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Wine Produced From Fermentation of Honey Slurry and Dates Palm Fruit Juice Blend Using *Saccharomyces cerevisiae* Isolated From Palm Wine

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Abstract

This study aimed at evaluating the fermentative performance of *Saccharomyces cerevisiae* isolated from palm wine on honey slurry and dates palm fruit juice blend for wine production. The yeast was isolated from palm wine on saboraud dextrose agar (SDA) using pour plate technique and was identified using microscopic and standard biochemical techniques. Physicochemical parameters were determined during 21 days fermentation using standard procedures. The proximate composition of the blend before fermentation and the produced wine was evaluated. The microbiological and sensory evaluations of the produced wine was investigated. The yeast strain was identified as *Saccharomyces cerevisiae.* The fermentation recorded total viable yeast count from $2.5x10^6$ to 13.0×10^6 CFU/mL. The physicochemical parameters revealed that during the fermentation, the pH values ranged from 4.3 to 5.4, percentage titratable acidity (TTA) ranged from 5.2 to 9.4. The temperature of the fermentation ranged from 24 to 29°C and the specific gravity values decreased steadily from 1.100 to1.010. Proximate composition of the date fruit revealed low protein content between 1.00 and 1.05, but high moisture content (82.43%). The produced wine contained reasonable amount of total carbohydrate A (19.59%), B (25.28%), C (22.7%) and D (21.88%). There were variations on other proximate compositions observed. The produced wine was not contaminated with bacteria and fungi. Sensory evaluation of the wine revealed acceptable aroma/flavor and taste. This study indicates that *Saccharomyces cerevisiae* strain from the palm wine have good fermentative performance which suggested that it could be used for fruit wine production and other industrial applications preceded by further experiments.

Keywords: Yeast, date palm fruit, fermentation, wine, proximate composition

1. Introduction

Over the decades, the definition of Wine as an alcoholic beverage derived from fermented grape juice has been attributed to other alcoholic beverage from fermented fruit and vegetable. Fermented beverages and alcoholic drink culturally and socially accepted product for consumption, drinking, entertainment, customary practices and religious purpose. It starts with harvesting grapes separation of juice before fermentation and concludes with the variety of storage and ageing steps (Willey et al., 2008). Apples berries and blackcurrant are sometime also fermented for wine production. Grape berries have a natural chemical balance which allow a completely fermentation without the addition of sugar, enzyme or other nutrient. It is a rich source of vitamins, many essential amino acid, minerals, fatty acid and others; however other fruits with same characteristics have been discovered and used effectively for wine production (Awe, 2011). Across the globe (Europe, America Australia, Asia and currently, Africa), wine making processes are popular (Balogu et al., 2016).

Honey is a sweets (mostly consisting of monosaccharide of fructose, glucose) jelly-like substance made from the nectar of flowers by bees. The high sugar content present in honey predisposes it as a good substance for yeast fermentation to produce alcohol and carbon dioxide gas. Different fermentation technologies have been applied to achieve a various degrees of alcoholic honey beverages, popularly known as mead (Kraus, 2017). Most processes undertake a minimum of 21 days fermentation to achieve 7.6%-22% alcoholic content (Gupta & Sharma, 2009) compared to others fermented foods, alcoholic beverages of honey –fruits from mixture mostly have mostly been documented in personal blogs, as well as unpublished and scant published studies .There are studies of honey –

fruit meads from mixture of honey with fruit and vegetable such as apple, banana, berry, soya, grape, etc. (Sarba, 2015).

