromatic compounds, during fermentation. This observation is in line with Gobbetti *et al*. (2006) and Boboye and Dayo-Owoyemi, (2009) who reported that yeasts have innate potentials to impart appealing flavour to the baked products. Therefore, high aroma acceptability of bread produced using this strain suggests a possible influence of the organism's ecological origin on the aroma of the baked bread. The strong leavening performance of indigenous yeasts, particularly *S. cerevisiae* EXF-6472 and *S. cerevisiae* EXF-6498, reaffirms their suitability for large-scale baking applications. The results suggest that *Saccharomyces cerevisiae* was the most efficient yeast to ferment wheat dough compared to all other isolates, including the commercially available yeasts. Similarly, Ma'aruf *et al*. (2011) reported several other yeast isolates with better corresponding leavening ability than commercially available yeasts.

A proximate analysis of bread samples leavened with selected yeast isolates revealed that loaves were high in protein contents. The high protein content of bread samples can be attributed to the inherent protein content of wheat flour and the contribution of yeast which enhanced the functional properties of proteins, mainly gluten through metabolic activities (Gobbetti *et al*., 2006), may have contributed to elevated protein content of the bread samples. Fat content was high in all bread samples tested, while compositions of ash, fibre, moisture, protein and carbohydrate determined from this study correspond to range of values reported by Balarabe *et al.* (2017). High fat content of bread samples is speculated to have been derived from wheat flour type used coupled the solid fat added during dough formulation. Additionally, variation in fibre and fat content could be attributed to differences in metabolite production during fermentation, as well as the extent to which polysaccharides and proteins are retained or modified during baking (Kitessa, 2024).

Contrary to expectations, bread from the negative control (baked product without yeast) received favorable taste ratings, surpassing the dough leavened by *Hanseniaspora uvarum* HCF4317, and even outperforming bread produced with the commercial yeasts strain used as positive controls. This anomaly points to the possible impact of added ingredients such as sugar, fat, and flour type on perceived taste, independent of yeast-driven metabolic processes or could arise from individual variability or bias from the panelists.

Overall, all wheat bread samples were generally accepted by the panelists in relation to their corresponding organoleptic properties which rated on "like moderately" on the nine-point hedonic scale of assessment.

Conclusion

This study demonstrates that fruit-peel-derived yeasts are effective and sustainable alternatives to commercial Baker's yeast. Among the isolates, *Saccharomyces cerevisiae* EXF-6472 emerged as the best performing strain producing highest specific volume, superior leavening ability and most preferred bread texture, consistent with panelist's evaluations. *Issatchenkia orientalis* isolated from pineapple delivered the most appealing aroma profile, highlighting the potential of fruit-derived yeasts to impart appealing flavour on baked product. The high proximate compositions of the loaves validate the nutritional viability of these indigenous yeasts in providing sustainable staple food. Yeasts obtained from fruit peels offer a promising pathway toward sustainable baking practices, improved product quality and enhanced circular bioeconomy practices. We recommend strain optimization and integrating fruit-derived yeasts into pilot-scale baking trials to fully harness the industrial potential of these alternative yeasts.

Data Availability

All the data generated are included in this research work**.**

Conflicts of Interest

The authors declare that they have no competing interest.

References

Abbas, C. A., (2006). Production of antioxidants, aromas, colours, flavours, and vitamins by yeasts. In *Yeasts in food and beverages* (pp. 285-334). Berlin, Heidelberg: Springer Berlin Heidelberg.

Amara, N. I., Enemour, S. C., Nnabuife, O. O., and Ogbonna, J., C.. (2023). "Yeast-driven valorization of agro-industrial wastewater: an overview." *Environmental Monitoring and Assessment* 195 (10) : 1252.

Balarabe, M. M., Sani, S. D. M. and Orukotan, A., A. (2017). Screening of fermentative potency of yeast isolates from indigenous sources for dough leavening. *International Journal of Microbiology and Biotechnology*, 2(1): 12-17.

Boboye, B., and Dayo-Owoyemi, I. (2009). Comparative evaluation of the sensory properties of doughs fermented with yeasts isolated from orange. *Biotechnology*, 8(3): 389-392.

Cauvian, S., (2015). Bread: The Product. In Technology of Bread Making. Springer International Publishing, Netherland, Pp. 1-22.

Corriher, S., (2001). Yeast crucial role in bread making. *Fine cooking*, 43: 80-81.

