Antioxidant, Functional and Sensory Properties of Wine Produced from Yellow Mombin (*Spondias mombin* L.) Using a Wild Yeast (*Saccharomyces cerevisiae*) from Palm Wine

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Abstract: Yellow mombin is an underutilized indigenous fruit characterized by unique flavor and high sugar content making it suitable for exotic wine production though fermentation. This study was aimed at exploiting the fermentative capability of palm wine *Saccharomyces cerevisiae* in the production of wine and evaluating the functional, antioxidant and sensory attributes of wine produced from yellow mombin fruit. High ethanol tolerant (14%) *Saccharomyces cerevisiae* isolated from palm wine was used to ferment yellow mombin 'must' for 7 days of primary (aerobic) fermentation and 7 days of secondary (anaerobic) fermentation successively. Wine samples were subjected to microbial analysis, physicochemical analysis and antioxidant capacity assay using standard methods. Sensory attributes of the yellow mombin wine were evaluated adopting the nine-point hedonic scale using commercial indigenous wine as control. At the end of the fermentation, the yeast and coliform populations were at 6.02 and 0.0 log10CFU/ml respectively. The physicochemical values of the yellow mombin wine with respect to pH, titratable acidity, Brix^{o}, specific gravity, alcohol content, temperature were 3.35, 0.89%, 5.70, 1.012, 10.5% (v/v), 28 ^{o}C, respectively. The yellow mombin wine had a moisture content of 86.85%, total phenolic content of 19.10 mgGAE/100ml, DPPH (2,2-diphenyl-1-picrylhydrazyl), FRAP (ferric reducing antioxidant power) and ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonate) of 65.12%, 18.35 mgGAE/100ml, and 11.34% respectively. The yellow mombin wine was preferred by the panelists as its overall acceptance rating was 8.5. This study has shown yellow mombin to be good substrate for acceptable table wine production using *Saccharomyces cerevisiae* from palm wine.
Key word: Fermentation, *Saccharomyces cerevisiae*, Wine, Yellow mombin

INTRODUCTION

Wine is a product of fermenting a suitable fruit juice using yeast. Yeast metabolizes the sugar in the fruit juice to produce carbon dioxide and alcohol as by products (He *et al*., 2013; Okeke *et al*., 2015). Wine can be produced from any fruit with a good sugar content proportion, hence wines have been produced from some tropical fruits such as banana, pineapple, orange, pawpaw, water melon and others (Mathew *et al*., 2017; Ajit *et al*., 2018; Zainab *et al.,* 2018; Kantiyok *et al*., 2021). Interestingly, conversion of fruit juice to wine though fermentation is an important approach to adding value to plants and plant products. Fermentation improves the bioavailability of essential nutrients in plant materials, the functional and antioxidant properties of fruits have been reportedly enhanced by fermentation (Hu *et al*., 2023; Phovisay *et al*., 2024), the sensory properties such as the flavor, aroma, bitterness and astringency which influences the consumers sensory perception (Zhu *et al*., 2023) as well as the stability of wine are also being enhanced by fermentation (Ajit *et al*., 2018). The production of indigenous commercial wine in most developing countries is faced with a major setback of unavailability of effective fermentative yeast (*Saccharomyces cerevisieae*) strain (Mathew *et al*., 2017). The choice of yeast strain in wine production is one of the factors that determine the type and organoleptic properties of the wine produced (Kanter *et al*., 2020, Parapouli *et al*., 2020). Utilizing indigenous yeast strain in wine production is of economic advantage as it reduces the cost of production. Some researchers have reported the production of indigenous wine using wild yeast strain (*Saccharomyces cerevisiae*) with desirable traits such as; high viability, good metabolic activity and high ethanol tolerance (Mathew *et al*., 2017; Kantiyok *et al*., 2021; Phovisay *et al*., 2024). *Spondias mombin* (Linn) also known as Hug plum or yellow mombin an underutilized orphan tropical fruit is a member of the family anacardiaceae (Tiburski *et al*., 2011). *Spondias mombin* abounds in Nigeria as a

tropical country, the small ovoid fruit changes from its initial green color to golden yellow when ripe, it has sweet and tart taste, with high water content, highly nutritious with numerous health benefits (Tiburski *et al*., 2011). Some researchers have exploited the pharmacological activities of yellow mombin, Sabiu *et al*. (2016) reported its gastro-protective effect and Cabral *et al*. (2016) reported its anti-inflammatory and antioxidant potential. Hence, the production of wine with yellow mombin as the substrate could result to a novel tropical fruit wine, as Merlino *et al*. (2021) stated that young people have desire for consumption of novel wine.

