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Evaluation of Sweet Potato (*Ipomoea batatas*) for Wine Production Using *Saccharomyces cerevisiae*

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This research aims at establishing the possibility of making wine from sweet potato residues under aerobic and anaerobic fermentation regimes.
Study Design: Instruments were autoclaved, and sweet potatoes were grinded into paste, which was thereafter liquefied by α-amylase and amyloglucosidase. The fermentation was done using *Saccharomyces cerevisiae*
Place and Duration of Study: Department of Microbiology, Kwara State University, between June 2024 and September 2024.
Methodology: Fresh white sweet potatoes (*Ipomoea batatas*), without injury were purchase from Mandate Market, Ilorin, Nigeria. The sweet potato was peeled and proximate composition

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determined. Two commercial enzymes (amylase and amyloglucosidase) were used for saccharification of sweet potato roots.
Results: Aerobic fermentation showed a change in the pH from 4.1 to 3.8 while anaerobic fermentation decreased to 3.9. Titratable acidity was lower in aerobic 0.88 than in anaerobic condition (1.6). Yeast concentration was found to be at its highest of 4.6×10^2 cells/ml at the end of the aerobic fermentation experiment, the yeast activity was no observed under anaerobic conditions. Alcohol content reached 9.0% for both approaches and remained more or less constant. Sensory evaluation showed that sweet potato wine was accepted by 72.8% compared to 88% for Carlo Rossi commercial wine.
Conclusion: The proximal composition analysis revealed the sweet potato wine has more glucose and vitamin C than the locally available wines. From these results, it possible to make wine from sweet potato residues and it is comparable to commercial wines.

Keywords: Sweet potato residues; wine production; fermentation; Saccharomyces cerevisiae; proximate analysis; nutritional profile.

1. INTRODUCTION

Global concern in the consumption of good quality alcoholic beverages that are produced using eco-friendly materials has created demand for raw materials that are diverse in wine production. Of these, sweet potato (*Ipomoea batatas*), a root vegetable that is rich in carbohydrates, has gained research interest as a substrate for fermentation. Based on its high accessibility, low costs, and nutrient value, it offers a substitute for conventional wine sources (Gernet et al., 2019). Sweet potato is mainly grown in the tropical and subtropical zones and is an essential source of income and nutrition in food insecure regions, providing a great prospect for the expansion of the beverage sector (Luo et al., 2020). Sweet potatoes contain fermentable sugars and bioactive compounds including polyphenols and vitamins which can improve the nutritional and acceptability of fermented drinks (Maharramova & Maharramov, 2023). These characteristics not only make it suitable for wine production but also fits into the global trend of sustainable production by minimizing food wastage and enhancing underutilized crop innovation (Alaka & Ogunlade, 2024).

Saccharomyces cerevisiae is a yeast species that is most efficient for the fermentative process and has great influence in conversion of sugars to ethanol besides the generation of different aromatic and flavorful compounds in wine (Davydenko et al., 2025). New insights reveal that incorporation of sweet potato and *S. cerevisiae* can result in wines that have distinctive features and diversifying the innovation of beverage science (Natania & Kumalasari, 2022). Consequently, there is still extensive knowledge gap concerning the production of sweet potato based wine with specific emphasis on the effects of the different varieties of the produce, the rate of fermentation and the sensory properties of the final product (Feng et al., 2024). The objectives of this research include determining the potential of sweet potato in wine making using *S. cerevisiae* by analyzing the effects of different fermentation parameters, and evaluating the physicochemical and organoleptic properties of the resultant wine. The findings of this dissertation are expected to help in developing additional raw materials for wine-making which may help in the advancement for the world beverage sector.

2. MATERIALS AND METHODS

2.1 Sterilization and Disinfection

All heat-stable materials, including test tubes, conical flasks, measuring cylinders, and wine bottles, were washed with detergent, rinsed with clean water, and sterilized in a hot air oven at 170°C for 1 hour. Non-heat-stable equipment such as filtering kits, fermenters, stirrers, muslin cloths, and vinometers were disinfected with sodium metabisulfite solution. Workbench surfaces and non-disposable tools were sterilized by wiping with cotton wool soaked in 70% alcohol to maintain aseptic conditions throughout the study (Al Takash et al., 2025).

2.2 Sample Collection and Preparation

Fresh white sweet potatoes (*Ipomoea batatas*) were purchased from Mandate Market in Ilorin, Nigeria. The sweet potatoes were visually inspected for physical defects, cleaned thoroughly, and peeled. The proximate composition, including moisture, protein, fat, ash,

and crude fiber, was determined using standard AOAC methods (Okezie et al., 2025).

