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# Impact of Source of yeast on Volatile Composition and Sensory Properties of *Samanea saman* ( Rain tree) Wine

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Research

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## ABSTRACT

**Background**: *Samanea saman* (Rain tree) is commonly used in parks for ornamental. The ripe pods are usually littered around the tree site during fruiting season. Animals and children are attracted to it and eat the pods because of its aroma and sweet pulp. The sugary pulp is not optimally utilized in the food industry especially in wine production.

**Purpose***:* The aim was to ferment *Samanea* saman pulp must with different sources of *Saccharomyces cerevisiae* and investigate their impact on the volatile composition and sensory properties of the wine.

**Method***: Samnea saman* wine was processed from the de-seeded pods (pulp) fermented with *Saccharomyces cerevisiae* isolated from the pulp (inherent), brewer's yeast, baker's yeast and without starter culture. The volatile composition, odour activity values (OAVs) and sensory properties were investigated. Triplicate data obtained were subjected to One-Way ANOVA using SPSS software version 21.Mean values and Fisher's Least Significant Difference (LSD) were determined for the separation of the means at ($p \leq 0.05$).

**Results**: Isoamylalcohol (140.25-165.58µg/L), 1-propanol (133.53-153.32µg/L), methanol (58.57-66.65µg/L), ethylacetate (43.36-52.25µg/L) and ethylhexanoate (20.54-32.59µg/L) were the major congeners in the most accepted wine samples. Ethylhexanoate and isoamyl acetate with odour OAVs of 6517 and 482 respectively contributed highly to the aroma of the wine samples. The samples fermented with inherent yeast or brewer's yeast produced higher concentrations of volatile compounds, odour activity values and were very much liked (8) as the commercial wine (control) and significantly ($p \leq 0.05$) different from the other two.

**Conclusion**: The source of yeast influenced the volatile composition and sensory properties of *Samanea saman* wine. Since the inherent yeast compared favorably with brewer's yeast and even better than baker's yeast, it can be utilized industrially as alternative to commercial yeasts. The *Samanea saman* pulp can be used as alternative source of sugar in food industry.

**Keywords:** Congeners*,* Inherent yeast, Rain tree, *Samanea saman,* Odour Activity Values, Volatile compounds, Wine.

## 1. INTRODUCTION

*Samanea saman* is a specie of flowering tree in the *Fabaceae*/*Leguminosae* family [1]. It is native to Central and Southern America but has distributed to other continents including Africa. Its common names include *saman*, rain tree and monkey pod. It is easily recognized by its umbrella-shaped canopy. The name rain tree has been attributed to the light-sensitive leaflets that close together on cloudy days and at nights allowing rain-like fluid to drop through the canopy to the ground below [2].

Thousands of heads of flowers are borne during pinkish bloom covering the tree. The flower is a nectar producing organ that attracts pollinators. Usually, only one flower per head is pollinated and forms a pod [2]. The matured pods are black-brown, oblong, lumpy filled with a sticky, brownish pulp that is sweet and edible with aroma which attracts animals like cows when ripened and fallen. [3] reported that the pods are rich in proteins and carbohydrates and as such can be utilized as nutrient supplements in feeds. The sugary pulp must have contributed to the high carbohydrate content of the pod which also produced *Samanea saman* wine with above 9% alcohol content [1].

Wine is an alcoholic beverage made by the fermentation of grape juice or any other fruit juices by the action of yeasts, mainly *Saccharomyces cerevisiae.* Wines are composed of different volatile compounds. These volatile compounds are mainly produced during fruit juice fermentation [4]. The volatile composition of wines plays a major role in determining the quality of wines because they are responsible for aroma and mouth feel perception [5]. The aroma of wine is a combination of different aroma arising from the grape or other fruits, fermentative aroma compounds produced by yeasts during fermentation and maturation bouquet due to different chemical reactions during storage and ageing [6]. The combination of various volatile compounds defines the quality of wine and its distinction. To assess the contribution of individual compound to the overall aroma of wine, it becomes imperative to determine the odour activity values (OAVs) which is calculated as the concentration of single compound divided by its odour perception threshold. Usually, aroma active compounds are volatile compounds whose concentrations in the alcoholic beverage is greater than their perception threshold, hence their OAVs are greater than one [4].

