



Original Article

Fermentation performance of *Saccharomyces cerevisiae* isolated from palm wine

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ABSTRACT

Palm wine is a naturally fermented beverage containing diverse microorganisms, including yeasts with potential applications in alcoholic beverage production. This preliminary study was conducted to isolate and characterize fermentative yeasts from palm wine and evaluate the fermentation performance of the identified *Saccharomyces cerevisiae* isolates as a basis for selecting a suitable isolate for subsequent date palm wine production. Palm wine samples were collected from Maitumbi, Minna, Niger State, Nigeria. Yeast isolates were obtained using standard microbiological techniques and characterized based on cultural, microscopic and biochemical properties, including sugar fermentation, temperature tolerance, ethanol tolerance and hydrogen sulphide production. Three isolates identified as *Saccharomyces cerevisiae* were subsequently screened for fermentation performance based on sugar consumption, alcohol production, specific growth rate and doubling time. The palm wine samples recorded yeast counts ranging from 3.38×10^4 to 4.16×10^4 CFU/mL. The isolates demonstrated varying fermentation performances. Isolate SC3 recorded the highest estimated sugar consumption (70.0%) and alcohol production (6.83%), together with the highest specific growth rate (0.31 h^{-1}) and shortest doubling time (2.23 h), followed by SC2, while SC1 showed the lowest performance. Based on these fermentation characteristics, SC3 was selected as the most promising indigenous *S. cerevisiae* isolate for subsequent studies on date palm wine production. The findings demonstrate that palm wine is a potential source of indigenous fermentative *S. cerevisiae* with useful fermentation characteristics.

Keywords: fermentation performance, indigenous yeast, palm wine, *Saccharomyces cerevisiae*, yeast isolation.

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INTRODUCTION

Palm wine is a naturally fermented beverage produced from the sap of various species of palm trees. It is widely consumed in many tropical regions and constitutes an important component of traditional food and beverage systems.

The natural fermentation of palm wine is associated with a diverse microbial population, including bacteria and yeasts, some of which contribute significantly to the development of the beverage's characteristic properties. Previous studies have documented microbial diversity in

palm wine from different production systems, supporting its role as a natural fermentation environment [3-4].

Yeasts play an important role in alcoholic fermentation because of their ability to metabolize fermentable sugars into ethanol and carbon dioxide. Among the yeasts associated with alcoholic beverage production, *Saccharomyces cerevisiae* is particularly important because of its fermentative capacity and established application in the production of alcoholic beverages. Its metabolic activities also contribute to the formation of compounds that influence the characteristics of fermented products [8-9].

Palm wine represents a potential source of indigenous fermentative yeasts. Yeast strains isolated from traditional fermented beverages may possess characteristics that are useful for local fermentation applications. Such indigenous microorganisms may also be adapted to the environmental conditions in which the fermented beverage is traditionally produced. Previous studies have reported the isolation of *Saccharomyces cerevisiae* from palm wine and its potential application in ethanol and wine production. The fermentation performance of individual yeast isolates may, however, differ considerably. Screening is therefore necessary to identify isolates with desirable characteristics before their application as starter cultures [2,10].

Date palm (*Phoenix dactylifera* L.) is an important fruit crop containing considerable quantities of fermentable sugars and other nutrients. Its composition makes it a potentially suitable substrate for alcoholic fermentation. Previous studies have demonstrated the use of *Saccharomyces cerevisiae* strains in wine production from date palm fruits, indicating the potential of

date palm as a substrate for fermented beverage production [1,7]. The utilization of indigenous yeasts isolated from locally available fermented beverages may provide an alternative approach for the development of fermented products from date palm.

The present study therefore focused on the preliminary stages of the research, namely the isolation and characterization of yeasts from palm wine, identification of *Saccharomyces cerevisiae* isolates, and assessment of their fermentation performance. The best-performing isolate was selected for subsequent work on date palm wine production.

MATERIALS AND METHODS

Study Area

The study was carried out in Bosso Local Government Area of Minna, Niger State, Nigeria. Minna lies within the Guinea savanna zone and experiences distinct wet and dry seasons.

Collection of Palm Wine Samples

Palm wine samples were obtained in triplicate from Maitumbi, Minna, Niger State. The samples were collected and transported to the laboratory in an ice-packed container for microbiological analysis.

