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Production of Sparkling Wines from Pineapple and Grape Fruits

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ABSTRACT

The use of locally harvested fruits is necessary to reduce the high cost of purchase of wine in the market. The production of sparkling wine from fruit juice using pineapple and grape was carried out using Saccharomyces cerevisiae as the yeast strain. Sparkling wine is a multi-component hydro-alcoholic solution super saturated with CO_2 dissolved gas molecules. It is also the type of wine in which CO_2 not less than 5g/l at 20°C is produced during secondary fermentation in a closed container such as bottle or tank to retain the CO_2 produced. The aim of this study is to determine the level of carbonation and alcohol to the liqueur de tirage at secondary fermentation. The methods used were Descriptive analysis (DA) and Temporal Check - All - That - Apply (TCATA). The fruits were washed, peeled, sliced, rewashed and blended differently with a sterile blender into a sterile vessel and filtered separately. 0.28g of sodium metabisulphite was added for preservation. "Must" analysis was carried out before and after fortification with 23grams of sugar per litre. The "must" were pitched and primary and secondary fermented were carried out for seven days. Sensory evaluation tests of the wine were carried out using fifteen panelists through questionnaires. It was revealed wine had acceptable aroma /flavour and taste. The grape has better taste, aroma/flavor than the pineapple while the attributes of pineapple is more in colour and appearance more than the grape wine. The original gravity of the "must" before and after fortification ranged between 1060 to 1068°p for (Pineapple and grape "must") respectively. The specific gravity of 3days primary fermentation for pineapple and grape "must" ranged between 1020 to 1028°p, 1000 to 1002°p, 0.998 to 0.999°p. The pH for pineapple and grape "must" ranged between 4.28 to 4.31, 3.67 to 3.71, and 3.62 to 3.64 respectively. The percentage alcohol ranged between 13 and 12 for Pineapple and Grape. The statistical analysis tests used was analysis of variance (ANOVA), with mean separation carried out by Fishers Least Significantly Difference (LSD) test at $P \leq 0.05$ level of significant. The criteria for the significant differences among panelist as a function of CO^2 level were based on binominal distribution tables for paired comparison

Keywords: *Sparkling Wine, Saccharomyces Cerevisiae, Pineapple, Grape.*

1. Introduction

Since 2014, the global wine market has grown by 11.5%. Contributing to the growth of this market was the increased consumption of the whole sparkling wine category, including Champagne, Moscato, Prosecco, and other non-Champagne sparkling wines. Industry experts forecasted by 2019 that global consumption of sparkling wines will increase by an additional 7.4% (Mariani et al. 2012).

Sparkling wine is defined as a multi-component hydro-alcoholic solution supersaturated with CO_2 dissolved gas molecules (Liger-Belair et al. 2009). It is also the type of wine in which CO_2 not less than 5g/L at 20^{0}C is produced during secondary fermentation in a closed container such as bottle or tank to retain the CO2 produced. It is this dissolved CO_2 gas that creates the perception of carbonation and effervescence characteristics of sparkling wines. Sparkling wines are produced using various methods including: the traditional method, the charmat method, transfer method, ancestral method, continuous method, and carbonation method.

The traditional method is the more time and labor-intensive method. In this method, once the primary fermentation is completed, a second fermentation in bottle is necessary to produce CO_2. To induce this second fermentation, a liqueur de tirage is prepared. The tirage is composed of yeast, sugar. (Pérez-Magaino et al. 2013) and a riddling aid. The second fermentation lasts about 6-8 weeks once completed the wine ages and the yeast autolysis occurs. As this process occurs, the bottle is riddled, or turned a fraction of a turn which encourages the incorporation of yeast components into the wine. As aging nears completion, riddling eventually tilts the bottles until the neck is fully inverted this forces yeast and wine sediment into the neck of the bottle. At this point, the bottles are prepared for disgorgement. Specifically, the neck is frozen in a glycol bath, the bottle is turned upright and the cap removed. Natural pressure behind the cap expels the yeast and sediment. Some wine may be lost during this process. To make up for this loss, each bottle is topped up with wine, while some winemakers may add wine and/or a dosage liquor that can consist of sugar (0-50 g/L), liquor (cognac or brandy), or other wines. Each bottle is sealed with a cork and wire hood to prevent the cork from being expelled due to the high carbonation pressure.

