Wine Development from Marang Fruit

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Abstract

The suitability of ripe marang fruit (Artocarpus odoratissima) pulp was investigated for the production of marang wine under different treatments. Marang wine was produced from manually mashed ripe marang pulp (must) by fermentation process using Saccharomyces cerevisiae at room temperature (29±20C). Preliminary studies were conducted for optimum requirements for wine production such as pulp-water ratio (2:1) and fermentation time (4 days). Pulp mixtures were treated with 0.800 g potassium metabisulfite in 5 gallons of pulp mixture (T2) for 24 hours before fermentation while the other was not added with potassium metabisulfite (T1). The physico-chemical parameters such as pH, residual sugar content and percent alcohol and sensory test of marang wine from both treatments were determined.
Results showed that the average pH, sugar content (0brix) and percent alcohol (by volume) of marang wine for treatment 1 were 3.83±0.17, 8.8±1.7 and 10.53±0.53, respectively while 3.72±0.11, 10.13±0.58 and 10.79±0.50, respectively for treatment 2. The percent alcohol of marang wine from both treatments falls within the category of fruit wine of 8 to 11 percent with no sugar added to pulp mixture. Sensory evaluation of wine from both treatments showed an overall acceptability rating of good wine with clear golden yellow color, balance aroma, smooth texture and pleasant taste. Statistical results using t-test at 95% confidence level showed that there is no significant difference between two treatments. This indicates that marang wine can be produced either with or without potassium metabisulfite and can be recommended for small scale wine industry.

Keywords: pulp mixture, fermentation, Saccharomyces cerevisiae, potassium metabisulfite, alcohol

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Introduction

Marang has a scientific name of Artocarpus odoratissima, a tropical fruit grown in the Philippines particularly in the marginal and hilly areas of Mindanao like Zamboanga Peninsula. There are two different varieties grown in Zamboanga City, the brown and the evergreen varieties. The brown variety has light to dark brown peel with off-white pulp and its fruit size weighs 1,250-1,700 grams with 6-7 percent edible part. Likewise, the evergreen variety has green to light green peel and white pulp and its fruit size is heavier (1,300-1,800 grams), has more edible portion (10-15 percent) and is sweeter than the brown variety (Lim, 2015). The flesh is known for its juicy and aromatic (Coronel, 1983). The nutritional composition of the fruit pulp are carbohydrates, protein, fats, crude fiber, ash, potassium, calcium, sodium, phosphorus, iron, retinol, beta-carotene, vitamin A, vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin) and vitamin C (ascorbic acid) (Tang, Linda, & Franz, 2013). The highest mineral present in pulp is potassium (197-298 mg/100 g) which has health benefits that includes relief from stroke, blood pressure, heart and kidney disorders, anxiety and stress, as well as enhanced muscle strength, metabolism, water balance, electrolytic functions and nervous system (Jacob, 2001). The nutritional and health benefits of the fruits are also the same advantages you can get from the wine produced (Jacob, 2001). The pulp can also be used in making food products such as juice, jam, jelly, concentrate, ice cream, vacuum-fried and vinegar (BDP, 2015). Tang et al. (2013) also reported that edible part of the fruit contains fructose (6.9-13.7g/100 g), glucose (5.8-13.7g/100 g) and sucrose (0.3-11.2 g/100 g) which makes the flesh suitable for wine making because of its high sugar content. The sweetness of the fruit can be attributed to the presence of fructose and it depends on the maturity and ripeness of the fruit.