Human assessment such as sensory analysis is also necessary to evaluate the sensory attributes of wine such as flavour, appearance and overall acceptability or consumer preference for the wine. The sugary *Samanea saman* pods are usually found littered around the tree site or eaten by animals. However, the pods have not been fully utilized in alcohol industry and there is little or no literature on the impact of source of yeast on the volatile compounds, their odour activity values and sensory properties of *Samanea saman* wine.

The aim of this research was to identify the volatile composition, their odour activity values and how they affect the sensory quality of *Samanea saman* wine fermented with *Saccharomycescerevisiae s*yeast strains isolated from the *Samnea saman* pod, brewer's yeast, baker's yeast and control (without yeast starter culture).

## 2. MATERIALS AND METHODS

### 2.1. Collection of Materials

Some ripe, fallen wholesome rain tree (*Samaneasaman*) pods were picked from the tree sites around the School of Agriculture and Agricultural Technology (SAAT) of the Federal University of Technology, Owerri (FUTO) Nigeria.

### 2.2. Preparation of Yeast Growth Medium and Inoculum

Two hundred grams (200g) of chopped Irish potato was cooked in one litre of potable water for about ten minutes. The infusion was collected and made up to one litre with potable water. Twenty grams (20g) of glucose and five grams (5g) of sodium chloride were added to the infusion and the mixture shaken for about two minutes. Two hundred milliliters (200 ml) of the infusion was put into each of three 250ml volumetric flasks and covered with foil. The flasks and contents were autoclaved at 130 $^{o}$C for fifteen minutes after which they could cool to ambient temperature. The three media in the flasks were then separately inoculated with three *S. cerevisiae* strains isolated from the *Samaneasaman* pulp, brewer's yeast and commercial baker's yeast, plugged with cotton wool and incubated for 48 hours at 28$^o$C to obtain the starter cultures for "Must" samples fermentation.

**2.3. Preparation of Rain Tree Pulp "Must" Samples**

A six-kilogram (6kg) portion of deseeded rain tree pulp was crushed with a loosely set Corona manual grinding machine. The coarse meal was mixed with 24 litres of potable water (1:4) and pasteurized at 70˚C for 10 minutes before cooling to 30˚C [7]. The resulting mash was filtered with a clean muslin cloth to obtain a light, brown sugary liquid, which is the "Must". Three litres of pasteurized rain tree pulp must ameliorated with sucrose to 20.8 $^o$Brix and fortified with 0.3% diammonium hydrogen phosphate was transferred to each of the four 5-litre plastic cans. Among these four samples, one sample was pitched with 5%(v/v) starter of *Saccharomyces cerevisiae* isolated from the pulp culture of rain tree pod, the other with 5%(v/v) starter of brewer's yeast and the third with 5%(v/v) starter of baker's yeast. The fourth fortified sample was not pitched with any yeast, bringing the must samples to a total of four.

**2.4 The "Must" Fermentation**

Each of the "must" samples in three of the cans was pitched with 5% (v/v) of a specific yeast strain as the starter culture leaving the "must" in the fourth can without any yeast addition as the control. All the four plastic cans containing the prepared must samples were left open for about six hours to encourage initial yeast starter growth [8]. After 6 hours, the cans with contents were tightly fitted with fermentation locks (Plate3.1) and allowed to ferment. The primary fermentation process lasted for seven days at ambient temperature (28$^o$C-30$^o$C). The first racking was done on the 7$^{th}$ day and the young turbid wine samples were returned to the fermenters under racks and secondary fermentation could continue until the 12$^{th}$ day. Some aliquots of each of the fermenting "must" were withdrawn during the primary and secondary fermentations for the analysis of some physiochemical properties. At the end of the 12$^{th}$ day, they were again racked and passed through muslin filters and transferred to glass bottles where they were pasteurized at 70˚C for 10 minutes, cooled and stored in a freezer until needed for sensory evaluation.

