Characterization and Evaluation of Aratiles (Muntingia calabura) fruit Alcoholic Beverage

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Characterization and Evaluation of *Aratiles* (*Muntingia calabura*) fruit Alcoholic Beverage

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Abstract: *Aratiles fruit (Muntingia calabura) is one of the promising commodities which could be used in alcoholic beverage production due to its high sugar content. The aratiles juice was fermented for 9 days using three different yeast strains at different concentration of Diammonium Hydrogen Phosphate (DAHP) (0.1% and 0.2%) and citric acid (0.3% and 0.4%). It was observed that DAHP and citric acid tends to influence the potential hydrogen (pH), the soluble solid content (SSC) and the alcohol percentage (%) of the aratiles fruit alcoholic beverage. Samples with 0.1% DAHP and 0.4% citric acid as additives showed a great performance among treatments. The sample produced from Premier Curvee with 0.1% DAHP and 0.4% citric acid gained the highest rating which has 4.2 rating using the 5-point hedonic scale during the sensory evaluation. Sensory evaluation revealed that aratiles alcoholic beverage was moderately acceptable.*

Keywords: Aratiles Fruit, Alcoholic Beverages, Diammonium Hydrogen Phosphate, Citric Acid

1. INTRODUCTION

Numerous fruits can be used to make wine, beers, vodka, whiskey, or any kind of alcoholic beverages as long as they have enough sugar for the fermentation process [1]. Some studies found that low alcohol consumption has no effect on blood pressure and other diseases like coronary heart disease (CHD) [2]. However, some studies have showed that the moderate alcohol consumption could affect the ability to lessen stress and/or alter personality patterns associated with CHD risks [3].

The aratiles fruit has its potential as a raw material for alcoholic beverage due to its versatility and fast-growing abilities. Additionally, this fruit is packed with vitamins and antioxidants that boost health and help relieve symptoms of certain conditions. However, this fruit remains underutilized since only few has sought to examine or utilize this commodity [4] for food production and food innovation. Thus, a study showed that the *M. calabura* (a fast-growing tree with a cherry-like fruit) has multiple beneficial effects on one's health, including lowering blood sugar levels, preventing cancer, promoting cardiovascular health, reducing blood pressure, and blocking pain [5]. With the positive effects it has on one's health, the high sugar content of this fruit makes it a promising candidate for alcoholic beverages production. Based on the Journal of Bioprocessing and Biotechniques [6], fruits with high sugar content have the potential to serve in some capacity as a substitute for the purpose of appropriately recovering the usage of beverages production.

Hence, this study sought to utilize, characterize, and evaluate aratiles fruit as a potential for alcoholic beverages production.

2. MATERIALS AND METHODS

Generally, this study involved the following major activities: cleaning— removal of stem, crashing, determining the sugar content, application of activated yeast strains, straining fruit pulp, fermenting, racking, bottling, sensory evaluation test, data collection, and data analysis. During the harvesting process, only those aratiles that fall under yellow, yellow-orange, and red were harvested. Equipment used was thoroughly cleaned to avoid unwanted bacteria during the fermentation process. Using soap and detergents were avoided to avoid residues that might cause an off-taste to the alcoholic beverages; instead, using hot water and a long brush to clean the containers, like the bottles were done accordingly. All samples were cleaned with water and allowed to drain in a container before being crushed using a smashing tool to extract juice.

Table 1. Experimental research design used in the study.

	Factor B (Ratio)	
Factor A (Types of Yeast) 0.5 grams	**DAHP**	**Citric Acid**
	% (w/v)	% (w/v)
	0.1	0.3
	0.1	0.4
Premier Classique	0.2	0.3
	0.2	0.4
	0	0
	0.1	0.3
	0.1	0.4
Premier Blanc	0.2	0.3
	0.2	0.4
	0	0
	0.1	0.3
	0.1	0.4
Premier Cuvee	0.2	0.3
	0.2	0.4
	0	0

Table 1 showed the experimental research design used by the researchers in conducting this study. The Factor A were the types of yeast strain, namely: Premier Cuvee, Premier Blanc, and Premier Classique with 0.5 grams of yeast, while Factor B was the additive ratio consist of: Di-ammonium Hydrogen Phosphate (0.1 % and 0.2%), and citrate or citric acid (0.3 % and 0.4%). The controls (0) have no DAHP and citrate added, an experimental group – one control group designed was used.

2.1 Pulp Treatment and Fermentation

In every 500 ml of mixture of aratiles juice and water, (0.1 and 0.2%) in the form of Di-ammonium hydrogen phosphate (DAHP), and citric acid (0.3 and 0.4%). Pectin esterase enzyme of 3 grams per gallon (3.8 liters) was added to the must along with 1 campden tablet for every 1 gallon of water [7][8]. In this study, two factors that were evaluated– the type of yeast used, and the ratio of additives (DAHP and citric acid). The yeast that was used were the most common yeast strains used like the Premier Cuvee, Premier Blanc, and Premier Classique. The 0.5 grams of yeast was inoculated with warm water and fermentation process was carried out at 34 °C [9]. Moreover, researchers utilized the precision balance scale (BSA22025-CW-Sartorius) as shown in Figure 10 in weighing 0.5 g yeast, 0.1% and 2% of DAHP, 0.3% and 0.4% of citrate, and pectin esterase enzymes.