Yellow mombin on full maturity due to its prolific nature can yield more than 100 kg fruits per year, this bountiful harvest can be wasted if not properly preserved. The short shelf life of Yellow mombin as a result of its climacteric nature is a set back to its effective utilization, yellow mombin as an orphan fruit is also not getting adequate research attention as ought to be. Production of wine using yellow mombin could curb wastage and attract interest of consumers. Therefore, this study was aimed at exploiting the fermentative capability of palm wine *Saccharomyces cerevisiae* in the production of wine and evaluating the functional, antioxidant and sensory attributes of wine produced from yellow mombin fruit.

MATERIALS AND METHODS

Collection of Samples: Yellow mombins were purchased from Orie ugba market in Umuahia North LGA, identity of the fruit was authenticated at the department of Plant Science and Biotechnology of Michael Okpara University of Agriculture Umudike. Fresh palm wine samples were collected using sterile container from tappers in Ndioru community in Ikwuano LGA all in Abia State, Nigeria. The palm wine samples were conveyed to the laboratory using a thermo-flask with ice-packs.

Isolation and Identification of Yeast: Slightly modifying the methods of Olowonibi, (2017) yeast were isolated from palm wine by inoculating 1 ml of solution prepared by diluting 0.5 ml of palm wine with 5 ml of sterile water onto a yeast peptone dextrose agar, and Incubated at 30 ^{o}C for 72 h. Yeast were preliminarily identified microscopically, pure culture were obtained by plating the identified yeast colonies on yeast peptone dextrose agar supplemented with 30 mg/ml chloramphenicol and incubated at previously mentioned conditions. The identity of the yeast isolates were further confirmed based on utilization of various fermentable sugars. Sugar fermentation tests were carried out by separately dispensing 10 ml each of 1% prepared lactose, raffinose, xylose, glucose, sucrose, maltose, fructose and galactose into different tubes, Durham tubes were introduced into each test tube and autoclaved. The sterilized medium were inoculated with yeast culture and incubated at 30 ^{o}C for 96 h, the test tubes were observed for gas and acid production.

Ethanol Tolerance of the Yeast Isolate: Ten milliliter of the isolated *Saccharomyces cerevisieae* culture (24 h old) was inoculated into yeast peptone dextrose broth (100 ml) and subjected to different level of ethanol (6%, 8%, 10%, 12%, 14%, 16%, 18%, 20%) and incubated for 4 days in a rotary incubator (150 rpm) at 30 ^{o}C. Estimation of the yeast population was carried out at 12 h interval using spectrophotometer at 660 nm. Ethanol tolerance level was extrapolated from a growth curve constructed with the obtained data (Okeke *et al*., 2015).

'Must' Preparation: Healthy ripe yellow mombins fruits were washed with water, deseeded and crushed with a blender. The Yellow mombins juice was strained using a sterile muslin cloth (0.8 mm). The ^{o}Brix of the juice was adjusted to 20% (w/w) with a sugar solution prepared by addition of 100 g of sucrose to 250 ml of water. The pH of the must was adjusted to 4.0 using citric acid, the must was decontaminated with 0.2 M potassium metabisulphate (10%) and pasteurized at 75 ^{o}C for 20 min.

Inoculum Preparation: To prepare a pre-inoculum, 24 h old culture broth of *S.*

cerevisieae was centrifuge at 6000 rpm for 10 min at 4 ºC. The separated pellets were washed twice using a normal saline, the pellets were resuspended in a normal saline and adjusted to an optical density (O.D) of 0.1 at 660 nm. The pre-inoculum (10 ml) was transferred into an Erlenmeyer flask containing 100 ml of the must and incubated for 24 h on an orbital shaker at 60 rpm. The culture was further diluted with the yellow mombin must to obtain an O.D of 0.1 at 660 nm, this was used as the inoculum.

Fermentation of Yellow Mombin 'must' Primary and Secondary fermentation: Inoculum size of 5% (v/v) was used to pitch 1 L of the yellow mombin must, properly mixed pitched 'must' in a fermentation jar stoppered with 10% sodium benzoate solution soaked cotton wool was kept in a cool dry place (room temperature) while shaken once daily for 7 days. The fermenting must was racked and transferred to sterile fermentation bottle covered with airtight fitted stopper, then kept at a room temperature where it was allowed for further fermentation for 7 days. At the 7th day of the secondary fermentation the jar was placed in a water bath (70 ºC) to halt the fermentation process and racked off of the sediment 3 times, it was pasteurized for 20 min at 70 ºC , thereafter it was kept at 8 ºC in a refrigerator, this temperature was maintained for 7 days to enable maturation. The wine was further kept for 30 days in a stopper fitted airtight fermentation bottles at 20ºC to mimic aging (Okeke *et al*., 2015).