**2.5. Determination of Volatile Components of Wine Samples.**

Volatile compounds in the fresh fermented Must were analyzed according to procedure described by [9]. A Hewlett Packard 6890 plus gas chromatography coupled with computer programmer was used in this analysis. The components were separated on a Stabilwax DA Column (60m ×0.25µm ID).The Conditions of Chromatographic analysis were as follows: The initial column temperature was 50$^o$C for 2 minutes and then was raised up to 220$^o$C at a rate of 5$^o$C/min. Injector and detector temperatures were set at 230$^o$C and 240$^o$C respectively. The split ratio was adjusted to 1:30 and the flow rate of carrier hydrogen gas was 1.2ml/minute. The hydrogen and air provided to the detector were at a rate of 30 ml/minute and 300ml/minute respectively. A sample size of 0.8µL was injected using a 1 µL syringe (Model 1B7SGE Scientific Ltd, Melbourne). Individual volatile compound was identified by comparing the retention times of their peaks with those of authentic standards and the concentration of the component was obtained from the standard calibration plot.

**2.6 Determination of Odour Activity Values.**

To evaluate the contribution of an individual volatile compound to the aroma of a wine, the odour activity value (OAV) was determined. OAV is a measure of importance of a specific compound to the aroma of a sample. It was calculated as the ratio of the concentration of an individual compound to the perception threshold of the compound found in literature, [10].

**2.7 Sensory Evaluation of *Samanea saman* wine samples**

The four *Samanea saman* pulp wine samples obtained after twelve days of fermentation were presented to a 20-panelist of sensory evaluation. The panelists were selected mostly from among graduate students and staff of the Department of Food Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria. They were selected based on their familiarity with fruit wines and similar beverages. The following wine attributes: aroma, taste, clarity, astringency, and overall acceptability were evaluated on a 9-Point Hedonic scale as shown below. The sensory panelists were provided with clean transparent pre-labeled cups, questionnaire and water for rinsing their mouth between each tasting. A pre-session was held to familiarize the panelists with the products and questionnaire before the evaluation. The sensory attributes were weighted on a 9-point Hedonic scale where 9 = Like extremely, 8 = Like very much, 7 = Like moderately, 6 = Like slightly,5 = Neither like nor dislike, 4 = Dislike slightly,3 = Dislike moderately,2 =Dislike very much, and 1 = Dislike extremely.

## 3. RESULTS AND DISCUSSION

### 3.1. Volatile composition of Samanea saman wine

#### *3.1.1 The Alcohols in Samaneasaman Wine Samples*

Apart from ethanol, seven different alcohols were identified in the different fermented *Samanea saman* wine samples (Table 1). These were isobutyl alcohol, 1-propanol, 2-heptanol, 2-hexen-1-ol, 2-octanol, iso-amyl alcohol and methanol. Three of these alcohol compounds namely, 2-hexen-1-ol, 2-octanol and 2-heptanol were in trace amounts (<0.05mg/l) in all the studied samples. The predominant alcohols in all the samples were iso-amyl alcohol (140.25mg/l to 165.58mg/l) and 1-propanol (133.53mg/l to 153.32mg/l). For these alcohols, the wine sample produced by fermentation with brewer's yeast, added yeast nutrient and sugar had the highest 1-propanol level (153.32 mg/l) and highest level of iso-amyl alcohol (165.58mg/l). Significant differences ($p<0.05$) were observed in the levels of iso-amyl alcohol of all the samples. The values of Isobutyl alcohol in all the samples ranged from 19.37mg/l- 21.59mg/l. For this particular alcohol, there was a significant ($p<0.05$) difference between its value (19.37mg/l) in *Samanea saman* wine fermented with inherent pulp yeast and its value (21.59mg/l) in sample fermented with baker's yeast culture . The isoamyl alcohol content compares well with the result of [11], who obtained Isoamyl concentration range of 103.021mg/l-185.578mg/l in their Carbernet and Chardonnay wines. [12] reported that isoamyl alcohol concentration in wines is usually within the range of 90-292mg/l and that it accounts for about 50% of total higher alcohols in wine. The levels of 1-propanol identified in *Samanea saman* wine samples (values) were higher than the result of [13] who obtained a range of 14.70mg/l to 20.40mg/l in Royal Red wine. Although, the concentration of 1-propanol identified in *Samanea saman* wine was higher than that obtained by [13] and [14].It is still under the threshold concentration of 306.00mg/l [14] and within the acceptable limit of < 400mg/l [15].