2.2 Racking and Bottling

After the fermentation had been finished, the samples were transferred from one container to another using a siphon to separate the beverages from its sediment. The alcoholic beverages were gradually descended from the middle to the bottom of the container. The fermentation lock was replaced and the bottles were hold off for racking for a day. The beverage was stored in a clean place to reduce the possibility of oxidation- related off-flavor and off-color development.

2.3 Sensory Evaluation

The sensory evaluation test was conducted at Caraga State University- Main campus, Ampayon, Butuan City. Three trials were made by the researchers during sensory evaluation. Sole requirements for participation included being older than the age of 18 years old from College of Engineering and Geosciences (CEGS), having no known allergic or negative reaction to alcoholic beverages, and experiencing no illness symptoms during both recruitment and taste-testing. Participants were asked to indicate sensory parameters such as appearance, aroma, taste, and texture appeal using 5-point hedonic scale by completing individualized evaluation forms for each sample given. A maximum number of ten (10) respondents were selected per set of trials. Individuals who consume alcoholic beverages were chosen as respondents for the sensory evaluation. Each respondent was given equal amount of sample. Based on how frequently they had alcoholic beverage like wine in the past. Furthermore, researchers used 5-point hedonic scaling to evaluate each sensory parameter of the alcoholic beverage produced.

2.4 Data Collection

2.4.1 Determination of Color

A colorimeter was used to measure the CIE L* values indicating its lightness, CIE a* values indicating redness, and CIE b* values indicating yellowness of the aratiles fruit alcoholic beverage. Furthermore, the researchers used handheld precise colorimeter or PCE-CSM4 with SN: 1002000803 in measuring the color of the samples.

2.4.2 Determination of Soluble Solid Content

In measuring the soluble solid content, a digital brix and sucrose refractometer (Biobase Digital Refractometer, China) were used by taking extract after crashing the fruit. The soluble solid content of aratiles fruit alcoholic beverage were also measured at three days interval during and after fermentation of aratiles fruit juice.

2.4.3 Determination Alcohol Content

In measuring the alcohol content of aratiles fruit alcoholic beverage, the researchers used handheld alcohol refractometer. Furthermore, in getting the potential alcohol percentage (PAP), the brix value was employed to solve for the specific gravity

2.4.4 Determination of pH

To determine the pH level, a digital pH meter (PH800 pH Meter: APERA Instrument) was used. This measurement was taken every 3-days interval of the fermented aratiles fruit juice within 9 days of fermentation.

2.4.5 Determination of Odor, Taste, Texture, and Appearance

In this study, the researchers used 5-point hedonic rating scale for consumers' acceptance or acceptability of the product, such as odor, taste, appearance, and texture). The scaling will be 1-5, where the overall acceptability: 5= Extremely Acceptable, 4=Moderately Acceptable, 3= Acceptable, 2=Moderately Unacceptable, 1= Unacceptable.

2.5 Data Analysis

The statistical tool used was the Statistical Tool for Agricultural Research (STAR). In analyzing the data gathered, it was analyzed using the Analysis of Variance (ANOVA) through post hoc test ($p<0.05$) and for determining the significance of each variable, the Least Significance Difference (LSD) was used.

3. RESULTS AND DISCUSSION

3.1 Aratiles Alcoholic Beverage

The produced alcoholic beverage characterized through its color, pH, potential alcohol percentage and soluble solids. In addition, the acidity and alcohol content of the beverage produced were also evaluated and was assessed its acceptability through sensory evaluation.

3.2 Characterization of the Physicochemical Properties of Aratiles Fruit Alcoholic Beverage

In the study of Essiedu et al. [11], the color of alcoholic beverages depended on how much additives you add. The different concentrations of DAHP and citric acid affected the overall color of the produced beverages. These factors showed a significant difference ($p<0.05$) in the overall color of the produced product except for the redness. The low value of the redness may indicate the lack of anthocyanin present in the must during the fermentation process. Anthocyanin was the one responsible for the red color in an alcoholic beverage. In the study of Berg and Akiyoshi [12], the color behavior during the fermentation was materially affected by the aging of the alcoholic beverages; therefore, the longer it was stored, the shift in color was also observed. The overall colorimetric difference (ΔE) was calculated using the formula given in Equation 1.

$$\Delta E = \sqrt{\ }\ (L*)^2 + (a*)^2 + (b*)^2 \qquad \text{Eq. 1}$$

Where:
ΔE: overall colorimetric difference of aratiles fruit
L: values indicating its lightness
a: values indicating its redness
b: values indicating its yellowness

Table 2. Changes of aratiles alcoholic beverage color (L* a* b* and ΔE*) 3 to 9 days of fermentation

