Processing and Characterization of Wine by Using an Underutilized Fruit *Averrhoa carambola* L. (Star Fruit)

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Abstract

The star fruit, *Averrhoa carambola* L., is an attractive tropical fruit of the Oxalidaceae family and abundantly occurring throughout in Myanmar. As most of the star fruits are consumed fresh, very few are processed. The study was conducted to develop food products from underutilized fruit. Processing of star fruit wine can allow the utilization of low quality fruits, which cannot be market, hence that enchaces its value, value added product. The physico-chemical characteristics of star fruit like pH, acidity, moisture, ash, total soluble solids, reducing sugar, specific gravity, crude fiber and tannin content were studied. Star fruit wine was prepared by fermentation using yeast (*Saccharomyces cerevisiae*) at room temperature. The effects of concentration of sugar and yeast on the characteristics of wine during period of fermentation were assessed. Characteristics of prepared star fruit wine such as total soluble solids, reducing sugar, specific gravity, alcohol content, pH, acidity, tannin and colour (absorbance) were determined. Sensory properties were evaluated and the quality attributes compared with commercial white wine. The suitable condition based on the maximum yield of alcohol (10.98 %v/v) was obtained by fermenting 500 g. of star fruit, 1000mL. of distilled water, 200 g. of sugar, and 3 g. of yeast after (4) weeks of fermentation period. Though sensory evaluation rated the star fruit wine acceptable as an alcoholic beverage, slightly differences exist between the star fruit wine and the commercial white wine particularly in taste and overall acceptability.

Keywords: star fruit, wine, physico-chemical properties, sensory properties

Introduction

Carambola, *Averrhoa carambola*, commonly referred to as star fruit, is an attractive tropical fruit of the oxalidaceae family. The carambola is a species of tree native to Indonesia, India and is popular throughout Southeast Asia (Mapahde, Durce, Bharati & Chandra, 2010). Star fruit is green when unripe; the fruit vary from pale yellow to deep amber when ripe. It has four to six strongly pointed ridges that run from top to bottom, and the soft flesh is encased in a thin waxy, translucent skin. The fruit, which is mostly consumed fresh or as juice, is rich in vitamin A and C and it has high fiber content. There are two varieties one, smaller in size with strong sour taste and the other, larger in size with mild sweet in taste. Unripe star fruit is preserved in many parts in Southeast Asia and is used as a traditional remedy. The star fruit is an economically important commodity. Most str fruits are marketed in processed form and have numerous uses. The ripe fruit may be processed into fermented or unfermented drinks, preserves, jam or jelly, or eaten fresh as dessert (Minh, 2014).

The fruit has characteristics of soft, fragile, thin skin, short availability period and this spoilage occurs at the time of harvesting, storage and marketing resulting in waste. Approximately 25% of star fruits due to their size, shape and appearance, do not meet the desired market standards. Processing of star fruit wine can allow the utilization of low quality

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fruits, which cannot be market, to reduce waste and increase the value of the crop. Among the fruit crops, star fruit is also suitable raw material for wine production (Bridgebassie & Badrie, 2004). Wine is an alcoholic beverage typically made from fermented grape juice or variety of fruits. Any fruit with good proportion of sugar may be used in producing wine and the resultant wine is normally named after the fruit. Wine is produced by fermenting crushed fruit using various type of yeast. The species involved in fermenting process is mostly *Saccharmyces cerevisiae* (Sibounnavong, Daungpanya & Sidtiphanthon, 2010). Microorganisms have a prominent role in determining the chemical composition and hence the quality of wine. During fermentation process yeast consumes the sugar found in fruit and converts them into ethanol, CO_2 and hundreds of secondary end-product that contribute to the subtle and individually of wine character (Sharma & Sawant, 2012). The objective of this study was to evaluate the value added product from underutilized fruit *Averrhoa carambola* (Star Fruit).