Microbiological Analysis: Spread plate was adopted for the estimation of microbial population of the fermenting yellow mombin 'must'. Samples were serially diluted and plated on the following prepared media; Potato dextrose agar (PDA), DeMan Ragose Sharpe agar (MRS), Macconkey agar (MA) and Nutrient agar (NA). The PDA culture plates were incubated at 28ºC ±2 for 48 h while the MRS, NA and MAC culture plates were incubated at 30ºC for 24 h.

Proximate and Physicochemical Analysis: The physicochemical properties of the fermenting must were determined from the day 0 to the day 7 (primary fermentation) on a 24 h interval and also on the 14th day of the secondary fermentation. The density method was adopted in the determination of the alcohol content (AOAC, 2019), the analytical thermometer and digital pH meter were used to determine the temperature and pH respectively. Standard method was adopted to determine the total titratable acidity as% malic acid of the fermenting must (AOAC, 2019). The fermenting must Brix was determined using a refractometer. The specific gravity of the samples were determined using a pycnometer (50 ml) as described by AOAC (2019). The 'must' and wine proximate components were determined using standard methods. The moisture content was determined using the thermogravimetric method and Kjeidal method was adopted in the determination of the samples protein content Fat content was assayed using the acid hydrolysis method, enzymatic gravitational method was used in the determination of the crude fiber (AOAC, 2019), and the carbohydrate content determination was done by difference method calculation (Okeke *et al*., 2015).

Phytochemical Properties of the Wine and 'must' Total Phenolic Content Analysis: Folin-Ciocalteau reaction technique described by Hu *et al*. (2023) was adopted to determine the total phenolics compounds content of the yellow mombin 'must' and wine. Sequentially, 0.5 mL Folin-Ciocalteau reagent (10%) and 2 mL of sodium carbonate (7.5%) were added into 0.2 ml of the sample, absorbance was read at 760 nm after incubation in a dark room at 28 ºC ± 2 for 35 min. The results were expressed in mg gallic acid equivalent (GAE)/100 ml sample using gallic acid as standard.

Flavonoid Content Analysis: Chang *et al.* (2002) described spectrophotometric method was adopted to determine the total flavonoid content of yellow mombin Must and Wine. Methanol (0.9 ml) was added to 0.1 ml of the sample to make it up to 1 ml, thereafter deionized water 4 ml, 0.3 ml of $NaNO_2$ (5%) and 0.3 ml of 10% w/v $AlCl_3$ solution were added. The mixture was incubated at

ambient temperature for 6 minutes, after that 1 M NaOH (2 ml) and 2.4 ml deionized water were added then mixture was kept at room temperature for 15 min. Using Quercetin as the standard the absorbance was read at 515 nm.

Tannin Content Analysis: Ten milliliters of acetone (70%) was added into 50 mL of the sample then covered and placed in an ice bath shaker and agitated for 2 h. The mixture was centrifuged and supernatant collected and kept on ice, distilled water 0.8 ml was added into 0.2 ml of the supernatant in a test tube. Folin reagent (0.5mL) followed by 2.5 ml of Na_2CO_3 (20% w/v) was added to the test sample and the tannic acid solution standard and then incubated for at 28°C ± 2°C for 40 min. At 725 nm the absorbance and the the tannic acid standard curve was used to determine the tannin content (Watrelot, 2021).

Antioxidant Activity Analysis: The antioxidant assay was determined by slightly modifying the method reported by Ozgen *et al*. (2006) The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay reaction solution was prepared by adding 0.5 mL of methanolic DPPH solution (0.2 mmol/L) to 0.5 ml of the sample, the solution was kept at room temperature in the dark for 20 min. The absorbance of the mixture was measured at 517 nm and the DPPH radical scavenging activity was calculated and expressed as% inhibition. The ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonate) working solution 1 mL was mixed with 0.5 mL samples, then kept for 30 min before absorbance was read at 734 nm. Using Trolox as a standard the trolox equivalent antioxidant capacity was calculated, the final results were expressed as mmol of Trolox equivalents per liter of the sample (mmol/L). The FRAP (ferric reducing antioxidant power) reagent 1.8 Ml was mixed with 0.2 mL of the sample, the absorbance of the mixture was read at 595 nm. FRAP was calculated and the results expressed as mg ascorbic acid equivalent per 100 mL of the hog plum product samples.

Sensory Evaluation: The hedonic scale method was employed to evaluate the sensory qualities of wine samples. Ten semi-trained panelists (regular wine drinkers) within the age range 25–40 years were randomly served the yellow mombin wine (fresh and aged) and a commercial wine. Their preference was measured for five main attributes: color, mouth feel, tartness, taste, and flavor on a nine-point hedonic scale, with 1 signifying extremely disliked and 9 signifying extremely liked. The overall acceptability of each sample was evaluated by averaging the other attributes. To avoid mix up panelists rinsed mouth with water and took 10 min break between tasting.