Alcoholic fermentation is also known as ethanol fermentation, is an anaerobic (no oxygen) pathway carried out by yeast (e.g. Saccharomyces cerevisiae) in which simple sugars like glucose, fructose and sucrose are converted to ethanol and carbon dioxide (Okafor, 1987). Tropical fruit wines were usually augmented with sugar to meet the required alcohol content of 7-16% (Turner, 1971 and Vilanova, Cortes, Santiago & Fernandez, 2007). Several studies showed that wines can be produced by alcoholic fermentation from tropical fruits such as mango (Okunowo, Okotore & Osuntoki, 2005 and Reddy & Reddy, 2009), banana (Castro, Obiva & Celis, 1969; Idise & Odum, 2011 and Obaedo & Ikenebomeh, 2009), pineapple (Idise, 2012; Steinkraus, Ramos, Layese, Yap & Banzon, 1969), and ripe guava (Kocher & Pooja, 2011) and its distinct flavors depend on the fruit being used (Jacob, 2001). In the Philippines, studies on wine making from common native fruits had also been conducted like duhat, cashew, (Agcaoili, 1963; Labuanan, 1962), passion fruit (Sanchez, 1979) and bignay, (Aldemida, Sabularse, Dizon, Hurtada, & Torio, 2011).

Younis, Siddiqui, Jahan and Dar (2014) reported that 10.65 percent alcohol was produced from over ripe guava with an augmentation of granular sugar under anaerobic fermentation using Saccharomyces cerevisiae Var HAU 1 at 300C for 7 days fermentation. Obisanya, Aina, and Oguntimein (1987) studied the alcoholic fermentation of mango juice into fruit wine using locally isolated Saccharomyces cerevisiae and Schizosaccharomyces species of palm wine and reported that Saccharomyces cerevisiae were suitable for dry mango wine with a higher ethanol level. A study of fruit wine produced from pineapple was conducted by Idise (2012) that gave 13.75 percent alcohol. Banana wine has 13.70 percent alcohol with pH of 3.45 as reported by Reddy and Reddy (2009), Obaedo and Ikenebomeh (2009). and Many, Radhika, and Ganesan (2014) reported that the maximum production of ethanol from tomato juice was achieved on 4th day of fermentation under room temperature (29±20C) with 24 0brix at 5 percent inoculums level.

Marang fruit is seasonal and available only in May to September but when in season, it is very abundant. The ripe fruit is highly perishable and only last for 2 to 3 days. It is easily oxidized and lose its flavor once it is opened that's why the fruit must be consumed immediately. The oversupply of this fruit coupled with short shelf life caused its diminishing market value. Over ripe marang fruit is not preferred by consumers that is why it is dumped as garbage and is left to ferment and eventually decompose. This is evidently a wasted resource. Since very

little has been done to maximize the availability of this seasonal fruit, it is therefore necessary to find a way to utilize this resource which can be a potential cottage industry for livelihood for the rural people.

Therefore, it is vital to develop the potential of marang fruit in the production of wine. The unique properties of marang fruit may give a unique aroma and taste of its wine. Hence, this study was conducted.

Methods

Ripe marang samples were purchased from local market at Zamboanga City. The pulps of ripe marang were removed from the cover and separated from the seeds, and then the pulps were mashed manually. The mashed pulp was called the MUST. Two parts of the mashed pulp were diluted with one part of water by weight in a sterilized container. The must mixtures were added with 0.8000 g potassium metabisulfite, K2S2O5 (T2) per five galloons of pulp mixtures 24 hours prior to fermentation while the other must mixtures were fermented immediately (T1).

I. Fermentation of Marang Pulp Mixture

Fermentation was done for four days based on the preliminary analysis and on the study of tomato wine production and optimization (Many et al., 2014) at room temperature using Saccharomyces cerevisiae (Nwanekezi, Osuji, & Osuke, 2004). Fermentation was conducted in two stages: primary stage (aerobic) and secondary stage (anaerobic) of fermentation.

The mashed pulp was subjected to aerobic fermentation. Five gallons of pulp mixture was placed into a primary fermentor then 0.8000 grams of potassium metabisulfite (K2S2O5) was added. The fermentor was covered loosely with a piece of cloth and a rubber band around the opening. The must mixture was placed undisturbed for one day to kill the unwanted yeast at room temperature (28-310C). The cover was removed and the Saccharomyces cerevisiae (0.5%) was added into the mixture (Treatment 2) however, in Treatment 1, the wine yeast was added immediately into the must mixture to another fermentor. Both mixtures were covered properly and were stirred, and were

allowed to ferment for four days undisturbed. After four days, the wine produced was siphoned into another sterilized jug container for second stage of fermentation.