Research in the area of Sparkling wine carbonation pressure is limited. (Kemp et al. 2015) provide a review of the effect of processing on traditional sparkling wines. Studies have detailed sparkling wine foam. (Martinez-Lapuente et al. 2013) Bubble dynamics and the physicochemical nature of CO_2 and the influence of matrix components, such as foam active compounds and yeast cell wall compounds affect the final wine. Additionally, several studies have sought to describe the relationship between CO_2 and the perception of specific sensory properties through the development of carbonation and pressure. Recently, a sparkling wine-specific lexicon was developed to further detail the complex perceptions related to this style of wine, with attributes including nasal pungency aroma, as well as the mouth feel attributes of bubble pain, creamy, and foamy. (Le Barbe, 2014).

In the studies mentioned above, the sparkling wines were profiled using static sensory methods, such as descriptive analysis. Static methods are based on the concept that a perception is an average of the entire sensory experience. However, researchers agree that a sensory perception is a dynamic process in which attribute perceptions change over time (Cadena et al. 2014).

As carbonation perception encompasses mouth feel attributes that evolve over time, the application of temporal sensory evaluation methods would likely provide a more accurate depiction of the full sensory experience. Recently, a temporal method has been introduced, Temporal Check-All-That-Apply (TCATA), which allows for the simultaneous identification of both non-dominant and dominant attributes . Based on common TCATA methodology, studies using this method instruct panelists to evaluate the product over time and constantly check and uncheck the attributes as they are perceived or not respectively.

Beyond sensory methodologies to better detail sparkling wine profiles, no study has yet examined the effect of dosage on the final properties of the wine. A dosage liquid added at the final stage of sparkling wine processing serves to replace wine that was lost during disgorgement and possibly contribute sweetness. The composition of the dosage can consist of sugar (0-50+ g/L), liquor/spirits (brandy or cognac), older wines, wines aged in different vessels (i.e. stainless, oak, or concrete) (Kemp et al. 2015).

The lack of specific information related to the dosage and its influence on sparkling wine sensory profiles and sweetness perception warrants further study.

Statement of the problems

The production of Sparkling wine is mostly produced with imported fruits which are costly to purchase. As a result, the use of locally harvested fruits can replace the imported fruits in production of sparkling wine using traditional method.

Aim

This work is aimed at: Producing Sparkling wine from fruit juice using Pineapple and Grape.

Specific Objectives of this research include to:

i. Examine the impact of locally produced fruits in production of sparkling wine.
ii. Describe the impart of concentration of CO2 and sugar on production of Sparkling wine.
iii. Determine the sensory attributes that drive consumer acceptance of sparkling wines.

Materials and Methods

Materials

The materials used for the work included grape fruit, pineapple fruit (queen type), glucose, sugar, sodium metabisulphite, purified water, muslin cloth and Blending Machine. Grape fruits were bought from the shopping mall (Shoprite) Enugu and Pineapple were also bought from Odegba, New market Enugu. Others were obtained from Ogbete Main Market, Enugu. Strain of Saccharomyces cerevisiae were obtained from Applied Microbiology and Brewing Laboratory with other equipment used in the work.

Methods

The methods used were Descriptive Analysis (DA) and Temporal Check- all - that - apply (TCATA). (Kenneth, 2016).

Procedures

Select the healthy fruits from the market
↓
Wash the selected fruits properly
↓
Peel the fruits (if necessary) and slice
↓
Crush the fruits and extract the juice in a vessel or container
↓
Filter the fruit juice or centrifuge
↓
Determine the original gravity, pH, sugar level and the temperature of the "must"
↓
Fortify the must with sugar and determine the specific gravity, pH, Sugar level and temperature
↓
Add Sodium metabisulphite as preservation to the "must"
↓
Pitch the "must" (Addition of yeast Inoculum)
↓
Primary fermentation (for 7 days at room temperature)
↓
Rack the fermented must after settling at the bottom of the vessel
↓
Tirage, Bottling, and Secondary fermentation (For pressure development) (for 4 weeks) with sugar at 10 gm/L.
↓
Maturation/Ageing and Remuage/ Riddling for (4 weeks)
↓
Disgorging (freezer), Dosage, Corking, and labelling.

Preparation of the "Must"

The Grape fruit and Pineapple fruit were weighed, washed, peeled, sliced, rewashed and reweighed. The fruits were then blended differently with a sterile blender into a sterile container and then filter separately. 200ml of distilled water was added during blending to avoid friction in the blender. 200mls of distilled water was also added to the extract "must" by filtering the juice with muslin cloth. The "must" was poured into the fermenting vessel or jar for fermentation to obtain 3 litres of each jar. 0.28 gram per litre of Sodium metabisulphite was added for preservation and "must" analysis carried out before and after fortification with sugar to obtain sugar content of 17 ^{0}Brix for each jar.

