

Fermentation of Jamun (*Syzygium cumini* L.) Fruits to Form Red Wine

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Abstract: A red wine from anthocyanin-rich tropical jamun fruit having medicinal (anti-diabetic and curing bleeding piles) properties was prepared by fermentation using wine yeast (*Saccharomyces cerevisiae*) and the quality attributes compared with commercial grape red wines. The wine was sparkling red in colour, acidic in taste [titratable acidity (1.11 ± 0.07 g tartaric acid. 100 ml⁻¹)], high tannin (1.7 ± 0.15 mg. 100ml⁻¹) and low alcohol (6%) concentration. Though sensory evaluation rated the jamun wine quite acceptable as an alcoholic beverage, significant differences ($P < 0.05$) exist between the jamun wine and the commercial grape wine particularly in taste, flavour and after taste probably due to the high tannin content in the jamun wine.

Keywords: Anti-oxidant, diabetes, jamun, red wine, *Saccharomyces cerevisiae*

INTRODUCTION

Jamun (*Syzygium cumini* L.) is an evergreen tropical tree in the flowering plant family Myrtaceae, native to India and Indonesia. It is also grown in other areas of Southeast Asia including Malaysia, Myanmar, Pakistan and Afghanistan. The tree was also introduced to Florida, USA in 1911 by the United States Department of Agriculture and is now commonly planted in Suriname (<http://en.wikipedia.org/wiki/Jambul>). The other common names of jamun are java plum, black plum, jambul and Indian blackberry. Jamun, a fairly fast growing species, can reach heights of up to 30m and can live for more than 100 years. It is either found wild or cultivated by planting the grafts. The jamun tree is useful in several ways. The wood is strong, water resistant and is used in making railway sleepers, cheap furniture and village dwellings though it is relatively hard to work on. The leaves and

the bark are used to control blood pressure and gingivitis (Joshi, 2001).

The jamun tree starts flowering in March-April. This is followed by fruiting (a berry) which appears in May- June. The berry is oblong, ovoid and shining crimson black (rich in anthocyanin pigment, an anti-oxidant) when fully ripe. Fruits of the grafted variety are large and deliciously sweet but slightly sour (Pathak and Pathak, 1993). Jamun fruits are universally accepted to be very good for medicinal purposes especially for curing diabetes because of its effect on the pancreas (Joshi, 2001). The fruit and its juice and the seed contain a biochemical called 'jamboline' which is believed to check the pathological conversion of starch into sugar in case of increased production of glucose. Beside, the jamun fruit is an effective food remedy for bleeding piles and correcting liver disorders. The fruit or fruit juice should be taken with salt every morning for two or three months in

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its season. The use of the fruit in this manner in every season will effect radical cure and save the user from bleeding piles life long (Wealth of India, 1954; Joshi, 2001). Since the fruit is a very rich source of anthocyanin, it imparts antioxidant properties too. In view of these many medicinal and therapeutic properties of jamun fruit and because of its short availability period, an attempt has been made in this study to prepare wine from jamun fruit juice with the wine yeast, *Saccharomyces cerevisiae* var. *bayanus* and to compare the sensory attributes (taste, aroma, flavour, colour/appearance and after taste) with those of commercial grape red wine.

MATERIALS AND METHODS

Jamun Fruits

The fully ripened and undamaged jamun fruits (var. 'jamun') were collected from the Horticultural farm of Orissa University of Agriculture and Technology, Bhubaneswar during the month of May, 2005 (day temperature, $32 \pm 2^\circ\text{C}$ and night temperature, $28 \pm 2^\circ\text{C}$). The fruits were brought fresh to the Microbiology Laboratory of Regional Centre, Central Tuber Crops Research Institute, Bhubaneswar and immediately processed. The composition of jamun fruits is given in Table 1.

Table 1: Composition of jamun fruit (per 100g)

Composition	Value (g)
Moisture	83.20
Reducing sugar	14.00
Crude fibre	0.90
Ascorbic acid	0.25
Anthocyanin	0.14
Ash	0.33
Nitrogen	0.13
Tannin	1.90
Fat	0.30

Wine Yeast

The wine yeast, *Saccharomyces cerevisiae* var. *bayanus*, was maintained on Potato Dextrose Agar (PDA) slants. The yeast culture was provided by Dr. E.Suresh, Principal Scientist (Microbiology), Division of Postharvest Technology, Indian Institute of Horticultural Research, Bangalore, India.