Y	Additives: DAHP (% w/v)	Additives: CA (% w/v)	Parameters: LM ±SD	Parameters: RM ±SD	Parameters: YM ±SD	Parameters: OCDM ±SD
Y_1	0.1	0.3	28.83 ± 0.02^{a}	0.01 ± 0.88	10.34 ± 0.50^{b}	30.64 ± 0.19^{ab}
	0.1	0.4	28.70 ± 0.14^{a}	0.09 ± 0.38	10.26 ± 0.73^{b}	30.59 ± 0.05^{b}
	0.2	0.3	28.65 ± 0.06^{a}	-0.09 ± 0.26	10.50 ± 0.36^{ab}	30.51 ± 0.07^{bc}
	0.2	0.4	28.62 ± 0.02^{a}	0.05 ± 0.37	9.69 ± 0.73^{c}	30.22 ± 0.22^{c}
	0	0	28.93 ± 0.05^{a}	0.53 ± 0.59	10.88 ± 0.68^{a}	30.92 ± 0.21^{a}
Y_2	0.1	0.3	28.44 ± 0.32^{b}	0.03 ± 0.28	9.93 ± 0.32^{c}	30.12 ± 0.39^{c}
	0.1	0.4	28.65 ± 0.09^{b}	0.14 ± 0.41	10.14 ± 0.20^{bc}	30.39 ± 0.03^{bc}
	0.2	0.3	28.67 ± 0.08^{b}	0.01 ± 0.25	10.37 ± 0.53^{ab}	30.49 ± 0.19^{b}
	0.2	0.4	28.67 ± 0.04^{b}	-0.05 ± 0.25	10.31 ± 0.21^{abc}	30.51 ± 0.04^{b}
	0	0	29.42 ± 0.64^{a}	1.40 ± 1.38	10.66 ± 0.69^{a}	31.34 ± 0.43^{a}
Y_3	0.1	0.3	28.76 ± 0.19^{a}	0.64 ± 0.72	10.64 ± 0.31^{a}	30.67 ± 0.19^{ab}
	0.1	0.4	28.65 ± 0.11^{a}	-0.06 ± 0.15	10.12 ± 0.29^{b}	30.39 ± 0.08^{bc}
	0.2	0.3	28.60 ± 0.08^{a}	0.16 ± 0.52	9.62 ± 0.68^{c}	30.30 ± 0.01^{c}
	0.2	0.4	28.62 ± 0^{a}	-0.01 ± 0.25	10.01 ± 0.46^{bc}	30.33 ± 0.14^{c}
	0	0	28.82 ± 0.14^{a}	0.44 ± 0.71	10.61 ± 0.67^{a}	30.72 ± 0.15^{a}

Y: Yeast is 0.5 g/L, DAHP: Diammonium phosphate, CA: Citric Acid, LM: Lightness Mean, RM: Redness Mean, YM: Yellowness Mean, OCDM: Overall Colorific Difference Mean, SD: Significant Difference

3.2.1 Soluble Solid Content (SSC)

As displayed in the Table 3, all samples at different yeast and additive ratio showed to have an increased of SSC starting from day 3 to 6 which record shown to have at least 24% of its soluble solid content. In day 3, the Y1X4 and Y2X4 with 0.2% DAHP and 0.4% of CA showed a brix value of 24.25 then decreases at the end of the fermentation during the 9th day which records shown to have 19.97 brix, while Y1X3 in day 9 show to decrease also with its degree brix of 17.89. The controls with no DAHP and Citrate added also revealed the decrease of brix starting from the day 3 to 9 of fermentation. The addition of different additives altered how the sample behaves during the fermentation process. This was also found out in the study of Sancho et al. [13], that the presence of different ratio and yeast added will result in great differences during alcoholic fermentation. One of the factors that may influence the SSC to increase were the yeast applied and eventually it will decrease after 5 days [13]. Furthermore, DAHP caused to improves the yeast growth and fermentation process and based on the result of this study, Premier Cuvee tended to excel the most among the other yeast used. While in the DAHP and citric acid ratio, it was the 0.1% DAHP and 0.4% citric acid.

Table 3. Physicochemical Parameters of Aratiles Fruit Beverage varying from Different Yeast Strains and Additive Ratio