Dabels, N., Igbabul, B., Shar, F., Ilorliam, B., and Abu, J. (2016). Physicochemical, nutritional and sensory properties of bread from wheat, acha and mung bean composite flours. *Food Science and Quality Management*, 56: 21-26.

Dutta, D., Bhattacharya, S., and Nandi, S. (2024). Microbes in the Baking Industry: Harnessing the Power of Microbes in Baking Products. In *Microbial Products for Health and Nutrition* (pp. 261-284). Singapore: Springer Nature Singapore.

Dhiman, S., Kumar, A., Sharma, K., and Dhewa, T. (2025). Microbial Bioprocessing of Food and Agro-Industrial Residues for a Sustainable Circular Economy. *Indian Journal of Microbiology*, 1-32.

Dong, Y., (2022). Bio-protection of bread texture, flavor and overall qualities post-production and during shelf-life using lactic acid bacteria-based bio-ingredients: enzymes and exopolysaccharides. McGill University (Canada).

Dong, Y.,. and Karboune, S. (2021). A review of bread qualities and current strategies for bread bioprotection: Flavor, sensory, rheological, and textural attributes. *Comprehensive Reviews in Food Science and Food Safety*, 20(2): 1937-1981.

Fadahunsi, I. F., Ogunbanwo, S. T., and Fawole, A. O. (2013). Microbiological and nutritional assessment of bururkutu and pito (indigenously fermented alcoholic beverages in West Africa) during storage. *Nature and Science*, 11(4): 98-103.

Freshney, R. I., (2015). *Culture of animal cells: a manual of basic technique and specialized applications*. John Wiley & Sons.

Gebregergs, A., Gebresemati, M., and Sahu, O. (2016). Industrial ethanol from banana peels for developing countries: response surface methodology. *Pacific Science Review A: Natural Science and Engineering*, 18: 22-29.

Gobbetti, M., Rossi, J., Cossignani, L., Simonetti,M. S., Corsetti, A. and Damiani, V., (2006). Free D- and L-Amino Acid Evolution During Sourdough Fermentation and Baking. Journal of Food Science, 59(4):881 – 884.

Gui-Fang, D., Chen, S., Xiang-Rong, X., Ru-Dan, K., Ya-Jun, G., Li-Shan, Z., Li-Li, G., Xi, L., Jie-Feng X., En-Qin, X., Sha, L., Shan, W., Feng, C., Wen-Hau, L., and Hua-Bin, L. (2012). Potential of fruit wastes as natural

resources of bioactive compounds. *International Journal of Molecular Science*, 13: 8308-8323.

Hatoum, R., Labrie, S., and Fliss, I. (2012). Antimicrobial and Probiotic Properties of Yeasts: From Fundamental to Novel Applications**.** *Frontiers in Microbiology*, 3: 421.

Hussain, T., Kalhoro, D. H., and Yin, Y. (2023). Identification of nutritional composition and antioxidant activities of fruit peels as a potential source of nutraceuticals. *Frontiers in Nutrition*, 9: 1065698.

Ismail, S., Dubey, P. K., Mishra, A. A., and Ashka, F. (2024). Valorisation of banana peel and mango peel as functional ingredients in baked products: a review. *International Journal of Food Science and Technology*, 59(9): 5938-5950.

Joy, G. F. F., Sunday, O. Z., Remilekun, A., and Olusegun, A., D. (2022). Waste-to-wealth; nutritional potential of five selected fruit peels and their health benefits: A review. *African Journal of Food Science*, 16(7): 172-183.

Khan, R., Anwar, F., Ghazali, F. M., and Mahyudin, N., A. (2024). Valorization of waste: Innovative techniques for extracting bioactive compounds from fruit and vegetable peels - A comprehensive review. Innovative Food Science and Emerging Technologies, 97, doi.org/10.1016/j.ifset.2024.103828.

Kitessa, D. A. (2024). Review on effect of fermentation on physicochemical properties, anti-nutritional factors and sensory properties of cereal-based fermented foods and beverages. *Annals in Microbiology,* 74, 32 https://doi.org/10.1186/s13213-024-01763-w

Kogje, A. and Ghosalkar, A., (2016). Xylitol production by *Saccharomyces cerevisiae* overexpressing different xylose reductases using non-detoxified hemicellulosic hydrolysate of corncob. *Biotechnology*, 6(2): 127.

Ma'aruf, A. G., Asyikeen, Z. N., Sahilah, A. M., and Khan, A., M. (2011). Leavening ability of yeast isolated from different local fruits in bakery product. *Sains Malaysiana*, 40(12): 1413–1419.