Materials and Methodology

Materials

Collecting of Materials

The ripe star fruit, *Averrhoa carambola*, was collected from East Dagon Myothit Township, Yangon Region. The yeast, *Saccharomyces cerevisiae*, (LESAFFRE Co.Ltd., France), ammonium phosphate (ARCHEMICALS Ltd., England), potassium metabisulfite (Analar grade, BDH, England) were purchased from ACADEMY chemical shop, 28th St., Pabedan Township, Yangon Region.

Preparation of Star Fruit Wine

Five hundred grams of star fruits were cleaned by washing in tap water, drained and cut into pieces and blended in a blender. The juice wan strained through muslin cloth an the extracted juice was used for checking various parameters. 300 ml of concentrated juice was diluted up to 1000 ml with distilled water and was treated with sodium metabisulfite to inhibit the undesirable microorganisms such as acetic acid bacteria, wild yeasts and moulds. This is followed by the addition of sugar and ammonium phosphate to serve as additive before fermentation for wine production. The ameliorated must was inoculated with yeast (*Saccharomyces cerevisiae*) at room temperature approximately 27-30ºC for four weeks, after which the prepared wine were checked for physico-chemical characteristics. When fermentation has finished, the obtained wine will be racked into clean and dry bottle and store fro aging. After one year, during which clarification and stabilization process take place, the star fruit wine were subjected to sensory analysis.

Experimental Design

For the production of wine, five treatment were carried out corresponding to the levels of sugar (100, 150, 200, 250 and 300g) and the level of yeast (1, 2, 3, 4 and 5g) added to the star fruit must and the suitable condition were selected due to their highest alcohol percent. Based on suitable condition of sugar and yeast, the periods of fermentation were conducted. All experiments were run in triplicate to determine the ethanol production. The quality of the finished wine was analyzed after final racking for physico-chemical characteristics and organoleptic properties.

Physico-chemical Analysis

The physico-chemical composition of star fruit was determined as follows. Moisture was determined by oven drying method (AOAC 990.19, 2000), ash by muffle furnace method (AOAC 942.05,2000), crude fiber by fiber cap method (AOAC 991.42, 2000) and reducing sugar by Lane and Eynon's method (AOAC 920.183,2000). The physico-chemical characteristics of star fruit wine were determined as follows. Specific gravity was measured by using density bottle (AOAC 920.212,2000), alcohol percent by reading standard density table, pH by using pH meter (Pen Type pH Meter 009 (I)), acidity by titratable acidity method (AOAC 939.05,2000), tannin by titrimetric method (AOAC 952.03,2000), total soluble solids by using refractometer (Portable Refractometer, RHB-080) and colour (Absorbance) by using UV Spectrophotometer (UV-1800 SHIMAZU).

Sensory Evaluation

The sensory attributes of prepared wine and commercial wine (such as colour, clarity, odour, taste and overall acceptability) were evaluated using 9 point Hedonic scale (where, 9=like extremely, 5= neither like nor dislike and 1= dislike extremely) by 10 panelists (gender: 7 men and 3 women; age 18-30 year) selected from postgraduate students and staff of Industrial Chemistry Department who are familiar with wine consumption. Samples were served in clean transparent glasses which had been labeled with two digit random number. The star fruit wine and commercial white wine (Sauvignon Blanc, France) was presented to the trained panel of sensory analysis.

Results and Discussion

The physico-chemical characteristics of the base star fruit juice were determined in order to evaluate a potential of star fruit, as a raw material, for fruit wine processing. The physico-chemical characteristics of star fruit are shown in Table (1). pH value of star fruits was 1.93 ± 0.29 with acidity, 0.306 ± 0.09 %w/v. Good acid balance is important in winemaking. The right proportion of acid in selected fruits could provide to produce good wine. The acid in fruit is affected to fermented process during fermentation and acid could help to inhibit the other contaminated microorganism. The initial specific gravity of star fruit was 1.004 ± 0.0024 and tannin content was 0.4711 ± 0.048 %w/w. Tannin would contribute to the texture, colour and taste of wine. The moisture content of fruit was found to be 88.0 ± 1.7 %w/w, while the ash content was 0.53 ± 0.087 %w/w. Total soluble solids were 5.5 ± 0.87 (˚Brix) where the share of reducing sugar was 5.19 ± 0.219 mg/g. Sugar is an essential constituent of all wine must because it is fermented to alcohol by yeast. The data obtained generally indicated that the star fruits were suitable raw materials for wine processing. The juice contains fermentable sugar which could support the growth of ethanol fermenting microorganisms. These fruits can support fermentation to produce wine.