	Yeast (0.5g/l)	Additives: DAHP (%w/v)	Additives: CA (% w/v)	Parameters: SSC Mean± SD	Parameters: % PA Mean± SD	Parameters: pH Mean ± SD
D_3	T1	0.1	0.3	21.00 ± 0.2000^{bc}	11.78 ± 0.1300^{b}	2.86 ± 0.2751
		0.1	0.4	21.13 ± 0.2309^{b}	11.86 ± 0.1443^{b}	2.82 ± 0.1808
		0.2	0.3	21.80 ± 0.6245^{a}	12.29 ± 0.3995^{a}	3.01 ± 0.0200
		0.2	0.4	20.63 ± 0.5508^{c}	11.74 ± 0.0346^{b}	3.06 ± 0.0557
		0	0	10.99 ± 0.0794^{d}	5.82 ± 0.0473^{c}	3.81 ± 0.1706
	T2	0.1	0.3	24.05 ± 0.0252^{a}	13.74 ± 0.0153^{a}	2.87 ± 0.1323
		0.1	0.4	24.17 ± 0.1900^{a}	13.81 ± 0.1234^{a}	2.81 ± 0.1058
		0.2	0.3	24.15 ± 0.0800^{a}	13.80 ± 0.0551^{a}	3.01 ± 0.0115
		0.2	0.4	24.25 ± 0.0833^{a}	13.88 ± 0.0656^{a}	3.09 ± 0.0265
		0	0	10.96 ± 0.0850^{b}	5.80 ± 0.0473^{b}	3.98 ± 0.0721
	T3	0.1	0.3	22.08 ± 0.2335^{b}	12.46 ± 0.1473^{b}	3.00 ± 0.0200
		0.1	0.4	23.26 ± 0.3175^{a}	13.23 ± 0.2060^{a}	2.80 ± 0.4045
		0.2	0.3	23.11 ± 0.1249^{a}	13.13 ± 0.0777^{a}	2.98 ± 0.1587
		0.2	0.4	23.43 ± 0.4140^{a}	13.12 ± 0.1617^{a}	2.96 ± 0.2007
		0	0	08.90 ± 0.2403^{c}	4.67 ± 0.1301^{c}	3.98 ± 0.0200
D_6	T1	0.1	0.3	19.59 ± 0.2201^{a}	10.90 ± 0.1401^{a}	3.02 ± 0.0200
		0.1	0.4	19.56 ± 0.2350^{a}	10.88 ± 0.1450^{a}	2.93 ± 0.1375
		0.2	0.3	18.92 ± 0.1365^{b}	10.48 ± 0.0862^{b}	3.10 ± 0.1572
		0.2	0.4	19.46 ± 0.1222^{a}	10.82 ± 0.0764^{a}	3.11 ± 0.0854
		0	0	6.01 ± 0.0265^{c}	3.10 ± 0.0153^{c}	3.96 ± 0.3404
	T2	0.1	0.3	22.36 ± 0.4200^{b}	12.64 ± 0.2650^{b}	3.03 ± 0.5121
		0.1	0.4	22.94 ± 0.2594^{a}	13.02 ± 0.1665^{a}	2.88 ± 0.0400
		0.2	0.3	22.51 ± 0.1389^{b}	12.74 ± 0.089^{b}	3.06 ± 0.0557
		0.2	0.4	20.43 ± 0.1212^{c}	11.42 ± 0.0755^{c}	3.24 ± 0.1100
		0	0	5.49 ± 0.3236^{d}	2.83 ± 0.1721^{d}	4.01 ± 0.1179
	T3	0.1	0.3	20.63 ± 0.0874^{a}	11.54 ± 0.0569^{a}	2.95 ± 0.0954
		0.1	0.4	20.83 ± 0.0306^{a}	11.67 ± 0.0200^{a}	2.46 ± 0.1114
		0.2	0.3	19.01 ± 0.0462^{c}	10.54 ± 0.0289^{c}	3.20 ± 0.2600
		0.2	0.4	19.64 ± 0.2818^{b}	10.93 ± 0.1778^{b}	2.85 ± 0.2386
		0	0	5.19 ± 0.0379^{d}	2.66 ± 0.0231^{d}	3.96 ± 0.2700
D_9	T1	0.1	0.3	19.17 ± 0.1159^{b}	10.64 ± 0.0723^{b}	2.92 ± 0.2227^{c}
		0.1	0.4	19.49 ± 0.1997^{a}	10.84 ± 0.1217^{a}	3.00 ± 0.5900^{c}
		0.2	0.3	17.98 ± 0.0808^{d}	9.91 ± 0.0458^{d}	3.45 ± 0.4441^{b}
		0.2	0.4	18.76 ± 0.1442^{c}	10.39 ± 0.0929^{c}	3.10 ± 0.0404^{bc}
		0	0	5.43 ± 0.1229^{e}	2.79 ± 0.0643^{e}	3.84 ± 0.1200^{a}
	T2	0.1	0.3	20.25 ± 0.4491^{a}	11.31 ± 0.2821^{a}	2.98 ± 0.2390^{b}
		0.1	0.4	19.97 ± 0.0839^{b}	11.13 ± 0.0551^{b}	2.89 ± 0.1044^{b}
		0.2	0.3	20.47 ± 0.1155^{a}	11.44 ± 0.0751^{a}	3.12 ± 0.0700^{b}
		0.2	0.4	19.97 ± 0.0850^{b}	11.13 ± 0.0500^{b}	3.13 ± 0.0361^{b}
		0	0	4.18 ± 0.1537^{c}	2.14 ± 0.0814^{c}	4.82 ± 0.1179^{a}
	T3	0.1	0.3	20.01 ± 0.0058^{a}	11.16 ± 0.0058^{a}	2.91 ± 0.1480^{b}
		0.1	0.4	20.02 ± 0.0115^{a}	11.16 ± 0.0058^{a}	2.84 ± 0.1652^{b}
		0.2	0.3	18.90 ± 0.0755^{c}	10.47 ± 0.0503^{c}	2.98 ± 0.0854^{b}
		0.2	0.4	19.60 ± 0.0569^{b}	10.91 ± 0.0361^{b}	3.05 ± 0.0656^{b}
		0	0	3.99 ± 0.0265^{d}	2.04 ± 0.0115^{d}	3.98 ± 0.2829^{a}

Y-Type of Yeast; DAHP-Diammonioum phosphate; CA-Citric Acid; SSC-Soluble Solid Content; %PA-Potential Alcohol Percentage; pH-potential of Hydrogen; SD-Standard Deviation; D_3, D_6, D_9 – Days of fermentation; Different small letters within the same column and treatment indicates statistical difference ($P<0.05$) based on the Pairwise Mean Comparison Treatment LSD test. Means with the same letter are not significant different.