2.3 Enzyme and Yeast Preparation

Commercial α-amylase and amyloglucosidase were procured from the Federal Institute of Industrial Research (FIIRO), Oshodi, Lagos, and used for saccharification. The yeast *Saccharomyces cerevisiae* KIV-116, known for its tolerance to high alcohol concentrations and efficiency in alcohol production, was sourced from E.C. Kraus, USA, and activated for fermentation processes (Avila-Gaxiola & Avila-Gaxiola, 2022).

2.4 Saccharification Process

The peeled sweet potatoes, approximately 15 kg, were homogenized with 20 liters of tap water using a laboratory blender to create a mash. Two percent α-amylase was added, and the mixture was incubated at 90°C for 1 hour to facilitate liquefaction. After cooling to 45°C, 10% amyloglucosidase was introduced for saccharification, and the mixture was incubated at 45°C for 48 hours. The saccharified mash was then filtered through sterilized muslin cloth to obtain a clear must, which served as the substrate for fermentation (Yuansah et al., 2023).

2.5 Fermentation

The must, comprising 15 liters of saccharified juice mixed with 5 liters of warm water at 45°C, was treated with a Campden tablet to inhibit unwanted microbial growth and left to stand for 24 hours. The yeast was added directly to the surface of the must at 5 g per batch and stirred gently to initiate fermentation. Aerobic fermentation occurred for six days, with the must stirred twice daily to ensure sufficient oxygenation. The must was then strained, and anaerobic fermentation was carried out in a sealed fermenter fitted with an airlock for four weeks at ambient temperature (28 ± 2°C). After fermentation, the wine was aged for six weeks, filtered using a pressurized filtering system, and bottled (Nadai et al., 2021).

2.6 Proximate Composition

2.6.1 Determination of Ash Content

A clean crucible was weighed (W1) after drying in an oven. About 2 g of the sample was added to the crucible and weighed as W2. The crucible and its content were transferred into a muffle furnace set at 600°C for 4 hours until a gray color indicated complete ashing (Getachew & Mosneh, 2024). After cooling in a desiccator, the crucible was weighed as W3. Ash content was calculated as:

$$\%\ ash\ = \frac{(W3\ -\ W1)}{(W2\ -\ W1)} x100$$

2.6.2 Determination of crude fiber

Following Yunana (2024) methods, 2 g of the sample (W1) was defatted with petroleum ether for 2 hours and boiled under reflux for 30 minutes with 200 mL of 1.25% H_2SO_4. It was filtered, washed until neutral, and boiled with 200 mL of 1.25% NaOH for 30 minutes. The residue was filtered, dried at 100°C, and incinerated in a muffle furnace at 600°C for 3 hours (Al Takash et al., 2025). Crude fiber content was calculated as:

$$\%crude\ fibre\ = \frac{W2\ -\ W3}{W1} x100$$

2.6.3 Determination of moisture content

A clean crucible (W1) was weighed, and 2 g of the sample (W2) was added. The sample was dried in an oven at 105°C, cooled in a desiccator, and weighed as W3 (Oyekanmi et al., 2024). Moisture content was determined as:

$$\%\ Dry\ matter\ = \frac{W3\ -\ W1}{W2\ -\ W1} x100$$

2.6.4 Determination of crude protein

Crude protein was determined using the Kjeldahl method. A 2 g sample was digested with 25 mL of concentrated H_2SO_4, $CuSO_4$, and Na_2SO_4 catalysts at 80°C until a clear green solution was obtained. The digest was diluted to 250 mL, and nitrogen content was determined (Uwah & Ikwebe, 2020).

2.6.5 Determination of Vitamin C

Vitamin C was determined by titrating 1 mL of the sample with 20 mL of 0.4% oxalic acid and measuring absorbance at 520 nm using a spectrophotometer (Abifarin et al., 2020).

2.6.6 Determination of total solids

Two milliliters of wine were evaporated on a boiling water bath and dried at 70°C to a

constant weight. Total solids were calculated as a percentage (Tatah et al., 2024).

2.6.7 Determination of crude fat

Using the Soxhlet extraction method (Sofyan et al., 2021), 5 g of the sample was extracted with petroleum ether (40–60°C) for 6 hours. The extracted residue was dried and weighed to determine fat content.

2.7 Physicochemical Properties and Alcohol Content

2.7.1 Temperature

The fermentation temperature was monitored daily using a thermometer. pH and Titratable Acidity
pH was measured using a Hanna pH meter (HI96107), and titratable acidity was determined with a wine acid kit (Kalopesa et al., 2023).

2.7.2 Sugar content

The sugar content was measured using a refractometer (RF110), with readings taken from the Brix scale (Ajiboye & Olawoyin, 2024).

2.7.3 Specific gravity

Specific gravity was determined using a wine hydrometer (Wang et al., 2021).