Statistical Analysis: The collected experimental data significant difference were analyzed using one way analysis of Variance (ANOVA), the statistical significance of the obtained differences were determined by Duncan's multiple range test 5% level of probability. SPSS version 17 was used for this analysis.

RESULTS

Four wild yeasts were isolated from palm wine, presumptive identification of the yeast isolates based on their morphology and biochemical reaction (creamy, flat, circular, and negative for both lactose utilization and nitrate reduction) characterized the yeast as *Saccharomyces cerevisiae*. The ethanol tolerance test of the tentative *Saccharomyces cerevisiae* strains showed that the 4 isolates tolerated ethanol at 12% concentration, but one strain showed ethanol tolerance up to 14% concentration. The carbohydrate utilization profile of the selected high ethanol (14%) tolerant isolate was positive for maltose, glucose, raffinose, galactose, fructose, sucrose and negative for xylose and lactose (data not shown) these characteristics confirmed it to be *Saccharomyces cerevisiae*.

The microbial analysis of the wine (Figure 1) showed that there was a continuous increase in the yeast count from the initial count of 0 to 7.29 log 10 CFU/ml at day 6, a decline in yeast population was recorded on

the day 7 (6.05 log 10 CFU/ml), there was no significant viable growth of coliforms, the total bacterial count reduced to 0.0 at day 7 of fermentation while the total lactic acid bacteria count reduced to log 10 1.93 CFU/ml from the initial count of 2.62 log 10 CFU/ml.

Variations were observed in the physiochemical properties of the yellow mombin during fermentation with the selected *Saccharomyces cerevisiae* for the production of wine (Table 1). The ºBrix content continuously decreased from initial value of 20% (w/w) to final the value of 5.70% (w/w) following the same trend the specific gravity reduced from 1.07 to 1.012. There was steady production of alcohol from initial 0.20% (v/v) to final 10.50% (v/v). The pH decreased from 3.86 to 3.35 and a resultant increase in the titratable acidity from 0.64 to 0.89% (w/w) was recorded. A temperature increased from 27 ºC to 29 ºC was recorded from day 0 to day 3, furthermore, there was a decline to a final temperature of 28.00 ºC at day 14.

The proximate composition of the 'must', young wine and the aged wine (Table 2) showed that the moisture content ranged from 86.90 to 86.87%, the protein, fat, and carbohydrate contents were higher in the yellow mombin 'must' (1.22, 0.10, and 11.78 respectively) and least in the aged wine (1.11, 0.01, 0.54% respectively).

Table 3 shows the photochemical and antioxidant properties of the yellow mombin 'must' and wine. The total phenol content, flavonoid and tannin content was highest in the 'must' 24.05, 22.95 and 19.10 mg/GAE100ml respectively, with corresponding high antioxidant activities of DPPH 73.67%, FRAP 25.18 mgGAE/ml and ABTS 14.02%.

Sensory evaluation of the produced wine using a commercial grape wine as a control (Figure 2), showed that panelists had preference for the aged yellow mombin wine with overall acceptability of 8.5, while the least desired wine was the domestic commercial wine (7.6).

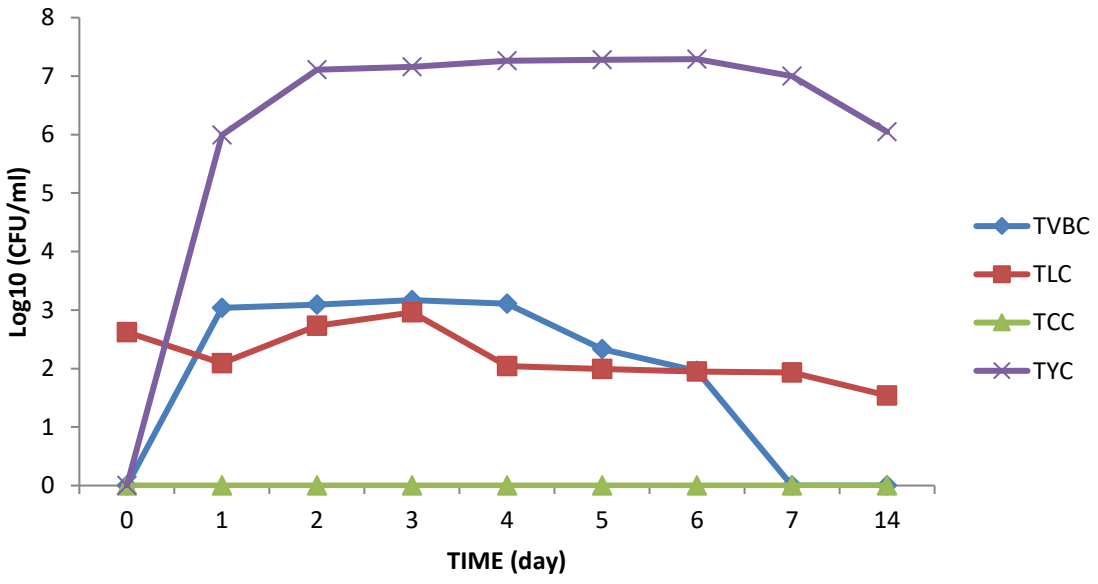


Figure 1: Microbial population during the fermentation of yellow mombin

Table 1: Change in physiochemical properties of yellow mombins during fermentation