3.2.2 Potential Alcohol Percentage

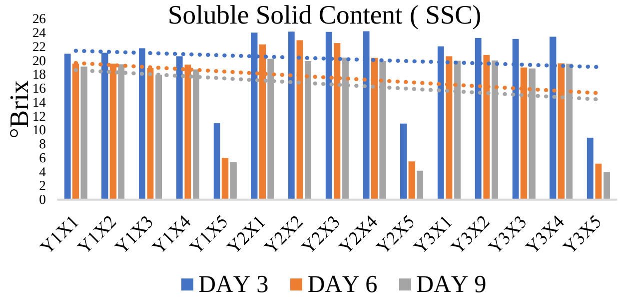
Based on the result of this study, SSC has a direct relationship to the potential alcohol. Provided that soluble solid content decreases, potential alcohol also decreases it was because the sugar present in the must was slowly converted into alcohol and carbon dioxide [15]. As shown in Table 3, the potential alcohol gradually decreased among the yeast used it was again the Premier Cuvee (Y3) that excel the most. This only meaned that the Y3 has a faster ability to breakdown the sugar in carbon dioxide compared to the other yeast used.

3.2.3 pH

As observed in the Table 3 of the aratiles beverages pH, the results have shown an increasing value of pH which indicates that beverage produced is less acidic, the decrease of value indicated to be more acidic otherwise. Mostly, pH value from the Table 10 revealed to have a value ranging from 2.8 to 3.98 of its acidity. Controls variables showed a pH ranging from 2.81 to 4.82 which was during the first six days of fermentation there were no significant difference ($p>0.05$) among the two factors (yeast and DAHP – Citric Acid Ratio). It was observed that all samples having the ratio of 0.1 % DAHP and 0.4% citric acid tends to have the lowest value of pH among the all the samples, therefore the ratio of DAHP and Citric can affect the acidity of the alcoholic beverage especially the citric acid due to its characteristics that may increase acidity.

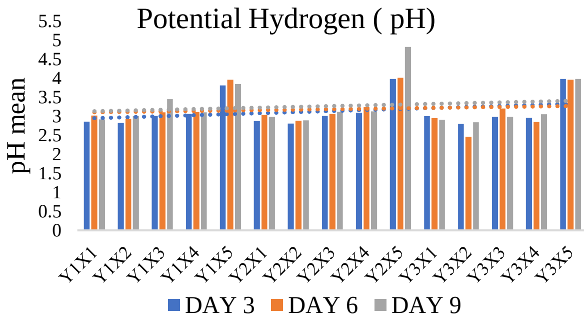
3.3 Evaluation of Soluble Solid Content, Acidity and %Alcohol Content after 9 days of fermentation

Based on the data in Figure 1, it presented that the fermentation during the first 3 days is faster than the latter days. The soluble solid content of the aratiles produced with the presence of the additives ranges from 18- 24.3 ◦Brix while for the sample without the presences of the additives ranges only 4.18- 11 ◦Brix which showed quite a lot of difference from samples with additives. The highest reduction in soluble solid content was observed in the treatment in X1 samples or the sample having the 0.1% DAHP and 0.3% CA followed by the other treatment that has also a presence of diammonium phosphate and citric acid with different concentration which was similar to the study of Sharma et.al [16]. The presence of the different additives caused a difference in the behavior of the sample during the fermentation stage. It was observed in the graph that the trend is decreasing starting from day 3 to 9. Similar observation that was found in the study Dominic and Linda **[9]**, the mean apparent °Brix range was 17.69 °Brix to 8.13 °Brix which was decreasing from the start of fermentation (24 hr) to the end (168 hr), respectively, by using different yeast strains. However, the changes of SSC (°Brix) were monitored throughout the fermentation period and showed a significant reduction in values during fermentation among the treatment yeast strains. Moreover, it was also observed that the rapid reduction of °Brix was recorded within the early hours 3 days (72 hr) to 9 days (216 hr) of fermentation in all the treatments that was similar to the report of Bhatane and Pawar [18] during the fermentation of must/juice into alcoholic beverages. Thus, the rapid reduction in sugar at the initial stage resulted from the active stage of the yeasts with sufficient nutrients present in the clear beverages at the initial stage. Furthermore, there was a significant difference between the additive ratio and yeast added to the soluble solid content (SSC) of the alcoholic beverages where $p<0.05$. Similarly, in the previous report of Olivero et al**.** [18], there was a significant difference in ability to ferment sucrose from different yeast strains all being in the same initial temperature and °Brix condition.