Fermentation Process

One kilogram of jamun fruits was cleaned by washing in tap water and immersed for two days in 5% salt (NaCl) solution to reduce the tannin content (Mohanty *et al.*, 2006) after which the lone seed was manually removed from the pulp. The pulp was then crushed with water (1:1 w/v ratio) in a Mixer-cum-Grinder (TTK Prestige Ltd., Bangalore, India) and the juice was extracted by using a juice squeezer. Approximately 400 ml juice was extracted from one kilogram pulp after subtracting the amount of water added. The juice (must) filtered through cheese cotton cloth had 12° Brix and was treated with sodium metabisulphite (SMS) ($100 \mu\text{g.ml}^{-1}$) to inhibit the growth of undesirable microorganisms such as acetic acid bacteria, wild yeasts and moulds. Then, cane sugar and tartaric acid were added into the juice (amelioration) to attain 16.5° Brix and pH 4.5, respectively. The ameliorated must was inoculated with 2% (v/v) starter culture (prepared with grape juice) of *S. cerevisiae* var. *bayanus* and fermentation was carried out at room temperature of $32 \pm 2^\circ\text{C}$ for six days. Racking of wine was carried out when total soluble sugars (TSS) reached $2\text{-}3^\circ$ Brix. Two or three more rackings were done at 15 days interval to remove any sediment deposited in the wine. The wine after racking was clarified with the addition of 0.04% bentonite and analyzed. Sodium metabisulphite ($100 \mu\text{g.ml}^{-1}$) was added as preservative before bottling. Three replicates were maintained for conducting this experiment. The flow-chart for making jamun wine is shown in Figure 1.