Time (days)	°Brix (% w/w)	Specific gravity (% Brix)	Alcohol (% v/v)	pH	Titratable acidity (% w/w)	Temperature (°C)
0	20.00 ± 0.02^{a}	1.072±0.009^{a}	0.20 ± 0.03^{f}	3.86 ± 0.00^{a}	0.64 ± 0.00^{f}	27.00±0.10^{d}
1	18.30 ± 0.11^{b}	1.071±0.017^{a}	1.62 ± 0.04^{e}	3.73 ± 0.02^{b}	0.67 ± 0.03^{e}	27.60±0.50^{d}
2	14.50 ± 0.04^{c}	1.069±0.011^{a}	5.10 ± 0.07 ^{d}	3.75 ± 0.55^{b}	0.71 ± 0.01^{d}	29.10±0.70^{c}
3	11.80 ± 0.20^{d}	1.068±0.012^{a}	8.01 ± 0.10^{c}	3.72 ± 0.23^{b}	0.72 ± 0.01^{d}	29.00±0.00^{c}
4	9.70 ± 0.07^{e}	1.067±0.026^{a}	8.23± 0.01^{c}	3.71 ± 0.08^{b}	0.75 ± 0.11^{c}	28.80±0.10^{c}
5	8.90 ± 0.15^{f}	1.064±0.012^{b}	8.50± 0.04^{b}	3.70 ± 0.05^{b}	0.76 ± 0.04^{c}	28.40±0.10^{b}
6	8.90 ± 0.05^{f}	1.057±0.001^{c}	8.68±0.01^{b}	3.59 ± 0.25^{c}	0.82 ± 0.02^{b}	28.40±0.00^{b}
7	8.75 ± 0.02^{f}	1.055±0.002^{c}	8.73±0.02^{b}	3.47 ± 0.17^{c}	0.83 ± 0.01^{b}	28.10±0.30^{a}
14	5.70 ±0.01^{g}	1.012±0.000^{d}	10.50±0.00^{a}	3.35 ± 0.10^{d}	0.89 ± 0.01^{a}	28.00±0.10^{a}

Keys: Each value shows means of three replicates ± SD. Values in the same column with different letter superscripts are significantly different at p<0.05.

Table 2: Proximate composition of the yellow mombins '*must*' and wine

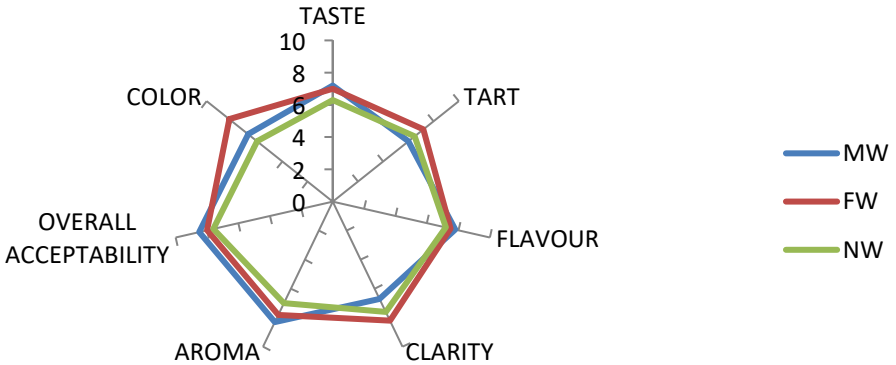
Parameters (%)	Percentage composition (%)		
	'Must'	Young wine	Aged wine
Moisture content	86.90±0.67^{ac}	86.87±0.91^{ac}	86.85±0.83^{ac}
Protein	1.22±0.02^{ab}	0.16±0.00^{bc}	0.11±0.00^{bc}
Fat	0.10±0.002^{a}	0.05±0.001^{b}	0.01±0.001^{c}
Crude fibre	0.00±0.0^{ab}	0.00±0.0^{ab}	0.00±0.0^{ab}
Carbohydrate	11.78±0.021^{a}	2.25±0.01^{a}	1.54±0.02^{a}

Keys: Each value shows means of three replicates ± SD. Values in the same column with different letter superscripts are significantly different at p<0.05.