An alcohol of concern in wine and other beverages is methanol and its values in the samples ranged from 58.58mg/l to 66.66mg/l. This alcohol is toxic at levels above 250mg/l for white and rose' wines and above 400mg/l for red wines [16]. However, its levels in this study are safe and within the acceptable level.

**Table 1:** Mean Values of Different Alcohols in *Samanea saman* wine

| Source of Yeast | Alcohol (mg/l) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Isobutyl alcohol | 1-Propanol | 2-Heptanol | 2-Hexen-1-ol | 2-Octanol | Isoamyl alcohol | Methanol |
| **Inherent** | 19.367±0.015$^b$ | 147.729±0.007$^b$ | 0.144± 0.000$^a$ | 0.046±0.000$^a$ | 0.022±0.000$^a$ | 160.241±0.012b | 66.657±0.031a |
| **Brewer's** | 20.260±0.010$^b$ | 153.321 ±0.011$^a$ | 0.125±0.000$^d$ | 0.042±0.000$^b$ | 0.022±0.000$^a$ | 165.577±0.015a | 58.657±0.012d |
| **Baker's** | 21.597±1.166$^a$ | 147.524 ± 1.175$^c$ | 0.136±0.000$^c$ | 0.041±0.000$^c$ | 0.021±0.000$^b$ | 155.380±0.010c | 63.340±0.026b |
| **No Yeast** | 19.873±0.015$^b$ | 133.533 ±0.003$^d$ | 0.142±0.000$^b$ | 0.041±0.000$^c$ | 0.020±0.000$^c$ | 140.253±0.006d | 59.967±0.015c |
| **LSD** | **1.098** | **0.165** | **0.0003** | **0.0001** | **0.0001** | **0.021** | **0.042** |

Means with different superscripts on the same column are significantly ($p\leq0.05$) different from each other