Dates are the sweets fruits of the tree *phonenix dactylifera* or date palm. This fruit are being relish all over the world and virtually all age of group of people, primary as a source of energy. It is rich in minerals, specially potassium, calcium and iron, along with many antioxidants and flavonoids (Habib & Ibrahim, 2011). It high dietary fibers, often makes it good food supplement for hyperglycemic patient (Vayalil, 2012). Beside these the dates are cholesterol free, fat free and sodium free. Very little knowledge is available on alcoholic beverages being produced from this fruit. The high sugar content of the fruit has been commercially exploited to produce vinegar directly. Date palm (*Phoenix dactylifera*), is a tropical and subtropical tree, belonging to the family *Palmae (Arecaceae)*. It is one of mankind's oldest cultivated plants, and in the Arabian Peninsula it has played an important role in the day-to-day life of the people for the last 7000 years. Worldwide production, utilization and industrialization of dates are continuously increasing and as per the production of date fruits are on the increase as recorded for some of the major date producing countries like Egypt, Saudi Arabia, Iran, UAE and Algeria. Date fruit is marketed all over the world as a high value confectionery, and as a fresh fruit it remains an important subsistence crop in most of the desert areas. It is produced largely in the hot arid regions of the world particularly in Gulf Cooperation Council (GCC) countries, and Saudi Arabia is considered as one of the world's major producer of dates. The development of date fruits is divided into three stages, Khalal, Rutab and Tamr, and dates are generally harvested at the fully ripened Tamr stage, that is after the development of Total Soluble Solids (TSS) of 60–70 brix that are edible at this stage. Most dates are consumed at the Rutab (semi-ripe) and Tamr (fully-ripe) stages, with little or no processing. Huge amount of wastes are generated from the Kabkab date and the wastes have potential for use in date syrup production with economic advantages (Al-Hooti et al., 1997). The date palm is dioecious perennial, the females of which normally begin to bear date fruits after four years depending on the agronomic practices. It is a monocotyledonous plant with no tap roots but fibrous root system. The trunk is vertical and columnar of the same girth all the way up. The fruit is single, oblong one seeded berry with terminal stigma, a fresh pericarp and a membranous endocarp (Zaid & Wet, 1999).

Unique strains *Saccharomyces cerevisiae* are involve in fermentation of most fruits and vegetables, with high alcohol content up to 20%, and acceptable flavour and aroma (Jyoti & Kasipathy, 2010). The aim of this study was to produce wine from fermentation of honey slurry and date palm fruit blend using *Saccharomyces cerevisiae* isolated from palm wine.

2. Materials and Methods

2.1 Collection of Samples

A total of 6kg of freshly harvested honey was purchased from a honey bee farmer and date palm fruit was purchased from local market both in Kaduna, Nigeria. Honey and date palm fruit were transported in a clean plastic bottle (< 4°C) and plastic bag respectively to the microbiology laboratory of the Kaduna State University. Honey and date palm fruit was stored in refrigerator and at room temperature respectively, prior to preparation and fermentation for wine production.

2.2 Isolation and Identification of Yeast from Palm Wine

Sabouraud Dextrose (SDA) was prepared according to manufacture instruction and supplement with 50 mg/m chloramphenicol for selective enumeration of yeast. Serial dilution of the palm wine was carried out and was inoculated using pour plate techniques pure culture was made on yeast glucose agar plate. Microscopic examination of the isolate was carry out using wet mount method according to the description of Thais and Danilo (2002).

2.3 Carbohydrates Utilization Test on Yeast Isolates from Palm Wine

One (1) ml each of glucose, fructose, sucrose, lactose, mannose and maltose sugar were prepared using yeast fermentation broth (YFB) and dispensed 10ml volume into clean test tubes. Clean Durham tubes were introduced into the tubes, displaced all bubbles and then autoclave at 121°C for 15minutes and allowed to cool. The sterile broth was inoculated with 0.2ml yeast culture broth and incubated at room temperature for 72 hours and observed evidence of fermentation. The ability to ferment six different carbohydrates was assessed by looking for the formation of gas (CO_2) in durham tube and color change of the fermentation media (Olowonibi, 2017).

2.4 Percentage Ethanol Tolerance Test

The test was carried out according to Alobo and Offonry (2009), where 2%, 5%, 8%, 11%, 14%, 16% and 19% of ethanol in molten yeast glucose agar medium were prepared and poured in sterile petri dishes. The plates were inoculated with the pure culture yeast isolates and incubated at room temperature for 72hours.