Analysis of the "Must" before Fermentation

Determination of Original gravity

After filtering the "must", the samples were poured each into 100ml measuring cylinder. A hydrometer (^{0}B) was dipped slightly into the solution while reading was immediately recorded accordingly. Original gravity is the amount of sugar available for fermentation or the amount of sugar present in the "must" before undergoing fermentation. It could also be defined as the density of the "must" before it is fermented.

Determination of pH

The pH of the "must" sample was determined by pouring each in 250ml round bottom flask, and the pH meter slightly dipped into the sample while readings were taken and recorded appropriately. pH helps to determine the level of the acidity of the "must".

Determination of the Temperature

The temperature of the "must" was determined by dipping thermometer into each sample while the reading were taken and recorded accordingly.

Preparation of Yeast Inoculum cum Pitching

The yeast strain, Saccharomyces cerevisiae was reconstituted from dormant active yeast stage to the active state by weighing 10g of it together with 5g of glucose-D into an air-tight container and also 2.5gml of Ammonium Sulphite. The content was mixed with 100ml of distilled water and shake for about 7 minutes until there was evolution of Carbon (iv) Oxide on opening the container. The evolution of CO_2 connotes the awakening of the yeast cells.

Finally, 10ml of the yeast inoculums was pitched in each fermenting vessels for the commencement of primary fermentation.

Primary Fermentation

Primary fermentation commenced as soon as the pitching was done and lasted for 7 days which includes 3days of anaerobic fermentation respectively at room temperature. At the end of the 7th day the fermented "must" were racked and clarified before some parameters were determined such as specific gravity, pH, Alcohol content or percentage alcohol were determined and recorded.

Analysis of the "Must" during Fermentation

Determination of specific gravity

After primary fermentation, the samples of the "must" were poured each into 100ml of measuring cylinder. A hydrometer was dipped slightly into the solution while the reading were taken immediately and recorded throughout the fermenting days. Specific gravity is the density of the "must" after it is fermented. It is also the ratio of the density of the liquid to the density of water. Specific gravity indicates the amount of fermentable sugar or possible alcohol percentage in the "must" or wine.

Determination of pH

The pH of each “must” sample was determined by pouring 50ml each in 250ml round bottom flask and` the pH meter slightly dipped into the sample while reading were taken and recorded.

Determination of “must” temperature

The temperatures of the “must” were determined by dipping the thermometer into each sample while the readings were taken and recorded throughout the fermenting days.

Determination of percentage Alcohol

The percentage alcoholic content was determined using the formula

% Alc v/v = (OG —— SG) × 100

OG = Original gravity

SG = Specific gravity.

Racking of the Fermented “Must” or Wine

Racking is the movement of wine from one fermenting vessel to another for fining. Racking was carried out by allowing the “must” or wine into settling to be transferred to another vessel. It was done at (10-16) ^{0}C.

Tirage, Bottling and Secondary Fermentation

Tirage is when the yeast and sugar are added to the cuvee prior to bottling. It is necessary for the secondary fermentation to take place in the bottle. 10g of the yeast were weighed together with 50gml of glucose and sucrose into an air tight container. The content was mixed with 200ml of distilled water and shaken for about 7 minutes for evolution of carbon (iv) oxide and poured back into the “must” or wine and bottled for secondary fermentation. The crown caps (not corks) are used to trap the carbon (iv) oxide that is produced by the yeast consuming the sugar, as a result the alcohol percent rises (to about 12%) and fizz sound is produced.

Maturage / Ageing and Remuage/ Ridding

This is the lengthy labour- intensive and expensive stage of traditional sparkling wine production. It is the changes that tend to improve the taste and flavor of the wine over time. During ageing process, the yeast that was added in tirage stage eventually dies once they have consumed all the sugar (yeast autolysis) and settle at the bottom of the bottle. Yeast autolysis contributes to the creaminess, biscuit and toasty notes typically found in aged sparkling wines. Remuage or riddling is performed to bring the yeast lees from the bottom of the bottle to the neck of the bottle by turning it upright.