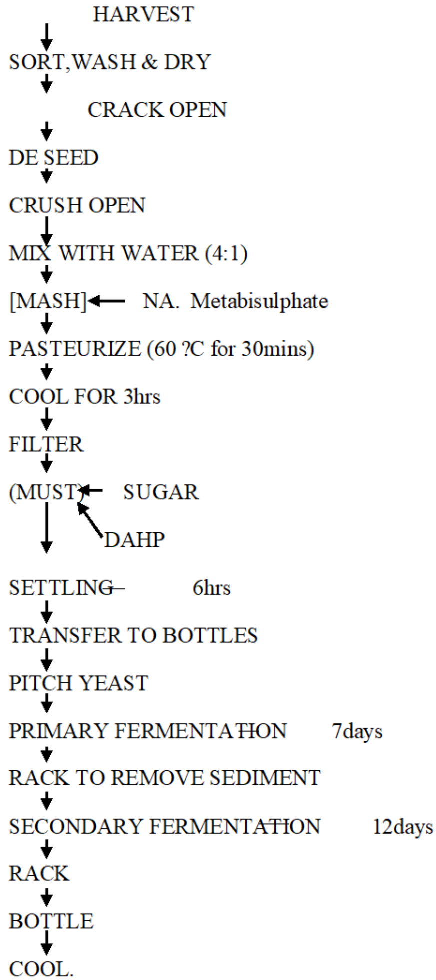


**Fig1.** Flow diagram of *Samanea saman* wine production

### *3.1.2 Esters in Samanea saman Wine Samples (mg/l)*

Five esters were identified in all the *Samanea saman* wine samples, namely Ethyl acetate, iso-amyl acetate, ethyl hexanoate, ethyl lactate and methyl octanoate (Table 2). Two of these five namely, ethyl acetate (43.36 mg/l – 52.25mg/l) and ethyl hexanoate (20.54 mg/l -32.59mg/l) were predominant while another two namely, ethyl lactate (0.99 mg/l -1.15 mg/l) and methyl octanoate (0.05mg/l- 0.06 mg/l) were only in trace amounts in all the wine samples. Ethyl acetate concentrations identified in *Samanea saman* wine samples were higher than the results of [13], who reported a range of 24.50mg/l to 39.90.mg/l in Rogal red wine and [12], who obtained a range of 30.42mg/l to 35.15mg/l from Indian mango wine. The ethyl acetate result of this research falls within the range obtained by [17], who recorded a range of 29.04mg/L to 55.22mg/L in Blossom Honey mead wine. There were significant ($p<0.05$) differences between the ethyl acetate values of all the samples. Ethyl acetate contributes significantly to the volatile character of wines. [18] reported that at a low concentration of between 50 to 80mg/L, it has a pleasant aroma which contributes to the olfactory complexity and has a significant influence on the quality of wine but imparts spoilage character to wines when the levels are between 150 – 200mg/l or more. The levels of isoamyl acetate and ethyl hexanoate ranged from 12.37mg/l to 32.59mg/l in all the samples. There were significant differences ($p< 0.05$) in the levels of the predominant esters in the wine samples. The wine sample produced with the inherent yeast of *Samanea saman* pulp had the highest ethyl acetate level (52.25mg/l) followed by the sample with brewer's yeast (50.45 mg/l). The sample without any starter culture produced the least ethyl acetate (43.36 mg/l).The sample produced with the inherent yeast culture had the highest level of both iso-amyl acetate (14.47mg/l) and ethyl hexanoate (32.59mg/l) among the samples. The levels of ethyl hexanoate obtained in this research were much higher than 4.1 to 5.5 mg/l obtained by [11]. The variation in concentration of ethyl hexanoate obtained in this research may not be unconnected with fermentation conditions and constituents of different fruits. The concentration of isoamyl acetate identified in *Samanea saman* wine conforms to the result obtained by [11]. They reported a range of 13.99mg/l to 24.84mg/l.

**Table 2:** Mean Values of Different Esters in *Samanea saman* wine

| Source of Yeast | Ester (mg/l) | | | | |
|---|---|---|---|---|---|
| | **Ethylacetate** | **Isoamylacetate** | **Ethylhexanoate** | **Ethyl lactate** | **Methyl Octanoate** |
| **Inherent** | 52.250±0.010[a] | 14.473±0.015[a] | 32.585± 0.056[a] | 1.037±0.002[b] | 0.064±0.000[a] |
| **Brewer's** | 50.447±0.015[b] | 12.368 ±0.008[d] | 20.545±0.013[d] | 1.148±0.001[a] | 0.055±0.000[b] |
| **Baker's** | 49.640±0.036[c] | 14.053 ±0.006[b] | 21.470±0.005[c] | 0.995±0.003[d] | 0.048±0.000[d] |
| **No yeast** | 43.360±0.010[d] | 13.550 ±0.010[c] | 23.738±0.123[b] | 1.014±0.002[c] | 0.054±0.000[c] |
| **LSD** | **0.0392** | **0.0194** | **0.1281** | **0.0039** | **0.0002** |

Means with different superscripts on the same column are significantly ($p \leq 0.05$) different from each other

**Table 3:** Mean Values (mg/l) of Aldehydes and Ketones in *Samanea saman* wine

| Source of Yeast | Aldehydes and Ktones (mg/l) | | | |
|---|---|---|---|---|
| | **Nonanal** | **Benzylaldehyde** | **Geranylacetone** | **Furfural** |
| **Inherent** | 0.045±0.000[a] | 3.403±0.002[a] | 0.030±0.000[a] | 0.120±0.000[b] |
| **Brewer's** | 0.043±0.000[b] | 3.256±0.002[c] | 0.028±0.000[c] | 0.119±0.000[c] |
| **Baker's** | 0.040±0.000[c] | 3.201±0.002[d] | 0.026±0.000[d] | 0.122±0.000[a] |
| **No Yeast** | 0.034±0.000[d] | 3.309±0.007[b] | 0.029±0.000[b] | 0.120±0.000[b] |
| **LSD** | **0.0001** | **0.0067** | **0.0001** | **0.0001** |

Means with different superscripts on the same column are significantly ($p \leq 0.05$) differet from each other

### *3.1.3. Aldehydes and Ketones in Samanea saman Wine Samples*

Three aldehydes namely, nonanal, benzaldehyde and furfural were identified in the *Samanea saman* wine samples (Table 3). Geranylactone was the only Ketone identified in the wine samples. The predominant aldehyde in all the samples was benzaldehyde (3.20mg/l - 3.40mg/l) and there were relative differences between its values in the different samples. The other compounds, nonanal, geranylactone and furfural were only in trace amounts (0.02-0.12mg/l).