2.7.4 Alcohol content

Alcohol content was assessed using a vinometer (Jirasatid et al., 2024).

2.7.5 Enumeration of Yeast in Wine and Must

Yeast population during fermentation was monitored using a hemocytometer under a light microscope (Wang et al., 2021).

2.7.6 Sensory evaluation

Sensory properties of the wine, including taste, aroma, and clarity, were assessed by a panel using a structured point evaluation system and compared with a commercial wine (Lesschaeve & Noble, 2022).

2.7.7 Statistical analysis

Data were analyzed using ANOVA, with significance set at $p < 0.05$. Mean separation was performed using Duncan's Multiple Range Test, and results were expressed as mean ± standard deviation (Bashir et al., 2021).

3. RESULTS

The quest for utilization of cheaper, readily available agricultural produce to boost industrial productivity is essential to achieve growth and development in the country. This research study was undertaken to evaluate sweet potato for wine production using *Saccharomyces cerevisiae.* The results obtained indicated there were variations in the percentage sugar and specific gravity of the must during aerobic fermentation of the wine produce. The sugar content in the wine dropped from an initial value of 16% to 8%, while the specific gravity dropped from 1.062 sp. gr. to 1.030 sp. gr. (Fig 1). Variations in the pH and titratable acidity of the fermenting Sweet potato must during aerobic fermentation are shown in Fig. 2. pH of the must was within the acidic range, the pH ranged from 4.1 to 3.8; there was a general increase in titratable acidity from initial volume of 0.45 to 0.51. During anaerobic fermentation the changes in pH and titratable acidity are shown in Fig. 4. The pH ranged from 4.1 to 3.9 while the titratable acidity increased from 0.8 to 0.9. Fig. 5 shows the Specific gravity and Sugar content during anaerobic fermentation. After aerobic fermentation, specific gravity values were observed to range from 1.028 to 1.025 sp. gr and Sugar content dropped from 7 to 6%. Yeast counts and percentage alcohol produced during aerobic and anaerobic fermentation are shown in Fig. 3 and 6 respectively. The yeast counts increased from 0 to 4.6×10^2 cells/ml. A steady increase in alcohol content was observed in the wines throughout the period of aerobic fermentation, alcohol content increased from 0 to 9% during aerobic fermentation while during anaerobic there was a dropped in yeast counts from 1.8×10^2 cells/ml to 0×10^2 cells/ml, alcohol content was 9%. The percentage acceptability level of the wine produced as compared to white wine is shown in Fig. 7 with sweet potato wine having 72.8.8% acceptability and Carlo rossie wine having 88% acceptability. The proximate composition of sample (sweet potato) is shown in Table 1 parameters of the sample that was analyzed include Protein (5.39 ± 0.01), Ash (2.32 ± 0.01%), Fat (1.36 ± 0.01%), Carbohydrate (26.75 ± 0.02), Fibre (1.26 ± 0.08), Dry matter (37.12 ± 0.02) and Moisture (62.89 ± 0.02). The proximate analysis of the sweet potato wine in comparison with a white wine is shown in Table

2. Vitamin C content in the sweet potato wine is higher than white wine, while Ash and Fat content is present in sweet potato wine and absent in white wine.

Table 1. Proximate composition of sweet potato sample

Parameters	Value (%)
Fibre	1.26 ± 0.08
Carbohydrate (%)	26.75 ± 0.02
Protein (%)	5.39 ± 0.01
Ash (%)	2.32 ± 0.01
Fat (%)	1.36 ± 0.01
Moisture (g/l)	62.89 ± 0.02
Dry matter (%)	37.12 ± 0.02

Table 2. Proximate composition of Standard wine (Carlo rossie) & sweet potato wine

Parameters	White wine (carlo rossie)	Sweet potato wine
Vitamin C (µg/g)	12.98	42.40
Total dissolved solid (g/l)	2.47	16.82
Total solid (g/l)	2.61	18.34
Protein (%)	0.56	0.78
Glucose (%)	4.10	4.80
Ash (%)	ND	0.46
Fat (%)	ND	0.23