Disgorging, Dosage, Corking and Labelling

Disgorging happens once the sparkling wine has been aged to its requirement. Disgorging is the technique used in sparkling wine production to remove frozen yeast sediments remaining in the bottle after secondary fermentation when the bottle is turned upright. The neck of the bottles is dipped into extremely cold glycerol to freeze the yeast lees. The crown cap is then popped off, allowing the frozen yeast plug to shoot out of the pressurised bottle. Some wine is lost as a result, hence the dosage which is made up of the base wine and sugar is added prior to corking with a sparkling wine cork and secured with wire. Sugar is added to adjust the sweetness of the sparkling wine. Labelling wraps up the whole process and method of traditional production of sparkling wine.

Sensory Analysis of the Wine

A comparison test was used, with pairs presented to each panellist for the identification of the sample with the higher intensity of a particular attribute. During day 1, comparison tests in which CO_2 concentration 7.5 g CO_2/L) was compared to the control sparkling wine 0g CO_2/L). The experiment was repeated on a second day. Wine samples were served using a randomized block design for sample presentation.

Due to the influence of temperature on CO_2 perception, all wines were presented at 8-9°C. At least two bottles per treatment were opened so as to avoid significant CO_2 losses from the kinetics of pouring and wait time between panelists. The same employee poured the carbonated sample or control to standardize the pouring process and minimize variation in sample preparation. Consumers were also provided with the definition of the mouth-feel attribute of “bite”, which was defined as the stinging experience in the oral cavity when exposed to carbonation. Consumers were also asked about their familiarity with the perception of carbonation. Each panelist was presented with a bottle of wine. For each bottle, consumers were required to evaluate the sample and indicate on paper ballots (given with each presented) which had a greater intensity of the mouth-feel attributes of carbonation and “bite”, along with identifying which sample had a more sour taste. Comment boxes were provided for each comparison. The panelists rested at least 2 min in between pairs, with a 10 minutes break following the set of wines.

Statistical Analysis of the Wine

Wine chemistry parameters were analyzed by analysis of variance (ANOVA), with mean separation carried out by Fishers Least Significantly Difference (LSD) test at $p \leq 0.05$. For the paired comparison data, criteria for the significant differences among panelists as a function of CO_2 level were based on binomial distribution tables for paired comparison (Roessler, Pangborn, Sidel, and Stone, 1978). Levels of significance were established at $p \leq 0.05$ and $p \leq 0.001$.

RESULTS

Table 1, showed values of the “must” analysis of fruits juice before and after fortification with sugar.

SAMPLE (A AND B)	ORIGINAL GRAVITY (^oP)	PH	SUGAR LEVEL(^oB)	TEMP(^oC)
PINEAPPLE A	1060	5.22	17	20
GRAPE B	1060	4.28	17	20
PINEAPPLE A	1068	5.22	18	20
GRAPE B	1068	4.28	18	20

The fortification of the “must” allows the “must” to be bound for complete fermentation and to obtain sugar content of 17-18o Brix for each jar. There was slight change in original gravity of the “must” after fortification with sugar. The available sugar left for fermentation increased as a result of additional sugar to the “must” but no changes were observed in value of pH, and sugar level.

Table 2: Summary on the analysis of the “must” after primary fermentation for 3days (0-72hrs) and secondary fermentation. OG=1.068

Days	Samples	SG(^op)	%Alcohol (OG-SG)100 v/v	pH	Sugar level (^{0}Brix)	Temp (^oC)
1	A.24hr	1.020	4.8	4.28	5.08	20
	B.24hr	1.028	4.31	4.31	7.06	20
2	A.48hr	1.000	6.8	3.67	0	20
	B.48hr	1.002	6.6	3.71	0.52	20
3	A.72hr	0.998	7	3.62	0.52	20
	B.72hr	0.999	6.9	3.64	0.51	20
After 2nd fermentation	A.	0.938	13	2.30	0.21	20
	B.	0.948	12	2.0	0.10	20

In Table 2, it was observed that there was decrease in values of the specific gravity, pH and sugar level of the “must” of Pineapple and Grape which indicated fermentation process and increased percentage alcohol at a constant temperature of (200C).

After secondary fermentation and ageing, the percentage alcohol of Pineapple wine increased to 13 while the percentage alcohol for Grape wine increased to 12.

Table 3: Sensory Evaluation of the Wine

ATTRIBUTES	PINEAPPLE	GRAPE
TASTE	3.1	4.5
AROMA	2.9	3.5
FLAVOR	2.5	4.0
COLOUR/ APPEARANCE	4.2	3.5
AFTERTASTE	3.3	4.0

N=15

Values are means of the panelist` scores. 1= dislike extremely, 2=like moderately, 3=like much, 4=like very much, 5=like extremely.