2.5 Preparation and Fermentation of Honey Slurry and Date Palm Fruit Juice Blend

Date palm fruit was slice using a sterile shape knife to remove seed and macerate using a clean sterile grinding engine, to produce a small, granular texture of the date palm fruit so has to increase the surface area of the for activity of fermentation. Juice was press out from the slurries sieve with muslin bags and was label as dates juice (DJ). Honey was dilute with water at the ratio of 1.1 and was label as slurry (HS).Four (4) set of 2000ml long necked round bottom glass flask were washed and label with the flowing code A (1.1) B (1.2) C (2.1) and control as CTRL (1:0).The ratios in parentheses denote the mixture of HS:DJ of each tagged flask to the maximum of1800mL .This means that A was mixture of 900mLHS + 900 mL DJ,B(600 mLHS+1200 mL DJ), C(1200mL HS+600 mL DJ) and CTRL(1800mlHS only).The glass flasks were sealed with airtight gas value and steam sterilized (121°C at pressure 15psi for 15minute) and were allowed to cool at ambient temperature below 35°C before the addition of 200 mL of standardized starter culture (~6.0log10 CFU/mL) and vigorous agitation for 2 minutes. The setups was fermented for 21 days at room temperature (25±2°C), periodically agitated, and degassed for 2-days intervals. The wine was pasteurized (60°C) for 15 minutes to stop fermentation. Clarified wine (by siphoning supernatant of wine sediment into a clean bottle) were stored in 100ml glass vessels seeded with 5mL of citric acid (0.02w/) solution to limit bacterial growth as described by Balogu and Towobola (2017).

2.6 Specific Gravity of the Produced Wine

Specific gravity (SG) of the produced wine was determined by measuring 50ml of the wine sample into a measuring cylinder at 20°C, and a hydrometer was drop into it to determine the specific gravity with appropriate temperature corrector factor (Balogu & Towobola, 2017).

2.7 Proximate Composition and Physiochemical Analysis of the Produce Honey and Date Palm Fruit Juice Wine

Nutritional proximate composition of HS and DF mixtures was analyze with Association of Office Analytical Chemist (AOAC) method and Selected parameters (titratable acidity pH, and temperature) was detected using the method of Association of Official Analytical Chemist (AOAC) method with slight modification as describe by Balogu et al. (2016). Ambient temperature and pH was determined with a dual pH and temperature portable digital device (Jenway 3510, Camlab, UK). Probes of pH and temperature was dipped into 50ml sample for (2minute for stable reading). Recorded data was means of triplicate values. Total titratable acidity (TTA) was assessed by titrating 10mL of sample with 0.1M of NaOH to obtain 7.1 natural pH. The titre of NaOH was used to calculate the TTS (7.5 x 0.1 x titer value) and was expressed in g/L; acetic acid and using OIV (International Organization of Vine and Wine) methods. Free SO_2 was calculated (Coelho et al., 2015).

2.8 Determination of Ash Content

This was carry out as describe by Moronkola et al. (2011). Where porcelain crucible with lid was ignite in a hot Bunsen burner flame and was transfered into desiccators to cool and the crucible was weighed .5g of the sample was accurately weigh into the crucible and was gently place in the muffle furnace set at 600°C for 4 hours. The crucible was place in desiccators to cool. The ash sample in the crucible was kept at room temperature in sterile laminar flow until for fermentation up to 5 days (Butz, 2007). The total ash content was calculated by using this formula: Total Ash content (% of ash) = (weight of ash /weight of sample) x 100

2.9 Determination of Total Carbohydrate Content

Chemical analysis for the determination of total carbohydrate was checked by the phenol-sulphuric acid method (Moronkola et al., 2011).

2.10 Total Protein Analysis

The total protein analysis was carried out by Biuret method.

2.11 Determination of Fat Content

Homogenized date- honey (10 g) was progressively added to a small amount of a chloroform /methanol 2:1(v/v) mixture (up to 200 ml), with vigorous shaking, and then the extraction was carry out on for a further 2 hours, with constant stirring. This was filtered and the residue was re-washed with fresh solvent and press. Fifty milliliters of 0.88% potassium chloride was add to the filter with content stirring. The aqueous layer (upper) was removed by aspiring and the procedure repeated a couple of times. This was dry by pressing through anhydrous sodium sulfate, and then solvent was remove by using a rotary evaporator. The residue was weigh to find the fat content (Moronkola et al., 2011).

2.12 Determination of Moisture Content

Exactly 5g of the sample was weighed into a petri dish and was placed in air draught oven at 100°C for 1 hour. The Petri dish will then be weigh after cooling. The process was repeated thrice until a constant weigh is obtained. Loss in weigh was calculated as the percentage moisture content (Moronkola et al., 2011).