Isolation of Yeasts from Palm Wine

Yeast isolation was carried out using previously described methods with modifications. Palm wine samples were serially diluted, and 0.1 mL of the appropriate dilution was inoculated onto potato dextrose agar (PDA). The inoculated plates were incubated at 30°C for 72 hours. Distinct colonies were selected based on their observable characteristics and subcultured repeatedly on PDA to obtain pure isolates. The purified isolates were maintained on PDA slants at 4°C for short-term storage. [6].

Identification and Characterization of Yeast Isolates

The purified yeast isolates were characterized using cultural, microscopic and biochemical characteristics. Cultural characteristics of the colonies were observed, while microscopic examination was carried out following staining with lactophenol cotton blue. The isolates were subjected to sugar fermentation tests using glucose, sucrose, maltose, galactose, mannitol, lactose and xylose. Temperature tolerance and ethanol tolerance were also assessed. The isolates were further examined for hydrogen sulphide (H₂S) production and other relevant characteristics. The characteristics obtained were used for the identification of isolates consistent with *Saccharomyces cerevisiae*. [6].

Screening of Isolates for Fermentation Performance

The fermentative ability of the identified yeast isolates was evaluated using yeast peptone glucose broth. Ten millilitres of the medium was inoculated with a standardized yeast suspension and incubated at $35 \pm 2^\circ\text{C}$ with agitation at 200 rpm for five days. Fermentation activity was monitored spectrophotometrically, while sugar utilization was determined using a refractometer. The fermentation performance of the isolates was assessed based on estimated sugar consumption, estimated alcohol production, specific growth rate and doubling time. All experiments were performed in triplicate. The isolate demonstrating the most desirable overall fermentation characteristics was selected for subsequent research. [5].

RESULTS

Yeast Count of Palm Wine Samples

The yeast counts obtained from the three palm wine samples ranged from $3.38 \times$

10^4 to 4.16×10^4 CFU/mL. Palm wine sample PW1 recorded the highest yeast count of 4.16×10^4 CFU/mL, followed by PW3 with 3.97×10^4 CFU/mL, while PW2 recorded the lowest count of 3.38×10^4 CFU/mL (Table 1).

Table 1: Total Yeast Count of Palm Wine Samples

Palm wine sample	Yeast count ($\times 10^4$ CFU/mL)
PW1	4.16 ± 0.11
PW2	3.38 ± 0.24
PW3	3.97 ± 0.88

Values are presented as mean $\pm$ standard error of mean.

Cultural and Microscopic Characteristics of the Isolates

The yeast isolates obtained from the palm wine samples exhibited cultural and microscopic characteristics consistent with *Saccharomyces cerevisiae*. The colonies were creamy to white in colour, while microscopic examination showed oval-shaped budding cells. The isolates also demonstrated the ability to ferment several of the sugars tested. These cultural, microscopic and biochemical characteristics supported their identification as *Saccharomyces cerevisiae*. Three isolates, designated SC1, SC2 and SC3, were selected for further evaluation of their fermentation performance.

Fermentation Performance of the Isolated *Saccharomyces cerevisiae*

The three *Saccharomyces cerevisiae* isolates showed differences in fermentation performance (Table 2). SC3 demonstrated the highest estimated sugar consumption (70.0%) and estimated alcohol production (6.83%). SC2 showed intermediate values of 64.3% sugar consumption and 5.78% alcohol production, while SC1 recorded the lowest values of 45.0% and 3.94%, respectively. SC3 also recorded the highest specific growth rate of 0.31 h^{-1} and the shortest doubling time of 2.23 hours. SC2 recorded a specific growth rate of 0.28 h^{-1} and a

doubling time of 2.48 hours, whereas SC1 recorded 0.25 h^{-1} and 2.77 hours, respectively

Table 2: Fermentation Performance of Isolated *Saccharomyces cerevisiae*

Parameter	SC1	SC2	SC3
Estimated sugar consumption (%)	45.0	64.3	70.0
Estimated alcohol production (%)	3.94	5.78	6.83
Final specific gravity	1.151	1.137	1.129
Specific growth rate (h^{-1})	0.25	0.28	0.31
Doubling time (hours)	2.77	2.48	2.23

DISCUSSION

The present study demonstrated that palm wine contained viable yeast populations and yielded isolates with characteristics consistent with *Saccharomyces cerevisiae*. The yeast counts ranged from 3.38×10^4 to 4.16×10^4 CFU/mL, indicating the presence of appreciable yeast populations in all three samples. The occurrence of fermentative yeasts in palm wine is consistent with previous reports describing palm wine as a naturally fermented beverage containing diverse microbial communities [3-4]. The cultural and microscopic characteristics of the isolates, together with their sugar fermentation profiles, provided preliminary evidence supporting their identification as *Saccharomyces cerevisiae*. The creamy colonies and oval, budding cells observed are consistent with common characteristics used in preliminary yeast identification. However, the identification in this study was based on phenotypic characteristics rather than molecular confirmation and should therefore be interpreted as preliminary.