Table 4, showed the values for sensory evaluation test of the sparkling wine. The Sensory evaluation test of the Sparkling wine showed no significance difference at $p \leq 0.05$ and $p \leq 0.001$.

Discussion

The analysis of the “must” before and after fortification for Sample A (pineapple) has the original gravity of 1.060 (°P), pH 5.22, sugar level 17(°Brix) and temperature 20°C. On the other hand for sample B (grape) has the original gravity of 1.060. pH 4.28, sugar level 17(°Brix) and temperature 20°C. After fortification, the original gravity 1.068 (°p), pH 5.22, sugar level 18°Brix, and temperature 20°C. There was change in value of original gravity of the “must” samples A and B (Pineapple and grape) respectively but there was no changes in values of pH, sugar level and the temperature of the “must” for Pineapple and Grape respectively. This change observed in the original gravity of the “must” was as a result of the fortification of the “must” with sugar. The result signifies the appropriate amount of sugar present in the “must” to undergo primary fermentation by the action yeast strain (*Saccharomyces cerevisiae*) to generate alcohol and CO_2. The recorded values were comparable to the reference values as documented by (Ohwesiri *et al*. 2016).

The “must” sample A (Pineapple) and sample B (Grape) has the specific gravity ranged from 1.020 - 1.028°p for both Pineapple and Grape. The percentage alcohol ranged from 4.8 - 4%. The corresponding pH of the samples ranged from 4.28 - 4.31 for Pineapple and Grape. The sugar level ranged from 5.08 - 7.06 for Pineapple and Grape at specific temperatures of 20°C. The second day of fermentation as the specific gravity of the Pineapple and Grape ranged from 1.000 - 1.002 °p. The percentage alcohol ranged from 6.8 to 6.6%. The pH for Pineapple and Grape ranged from 3.67 - 3.71. The sugar level for Pineapple and Grape ranged from 0 - 0.52 at constant room temperatures of 20°C.

The Third day as the specific gravity for samples A (Pineapple) and B (Grape) ranged from 0.998 - 0.999. The percentage alcohol ranged from 7and 6.9%, pH ranged from 3.62 - 3.64, the sugar level ranged from 0.52 - 0.51 for Pineapple and Grape at constant temperatures of 20°C. During the days of fermentation, it was noticed that there are decrease in specific gravity, pH, sugar level as the percentage alcohol increased to generate CO_2 gas molecule. After secondary fermentation and ageing of the wine, the percentage alcohol increased to 13 and 12 respectively for pineapple and grape wine. This result was in compliance with the work of (Mashra, 2016).

The Sensory attributes of the Sparkling wine for Pineapple and Grape wine include taste, aroma, flavor, colour/appearance and aftertaste. Taste has its attributes for Pineapple and Grape wine as 3.1 and 4.5, Aroma for Pineapple and Grape 2.9 and 3.5, Flavor 2.5 and 4.0 for Pineapple and Grape, Colour/Appearance 4.2 and 3.5 for Pineapple and Grape, Aftertaste 3.3 and 4.0 for Pineapple and Grape wine. It was discovered that Grape wine has the highest attributes in taste, aroma, flavor, and aftertaste while the Pineapple has the highest attributes in colour/ appearance. It is shown that Grape fruit has the highest attributes for production of Sparkling wine. This is in compliance with (Gawel and Godden, 2008).

Conclusion

Conclusively, this study is to ascertain that sparkling wine could be satisfactorily produced from locally harvested fruits using Saccharomyces cerevisiae yeast strain, sugar, and glucose to generate higher carbonation and alcohol to replace the expensive wine. The influence of the carbonation on the sensory attributes was explored by trained sensory evaluation panel using descriptive analysis (DA) and Temporal Check- All- That- Apply (TCATA) with no significant difference at $P \leq 0.05$ level of significant. The sensory attributes will drive the consumer’s acceptance of the Sparkling wine.

Recommendations

The production of sparkling wine using locally harvested fruits is recommended by brewing industries in Nigeria to serve our local industries. It is recommended that farmers should embark on mass production of indigenous fruits to ensure that they are readily available to replace the imported fruits and to reduce its cost. Future studies should evaluate the effect of higher carbonation levels (7.5-11) and above on temporal profiling and consumer perception of carbonation. More studies on sensory aspects of sparkling wine are needed to further detail these complex metrics and wine. More knowledge on these subjects will benefit the Sparkling wine makers and business to better understand the complexities associated with this style of wine and market preferences.

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