It may be remarked at this point that though these aldehydes were not in great amount in the wine samples, but they are important congenials with regards to the flavor of *Samanea saman* wine.

### 3.2 The Odour Activities of the Volatile Compounds in *Samanea saman* Wine Samples

The Odour Activity Values (OAVs) is a measure of the contribution or impact of each identified compound to the perceived aroma of the wine sample. A volatile compound contributes to wine aroma if its Odour Activity Value (OAV) is greater than or equal to one (≥1). Of all the alcohol compounds identified in the wine samples, 2-hezen-1-ol, 2-octanol and iso-butyl alcohol had the least impact (OAV≤0.52) on all the wine samples. The OAV of 1-propanol ranged from 0.89-1.02 for all the samples. The only identified alcohol whose OAV in some of the samples (specifically three samples) reached up to 2.0 was 2-heptanol with a value range of 1.79-2.18 OAV, thus made more impact on the *Samanea saman* wine aroma than the other alcohols. Isoamyl alcohol had an odour activity value of range 0.99-1.42 though there were significant differences ($p<0.05$) between its values in the different samples. This could imply that the source of yeast affected the odour activity values of *Samanea saman* wine samples. The sample pitched the inherent yeast had the highest OAV for isoamyl alcohol. It seemed that the more aroma contributory compounds were the esters (Table 4, 5, 6). The OAV of ethyl acetate in all the wine samples ranged from 5.78-6.97 and these values in all the wine samples were much lower than those values obtained for isoamylactate (412.3-482.4) and ethyl hexanoate (4109-6517).These values indicated that among the compounds identified in the wine samples, ethyl hexanoate had the greatest impact on the aroma of *Samanea saman* wine followed by Isoamyl acetate. Generally, there were significant ($p<0.05$) differences in the Odour Activity Values of each esters across the samples which also suggest that the source of yeast influenced the odour activity values. Sample pitched with inherent yeast produced the highest OAV for all esters. Among the aldehyde compounds identified, nonanal had greater impact on the aroma of the wine samples than benzaldehyde. While its odour activity values in the samples ranged from 34.46-44.46, those of benzaldehyde ranged from 1.60-1.72.

It should be remarked that the final perceived aroma or flavour of a product, wine inclusive, is a combination of all the aroma/flavor notes contributed by all the aroma/flavor principles such as these alcohols, esters and aldehydes in it. For the *Samanea saman* wine, ethyl hexanoate and isoamyl acetate might be the major aroma contributing compounds (principles). However, they may not be the major contributing aroma compounds in other fruit wines.

**Table 4:** Mean Odour Activity Values (OAVs) of Different Alcohols in *Samanea saman*

| Source of Yeast | Alcohol (OAV) | | | | | |
|---|---|---|---|---|---|---|
| | **Isobutyl alcohol** | **1-Propanol** | **2-Heptanol** | **2-Hexen-1-ol** | **2-Octanol** | **Isoamyl alcohol** |
| **Inherent** | 0.480±0.000[c] | 0.980±0.000[c] | 2.054± 0.003[a] | 0.114±0.000[a] | 0.185±0.000[a] | 1.142±0.000[a] |
| **Brewer's** | 0.510±0.000[a] | 1.020±0.000[a] | 1.793±0.003[d] | 0.106±0.000[b] | 0.189±0.005[a] | 1.081±0.000[c] |
| **Baker's** | 0.510±0.000[a] | 0.983 ± 0.001[b] | 1.950±0.003[c] | 0.103±0.000[c] | 0.170±0.000[b] | 1.108±0.000[b] |
| **No Yeast** | 0.500±0.000[b] | 0.890 ±0.000[d] | 2.033±0.002[b] | 0.102±0.000[d] | 0.165±0.000[c] | 0.999±0.000[d] |
| **LSD** | **0.0001** | **0.0012** | **0.0047** | **0.0001** | **0.0044** | **0.0002** |

Means with different superscripts on the same column are significantly ($p \leq 0.05$) different from each other