2.13 Microbial Analysis of Honey and Date Palm Fruit Juice Blend Wine

Microbial population of wine was evaluated using PDA (yeast), Nutrient Agar (bacteria), and relevant biochemical assays, in accordance with the method ISO (International Standard Organization). Four periodic microbial sampling was done at 15-day interval to determine the microbial kinetic profile of the system (Balogu & Towobola, 2017).

2.14 Sensory Evaluation of the Produced Honey and Dates Palm Fruit Juice Blend Wine

A total number of 20 assessors (Train and Untrained) from staff and student of Kaduna State University was selected to evaluate the wine using a 7- point hedonic scale. Only +18 years old assessor (those with prior exposure and non exposure to alcoholic beverages) was selected to limit biased responds. Prior to sensory evaluation, ISO standard for selection, training (Less than – 2days) and monitoring of assessor (ISO8886:2012), design of testing room (ISO8589:2010), and methodology of monitoring performance of sensory panel (ISO11132:2009) followed. Each assessor was served with 50ml of test sample (182°C) with 250ml wine testing glasses (ISO3591: 1977); result was ranked (ISO8587:2006) and was express in according with the sensory vocabulary (ISO5492: 2008en) (Balogu & Towobola, 2017).

2.15 Statistical Analysis of Data

All data generated from this study was subjected to relevant statistical tools (ANOVA, Chi-square, and Duncans Multiple Range Test) using SAS statistical software (Version 8, SAS institute, cary, NC, USA) and SPSS software (version 20 of 2014), and significance was taken at 95% confidence level.

3. Results

The morphology of the vegetative cells of the yeast isolates were observed. Culturally, the yeast isolates had flat elevation and were creamy in appearance and were circular in shape (Table1). *Saccharomyces cerevisiae* showed variation of utilization of six different sugars. The palm wine strain of *Saccharomyces cerevisiae* utilized glucose, maltose and sucrose but failed to grow on fructose, lactose and mannitol after 48 hours (Table 2). The *S. cerevisiae* were tolerant to 2, 5, 8, 11 and 14 % alcohol and not tolerance to 16 and 18 % alcohol (Table 3). The result obtained from proximate composition of honey slurry and dates palm fruit juice blend before fermentation and production of wine are presented in table 4. Sample A with equal proportion of honey and dates palm fruit juice (500ml honey and 500ml dates palm fruit juice) had a moisture content, ash content, crude fat, protein content and carbohydrate of 79.20%, 0.12%, 0.07%, 1.02%, and 19.59% respectively while the specific gravity was 1.0110. The proximate composition of sample B with 250ml honey and 750ml dates palm fruit juice revealed moisture content of 73.42% and ash content, protein content, crude fat and total carbohydrate of 0.17%, 1.04%, 0.09%, and 25.28% while the specific gravity was 1.0003.The proximate composition sample C with 750ml honey and 250 dates palm fruit juice revealed moisture content of 76.06% and ash content, protein content, crude fat and total carbohydrate of 0.15% , 1.03%, 0.06% and 22.7% while the specific gravity was 1.0001.The proximate composition of sample D with 1000ml of honey and 0ml of dates palm fruit juice revealed moisture and ash content of 78.03% and 0.09% respectively while protein content and crude fat were not detected (ND) and the total carbohydrate was 21.88% and specific gravity was 1.1010 (Table 4)**.** The result obtained from proximate composition of honey slurry and dates palm fruit blend wine are showed in table 5. The result revealed that after fermentation and production of wine, sample A with equal proportion of honey and dates palm fruit extract (500ml honey and 500ml dates palm fruit juice) had a moisture content of 90.01%, ash content of 0.09%, crude fat of 0.002%, the protein content of 1.04%, carbohydrate (8.84%) and specific gravity of 1.0110. The proximate composition of sample B with 250ml honey and 750ml dates palm fruit juice revealed moisture content of 88.60%, ash content of 0.010%, protein content of 1.05%, crude fat of 0.01%, total carbohydrate of 10.2% and specific gravity of 1.0003.The proximate composition of sample C with 750ml honey and 250 dates palm fruit juice revealed moisture content of 89.20%, the ash content of 0.08%, protein content of 1.00%, total carbohydrate was 9.72% while crude fat was not detected (ND) and specific gravity was 1.0001.The proximate composition of sample D with 1000ml 0f honey and 0ml of dates palm fruit juice revealed moisture content 86.05%,the ash content was 0.07%, protein content, total carbohydrate of 13.88% while crude fat were not detected (ND) and specific gravity of 1.1010 was recorded (Table 5). The result of the physicochemical composition of sample A with equal amount of honey slurry and dates palm fruit juice (500mL-500mL) revealed initial pH of 4.3, temperature of 29°C, gravity of 1.122 while final the pH was 5.4, temperature was 26°C and specific gravity was 1.0110. The pH after dealcoholization was 5.3, temperature was 25°C, TTA was 9.5 and TTA after dealcoholization was 7.9. Sample B with 250mL of honey slurry and 750ml of dates palm fruit juice revealed the initial pH of 4.4, temperature of 28°C, specific gravity of 1.119 while final pH was 5.4, temperature was 26°C and specific gravity was 1.0003. The pH after dealcoholization was 5.4, temperature was 24°C, TTA before dealcoholization was 5.6 and TTA after dealcoholization was 6.4. Sample C with 750mL of honey slurry and 250mL dates palm fruit juice blend