Y (1,2,3) + X5, no Diammoniun Hydrogen Phosphate or DAHP and Citric Acid or CA added; Y (1,2,3) + X1, 0.1% DAHP and 0.3% CA; +X2, 0.1% DAHP and 0.4% CA; +X3, 0.2% DAHP and 0.3 % CA; +X4, 0.2 DAHP and 0.4% CA

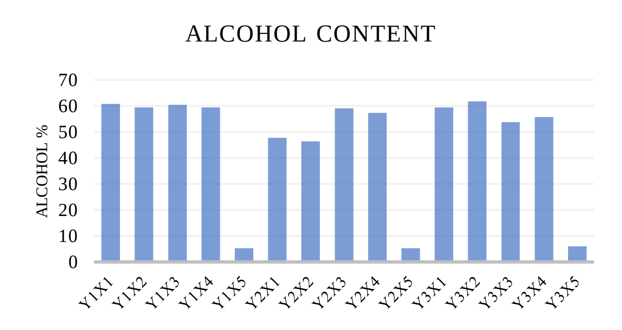
Figure 1. SSC of aratiles alcoholic beverages after 9 days of fermentation



Y (1,2,3) + X5, no Diammoniun Hydrogen Phosphate or DAHP and Citric Acid or CA added; Y (1,2,3) + X1, 0.1% DAHP and 0.3% CA; +X2, 0.1% DAHP and 0.4% CA; +X3, 0.2% DAHP and 0.3 % CA; +X4, 0.2 DAHP and 0.4% CA

Figure 2. pH of aratiles alcoholic beverages after 9 days of fermentation

The pH of the alcoholic beverage produced from the aratiles fruit based on Figure 2 above indicated that the samples pH ranges from 2.91 to 3.98 which was different from the study of Sharma et.al [16] where the same amount of DAHP and CA was applied. The pH value viewed from the range of 3.52 to 3.80 but the pH value of the alcoholic beverage produced falls from the standard pH of a fermented beverage of 2.5 – 4.5. The acidity of the fruit alcoholic beverage was influenced by the acidity of the fruit used in alcoholic beverages making [19]. Sample with premier classique yeast strain (Y3X2) with 0.1% DAHP and 0.4% CA were the most acidic from all the sample. Based on graph above it was observed that those sample that has no DAHP and CA tends to have higher pH compared to those sample from X1 to X4. Similarly, a study conducted by Dominic and Linda [8] which record shown that alcoholic beverage with redstar premier classique yeast strain gives a minor pH of 3.6-3.8 and thus pH values increased for all the treatments throughout the fermentation period. Thus, potential hydrogen (pH) from day 3 to 9 showed to have a significant difference ($p<0.05$) between pH and yeast and the additive ratio on the alcoholic beverages. According to Leonardelli [20], the addition of citric acid (CA), diammonium hydrogen phosphate (DAHP), and yeast often influenced the acidity of the alcoholic beverages [20]. Hence, the different additive concentration affected the acidity of the wine. Furthermore, the instability of pH across the fermentation period could result from other yeast competitors actively involved in the fermentation process, which was due to fermentation progress and accumulation of ethanol [21]. Moreover, pH of 3.5 juice was suitable enough for fermentative agents to escape pH from stress as it was reported by Liu et al. [22]. Additionally, the evolution of acetic acid bacteria during ethanol fermentation may have an impact on pH changes [23].



Y (1,2,3) + X5, no Diammoniun Hydrogen Phosphate or DAHP and Citric Acid or CA added; Y (1,2,3) + X1, 0.1% DAHP and 0.3% CA; +X2, 0.1% DAHP and 0.4% CA; +X3, 0.2% DAHP and 0.3 % CA; +X4, 0.2 DAHP and 0.4% CA

Figure 3. Alcohol content of aratiles alcoholic beverage

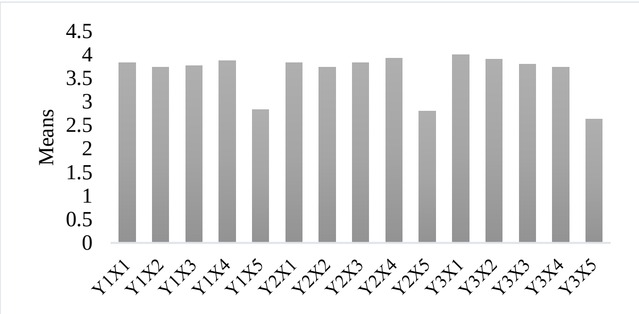
Figure 3 depicted the alcohol content of the aratiles alcoholic beverages. The controls with no diammonium hydrogen phosphate (DAHP) and citric acid (CA) added showed the lowest alcohol content ranges from 5.33% to 6 % while treatments with DAHP and CA added reveals to have higher alcohol content ranges from 46.33% to 61.67%. This presented that the premier cuvee with 0.1% DAHP and 0.4% CA (Y3X2) had a higher alcohol content among the samples presented. Thus, alcohol content ranged from 35%-46 was considered as vodka; %40%-46% is considered as whiskey, rum and tequila; 55%-60% is considered as cask strength whiskey [23]. Furthermore, the increased of percentage alcohol content on the samples were highly influenced by additive ratio and yeast added to the alcoholic beverages where ($p<0.05$) which showed to have a significant difference. Similarly, a study of Vidal et al. [24] confirmed that the *S. cerevisiae* strain directly influences higher alcohol formation. Thus, the higher alcohol formation by yeast was of great interest in the field of fermented beverages. The varying substrate compositions and methods of fermentation that were employed may have had an impact on the wines' alcohol concentration which can be also observed through comparing the controlled samples (no DAHP and CA) to those samples with DAHP and CA. Moreover, the yeast played a vital role in the production of alcoholic beverages. Thus, a good selection of suitable yeast strains was important not only to maximize alcohol yield, but also to maintain beverage sensory quality.