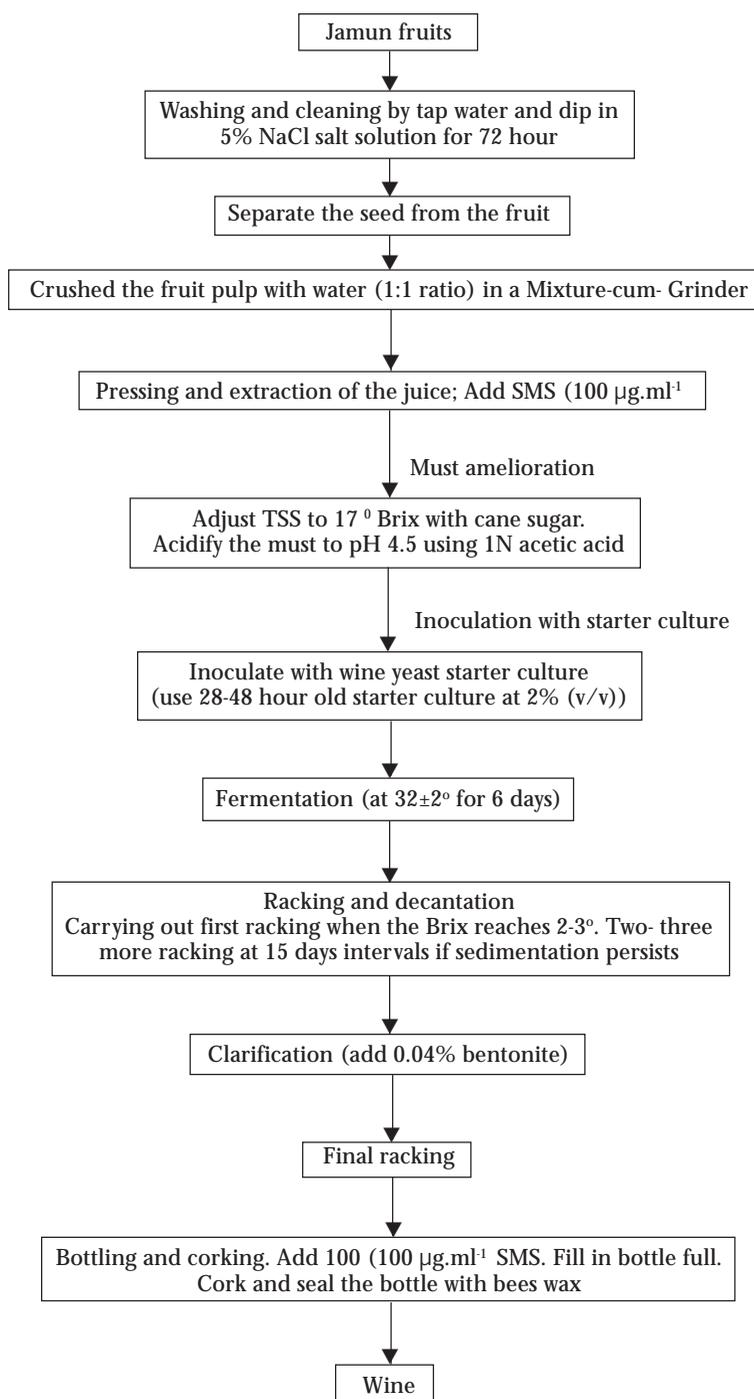


Figure 1: The flow chart for making jamun wine

Grape Wine

Two commercial red wines made out of grapes (Brand name: "Figueira", Champagne Indage ltd., Narayangaon, Maharashtra, India and "Monarch", A.C. Thomas Agro, Hyderabad, India) were procured from the local wine shop at Bhubaneswar, Orissa and were used as 'standard' for comparison of sensory and quality attributes of jamun wine. These are popular brands of wine and are readily available in eastern India where the Institutes/ University is situated.

Chemical Analysis

The chemical composition of jamun fruit was determined as follows. Moisture was determined by vacuum oven, total nitrogen (N) by Kjeldahl, fat (ether free) by Soc.Tech Instrument (Pelican Equipments, Chennai, India) and ash by the muffle furnace methods (Analytical Methods for Tuber Crops, CTCRI, 2000). Crude fibre was determined by enzymatic-gravimetric method (Prosky *et al.*, 1985) using Fibre Tech Instrument (Pelican Equipments, Chennai, India). Reducing sugar and ascorbic acid were quantified by Nelson's (Nelson, 1944) and Mahadevan and Sridhar (1999) methods, respectively and were expressed as g. 100g⁻¹. Tannin content was estimated by the method described by Amerine and Ough (1984) and expressed as g 100g⁻¹.

The chemical compositions of jamun must and wine and grape wines were determined as follows. Total titratable acidity, tannin, lactic acid, anthocyanin and ethanol content of wine were determined by the methods described by Amerine and Ough (1984). Reducing sugar in must/wine was quantified by Nelson's method (Nelson, 1944). Total phenolic content in must/wine was quantified by Folin-Ciocalteu method (Bray and Thorpe, 1954). The pHs of the must/wine were measured using a pH meter (Systronics Ltd., Ahmadabad, India).

Sensory Evaluation Assay

Sensory attributes (such as taste, aroma, flavour, colour/appearance and after taste) were evaluated using a 5 point Hedonic scale (where 1 = dislike extremely and 5= like extremely) by 15 panelists (gender: 8 men: 7 women; age group: 20-35) selected from post-graduate students, staff and faculty of several horticulture related departments who are familiar with wine consumption (Mohanty *et al.*, 2006). Most of the panel members were earlier invited to taste wine made from other tropical fruits such as cashew (*Anacardium occidentale* L.) apple (Mohanty *et al.*, 2006), litchi (*Litchi chinensis* L.), mango (*Mangifera indica* L.) and others (unpublished results). Samples were served in clean transparent glasses (tumblers) which had been labeled with a 3-digit random number. Questionnaires and water for mouth rinsing between each tasting were provided. Prior to evaluation, a session was held to familiarize panelists with the product. Panelists were asked to read through the questionnaires and the meaning of each attribute (taste, aroma, flavour, colour/appearance and after taste) was explained to the panelists to avoid any misinterpretation (Meilgaard *et al.*, 1991; Kilcast and Subramanian, 2000). Tasters were not allowed to discuss their scores with one another during the evaluation session.

The jamun wine along with selected commercial brand of grape wines ("Figueira" and "Monarch") were presented to the trained panel of sensory analysts. Another set of jamun and grape wine samples were evaluated as replication 2 the following day. The sensory evaluation data were presented as means of the panelist's score. A standard t-test was used to test for the statistical significance of the differences observed between the scores of the two drinks (Cass, 1980).