revealed initial pH of 6.5, temperature of 28°C, specific gravity of 1.120 while final pH, temperature and specific gravity were 5.4, 26°C and 1.0001 respectively. The pH and temperature after dealcoholization were 5.5 and 24°C respectively while the TTA before and dealcoholization were 7.4 and 8.8. Sample D with 1000ml of honey slurry and 0ml of dates palm fruit juice revealed initial pH and temperature 4.3 and 29°C while the initial specific gravity was 1.3125. The final pH, temperature and specific gravity were 5.4, 26°C, and 1.1010 respectively while pH, temperature after dealcoholization were 5.3 and 24°C while TTA before dealcoholization was 6.7 (Table 6). The produced wine was free of bacteria and fungi contaminations (Table 7a &b). The sensory evaluation of sample A were significantly different ($p < 0.05$), the overall acceptability was within the range of 2-4 in the hedonic scale, while sample B was not significantly different ($p>0.05$). The range of the overall acceptability is within 2-5 in the hedonic scale and sample D is significantly different ($p < 0.05$), the overall acceptability was within the range of 3-9. Among the accessed wines, sample C and D had more acceptability probably due to the sweet taste and aroma (Table 8, 9, 10 and 11).

Table 1. Cultural and Morphological Characteristics of Yeast Isolates from Palm Wine

Parameters	**Result**
Shape	Circular
Elevation	Flat
Pigmentation	Creamy
Budding	Positive

Table 2. Carbohydrate Fermentation Characteristics of Yeast Isolates from Palm Wine

Sugars	Result
Fructose	-
Glucose	+
Lactose	-
Maltose	+
Mannose	-
Sucrose	+

+: positive, -: negative.

Table 3. Alcohol Tolerance Test against Yeast Isolates from Palm wine

Fermentation isolates	Ethanol Concentration (%)						
	2	5	8	11	14	16	19
1	++	++	++	++	++	-	-
2	++	++	++	++	++	-	-

++: positive growth/ tolerance, -: no growth, %: percentage.

Table 4. Proximate Composition of Honey Slurry–Dates Palm fruit Juice Blend

Parameters	Samples			
	A 1:1	B 1:2	C 2:1	D 1:0
Moisture content (%)	79.20	73.40	76.06	78.03
Ash content (%)	0.12	0.17	0.15	0.09
Protein (%)	1.02	1.04	1.03	ND
Crude fat (%)	0.07	0.09	0.06	ND
Total carbohydrate (%)	19.59	25.28	22.7	21.88
Specific gravity	1.122	1.199	1.120	1.3125

Key: A (1:1) = honey (500mL) + dates palm fruit extract (500 mL), B (1:2) = honey (250mL) + dates palm fruit extract (750 mL), C (2:1) = honey (750 mL) + dates Palm fruit (250 mL CTRL (1:0) = honey (1000 mL) + dates palm fruit extract (0 mL).