The three isolates differed in their fermentation performance. SC3 recorded the highest sugar consumption (70.0%) and alcohol production (6.83%), followed by SC2, while SC1 recorded the lowest values. The variation observed among the

isolates indicates differences in their ability to utilize available fermentable sugars and produce ethanol. Previous studies have similarly reported differences in the fermentation capabilities of yeast strains isolated from traditional fermented beverages. Ukwuru and Awah [2013] reported fermentation-related properties of palm wine yeasts, while Antia et al. [2018] demonstrated the potential of indigenous palm wine yeasts for ethanol production. The growth characteristics further supported the observed differences among the isolates. SC3 recorded the highest specific growth rate (0.31 h^{-1}) and shortest doubling time (2.23 hours), compared with SC2 and SC1. A higher specific growth rate together with a shorter doubling time indicates faster multiplication under the conditions used for screening. Rapid establishment of a fermentative yeast population may facilitate effective utilization of available nutrients and sugars. Nevertheless, growth rate alone does not determine fermentation suitability; it should be considered together with substrate utilization and alcohol production.

The importance of strain characteristics and fermentation conditions in starter-culture performance has also been demonstrated in other fermentation studies [5]. The relatively high sugar

utilization and alcohol production recorded by SC3 are relevant to alcoholic beverage production. Efficient utilization of fermentable sugars is an important characteristic of fermentative yeast because incomplete utilization may leave higher residual sugar and limit alcohol formation. The results therefore provide a practical basis for selecting SC3 for the next stage of the research. The established importance of *Saccharomyces cerevisiae* in fermented beverage production and its broad industrial applications further supports continued evaluation of promising strains [8,9,11].

The selection of SC3 was based on the combined performance of the isolates rather than species identification alone. This is important because isolates belonging to the same species can exhibit different physiological and fermentation characteristics. In the present preliminary screening, SC3 performed comparatively better across sugar consumption, alcohol production, specific growth rate and doubling time. Similar strain-dependent differences have been reported in fermentation systems, emphasizing the need to evaluate individual isolates before their use as starter cultures [5,8]. The selection of SC3 provides the microbiological basis for the subsequent phase of the research involving date palm wine production. Date palm fruits contain fermentable sugars and have previously been investigated as substrates for wine production using *Saccharomyces cerevisiae* strains [1,7]. Further fermentation experiments are therefore required to determine the performance of the selected indigenous isolate in date palm wine and to evaluate the resulting physicochemical and sensory characteristics.

CONCLUSION

This study demonstrated that palm wine is a source of fermentative yeasts with characteristics consistent with *Saccharomyces cerevisiae*. Three isolates, designated SC1, SC2 and SC3, were obtained and characterized. The isolates exhibited differences in fermentation performance. SC3 recorded the highest estimated sugar consumption (70.0%) and alcohol production (6.83%), as well as the highest specific growth rate (0.31 h^{-1}) and shortest doubling time (2.23 hours). These characteristics supported the selection of SC3 for subsequent research. The findings provide a preliminary basis for further investigation of the selected indigenous *Saccharomyces cerevisiae* isolate in date palm wine production.

DECLARATION SECTION

Ethics Approval and Informed Consent.

This study did not use human or animal subjects. Therefore, ethical consideration was not applicable.

Authors' Contribution

Conceptualization: Bala Jeremiah David Maina Caleb Yakubu and Anuonye Julian Chukwuemeka; **Supervision:** Bala Jeremiah David **Investigation:** Bala Jeremiah David and Ndanusa Fatima Adamu ; **Writing the first draft of the article:** Ndanusa Fatima Adamu; **Editing:** Ummulkhair Salamah Ilyasu, Ndanusa Fatima Adamu and Usman Abdulmalik Shehu. All authors contributed to the development of the final manuscript and approved its submission.

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Disclosure of Conflict of interest.

None

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