Table 2: Composition of jamun must and wine and commercial red (grape) wine

Parameters	Jamun wine		Grape wine	
	Must	Wine	“Figueira”	“Monarch”
TSS (^o Brix)	16.50 ± 0.00*	2.8 ± 0.00	2.8 ± 0.04	2.8 ± 0.04
Reducing sugar (g 100 ml ⁻¹)	6.48 ± 0.06	0.49 ± 0.04	0.68 ± 0.05	0.74 ± 0.06
Titrateable acidity (g tartaric acid 100 ml ⁻¹)	0.51 ± 0.04	1.11 ± 0.07	0.53 ± 0.07	0.64 ± 0.07
pH	4.50 ± 0.12	3.3 ± 0.06	3.89 ± 0.07	3.75 ± 0.04
Phenol (g 100 ml ⁻¹)	0.23 ± 0.01	0.22 ± 0.03	0.22 ± 0.00	0.22 ± 0.00
Anthocyanin (mg 100ml ⁻¹)	85.00 ± 8.00	60.00 ± 4.50	55.00 ± 3.20	57.00 ± 4.20
Tannin (mg 100 ml ⁻¹)	1.70 ± 0.15	1.40 ± 0.75	0.08 ± 0.00	0.06 ± 0.00
Lactic acid (mg 100 ml ⁻¹)	N.D.	0.80 ± 0.02	0.21 ± 0.04	0.32 ± 0.05
Ethanol (%)	N.D.	6.00 ± 0.25	10.00 ± 0.00	8.00 ± 0.00

*Standard error

N.D. = Not detected

RESULTS AND DISCUSSION

Tropical countries possess a wide diversity of fruits with many possibilities of commercial exploitation; some of them are considered exotic and rare. Major tropical fruits like mango (Srisamatthakarn *et al.*, 2003) and banana (Onwuka and Awan, 2001) could enhance local or international markets by appropriate utilization processes and fermentation remains as a technological attempt of such utilization (Muniz *et al.*, 2006). Despite the high level of tannin content (causing astringency), jamun fruits could be processed into beverage owing to its fleshy pulp, soft peel and single seed which can be easily removed from the pulp, high sugar and anthocyanin concentrations and strong exotic flavour. However, it has been underutilized and the development of a new product to utilize the surplus fruits includes fermentation of the juice yielding an alcoholic beverage like wine (Shukla *et al.*, 1991).

The composition of must and wine prepared from jamun fruits is presented in Table 2. The titrateable acidity increased from 0.51±0.04 (g tartaric acid 100 ml⁻¹) in must to 1.11±0.07 (g tartaric acid 100 ml⁻¹) in the finished wine. The increase in titrateable acidity

was concomitant with a decrease in pH from 4.5±0.12 in must to 3.3± 0.06 in wine. As expected, the reducing sugar (g100ml⁻¹) content decreased from an initial value of 6.48±0.06 in must to 0.49±0.04 in wine. However, the phenolic content remained unchanged in wine samples. Jamun wine obtained from our study was a sparkling red (in appearance) beverage with alcohol content of 6.0%. The low alcohol content in jamun wine was probably due to low TSS (16.5^o Brix) in jamun must in comparison to grape must TSS (usually 22-24^o Brix) which yields wine with 8- 10% alcohol (Ethiraj and Suresh, 1993; Saigal and Ray, 2006). The anthocyanin content in the must was 85 ± 8mg 100 ml⁻¹ which was reduced to 60 ± 4.5 mg 100 ml⁻¹ in the finished wine. It was slightly acidic (1.11 g tartaric acid 100 ml⁻¹), which together with comparatively high tannin content (1.4±0.8 mg 100 ml⁻¹) imparted the characteristic jamun flavour and astringency. Lactic acid concentration in the wine was very low (0.8 mg 100ml⁻¹). The composition of jamun wine prepared in our study was compared with that of commercial grape wines (“Figueira” and “Monarch”) and the results are shown in Table 2. The grape wines used as standard in our study were comparatively less acidic (TA, 0.53

-0.64g tartaric acid 100ml⁻¹ and lactic acid, 0.21-0.32mg 100 ml⁻¹), and consequently had a higher pH but with a higher ethyl alcohol content (8 - 10 % v/v). The other parameters such as TSS, reducing sugar and anthocyanin concentrations were somewhat similar in both jamun and grape wine samples. As expected, the tannin content in grape wine was very low as compared with jamun wine. Further, there were not many variations in biochemical compositions of grape wines used in this study from the two brands, "Figueira" and "Monarch".