3.4 Assessing the Wine using Sensory Evaluation Test

The following steps were taken when evaluating a wine's sensory qualities: (i) appearance, which included the color and clarity of the liquid when the wine bottle or glass is tilted and its contents are viewed against a light source; (ii) aroma, which involved the olfactory response; (iii) taste, which begins in the mouth and ends with the finish; and (iv) texture, which combined the in-mouth sensations felt during ingestion and further swallowing. The testers described the wine they are evaluating using a score value assigned based on these characteristics.

3.4.1 Appearance

As displayed in Figure 4, that the appearance attributed of Y3X1 (0.5 grams of Premier Classique yeast, 0.1% w/v of DAHP, and 0.3% w/v of Citric Acid) showed to have (4) score value which was higher compared to other samples and indicated to be moderately acceptable to the participants, while Y2X5 displayed the lowest one with its mean average of 2.8 and shows to be acceptable to panels. In fact, according to Joshi et al. [25], color and appearance made an impact right away and were linked to alcoholic beverage quality. Acceptance or rejection mostly relied on what the eye notices fast. In determining, optimizing, and comparing the appearance with instrumental analysis, sensory evaluation can be quite important. The difference in measuring color presented another challenge, and in order to obtain reliable results, using sensory analysis might easily be identify due to its color distinction. Based on the findings of Olivero et al. [18], premier classique was one of the best yeast strains that offered an appreciable acidity on alcoholic beverages and also displayed an average intensity on the product. Moreover, it was also revealed that regarding the intensity color/appearance, the highest value for appearance was obtained from aratiles alcoholic beverages samples with premier cuvee yeast strain which was also similar to the study of Olivero et al. [18]. Thus, in sensory evaluation test held by Olivero et al. [18], the visual parameter, the clarity, tonality and fluidity of alcoholic beverages were evaluated by identifying each alcoholic beverage with the respective parameters. Furthermore, the study reveals that there is no significant difference ($p>0.05$) between the factors and the sensory attributes to the alcoholic beverages of aratiles. However, the result showed that during fermentation process, samples with the premier cuvee generated more sediments which directly impacted the juice yield and the appearance of the alcoholic beverages [18].



Y (1,2,3) + X5, no Diammoniun Hydrogen Phosphate or DAHP and Citric Acid or CA added; Y (1,2,3) + X1, 0.1% DAHP and 0.3% CA; +X2, 0.1% DAHP and 0.4% CA; +X3, 0.2% DAHP and 0.3 % CA; +X4, 0.2 DAHP and 0.4% CA

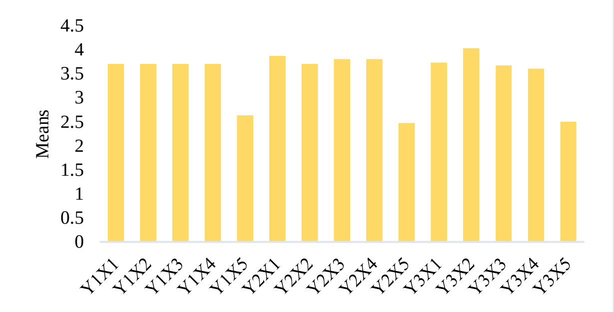
Scale: 5= Extremely Acceptable, 4= Moderately Acceptable, 3= Acceptable, 2= Moderately Unacceptable, 1= Unacceptable

Figure 4. Appearance value using evaluation

3.4.2 Aroma

The experience of smelling was usually referred to as aroma and was described as aromatic. In Figure 5 provided above, from the different additives concentration of making alcoholic beverages, the Y3X2 revealed to be the most aromatic compared to other treatments with the score value of 4.03 which means that it was moderately acceptable for the testers, followed by Y2X1 (0.5 grams of

Premier Blanc of yeast, 0.1% w/v of DAHP, and 0.3% w/v of Citric Acid) garnering its score value also of 3.87 which also near to moderately acceptable. However, the result showed that there was no significant difference ($p>0.05$) between the factors of treatment to the sensory attributes of aroma which contradict to the study of Joshi et al. [25], that aroma has significant attribute in sensory analysis and is highly influences a product's acceptability. Similar to the study of Olivero et al. [18], *Saccharomyces bayanus* premier cuvee red star yeast strain gave an amazing and intense aroma compared from the other strain, and found out to be more pleasant in terms of sensory experience. Furthermore, a good selection of yeast strains was significant to maintain the sensory quality of the alcoholic beverages like aroma [24].