Key: ND = not detected

Table 5. Proximate Composition of Honey Slurry–Dates Palm fruit Juice Blend Wine

Parameters	Wine Sample			
	A 1:1	B 1:2	C 2:1	D 1:0
Moisture content (%)	90.01	88.60	89.20	86.05
Ash content (%)	0.09	0.010	0.08	0.07
Protein (%)	1.04	1.05	1.00	ND
Crude fat (%)	0.002	0.01	ND	ND
Total carbohydrate (%)	8.84	10.24	9.72	13.88

Key: A (1:1) = honey(500mL) + dates palm fruit extract (500 mL), B (1:2) = honey (250 mL) + dates palm fruit extract (750 mL), C (2:1) = honey (750 mL) + dates Palm fruit (250 mL CTRL (1:0) =honey(1000 mL) + dates palm fruit extract (0 mL).

Key: ND = not detected.

Table 6. Physicochemical Composition of Honey Slurry and Dates Palm Fruit Juice Blend

Parameters	Wine Sample			
	A (1:1)	B (1:2)	C (2:1)	D (1:0)
Initial pH	4.3	4.4	4.4	4.3
Initial Temperature	29	28	28	29
Initial Specific Gravity	1.122	1.119	1.120	1.3125
Final pH	5.3	5.4	5.5	5.3
final Temperature	25	24	24	24
Final Specific Gravity	1.0110	1.0003	1.0001	1.1010
pH after Dealcoholization	5.4	5.4	5.4	5.4
Temperature after Dealcoholization	24	24	24	24
TTA before Dealcoholization	9.5	5.6	7.4	6.7
TTA after Dealcoholization	7.9	6.4	8.8	5.2

Key: A (1:1) = honey(500mL) + dates palm fruit extract (500mL), B (1:2) = honey (250mL) + dates palm fruit extract (6 mL, C (2:1) = honey (750 mL) + dates Palm fruit (250 mL CTRL (1:0) = honey(1000 mL) + dates palm fruit extract (0 mL). Key TTA; Total Titratable Acidity

Table 7a. Bacteriological Quality Assessment of the produced Wine

Wine Sample (CFU/mL)				
Treatment	A(1:1)	B(1:2)	C(2:1)	D(1:0)
Before pasteurization	1.48×10^4	1.57×10^4	1.52×10^4	1.56×10^4
After pasteurization	0	0	0	0

Table 7b. Mycological Quality Assessment of the Produced Wine

	Samples			
	A(1:1)	B(1:3)	C(3:1)	D(1:0)
Before pasteurization	5.0x106	4.4x106	4.0x106	5.4x106
After pasteurization	0	0	0	0

Key

CFU/mL=Colony Forming Unit

ND: Not Detected, Sample A honey slurry and date fruit juice (1:1)=500mL:500mL, Sample B honey slurry and date fruit juice (1:3)=250mL:750mL, Sample C honey slurry and date fruit juice (3:1)=750mL:250mL, Sample D honey slurry and date fruit juice (1:0)=1000mL

Table 8. Sensory Evaluation of wine (A-1:1)

Parameters	Hedonic scale								
	1	2	3	4	5	6	7	8	9
Appearance	0	0	0	6	5	4	3	0	2
Texture	0	0	0	4	6	5	3	1	1
Aroma	0	0	4	3	3	4	2	3	1
Sweet	4	0	0	1	0	4	2	1	1
Sour	0	1	0	2	1	1	0	1	0
Bitter	0	0	0	1	0	0	0	0	0
Overall acceptability	0	2	2	2	2	4	4	2	2

Hedonic scale.

9=like extremely,8=like very much,7=like moderately,6=like slightly,5=neither like nor dislike 4=like slightly,3=dislike moderately,2=dislike very much,1=dislike slightly.