There are only a few studies on fermented beverages from tropical fruits. Onwuka and Awan (2001) produced a sparkling wine from overripe banana and plantain with alcohol content of 11.3%, pH of 4.1, 1.02 g l⁻¹ tartaric acid for TA, and 8.0 °Brix for TSS. Carreno and Aristizbal (2003) also carried out the fermentation of plantain to produce a wine having alcohol content of 8%; 0.65 g l⁻¹ tartaric acid for TA, and 9.6 °Brix for TSS. Akubor *et al.* (2003) obtained a different composition (pH was 3.3, 0.85 g l⁻¹ tartaric acid for TA, 5% alcohol, 4.8 °Brix for TSS and 0.04 g 100ml⁻¹ residual sugar) after a fermentation process to produce banana wine. In comparison to a German grape wine which was used as a standard reference for flavour, taste, clarity and overall acceptability, there were no significant (p= 0.05) differences. Kinnow, a hybrid of *Citrus nobilis* and *C. delicosa* contributes towards a major fruit production in Indian sub-continent but has a poor shelf-life (Muniz *et al.*, 2006). Singh *et al.* (1998) prepared a wine from kinnow juice with moderate acceptability as compared with grape wine. Other tropical fruits from which wine preparation are reported included carambola (*Averrhoa carambola* L.) (Bridgebassie and Badrie, 2004) papaya (*Carica papaya* L.) (Byakweli *et al.*, 1994), mango (*Mangifera indica* L.) (Srisamatthakarn *et al.*, 2003), Black Mulberry (*Morus nigra* L.) (Darias-Marin *et al.*, 2003), melon (*Cucumis melo* L.) (Hernandez-Gomez *et al.*, 2005), marula (*Sclerocarya birrea* subsp. *Caffra*) (Fundira *et al.*, 2002; Pretorius *et al.*,

1999), yellow mombin (*Spondis purpurea* L.) (Dias *et al.*, 2003), custard apple (*Annona squamosa* L.) (Muniz *et al.*, 2002), mangaba (*Hancornia speciosa* Gomes) (Muniz *et al.*, 2002). In a recent study, Mohanty *et al.* (2006) prepared wine from cashew apple using *S. cerevisiae* var. *Bayanus* as the starter culture.

There is very little study on beverage produced from jamun fruits. In the Philippines and Suriname, it is reported that wine is made from jamun fruits (www.tropilab.com/syzygium-jamun.html). Shukla *et al.* (1991) standardized a methodology and screening cultivars to prepare wine from jamun fruits. The clarity, colour, bouquet and taste of jamun wine received high scores and all the cultivars ("pharenda", "jamun" and "kathjamun") tasted were found suitable for making wine. However, the jamun wine was not compared with any standard grape wine in both studies.

Preliminary sensory evaluation analysis (Table 3) showed that the panelists rated jamun wine somewhat inferior (except colour/appearance) to commercial grape wine (p< 0.05) but the attributes like aroma, taste, after taste and colour/appearance were scored at about 3.0 (like much). However, the panelists rated flavour scores between 2.0- 3.0 (like moderately-like much) probably because of high tannin content in jamun wine which imparted somewhat an astringent flavour. Nevertheless, the jamun wine was acceptable to all the panelists.

Many tropical fruits such as mango, jackfruit, banana, and cashew apple have been shown to be suitable for fermentation, mainly because of their appropriate taste, flavour, availability, high sugar and water contents and overall chemical composition (Ward and Ray, 2006; Mohanty *et al.*, 2006). In this context, many process characteristics have to be taken into account: adequate juice extraction and variables that may influence the final beverage quality such as must amelioration, enzyme application, vessel capacity, yeast strain involved and finally the storage method (Saigal and Ray, 2006). Jamun fruits are seasonally available in tropical countries like India and

Table 3: Sensory evaluation of the jamun fruit wine*

Attributes**	Jamun wine	Grape wine	
		“Figueira”	“Monarch”
Taste	3.5	4.5	4.5
Aroma	3.5	3.5	4.0
Flavor	2.8	4.0	4.0
Color/appearance	3.5	3.5	3.8
After taste	3.0	4.0	4.5

n= 30

*Values are means of the panelists’ scores.

** 1= dislike extremely; 2= like moderately; 3= like much; 4= like very much; 5= like extremely

Pakistan in huge quantities during summer months (May- June) but they find little application at present despite their many pharmaceutical and anti-oxidant (high anthocyanin content) properties especially against diseases like diabetes (Joshi, 2001). Asian and African countries require food-processing technologies that will meet the challenges of the peculiar food security combined with health benefits in these continents. Such technologies should be low-cost to be affordable by the poor sectors of the community and uses locally available raw materials like jamun. However, more research may be conducted to find out the method for reduction of tannin concentration in jamun must and consequently in wine to minimize the astringent flavour.

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