In this process, an airlock was used to keep the air out of the sterilized jug container. The wine was allowed to ferment further for two weeks, then solution was siphoned again to another sterilized jug container. Siphoning process was done after a month and then was allowed to stand for two months.

Racking process was done by siphoning the wine off the sediments into a sterilized jug container using a flexible siphon plastic tube. This was done every month for over several months until the wine was cleared and ready to be placed in wine bottles. Bentonite was added to clarify the wine.

The clear fermented wine produced was placed in a sterilized wine bottle and one half teaspoon of potassium sorbate was added into one gallon of wine to stabilize the wine.

II. Physico-chemical Analysis of Marang Pulp Mixture and Wine

The physico-chemical parameters were conducted on the marang pulp mixture (must) and wine include the specific gravity using hydrometer at 20oC, sugar content in terms of brix using ABBE Refractometer at 20oC, and pH using HANNA digital pH meter. The alcohol content of the wine was calculated from its initial and final specific gravity. A t-test was conducted for the comparison between the two mixtures (T1 & T2) in terms of the percent alcohol content.

III. Sensory Analysis of Marang Wine

Thirty (30) ml of each T1 and T2 wine was prepared in labelled glass containers and was refrigerated.

Simple random selection was done in identifying the twenty (20) respondents (18-40 years old). Permission was sought from each respondent to evaluate the marang wine. The respondents were invited and requested to follow the instructions for wine evaluation using AWS chart (AWS, 2014).

Results and Discussion

Physico-chemical Analysis

The physical characteristics of the marang wine from both treatments had a clear golden yellow color and fruity odor. Table 1 shows the chemical analysis of the untreated and treated pulp mixture and marang wine.

Table 1
Chemical analyses from both treatments of marang pulp mixture and wine.

Treatments		Parameters						
		Before Fermentation			After Fermentation			
		Specific Gravity	pH	Sugar Content	Specific Gravity	pH	Residual Sugar	Percent Alcohol by Volume
T1	Mean	1.080	5.19	24.8	1.001	3.83	8.8	10.53
	Standard dev.	±0.002	±0.60	±5.29	±0.001	±0.17	±1.73	±0.53
	Reported value	**1.080±0.002**	**5.19±0.60**	**24.8±5.3**	**1.001±0.001**	**3.83±0.17**	**8.8±1.7**	**10.53±0.53**
T2	Mean	1.082	5.47	29.5	1.000	3.72	10.13	10.79
	Standard dev.	±0.004	±0.25	±3.2	±0.001	±0.11	±0.58	±0.50
	Reported value	**1.082±0.004**	**5.47±0.25**	**29.5±3.2**	**1.000±0.001**	**3.72±0.11**	**10.13±0.58**	**10.79±0.50**

Specific gravity indicates the amount of fermentable sugar or potential alcohol in wine. This is also an indication that fermentation is almost done. Results reveal that the average specific gravity of untreated and treated marang pulp mixture before fermentation is almost the same, 1.080 and 1.082, respectively. Also, the untreated and treated marang wine after fermentation is almost same average specific gravity of 1.001 and 1.000, respectively but lowers than the pulp mixture. The decrease of the specific gravity from 1.080 to 1.001 for treatment 1 likewise for treatment 2 from 1.082 to 1.000 is due to the fermentation process, conversion of sugar to alcohol. This result agrees with the reports of Amerine, and Kunkee (1968), Idise and Ofiyai (2011); Noah, Alechenu, Abiaziem, and Aduwobi, (2013); Okafor (2007); Robinson (2006); and Uraih (2003). According to Jack (2007) that fermentation of wine occurs if the specific gravity drops to 1.000 or less.