Key: ND: Not detected

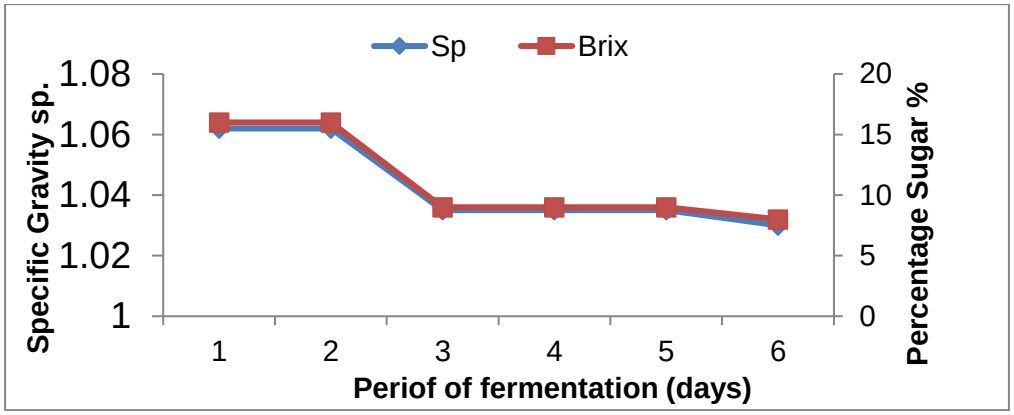


Fig. 1. Relationship between specific gravity and percentage sugar during aerobic fermentation of must

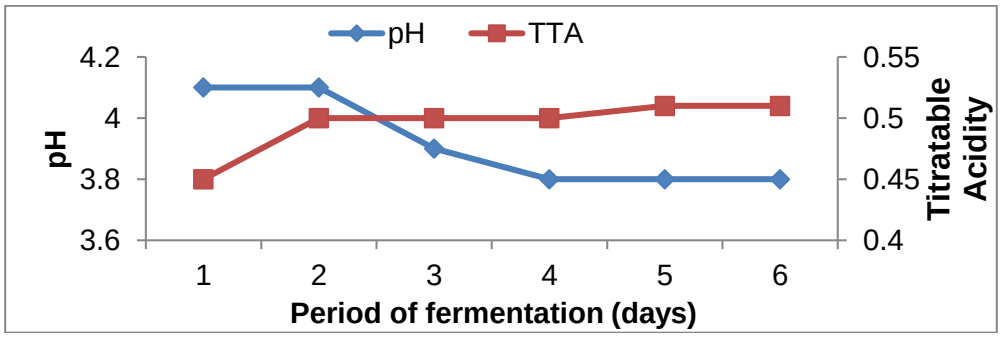


Fig. 2. Relationship between pH and Titratable acidity (TTA) during aerobic fermentation of must

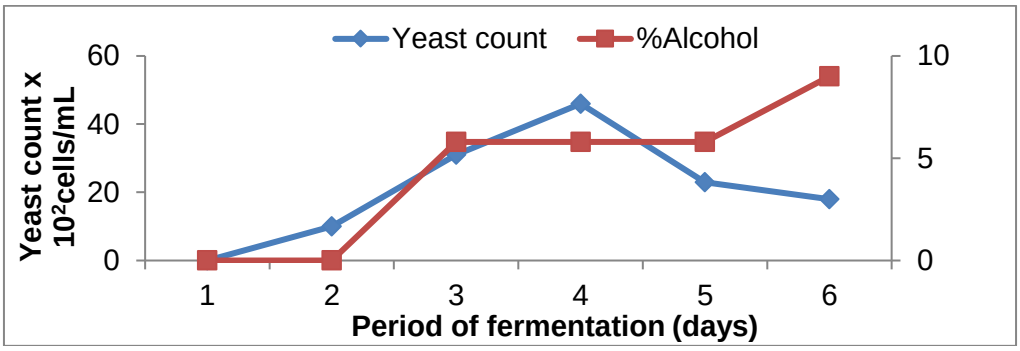


Fig. 3. Relationship between percentage alcohol and total yeast count during aerobic fermentation of must

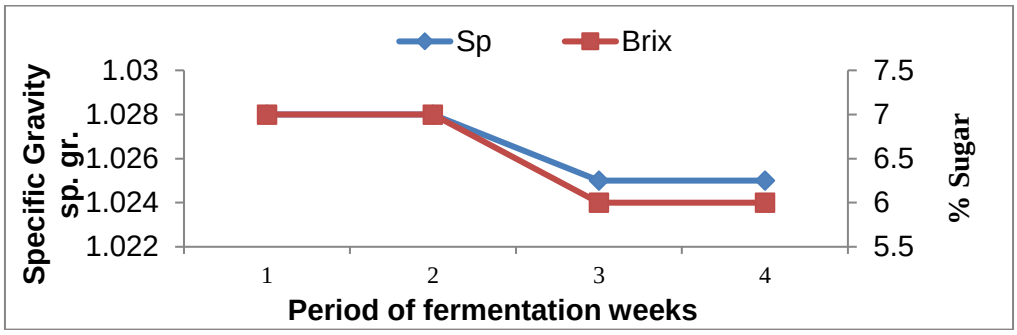


Fig. 4. Relationship between pH and Titratable acidity (TTA) during aerobic fermentation of must