Table (1) Physico-chemical Characteristics of Star Fruit Juice

Sr.No	Physico-chemical Characteristics	Star Fruit Juice
1	pH	1.93 ± 0.29
2	Acidity (%w/v)	0.306 ± 0.09
3	Specific gravity	1.004 ± 0.0024
4	Ash (%w/w)	0.53 ± 0.087
5	Moisture (%w/w)	88.0 ± 1.7
6	Total soluble solids (ºBrix)	5.5 ± 0.87
7	Tannin (%w/w)	0.4711 ± 0.048
8	Reducing sugar (mg/g)	5.19 ± 0.219
9	Crude fiber (%w/w)	1.08 ± 0.059

In this research work, star fruit wine was fermented by using yeast (*Saccharomyces cerevisiae*) and sugar. To determine the most processing condition of star fruit wine, the processing was carried out by varying the amount of sugar, yeast and fermentation period while keeping the amount of potassium metabisulfite, ammonium phosphate, star fruit and distilled water as constant.

Table (2) Effect of Fermentation Periods on Yield of Alcohol Percent and Characteristics in the Preparation of Star Fruit Wine

Weight of star fruit = 500 g. Volume of distilled water = 1000 mL.
Weight of yeast = 2 g. Weight of ammonium phosphate = 2 g.
Weight of sugar = 200 g. Weight of potassium metabisulfite = 0.2 g.
Fermentation temperature = 27-30ºC

Sr. No	Fermentation Period (Week)	pH	Total Soluble Solids (ºBrix)	Specific Gravity	Alcohol (%v/v)	Reducing Sugar (mg/g)
1	0	2.9±0.1	15.3±0.29	1.0540±0.0288	Nil	4.0±0.16
2	1	3.3±0.1	7.83±0.29	0.9901±0.0003	7.05 ±0.24	3.06±0.06
3	2	3.3±0.0	6.17±0,58	0.9871±0.0002	9.51±0.22	1.79 ±0.04
4	3	3.3±0.1	4.67±0.29	0.9861±0.0002	10.31±0.17	1.48±0.04
5	4*	3.3±0.0	3.83±0.29	0.9853 ± 0.0002	10.98 ± 0.19	1.44±0.17
6	5	3.4±0.1	3.5±0.0	0.9863 ±0.0003	10.17 ±0.25	1.39±0.03
7	6	3.5±0.4	3.5±0.0	0.9871±0.0001	9.45±0.13	1.34±0.05

*Most suitable condition

Table (2) shows the physico-chemical changes during the fermentation of star fruit wine. It was noted that, pH significantly increased from 2.9 to 3.5 throughout the period of fermentation. Studies have shown that during fermentation of fruits, low pH is inhibitory to the growth of spoilage organisms but creates conductive environment for the growth of desirable organisms. In the case of the specific gravity of the sample, gradual decreases in values was observed throughout the fermentation. At the end of the 4 weeks of fermentation time, specific gravity values observed to have fallen to 0.9853 in wine. The steady decreased in the specific

gravity of the sample was due to the activities of yeast which fed on the sugar to produce alcohol and carbon dioxide (Asli, 2010). As expected, the reducing sugar content decreased from initial value of (4.0 ± 0.16 mg/g) in must to (1.34 ± 0.05 mg/g) in wine. The ethanol concentration was (10.98 ± 0.19 %v/v) at the end of the 4 weeks fermentation period. For total soluble solids, the initial decrease took place after 1 week of fermentation period. Most rapid sugar consumption and ethanol production occur between 1 week and 3 weeks. As sugar consumption decreased, ethanol production increased linearly within 4 weeks. After 6 weeks fermentation period, there were little changes in ethanol concentration. It was observed that, the yield of alcohol percent decreased at longer fermentation period of 4 weeks. That may be caused by the further oxidation of wine and undesirable side reactions.