**Table 5:** Mean Odour Activity Values (OAVs) of Different Esters in *Samanea saman* wine

| Source of Yeast | Esters (OAV) | | | | |
|---|---|---|---|---|---|
| | **Ethylacetate** | **Isoamylacetate** | **Ethylhexanoate** | **Ethyllactate** | **Methyloctanoate** |
| **Inherent** | 6.967±0.001[a] | 482.443±0.510[a] | 6517.000±11.269[a] | 0.006±0.000[b] | 0.317±0.006[a] |
| **Brewer's** | 6.726±0.002[b] | 412.277±0.254[d] | 4109.000±2.646[d] | 0.007±0.000[a] | 0.283±0.006[b] |
| **Baker's** | 6.619±0.005[c] | 468.457±0.186[b] | 4293.933±0.9018[c] | 0.006±0.000[b] | 0.2433±0.006[d] |
| **No Yeast** | 5.781±0.001[d] | 451.667±0.335[c] | 4747.600±24.6024[b] | 0.006±0.000[b] | 0.267±0.006[c] |
| **LSD** | **0.0053** | **0.6461** | **25.611** | **0.0001** | **0.011** |

Means with different superscripts on the same column are significantly ($p \leq 0.05$) different from each other

**Table 6:** Mean Odour Activity Values (OAVs) of Aldehydes and Ketones in *Samaneasaman* wine

| Source of Yeast | Aldehydes and Ketones (OAV) | | |
|---|---|---|---|
| | **Nonanal** | **Benaldehyde** | **Geranylacetone** |
| **Inherent** | 44.463±0.021[a] | 1.717±0.015[a] | 0.487±0.006[a] |
| **Brewer's** | 42.673±0.021[b] | 1.620±0.017[b] | 0.450±0.010b[c] |
| **Baker's** | 39.933±0.042[c] | 1.603±0.006[b] | 0.433±0.012[c] |
| **No Yeast** | 34.460±0.020[d] | 1.627±0.025[b] | 0.460±0.020[b] |
| **LSD** | **0.0516** | **0.0326** | **0.0243** |

Means with different superscripts on the same column are significantly ($p \leq 0.05$) different from each other

### 3.3 The Sensory Qualities of *Samanea saman* Wine Samples.

The aroma scores of the wine samples (plate 2) produced from the *Samanea saman* pulp ranged from slightly liked (6.2) to very much liked (7.7) (Table 7). The sample produced with the yeast strain isolated from *Samanea saman* pulp (inherent yeast) had the most preferred aroma (very much liked,7.7) among all the samples evaluated including the control (commercial wine) and there was significant ($p > 0.05$) difference between its aroma score and other samples.

The samples produced with baker's yeast as well as those produced with brewer's yeast and the commercial wine (control) were all moderately liked (6.6-7.2). The sample with no starter culture had the poorest aroma score being only slightly liked (6.2) by the panelists. Though the samples produced with baker's yeast and wild yeast (no starter culture added) had relatively low numerical taste score (6.7), all the samples including the control, were moderately liked (approximately 7). The clearest sample (sensory wise) among them was that produced with brewer's yeast with sugar and nutrient added. This sample was "very much liked" (score 7.7) as well as the control (7.5). All other wine samples studied had at least moderately liked scores clarity wise. Like the case in aroma scores, the wine sample produced without added yeast starter culture had the lowest astringency score (slightly liked 6.4).The sample produced with inherent *Samanea saman* pulp yeast strain was most preferred (6.9), though two of the samples as well as the control, were moderately liked (6.6-6.9) with regards to their degree of astringency. Two of the experimental samples, specifically, the sample produced with the pulp- inherent yeast strain with added nutrient and sugar and the sample produced with brewer's yeast with added nutrient and sugar as well as the control wine were very much liked (7.5-7.7) by the panel in overall acceptability and there were significant ($p > 0.05$) differences between them and others in this regard. Considering the actual numerical scores, the most preferred (7.7) wine sample in the study generally was the sample produced with brewer's yeast with sugar and nutrient addition, though the sample with inherent yeast and control were also very much liked. The samples produced with baker's yeast and that without any starter culture were moderately liked (7.13 and 6.80 respectively) by the panelists. This study indicated that good wine comparable to some commercial wines with regards to sensory qualities could be produced by fermenting with brewer's yeast or the yeast strain isolated from the *Samanea saman* pulp.