According to Duncan and Acton (1973) that acidity of the must contributes to the production of good quality wine. Lack of acidity means poor fermentation (Berry, 2000). Results reveal that the average pH of the pulp mixture (must) for both treatments is almost the same, 5.19 and 5.47, respectively which is moderately acidic. These results agree with the study of Reddy and Reddy (2005) on mango fruit that the optimum pH and temperature values for quality wine production was 5.0 and 300C, respectively. On the other hand, the marang wine from both treatments has an average pH of 3.83 and 3.72, respectively which is within the desirable pH range for dry wine of 3.0 to 4.0 (Duncan &Acton, 1973). These results also agree with the study of Agbor, Ben, Ubana, Olayinka, and Okon (2011) that the maximum pH for mixed fruit wine is 3.5. According to Reddy and Reddy (2005) that low pH (acidic) during fermentation is inhibitory to the growth of spoilage organisms but creates conducive environment for the growth of desirable organisms.

Sugar is an essential component in wine making through fermentation using wine yeast to produce alcohol. According to Alobo and Offonry (2009) that the major problem associated with the use of tropical fruits in wine making is their low of sugar content. However, in this study no sugar was added to the pulp mixture since the average sugar content (0brix) of the untreated and treated pulp mixture was already 24.8 and 29.5, respectively which already met the required sugar for fruit wine that is 20-26 0brix (Many et al., 2014). These findings are supported by the proximate analysis of Artocarpus odoratissimus (marang) conducted by Tang et al. (2013) which showed that the edible part of marang fruit (pulp) contained fructose (6.9-13.7% by weight), glucose (5.8-13.7% by weight) and sucrose (0.3-11.2% by weight). In the study conducted by Turner (1971), most tropical wine fruits were usually added with sugar to produce wines with alcohol content of up to 10%. The use of sugar substrate is one of the ways to obtain high ethanol yield during fermentation, however, according to Jones, Pamment and Greenfield (1981) higher sugar concentration is inhibitory to fermentation due to osmotic stress.

Alcohol in wine is expressed as percent ethanol by volume which is produced by fermentation. Results show that the mean percent alcohol of the untreated and treated marang wine was 10.53 percent and 10.79 percent, respectively. The percent alcohol produced of the untreated and treated marang wines fall within the category of fruit wine which is 8 to 11 percent alcohol by volume (Kumar & Mishra,

2010) without sugar added to the pulp mixture and it is comparable with guava wine (10.65% alcohol) with sugar added to the guava juice extract (Kocher & Pooja, 2011). Michael (2000) mentioned that good wine must have alcohol content between 8% and 14%. However, lower alcohol content of fruit wine is already sensitive to microbial spoilage (Reddy & Reddy, 2005). Therefore, the percent alcohol content of marang wine (10.53 and 10.79) is a characteristic of a good wine.

Statistical results using t-test at 95% confidence level (tcalculated = 0.07; tcritical = 2.23) showed that there was no significant difference between the two treatments. This indicates that ripe marang fruit pulp can be used in producing wine with or without potassium metabisulfite treatments. In most wine production, potassium metabisulfite is always added before fermentation specially in wine making to kill unwanted wild yeast to increase the yield of alcohol in wine and enhance wine aroma and color. However, results of this study reveal that with or without potassium metabisulfite treatments marang wine can be successfully produced. This might be due to less chance of wild yeast contamination to marang pulp since the pulp is well protected with the thick hairy spines of the fruit exocarps.

Sensory Evaluation Test

The twenty (20) respondents who evaluated marang wine were selected randomly and the results of sensory evaluation were presented on Table 2.