Table 3: Phytochemical and antioxidant capacity of the yellow mombin wine

Parameters	Samples		
	'Must'	Young wine	Aged wine
Total phenolic (mgGAE/100ml)	24.05±0.11 ^{a}	22.95±0.09^{b}	19.10±0.12^{c}
Tanins (mg/100ml)	11.42^{ab}±0.11	10.75±0.17^{bc}	10.25±0.09^{cd}
Flavonoid mg/100 ml	9.14±0.05 ^{a}	8.66 ±0.21^{b}	8.07^{c}±0.07
DPPH (%)	73.67^{a}±0.65	71.76±0.91^{b}	65.12±0.03^{c}
FRAP (mgGAE/ml)	25.18±0.17^{ab}	20.25±0.18^{bc}	18.35±0.51^{cd}
ABTS (%)	14.02±0.22^{a}	12.21±0.11^{b}	11.34±0.04^{c}

Keys: Each value shows means of three replicates ± SD. Values in the same row with different letter superscript are significantly different at p<0.05.



MW= yellow mombin wine, FW= foreign commercial wine, NW= domestic commercial wine

Figure 2: Comparative mean score of yellow mombin wine, local commercial wine and foreign commercial wine

DISCUSSION

The yeast isolate used in this study is a *Saccharomyces cerevisiae* as indicated by its morphological and cultural characteristics (creamy, circular, convex and cocci) (Barnett *et al*., 2000; Olowonibi, 2017; Zainab *et al*., 2018) also the sugar fermentative characteristics of the isolate which showed positive for glucose, sucrose, fructose, maltose galactose and negative for lactose corroborates with the previous studies of Ebana *et al*. (2021) and Mohammed *et al*. (2022) which isolated and characterized *Saccharomyces cerevisiae* from palm wine. The isolated *Saccharomyces cerevisiae* showed ethanol tolerance of up to 14% which means that this yeast strain can be active metabolically in a medium during fermentation with up to 14% alcohol. The findings of Hawaz *et al.* (2022) and Mohammed *et al*. (2022) are in consistent with the findings of this study as they isolated wild *Saccharomyces cerevisiae* with 14% and 18% ethanol tolerance respectively. Even higher yeast (*Meyerozyma caribbica*) ethanol tolerance level of 20% was reported Hawaz *et al*. (2022).The continuous increase in yeast population from day 2 of fermentation to day 6 (5.99-7.29 Log10 CFU/ml) showed that yellow mombin has adequate readily utilizable sugar and also a suitable medium and substrate for fermentation of yeast. At day 7 there was a decline of yeast cell population to 6.05 Log10cfu/ml, this might be due to reduction in the 'must' sugar content as a result the yeast cells metabolism. Coliform was not isolated from both the fermenting must and wine hence it is fair to say that the produced wine was safe for consumption. The continuous reduction in the count of viable culturable bacteria is an indication that the fermenting must was not a conducive environment for their propagation, as the fermenting 'must' was characterized by a decrease in nutrient content and pH and a resultant increase in alcohol content. At day 7 no viable bacteria was isolated. This is in agreement with the work of Kantiyok *et al*. (2021) and Zainab *et al*. (2018). The lactic acid bacteria had increased in population till day 4 of fermentation when a decrease in population was observed, a related result was obtained by Osaro-Matthew *et al*. (2024) during the fermentation of malay apple where a decline in lactic acid bacteria was observed at 72 h (day 3) fermentation. This could be as a result of deleterious effect of some metabolites accumulated during fermentation (Ogodo *et al*., 2018). The presence of these autochthonous bacteria can be explained by the fact that some bacteria are heat resistant (thermoduric) and could survive pasteurization (Lee *et al*., 2024). It is important to track the physicochemical properties of the wine during fermentation, so as to keep record of the fermentation progression. ^{o}Brix a vital parameter in the monitoring of fermentation progress, was observed to have dropped from the initial 20% to 8.75% at day 7 when the primary fermentation process was halted. The continuous change in the brix showed that the fermentation was making head way and the yeast cells were active. A final brix of 5.70% was obtained at the day 14 of fermentation, this is an indication that the wine contains low residual sugar, hence can be categorized as a dry wine (Awe and Nnadozie, 2015). Similar reduction in ^{o}Brix content from 21.84 to 6.22 was obtained by Ezenwa *et al*. (2020) and from 20 to 7 by Hu *et al* (2022) during yeast fermentation of beetroot and pitaya respectively. The specific gravity of the yellow mombin wine gradually decreased during the 14 days fermentation from the initial 1.072 to 1.012 final specific gravity. This same trend was observed by Balogu and Towobola (2017) and Hu *et al*. (2020) during fruit wine production. This implies that the reducing sugar is being utilized efficiently by the yeast cells for alcohol production and growth.