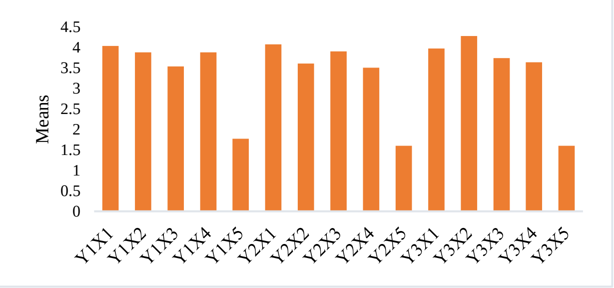


Y (1,2,3) + X5, no Diammoniun Hydrogen Phosphate or DAHP and Citric Acid or CA added; Y (1,2,3) + X1, 0.1% DAHP and 0.3% CA; +X2, 0.1% DAHP and 0.4% CA; +X3, 0.2% DAHP and 0.3 % CA; +X4, 0.2 DAHP and 0.4% CA; Scale: 5= Extremely Acceptable, 4= Moderately Acceptable, 3= Acceptable, 2= Moderately Unacceptable, 1= Unacceptable

Figure 5. Aroma value using sensory evaluation

3.4.3 Taste

When tasting wines, the mouthfeel sensations that were experienced include bitterness, acidity, and heat in the body. As shown in Figure 6 above, the taste of alcoholic beverage was being perceived by the testers, it indicates in the figure that Y3X2 (0.5 grams of Premier Classique yeast, 0.1% w/v of DAHP, and 0.4% w/v of Citric Acid) gave the better taste with its score value 4.27 which is labeled as moderately acceptable. Similarly, a study of Olivero et al. [19] showed that the *Saccharomyces bayanus* premier cuvee redstar yeast strain gives an amazing taste attack on the mouth and reveals to be the best yeast strain for producing alcoholic beverages because of its best effect on the fermentation period. However, controls (Y2X5 and Y3X5) also showed a bad result/taste with its score value of 1.6 which falls under moderately acceptable for them which means that DAHP and Citric Acid highly influences the taste of an alcoholic beverages. Furthermore, it was advisable to use the yeast Premier Cuvee and a ratio of 0.1% and 0.4% of DAHP and citric acid respectively when making alcoholic beverages out from this commodity.

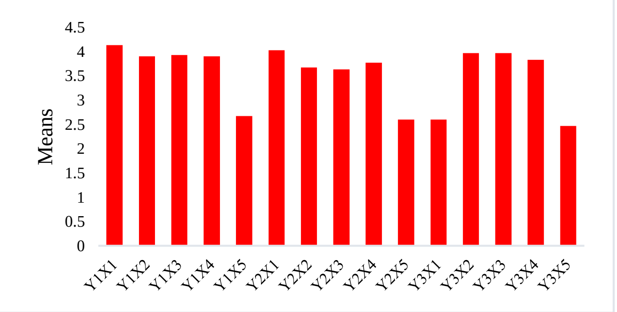


Scale: 5= Extremely Acceptable, 4= Moderately Acceptable, 3= Acceptable, 2= Moderately Unacceptable, 1= Unacceptable

Figure 6. Taste value using sensory evaluation

3.4.4 Texture

Texture was one of the most important food characteristics, thus, it was a sensory attribute and was measurable directly by sensory means. As displayed in the Figure 7, Y1X1 showed to have a higher score value with 4.13 that falls under moderately acceptable. However, Y3X5 revealed to be moderately unacceptable with score value of 2.47. In the study of Joshi et al. [25], finger feel or mouth feel via hedonic rating were methods for determining texture through sensory testing. The optimum approach was to measure a portion of the complex texture's components using appropriate equipment, and then to match these instrumental measurements to how the texture is perceived by the senses of the tester. The yeast and DAHP- Citric Acid ratio showed a highly significant result. Based on the result shown in Figure 7, the yeast that outstand among other sample was the Premier Classique which means when it came to texture evaluation, it was the Premier Classique (Y1) together with the different ratio of DAHP and citric acid performs the best.



Scale: 5= Extremely Acceptable, 4= Moderately Acceptable, 3= Acceptable, 2= Moderately Unacceptable, 1= Unacceptable

Figure 7. Texture value using sensory evaluation

4. CONCLUSION & RECOMMENDATION

Based from the result of this study, the three types of yeast strain used and the two factor (yeast and the DAHP-Citric Acid ration) showed significant difference in SSC, pH, potential alcohol and the final alcohol content. Out of the three types of yeasts strain used, Premier Cuvee counted and excelled for the commodity aratiles in producing alcoholic beverage. The presence of DAHP and Citric Acid influenced the SSC, color, pH and appearance, aroma, taste, texture of the alcohol. The final alcohol content of the beverages ranges from 46.33 to 61.67 per cent alcohol. The other additives like the pectin enzymes and Campden tablets were also influence the beverage free off-odor and vinegar bacteria. Thus, aratiles fruit has a great potential for alcoholic beverages.

For the recommendation was to determine the nutritional values and microbial counts present in the aratiles alcoholic beverage through testing; to characterize and evaluate aratiles fruit alcoholic beverages based on the physicochemical properties through more critical parameters such as titratable acidity, mineral content, moisture, ascorbic acid, and volatile acidity and other parameters.; and to examine and/or conduct a laboratory testing on aratiles alcoholic beverages for anti- diabetes or anti-oxidant properties.

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