**Table 7:** Mean Scores for the Sensory Attributes of *Samanea saman* wine Samples

| Source of Yeast | Attribute | | | | |
|---|---|---|---|---|---|
| | **Aroma** | **Taste** | **Appearance** | **Astringency** | **overall Acceptability** |
| **Inherent** | $7.67\pm0.58^{a}$ | $7.23\pm0.25^{a}$ | $7.43\pm0.21^{ab}$ | $6.93\pm0.12^{a}$ | $7.50\pm0.10^{a}$ |
| **Brewer's** | $6.80\pm0.20^{bc}$ | $7.40\pm0.20^{a}$ | $7.67\pm0.12^{a}$ | $6.63\pm0.15^{ab}$ | $7.73\pm0.12^{a}$ |
| **Baker's** | $7.20\pm0.20^{ab}$ | $6.67\pm0.31^{b}$ | $6.87\pm0.12^{c}$ | $6.63\pm0.15^{ab}$ | $7.13\pm0.12^{b}$ |
| **No Yeast** | $6.23\pm0.25^{c}$ | $6.67\pm0.15^{b}$ | $7.17\pm0.06^{bc}$ | $6.37\pm0.15^{b}$ | $6.80\pm0.20^{c}$ |
| **Control** | $6.83\pm0.15^{b}$ | $7.33\pm0.15^{a}$ | $7.53\pm0.31^{a}$ | $6.50\pm0.30^{b}$ | $7.60\pm0.10^{a}$ |
| **LSD** | **0.5733** | **0.4013** | **0.3322** | **0.3387** | **0.2395** |

Means with different superscripts on the same column are significantly ($p\leq0.05$) different from each other.

**Plate 1:** Rain tree (*Samanea saman*) Plant at FUTO

**Plate 2:** Rain tree (*Samaneasaman*) Pod


**Plate 3:** A cross section of the *Samaneasaman* wine samples bottled and labeled as Samanto wine.
Where
1. *Samaneasaman* wine fermented with inherent yeast, yeast nutrient and added sugar(SSIN)
2. *Samneasaman* wine fermented with brewer's yeast, yeast nutrient and added sugar (SSBR)
3. *Samaneasaman* wine fermented with baker's yeast, yeast nutrient and added sugar (SSBK)
4. *Samaneasaman* wine produced without yeast starter culture, but with yeast nutrient and added sugar (SWNY)

**CONCLUSION**

The source of yeast significantly ($p<0.05$) influenced the concentrations and odour activity values of various volatile compounds identified in the *Samanea saman* wine samples. Isoamyl alcohol and 1-propanol were the most abundant alcohols identified in all the wine samples. Though methanol was identified in all the *Samanea saman* wine samples, they were found within the acceptable range of less than 100mg/l. Esters were the predominant volatile compounds identified in all the wine samples. Ethyl hexanoate and isoamyl acetate were most abundant in all the *Samanea saman* wine samples. The wine sample fermented with the inherent yeast produced the greatest number of esters with highest odour activity values and were significantly ($p<0.05$) different from other samples. The *Samanea saman* wine samples produced with the inherent yeast or brewer's yeast were very much liked (8) just as the commercial wine (control). It therefore concludes that the source of yeast influenced the volatile composition, their odour activity values and sensory properties (aroma) of *Samanea saman* wine.

**Recommendations**

The results of this study have revealed the need for:
Utilization of the sugary pulp of Samanea saman in wine production.
Industrial isolation of yeasts from *Samanea saman* pods or other under-utilized fruits for their application in breweries or other industries as alternative to existing commercial yeast strains.
Extraction of the flavor compounds of the *Samanea saman* pods as flavor concentrate that can be used in food industries is also recommended.

**Competing interests**

The authors hereby declare that there were no competing interests in this research.

**Authors contributions**

Uzoukwu, A.E and Ubbaonu .C.N conceived and designed the research, with the participation of Nwosu, J.N, Ogueke, C.C and Chukwu, Chukwu, M.N in acquisition, analysis and interpretation of data. All authors were involved in critical revision of the research for its intellectual content and final approval for publication.

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