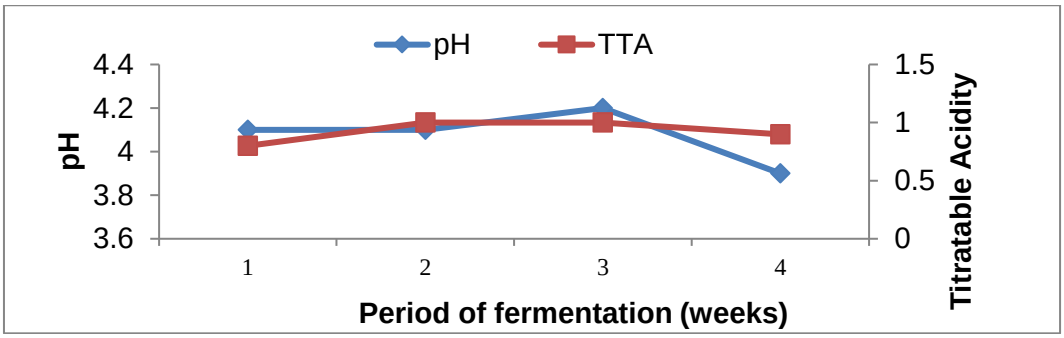


Fig. 5. Relationship between specific gravity and percentage sugar during anaerobic fermentation of must

4. DISCUSSION

The pH of sweet potato wine in this study was decreased to 3.9 during fermentation due to organic acids synthesised by *Saccharomyces cerevisiae*. This corresponds with studies that show fermentation can lower the pH value of sweet potato residues thereby improving their nutritive and functional value (Wu et al., 2024). The titratable acidity was significantly higher in the samples fermented anaerobically, with titratable acidity touching a high of 1.6 while in aerobic fermentation it only got up to 0.88. Acidity is significant to winemaking since it determines fermentation, and impacts the balance of wine. The pH of wines varies with the type of wine, but for dry wines falls within the range of 3 to 7, for sweet wines falls within range of 3.5 to 4.5. The paper also established that higher acidity levels can be as a result of the fortification processes (Kumsa, 2020). Under aerobic conditions, yeast count rose to 4.6 × 10^2 cells/ml in the fourth day while under anaerobic conditions, yeast cells were dead in the fourth week. Oxygen accounted for one of the most critical factors of yeast growth and rate at which

the fermentation took place. Adjustable by O^2 can enhance yeast stress tolerance before fermentation, ensuring the yeast quality as well as the fermentation performance (Tesfaye & Tizazu, 2022).

The decrease in specific gravity from 1.062 to 1.030, in aerobic; and 1.028 to 1,025 in anaerobic signifies decrease in sugar content due to change by yeast from sugar into alcohol. This decrease in specific gravity is a standard sort of fermentation (Adedayo et al., 2021). Alcohol content in both processes was at 9% alcohol per volume. It is perhaps because aerobic fermentation alcohol content fluctuates in a sinusoidal manner that results from interactions between yeast metabolism and the environment. Like any beer, the wine has to be produced consistently to quality, and any changes in it can be attributed to the fluctuations in fermentation as well as the yeast (İlpars et al., 2023). One expects not to find such bacteria since the production of the foods requires high standards of hygiene and sterilization. The products need to be sanitized to avoid a spoilt product and also to promote safety (Shymialevich et al., 2024).

Sensory evaluation showed a 72.8% acceptability for sweet potato wine as opposed to 88% for Carlo Rossi white wine. This point to the fact that sweet potato wine may be considered to be like commercial white wine in terms of sensory properties (Gomis-Bellmunt et al., 2024). In regard to proximate composition, it was observed that sweet potato wine contains more Glucose and Vitamin C than Carlo Rossi white wine. This brings out the nutritional value in the sweet potato as a source of substrate in wine making and an added value (Panda, 2019).

The result indicate that sweet potato is a suitable substrate for winemaking as it produces a product of acceptable organoleptic properties and desirable nutritional profile as the commercial white wines. The improvement of fermentation factors can improve the quality and nutrient content of sweet potato wine.