Table 9. Sensory Evaluation of Wine (B 2:1)

Parameters	Hedonic scale									
	1	2	3	4	5	6	7	8	9	
Appearance	0	0	0	2	3	5	5	5	0	0
Texture	0	0	0	3	3	4	6	4	0	0
Aroma	0	0	1	1	4	5	4	5	0	0
Sweet	0	2	1	0	1	2	0	0	0	0
Sour	0	7	3	2	0	0	0	0	0	0
Bitter	0	4	0	0	0	0	0	0	0	0
Overall acceptability	0	2	2	0	5	3	3	2	3	0

Hedonic scale

9=like extremely,8=like very much,7=like moderately,6=like slightly,5=neither like nor dislike 4=like slightly,3=dislike moderately,2=dislike very much,1=dislike slightly

Table 10. Sensory Evaluation of Wine (C 1:2)

Parameters	Hedonic scale								
	1	2	3	4	5	6	7	8	9
Appearance	0	0	0	3	0	6	6	5	1
Texture	0	0	0	5	0	5	9	1	1
Aroma	0	0	0	0	6	4	5	2	3
Sweet	0	0	0	1	3	2	5	0	0
Sour	1	0	0	1	1	1	1	2	0
Bitter	1	0	1	0	0	0	1	1	0
Overall acceptability	0	0	0	5	1	0	6	5	3

Hedonic scale

9=like extremely,8=like very much,7=like moderately,6=like slightly,5=neither like nor dislike 4=like slightly, 3=dislike moderately,2=dislike very much,1=dislike slightly

Table 11. Sensory Evaluation of Wine (D 1:0)

Parameters D	Hedonic scale								
	1	2	3	4	5	6	7	8	9
Appearance	0	0	0	0	2	3	5	7	3
Texture	0	0	3	0	0	2	7	6	3
Aroma	0	0	0	1	1	3	7	4	4
Sweet	0	0	0	1	1	3	3	5	4
Sour	1	0	1	0	1	1	1	1	0
Bitter	0	0	0	0	0	0	0	0	0
Overall acceptability	0	0	0	0	2	3	6	5	4

Hedonic scale

9=like extremely,8=like very much,7=like moderately,6=like slightly,5=neither like nor dislike 4=like slightly, 3=dislike moderately,2=dislike very much,1=dislike slightly

4. Discussion

Culturally, the yeast isolates had flat elevation and creamy in appearance and was circular in shape. The yeast showed variation of utilization of the six different sugars. This could be attributed to the metabolic activities of the yeast during fermentation. The yeast had variations on the alcohol tolerance (between 2 and 14 %). The organism was probably identified as *Saccharomyces cerevisiae*. Similarly, Ukwuru & Awah (2013) reported that purified yeasts from palm wine showed highly viable cells and good metabolic activity during substrate fermentation. The proximate composition of various mixtures (blend) before fermentation revealed high percentage moisture content of A (79.20%), B (73.42%), C (76.06) and D (78.03) and this could be as a result of the ratio of honey slurry and date palm fruit juice blend. This according to Okaka (2010) accounts for their high perishable nature and their short shelf life under normal storage condition. The pre-proximate of the blend wine in this study is similar to the study of Yabaya et al. (2016) on the production of wine from fermentation of *Vitis vinifera* (grape) juice using *S. cerevisiae* strain isolated from palm wine. Though revealing high percentage moisture content (82.43%) due to the nature of fruit used, the fruit also contained reasonable amount of total carbohydrate (14.23%) which invariably account for their high caloric values suggesting the presence energy source for metabolic activity of the yeast, the fruit also contain a protein content of 0.53% similar to the low protein content of 4.30%. The moisture contents were significantly different ($p < 0.05$). Chilaka et al. (2010) reported that the moisture content of wine do not have any remarkable relationship to the mixing ratios of the various wine blend. The produced wine contained reasonable amount of total carbohydrate A (19.59%), B (25.28%), C (22.7%) and D (21.88%) invariably account for their high caloric values suggesting the presence energy source for metabolic activity of the yeast. The carbohydrate content were significantly different ($p < 0.05$). The protein content for sample A was (1.02%), B (1.04%), C (1.03%) and D was not detected (ND) and according to Okegbile and Taiwo (2009), the low protein and mineral contents of the fruit as reported in this study is a probable indication that fear of over accumulation due to consumption of the fruits do not arise. The proximate composition in this investigation was in agreement with the general case for fruits as reported by Pearson (2007). The protein content were not significantly difference (.>0.05). The results of the proximate composition after fermentation revealed high percentage moisture content for sample A as (90.01%), B (88.60%), C (89.20%) and D (86.05%) and this according to Okaka (2010) accounts for their high perishable nature and their short shelf life under normal storage condition the moisture content increase after fermentation. The moisture contents were significantly different ($p < 0.05$) and do not have any remarkable relationship to the mixing ratios of the various wine blend as reported by Chilaka et al. (2010). The result also contained reasonable amount of total carbohydrate A (8.84%), B (10.24%), C (9.72%) and D (13.88%) invariably account for their high caloric values suggesting the presence energy source for metabolic activity of the yeast. the carbohydrates content reduced after fermentation. The carbohydrate content were significantly different ($p < 0.05$). The protein content was A (1.04%), (1.05%), (1.00%) and D (ND) and according to Okegbabile & Taiwo (2009), the low protein and mineral contents of the fruit as reported in this study is a probable indication that fear of over accumulation due to consumption of the fruits do not arise. The proximate composition in this investigation was in agreement with the general case for fruits as reported by Pearson (2007) that the protein content were not significantly difference (.>0.05). The crude fat for sample A (0.07), B (0.09), C (0.06) and D (ND) were not significantly different (>0.05). The ash content for sample A was (0.12), B (0.17), C (0.15) and D (0.09) and were not significantly difference (>0.05). Ash content revealed that sample A was (0.12), B (0.17) C (0.15) and D (0.09), and were not significantly different (>0.05). The present study revealed that pH values were