The findings of this study showed a steady production of alcohol during the fermentation period. However, a rapid increase in alcohol content was recorded from day 1 to day 3 of the fermentation

period, which clearly showed that the *S. cerevisiae* was actively growing and rapidly converting the sugar to alcohol. The end product alcohol quantity was about 10.50±0.02% v/v, this is within the alcohol tolerance range of the studied yeast strain. It is important that the alcohol content of a wine is above 10% as it helps in the stability of the wine and also makes it less accommodating to spoilage microorganisms (Chilaka *et al*, 2010). Corresponding results of a final alcohol content of 8.4%v/v was reported by Ezenwa *et al.* (2020) in beetroot wine and also 8.0%v/v alcohol in banana and pineapple wine mixture was reported by Ajit *et al*. (2018). According to the wine ranking by European Economic Community, yellow mombins wine can be categorized as a table wine as its alcohol content fell within recommended table wine alcohol content range of 8.5 to 19.5% (Umeh *et al*., 2015). Titratable acidity is one of the parameters that affects the organoleptic properties of wine, hence should not be overlooked. The titratable acidity of the fermenting yellow mombins must increased steadily from 0.34 to 0.49% and inversely the pH of the yellow mombins wine continuously decreased from the initial pH of 4.36 to 4.05 which fell within the category of sweet wine (Awe and Nnadozie, 2015). Although, it is expected that the final titratable acidity of wine falls between 0.5 to 1% (Okeke *et al*., 2015; Chidi *et al*., 2018), a final titratable acidity of 0.49% in the studied yellow mombins wine is also close to the range. Consistent increase in acidity is due to accumulation of organic acids during fermentation, this is favorable to the *S. cerevisiae* which is acidophilic and also keeps spoilage microorganisms at bay (Okeke *et al*., 2015; Ogodo *et al*., 2018). Similar trend was observed by Ezenwa *et al*. (2020) in beet root wine the titratable acidity increased from 0.15 to 3.4% and consequently the pH decreased from pH 4.7 to 3.9. Balogu and Towobola (2017) report on honey and coconut milk wine mixture also corroborates with these findings. Won *et al*., 2015 emphasized that the pH of a fermentation end product should be lower than 6.0 to eliminate contaminants, therefore the yellow mombins wine is safe for consumption as the final pH was 4.05.

The metabolic activities of the fermenting yeast can affect the temperature of the fermenting must, fermentation is an exothermic process that generates heat which results to temperature rise (Mathew *et al*., 2017). The initial (day 0) and final (day 14) temperature of the yellow mombin must was at 27.0 ºC and 28.0 ºC respectively. However, at day 2 and day 3 fermentation period a higher temperature of about 29.1 ºC was obtained, this might be attributed to the yeast cells rapidly catabolizing the sugar in the must as reflected on the spontaneous drop in the must brix observed. This is in agreement with the reports of Zainab *et al*. (2018) and Mohammed *et al.* (2022).

The moisture content of the yellow mombins wine was 86.87% for the young wine and 86.85% for the aged win, which were slightly lower than that of the 'must' (86.90%), evaporation due to increase in temperature as a result of metabolic heat generated by the yeasts cells might account for this insignificant reduction Zainab *et al*. (2018). Generally, the yellow mombins wine has high moisture content which is one attribute of a good beverage to enable it refresh and hydrate the consumer (Okeke *et al*., 2015; Kantiyok, 2021). Reduced protein content was recorded in the young wine (1.16) although that of the aged wine was much lower (1.11%), the importance of protein to the yeast cell might explain this decrease as it is essential in the maintenance of cell (Awe and Nnadozie, 2015). For clarity and stability of wine it is desirable that the protein content of wine is low (Cosme *et al*., 2020). Generally, the fat content of the yellow mombins must and wine was low, hence yellow mombin wine can be categorized as a healthy drink that is low in cholesterol. A reduced carbohydrate content from 11.78% in the must to as low as 2.25% and 1.54% was observed after the fermentation and aging process respectively, this decline in the carbohydrate might be

ascribed to the breakdown of sugar due to the metabolic activities of the yeast cells. Mohammed *et al*. (2022) reported a consistent decrease in carbohydrate content during fermentation of green and purple grapes using *Saccharomyces cerevisiae*. Similar results were obtained by Zainab *et al*. (2018); Ebana *et al*. (2019); Silas and Abah (2025) during the yeast fermentation of some indigenous fruits and vegetables. There was no crude fiber detected in the yellow mombins 'must' and wine, this might be due to the fact that the juice extract was fermented not the whole fruit. Correspondingly Mohammed *et al*. (2022) had a record of no crude fiber in green and purple grape wine.