Maicas, S., (2020). The role of yeasts in fermentation processes. *Microorganisms*, 8(8): 1142.

Müller, D. C., Nguyen, H., Li, Q., Schönlechner, R., Schwenninger, S. M., Wismer, W., and Gänzle, M. (2021). Enzymatic and microbial conversions to achieve sugar reduction in bread. *Food Research International*, 143: 110296.

Nebo, U. C., Boboye, B. E., and Agbo, S. O. (2024). Molecular characterization and prospective economic value of yeasts isolated from different waste fruit peels. *Malaysian Journal of Microbiology*, 20(7): 657-668

Nebo, U. C., Lawal, A. M., Akinyele, H. A., Nwokeoma, C. I., Oko, C., and Agbo, S., O. (2025). Degradative ability of yeast isolates and bioethanol production from ripe fruit peels of pawpaw, banana, watermelon, pineapple and lime. J. Appl. Sci. Environ. Manage. 29 (5): 1537-1546

Panda, S. K., Kayitesi, E., Mishra, S. S., and Ray, R., C. (2016). Microbial processing of fruit and vegetable wastes for production of vital enzymes and organic acids: Biotechnology and scopes. *Environmental Research*, 146: 161-172.

Pang, Y., Zhang, H., Wen, H., Wan, H., Wu, H., Chen, Y., ... and Liu, X. (2022). Yeast probiotic and yeast products in enhancing livestock feeds utilization and performance: An overview. *Journal of Fungi*, 8(11): 1191.

Patra, A., Abdullah, S., and Pradhan, R., C. (2022). Review on the extraction of bioactive compounds and characterization of fruit industry by-products. *Bioresources and Bioprocessing*, 9(1): 14.

Thaler, M., and Safferstein, D. (2014). A Curious Harvest: The Practical Art of Cooking Everything. Quarry Books. p 129.

Thapa, S., Shrestha, S., Tibrewal, A., Sharma, A. and Yuvraj, K., C. (2015). Isolation of yeast from soil and different food samples and its characterization based on fermentation. *Nepal Journal of Biotechnology*, 3(1): 29-34.

Rani, P., Singh, S., Kumar, A., and Gautam, S. (2024). Utilization of fruit and vegetable processing waste: A step toward sustainable waste management. *Science of the Total Environment*, 922: 171634.

Rathnayake, H. A. I., Navaratne, S. B., and Navaratne, C. M. (2018). Bread making: An overview. *International Journal of Food Science*, 2018**,** Article ID 8187318.

Rodrigues, C. I. S., Wahl, A. and Gombert, A. K. (2021). Aerobic growth physiology of *Saccharomyces cerevisiae* on sucrose is strain-dependent. FEMS Yeast Res. 21(3): foab021. doi: 10.1093/femsyr/foab021. .

Sahlström, S., Park, W., and Shelton, D., R. (2004). Factors influencing yeast fermentation and the effect of LMW sugars and yeast fermentation on hearth bread quality. *Cereal Chemistry.* 81: 328–335.

Struyf, N., Laurent, J., Verspreet, J., Verstrepen, K. J., and Courtin, C., M. (2017). Substrate-limited *Saccharomyces cerevisiae* yeast strains allow control of fermentation during bread making. J. Agric Food Chem. 65(16):3368-3377.

Sun, X., Wu, S., Li, W., Koksel, F., Du, Y., Sun, L., Fang, Y., Hu, Q., and Pei, F. (2023). The effects of cooperative fermentation by yeast and lactic acid bacteria on the dough rheology, retention and stabilization of gas cells in a whole wheat flour dough system—A review. *Food Hydrocoll.* 135, 108212.

Tesfaye, E. L., Tefera, A. T., and Muleta, D. (2025). Assessing the bread-leavening ability of wild yeasts isolated from selected fruits collected from local markets. *PLOS ONE*, 20(5), e0324252.

Timmermans, E., Langie, I., Bautil, A., Brijs, K., Buvé, C., Van Loey, A., Scheirlinck, I., Van der Meulen, R., and Courtin, C., M. (2023). Study of the fermentation characteristics of non-conventional yeast strains in sweet dough. foods. 12(4):830. .

Yadav, D., and Sirohi, R. (2023). Recent advances in fruit peel valorization: Extraction, characterization, and applications. *Future Foods,* 19: 100134.