Table (3) Comparison between the Properties of Prepared Wine and Commercial White Wine (Sauvignon Blanc, France)

Star Fruit Wine = Star Fruit -500 g., Distilled Water -1000 mL., Sugar -200 g., Yeast -3 g., Potassium Metabisulfite- 0.2 g., and Ammonium Phosphate -2 g.

Age of wine = 1 year

Sr. No.	Properties	Prepared Star Fruit Wine	Commercial White Wine (Sauvignon Blanc, France)
1	pH	3.37 ± 0.04	3.0
2	Acidity (%w/v)	0.234 ± 0.013	0.50
3	Specific Gravity	0.9853 ± 0.0002	0.9857
4	Alcohol (%v/v)	10.98 ± 0.19	10.67
5	Total Soluble Solids (ºBrix)	3.5 ± 0.0	6.5
6	Reducing Sugar (mg/g)	1.44±0.17	1.51
7	Tannin (%w/v)	0.4711 ± 0.0679	0.2494
8	Colour (Absorbance)	0.231	0.05

The physico-chemical characteristics of prepared wine were compared with that of commercial white wine (Sauvignon Blanc, France) and the results are shown in Table (3). The commercial white wine used as standard in this study was comparatively high acidity (0.50 %w/v) and consequently had a lower pH but with a higher total soluble solids (6.5 °Brix) . The other parameter such as specific gravity, alcohol percent and reducing sugar content were somewhat similar in both star fruit wine and commercial white wine. The tannin content and colour (absorbance) in star fruit wine were high as compared with commercial white wine.

Table (4) Organoleptic Properties of Prepared Wine and Commercial White Wine (Sauvignon Blanc, France)

Scale used to assess scores: 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, 1- dislike extremely

Sr. No.	Wines	Sensory Properties				
		Colour	Clarity	Odour	Taste	Overall acceptability
1	Star Fruit Wine	6.9	7.5	7.1	7.3	7.2
2	Commercial White Wine (Sauvignon Blanc, France)	6.7	7.8	7.0	7.9	7.35

The sensory attributes of prepared wine and commercial wine (such as colour, clarity, odour, taste and overall acceptability) were evaluated using 9 point Hedonic scale (where, 9=like extremely, 5= neither like nor dislike and 1= dislike extremely) by 10 panelists (gender: 7 men and 3 women; age 18-25 year) selected from postgraduate students and staff of Industrial Chemistry Department who are familiar with wine consumption.

The results of the sensory evaluation of the prepared wine and commercial white wine are shown in Table (4). It shows that the panelist rated the commercial white wine had higher score for clarity, taste and overall acceptability than prepared star fruit wine. There was no significant differences in odour and colour between the prepared star fruit wine and commercial white wine. Sensory evaluation of the star fruit wine produced with optimized fermentation conditions showed good quality, according to the assigned average values for colour (6.9), clarity (7.5), odour (7.1) and taste (7.2).

Conclusion

The results of this study are significant for improvement of star fruit wine production, primarily in term of optimization of fermentation and to develop food product from underutilized fruits. In this research work, wine was prepared from underutilized star fruit by alcoholic fermentation. It can be seen that changes in ethanol concentration during fermentation are well described. The optimal conditions for star fruit wine, the maximum yield of alcohol percent (10.98 %v/v) was obtained by carrying out the fermentation for (4) weeks when star fruit 500 g., distilled water 1000 mL., sugar 200 g., yeast 3 g., sodium metabisulfite 0.2 g., and ammonium phosphate 2 g. were used. Star fruit wine had fruity aroma, deliciously sweet and pale yellow colour. Star fruit wine processed with the optimal conditions had good sensory properties and acceptability. The enhancement of primary fruit aroma of wine would be due to cool fermentation temperature. Aging in the oak or adding oak can further add pleasant aromas to wine.

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