The total phenolic content in the yellow mombin young and aged wine (22.95 and 19.10 mgGAE/100ml respectively) were comparatively lower than that in the must (24.05 mgGAE/100ml), According to Umeh *et al*. (2015) activities of enzymes during fermentation are capable of releasing free phenolic compounds, but the reverse was the case in this study where the fermented yellow mombin had a reduced phenolic compound. Similarly, reduction in total phenolic content of fermented *Flocoutia montana* wine was reported by Abhishek *et al*. (2019).

The flavonoid content of the must, young and aged wines were 9.14, 9.07 and 8.66 mg/100 ml respectively. The flavonoid content of the yellow mombin wine is high compared to the flavonoid content of sweet melon and sugar cane blend wine (4. 55 mg/100ml) reported by Silas and Abah (2025). Flavonoid is an essential polyphenol compound that contributes to the quality and the organoleptic properties of wine (Horndedo-Ortega *et al*., 2020). As well flavonoid have been said to be capable of promoting human well being though its antioxidant capability (Andrade and Fasolo, 2014; Lucarini *et al*., 2021). Tannin of 10.75 was recorded in the young wine and 10.25 mg/100ml in the aged wine of the yellow mombin. Tannin which is a key phenolic compound that have been associated with the free scavenging capabilities of plant and plant products and also believed to control dental caries hence supports good oral health (Fernandes *et al*., 2017). Generally higher total phenol, flavonoid and tannin content was recorded in the must, this could be attributed to precipitation, polymerization and adherence of polyphenols to yeast cells (He *et al*., 2013).

One can predict the *in vivo* oxidative stress amelioration effect of a food by measuring the antioxidant capacity. The yellow mombin wine exhibited antioxidant activities as determined by DPPH, FRAP and ABTS this might be linked to the bioactive compounds such as phenolic acids, flavonoid and tannin found in the wine. Studies have linked the phenolic contents of plant materials to their antioxidant capacity (Andrade and Fasolo, 2014; Horndedo-Ortega *et al*., 2020). The findings of Lucena *et al*., 2022 on the *in vivo* antioxidant activity of yellow mombin against liver oxidative damage in rats corroborates the findings from this study. Similarly, Ajit *et al*., 2018 reported that fruit wine produced from banana and pineapple had antioxidant activity, also fruit wine from a blend of sugar cane and sweet melon produced by Silas and Abah (2025) showed antioxidant activity. It is noteworthy that difference in geographical location and the production technology could affect the antioxidant properties of various fruit wine (Tiburski *et al*., 2011).

The complex biochemical reactions that take place during fermentation determine the organoleptic properties of a wine, which is a reflection of the distinctive fermentative characteristics of the yeast strain involved (Merlino *et al*., 2021; Zhu *et al*., 2023). The color of the commercial wine was most preferred this could be explained by the metabolic individuality of the yeast used in this study, as some commercial yeast strain are selected based on their ability to react with anthocyanins hence contributing to the color stability of the wine (Kanter, *et al*., 2020). The panelist preferred the foreign wine as regards to the clarity, comparably

Owoh, (2022) reported that panelist preferred commercial wine for its clarity over sour sop wine. This could be attributed to the fact that more standardized techniques for clarification of wine was adopted in the production of the foreign wine. The produced yellow mombin wine was preferred in taste, flavor and aroma by the panelists over the commercial foreign and domestic wine. The concentration of organic acids and residual sugar and their interactions could contribute to the variation in the taste of wine, also yellow mombin fruit being and exotic fruit with good flavor and aroma could have influenced the wine flavor, taste and aroma. Furthermore, the panelist showed an overall preference for yellow mombin wine with acceptance rating of 8.5 over the commercial wines, this is an indication that the consumers preference might be influenced by the sensory properties of a wine especially the taste (Merlino *et al*., 2021). Zhu *et al*. (2023) stated that consumers showed preference to wine produced from fruits other than grapes due to their variation in aroma profiles, low alcohol content and abundant bioactive compounds. Wine from tropical fruits could evoke a flavor of nostalgia feeling in the indigent consumers. Accordingly, the fruit wines produced by Ogodo *et al*. (2018); Kantiyok *et al*. (2021); Silas and Abah, (2020) from non-grape fruits, watermelon, Mango and sweet melon, respectively were adjudged good by the panelists, these reports upheld the position of Merlino *et al*., 2021 that young consumers desired novel fruit wine other than grape wine.

CONCLUSION

This research has provided a good insight that the studied wild indigenous *Saccharomyces cerevisiae* has a high ethanol tolerance (14%) and a good fermentation performance report, while the underutilize tropical fruit yellow mombin is suitable for the production of exotic flavorful and nostalgic taste table wine with alcohol content of 10.5%, which is within the 8-15% alcohol content of European Economic Community standard for table wine.

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