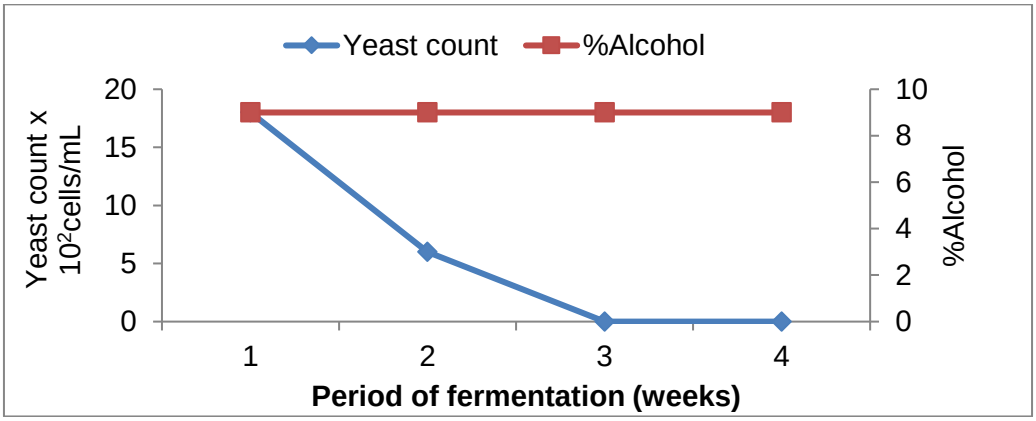


Fig. 6. Relationship between percentage alcohol and yeast count during anaerobic fermentation of must

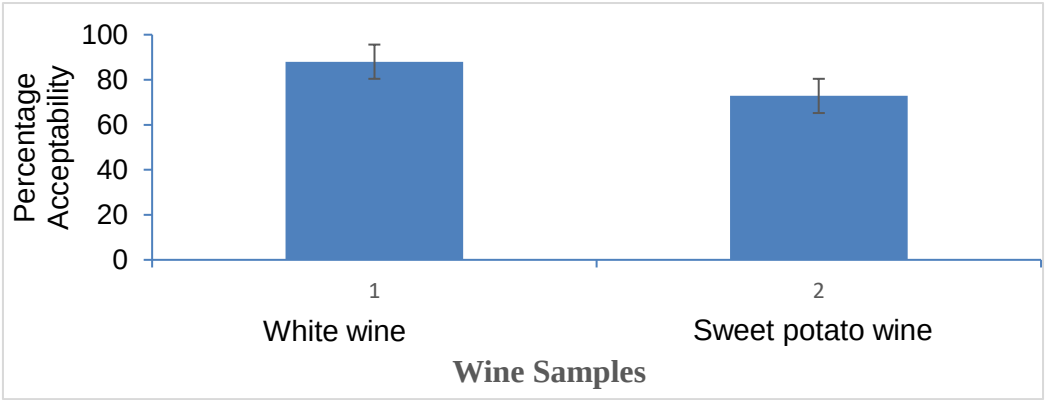


Fig. 7. Percentage acceptability of wine produced compared to white wine

5. CONCLUSION

This study proved that fermentation of sweet potato residues to wine was achieved under both aerobic and anaerobic condition. The pH of the fermenting must reduce in both the trials and anaerobic fermentation produced higher titratable acidity than the aerobic fermentation. The findings isolated oxygen as an important component of yeast metabolism, with aerophilic fermentation allowing for higher yeast yield and alcohol content. Fermentation in both methods yielded wines of comparable alcohol level and but with the anaerobic fermentation higher acid levels were achieved, an important factor in the wine. Sensory analysis of sweet potato wine relative to the commercial wines was established proving viability of using sweet potato residues. The proximate analysis also revealed that sweet potato wine is more nutritious than the brewed wort in glucose and Vitamin C content, implying more nutrition and energy value of the sweet potato wine.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Mubarak Muhammed Abdulrazaq and Bajepade Toheeb Taiye hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Abifarin, T. O., Otunola, G. A., & Afolayan, A. J. (2020). Nutritional composition and antinutrient content of Heteromorpha arborescens (Spreng.) Cham. & Schltdl. leaves: An underutilized wild vegetable. Food Science & Nutrition, 9(1), 172–179. Portico. https://doi.org/10.1002/fsn3.1978

Adedayo, M. R., Ajiboye, A. E., & Yahaya, O. A. (2021). Ethanol Production from Gmelina arborea Wood Wastes by Saccharomyces cerevisiae using Submerged Fermentation. Nigerian Journal of Biotechnology, 37(2), 144–151. https://doi.org/10.4314/njb.v37i2.14

Ajiboye, A. E., & Olawoyin, R. A. (2024). Comparative Studies of Bioethanol Produced from Cassava Peel Using Aspergillus niger and Saccharomyces cerevisiae in Submerged Fermentation. Pan African Journal of Life Sciences, 8(2), 131–137. Internet Archive. https://doi.org/10.36108/pajols/4202/80.0210

Al Takash, A., Faraj, J., Awad, S., El Hage, H., & Khaled, M. (2025). Heating water using the hot air of condensers and tubes-and-fins heat exchangers – Thermodynamic modeling and parametric study with economic and environmental insights. Unconventional Resources, 6, 100146. https://doi.org/10.1016/j.uncres.2025.100146