within the range of 4.3- 5.4 of honey slurry and date palm fruit in the wine fermentation period. The pH is significantly difference ($p < 0.05$). The trend of the changes in pH revealed consistent increases acidity of the fruit wine during the fermentation this could be due to the metabolic activities of the yeast. Chilaka et al. (2010) also recorded a similar pH ranged of 3.0 to 4.8 during fermentation of passion fruit, water melon and pineapple fruits must using commercial *Saccharomyces cerevisiae*. Studies have shown that during fermentation of fruits, low pH is inhibitory to the growth of spoilage organisms but creates conducive and competitive advantage environment for the growth of desirable organisms as reported by Reddy & Reddy (2009). The temperature of honey slurry and dates palm fruit juice was within the range of 24 -29°C and were not significantly different ($p > 0.05$) this could be attributed to the metabolic activities of the yeast during fermentation. The titrable acidity of honey slurry and dates palm fruit juice wine were significantly different ($p>0.05$). Only temperature (27–29°C) and pH (4.4–5.4) were relatively stable among the assessed wines. Similar to this study, most previous studies on fruit and vegetable wines reported acidic beverages of pH below 6.0. Bacteria and fungi contamination of the wines were not observed probably due to pasteurization of the wines and hygienic nature in which the wines were produced. This is similar to the report of Balogu & Towobola (2017). The sensory evaluation of sample A were significantly different ($p < 0.05$), the overall acceptability is within the range of 2-4 in the hedonic scale, sample B was not significantly different ($p>0.05$), the range of the overall acceptability is within 2-5 in the hedonic scale. This could be attributed to the ratio of the honey slurry and dates palm fruit juice blend or fermentative ability of the yeast used. Sample D was significantly different ($p < 0.05$). This is similar to the report of Balogu & Towobola (2017) who worked on production of wine from honey slurry and coconut milk.

5. Conclusion

The yeast isolate was identified as *Saccharomyces cerevisiae.* The wine was produced using the palm wine *Saccharomyces cerevisiae*. High percentage alcohol was produced by the *S. cerevisiae* strain during fermentation of honey slurry and date palm fruit juice wine and the pH level of the wine fall within acceptable limits. The proximate composition of the wine revealed variations in the parameters analyzed. After pasteurization, the wines were free of microbes. The sensory evaluation indicates that the wines produced had general acceptability. This study therefore indicates that *Saccharomyces cerevisiae* strain isolated from the locally tapped palm wine can be used to make wine from honey slurry and date palm fruit.

6. Recommendations

1) More research is needed to refine the quality of wine for commercial production. The results also indicate that other fruit might have the potential to produce high quality wine of viability. This research needs to be extended to other fruit and vegetables.

2) Process optimization and scale up will be required; and hence starter culture obtain to augment the more expensive and non-available commercial wine *Saccharomyces cerevisiae* strain for better applications in the industries.

Conflict of Interest

The authors declare no conflict of interest.

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