Table 2.
Sensory test results of twenty (20) respondents who evaluated the marang wine using the American Wine Society (AWS) Evaluation Chart

Wine Sample	Appearance (3 max)	Aroma & bouquet (6 max)	Taste & texture (6 max)	Aftertaste (3 max)	Overall impression (2 max)	*Overall acceptability (20 max)	*Rating
T1 wine	Clear with golden yellow color (2)	Characteristic aroma. Distinguishable bouquet (4)	Good balance. Smooth. may have minor imperfections (4)	Pleasant after taste (2)	Good (1)	Good (13)	good
T2 wine	Clear with golden yellow color (2)	Characteristic aroma. Complex bouquet. Well balanced (5)	Good balance. Smooth. may have minor imperfections (4)	Pleasant after taste (2)	Good (1)	Good (14)	good
Commercial wine	Very clear with golden yellow color (3)	Outstanding and complex bouquet. Exceptional balance of aroma and bouquet (6)	Extraordinary balance. smooth, full-bodied and overwhelming (6)	Lingering outstanding after taste (3)	Excellent (2)	Extraordinary (20)	extraordinary

*Note. *Quality rating: 20-18=extraordinary; 17-15=excellent; 14-12=good; 11-9=commercially acceptable; 8-6=deficient; 5-0 poor or objectionable*

Sensory test results reveal that the untreated and treated marang wine has clear golden yellow color, well balance aroma and smooth texture with pleasant taste. According to Olorunfemi and Adetuyi (2005) that the type and aroma of the wine produced during wine making depends on the yeast, environmental factors and physiochemical characteristics of the "must". According to Tang et al. (2013) that addition of potassium metabisulfite prior to fermentation enhances the flavor of the fruit wine. This can be shown on the above results that treated wine with potassium metabisulfite gave a well balance aroma than the untreated wine. However, the overall acceptability rating of the marang wine for untreated and treated marang wine using AWS evaluation chart is 12 and 14, respectively which are described as good wine. The sensory results of marang wine are comparable with other fruit wines like banana wine (Obaedo & Ikenebomeh, 2009), mango wine (Reddy & Reddy, 2009), pineapple wine (Idise, 2012) and ripe guava wine (Kocher & Pooja, 2011 and Younis et al., 2014). Thus, marang wine can be produced from its fruit pulp either using both treatments. However, treatment 1 is the most recommended method in producing marang wine since there is no chemicals added to it like potassium metabisulfite and the nutrients present in the fruit is also present in the produced wine.

Conclusion

The potential of ripe marang fruit pulp for wine production under different treatments was investigated. Marang wine was produced by four (4) days fermentation at room temperature (29±20C) using Saccharomyces cerevisiae (treatment 1). For treatment 2, potassium metabisulfite was added before the fermentation process to kill the unwanted microorganism. The physico-chemical parameters such as specific gravity, pH, and sugar content of the untreated and treated pulp mixture and marang wine were investigated. Also, the percent alcohol by volume and sensory test of marang wine from both treatments were conducted.

The physico-chemical analysis of pulp mixture from both treatments had an average specific gravity of 1.080±0.002 and 1.082±0.004, average pH of 5.19±0.60 and 5.47±0.25, and average sugar content of 24.8±5.30brix and 29.5±3.20brix, respectively while the marang wine had an average specific gravity of 1.001±0.001 and 1.000±0.001, average pH of 3.83±0.17 and 3.72±0.11, average residual sugar content of 8.80±1.70 0brix and 10.13±0.580brix, and average percent alcohol of 10.53±0.53 and 10.79±0.50, respectively. The marang wine produced is within the category of fruit wines with alcohol content from 8 to 14 percent and no sugar added to the fruit pulp. Also, it is comparable with mango wine, pineapple wine, duhat wine and ripe guava wine. The results of sensory test for the untreated and treated marang wine gave a quality rating of good wine with clear golden yellow color with balanced aroma, smooth texture and pleasant taste. Statistical treatment using t-test at 95% confidence level that there is no significant difference between the two treatments. This implies that either of the two treatments can be used in producing wine from ripe marang pulp.

This study has demonstrated that it is possible to produce wine from ripe marang fruit pulp with or without potassium metabisulfite with a total acceptability rating of good wine. However, the recommended treatment in producing marang wine is the natural fermentation (T1) without adding any chemicals like potassium metabisulfite to retain and preserve the nutritional and health benefits of the fruit. The production of marang wine can be recommended for small scale wine industry to enhance the economy of our country as well as create a livelihood of the rural people of Zamboanga City and reduce our dependency on foreign and imported wines.

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