Alaka, A. C., & Ogunlade, C. A. (2024). Enhancing Food Safety and Quality Through Sustainable Food Production and Consumption Practices in the Global South. Food Safety and Quality in the Global South, 67–93. https://doi.org/10.1007/978-981-97-2428-4_3

Avila-Gaxiola, J. C., & Avila-Gaxiola, E. (2022). Ethanol production from Agave tequilana leaves powder by Saccharomyces cerevisiae yeast applying enzymatic saccharification without detoxification. Industrial Crops and Products, 177, 114515. https://doi.org/10.1016/j.indcrop.2021.114515

Bashir, M. A., Lawani, V. and Johnson, D. O. (2021). Physicochemical properties of *Saccharomyces cerevisiae* in wine production. Journal of Food Science and Technology, 58(5), 1851–1861. https://doi.org/10.1007/s11483-021-04123-1

Davydenko, S., Meledina, T., Vonsky, M., Shabelnikov, S., Kuntsova, M., & Mittenberg, A. (2025). Yeast Saccharomyces cerevisiae proteome responds to ethanol stress. Journal of Wine Research, 1–30. https://doi.org/10.1080/09571264.2025.2463098

Feng, Z., Ruiz-Rodríguez, A., & Palma, M. (2024). Sweet Red Wine Production: Effects of Fermentation Stages and Ultrasound Technology on Wine Characteristics. Applied Sciences, 14(19), 8864. https://doi.org/10.3390/app14198864

Gernet M. V, Gribkova I. N., Kobelev K. V, Nurmukhanbetova Dinara Erikovna, & Assembayeva Elmira Kuandykovna. (2019). Biotechnological aspects of

fermented drinks production on vegetable raw materials. NEWS of National Academy of Sciences of the Republic of Kazakhstan, 1(433), 223–230. https://doi.org/10.32014/2019.2518-170x.27

Getachew, M., & Mosneh, A. (2024). Basic Laboratory Manual: Analysis of Animal Feed and Physical Evaluation. International Journal of Bioorganic Chemistry, 9(2), 33–44. https://doi.org/10.11648/j.ijbc.20240902.14

Gomis-Bellmunt, A., Claret, A., Guerrero, L., & Pérez-Elortondo, F. J. (2024). Sensory evaluation of Protected Designation of origin Wines: Development of olfactive descriptive profile and references. Food Research International, 176, 113828. https://doi.org/10.1016/j.foodres.2023.113828

İlpars, E., Titlová, Š., Hanzalíková, K., Křížová, I., & Brányik, T. (2023). Alcohol-Free Beer Produced Using Maltose-Negative Wine Yeast Saccharomyces cerevisiae with Probiotic Potential. Fermentation, 9(9), 805. https://doi.org/10.3390/fermentation9090805

Isaac Uwah, E., & Daniel Ikwebe, E. (2020). Trace Metals, Potassium Bromate and Nutritional Potentials in Bread from Bakeries in Uyo, Akwa Ibom State, Nigeria. American Journal of Applied Chemistry, 8(3), 63. https://doi.org/10.11648/j.ajac.20200803.11

Jirasatid, S., Yuenyongputtakal, W., Srisuk, N., Intamaso, U., Chutoam, P., & Ittarat, P. (2024). Utilization of rice pasta by-products as the substrate for vinegar fermentation. Journal of Food Science and Technology, 62(2), 325–335. https://doi.org/10.1007/s13197-024-06030-z

Kalopesa, E., Gkrimpizis, T., Samarinas, N., Tsakiridis, N. L., & Zalidis, G. C. (2023). Rapid Determination of Wine Grape Maturity Level from pH, Titratable Acidity, and Sugar Content Using Non-Destructive In Situ Infrared Spectroscopy and Multi-Head Attention Convolutional Neural Networks. Sensors, 23(23), 9536. https://doi.org/10.3390/s23239536

Kovačević, I., Orić, M., Tolić, I. H., & Nyarko, E. K. (2024). Predicting the Specific Gravity of Must During Fermentation Using Machine Learning Models. 32nd International Conference on Organization and Technology of Maintenance (OTO 2023), 351–363. https://doi.org/10.1007/978-3-031-51494-4_29

Kumsa, N. A. (2020). Review on the Effect of Fruit Wine Quality and Fermentation Conditions on the Quality of Wine. Food Science & Nutrition Technology, 5(5), 1–9. https://doi.org/10.23880/fsnt-16000226

Lesschaeve, I., & Noble, A. C. (2022). Sensory analysis of wine. Managing Wine Quality, 243–277. https://doi.org/10.1016/b978-0-08-102067-8.00010-5

Luo, D., Mu, T., Sun, H., & Chen, J. (2020). Optimization of the formula and processing of a sweet potato leaf powder-based beverage. Food Science & Nutrition, 8(6), 2680–2691. Portico. https://doi.org/10.1002/fsn3.1555

Maharramova, S., & Maharramov, M. (2023). Use of Azerbaijan-grown berries to improve nutritional value and reduce toxic metals in soft drinks (including energy drinks). Innovaciencia, 11(1). https://doi.org/10.15649/2346075x.3538

Nadai, C., Giacomini, A., & Corich, V. (2021). The addition of wine yeast <i>Starmerella bacillaris</i> to grape skin surface influences must fermentation and glycerol production. OENO One, 55(2), 47–55. https://doi.org/10.20870/oeno-one.2021.55.2.4556

Natania, K., & Kumalasari, B. (2022). Utilization Of Cilembu Sweet Potato (Ipomoea batatas (L.) Lam.) As Prebiotic Functional Beverage. GCISTEM Proceeding, 1, 41–47. https://doi.org/10.56573/gcistem.v1i.8

Okezie, F. P., Udemba, C. O., Onwukwe, N. E., Eze, E. E., Amandikwa, C., & Elemuo, G. K. (2025). Quality assessment of breakfast gruel produced from sweet potatoes (<I>Ipomoea batatas</I>), soybean (<I>Glycine max</I>) and carrot (<I>Daucus carota</I>). Journal of Agriculture and Food Sciences, 22(2), 112–125. https://doi.org/10.4314/jafs.v22i2.8

Oyekanmi, F. B., Ekundare, O. V., & Oyekanmi, O. A. (2024). Effects of processing on the proximate and mineral composition of cultured and captured *Clarias gariepinus*. Fudma Journal of Sciences, 8(4), 377–381. https://doi.org/10.33003/fjs-2024-0804-2716

Panda, S. K. (2019). Review of Sweet Potato and Its Fermented Products. Technology for Wine and Beer Production from Ipomoea Batatas, 6–37. https://doi.org/10.1201/9780429057106-2

Shymialevich, D., Wójcicki, M., & Sokołowska, B. (2024). The Novel Concept of Synergically Combining: High Hydrostatic Pressure and Lytic Bacteriophages to Eliminate Vegetative and Spore-Forming Bacteria in Food Products. Foods, 13(16), 2519. https://doi.org/10.3390/foods13162519

Sofyan, S., Maesaroh, E., Windyaningrum, R., & Mahardhika, B. P. (2021). The comparison of crude fat analysis between separated soxhlet method and one extractor soxhlet method for several feed ingredients. Jurnal Temapela, 3(2), 60–64. https://doi.org/10.25077/temapela.3.2.60-64.2020

Tatah, S. V., Shadrach, P., & Abah, M. A. (2024). Nutritional and Biochemical Analysis of Locally Produced Wine from a Blend of Banana (Musa sapientum) and Date Palm Fruit (Phoenix dactylifera L.). Asian Journal of Science, Technology, Engineering, and Art, 2(3), 444–461. https://doi.org/10.58578/ajstea.v2i3.3210

Tesfaye, M., & Tizazu, B. Z. (2022). Characterization of Physicochemical and Rheological Properties on Qualities of “Tinsis” Culture and “Tella”: Ethiopian Traditional Fermented Beer. https://doi.org/10.21203/rs.3.rs-860599/v1

Wang, R., Lorantfy, B., Fusco, S., Olsson, L., & Franzén, C. J. (2021). Analysis of methods for quantifying yeast cell concentration in complex lignocellulosic fermentation processes. Scientific Reports, 11(1). https://doi.org/10.1038/s41598-021-90703-8

Wu, H., Shi, X., Fu, Q., Tang, T., Liu, Y., Ma, X., Zhao, M., Zhou, X., Yang, Y., Wang, Z., & Wang, B. (2024). Dynamic Changes of Quality Characteristics During Fermentation of Orange-Fleshed Sweetpotato Wine. https://doi.org/10.2139/ssrn.5048916

Yuansah, S. C., Laga, A., & Pirman. (2023). Enzymatic Saccharification of Purple Sweet Potato Flour by α-Amylase, Xylanase, Mannanase and Amyloglucosidase for Liquid Sugar Production. IOP Conference Series: Earth and Environmental Science, 1182(1), 012044. https://doi.org/10.1088/1755-1315/1182/1/012044

Yunana, Y. L., Olugbemi, T. S., Onimisi, P. A., Salihu, E. A., & Saleh, I. (2024). Evaluation of the proximate, phytochemical and essential oil composition of clove (*Syzygium aromaticum*) as phytogenic feed additive. Nigerian Journal of Animal Production, 1222–1224. https://doi.org/10.51791/njap.vi.6885

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