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Kavya HS

¹ Department of Food Processing Technology, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

² Department of Food Technology, Kuvempu University, Jnanasahyadri, Shivamogga, Karnataka, India

Ramkumar C

Department of Food Processing Technology, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

Viswanatha Angadi

Department of Food Microbiology, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

Anitha S

Department of Bakery Technology, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

Prashanth SJ

Department of Food Technology, Kuvempu University, Jnanasahyadri, Shivamogga, Karnataka, India

Satish GJ

Department of Biochemistry, Kuvempu University, Jnanasahyadri, Shivamogga, Karnataka, India

Corresponding Author:

Kavya HS

¹ Department of Food Processing Technology, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

² Department of Food Technology, Kuvempu University, Jnanasahyadri, Shivamogga, Karnataka, India

Studies on effect of different sources of sugar and pH level on the quality of arecanut (*Areca catechu* L.) wine

Kavya HS, Ramkumar C, Viswanatha Angadi, Anitha S, Prashanth SJ and Satish GJ

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Abstract

The present study investigated the effect of different sugar sources and pH levels on the quality characteristics of arecanut wine prepared from tender arecanuts (*Areca catechu* L.). Wine was produced using two sugar sources, sucrose and jaggery, with the must adjusted to three pH levels (3.0, 3.5 and 4.0) and fermented using *Saccharomyces cerevisiae* var. *ellipsoideus*. The fermented wines were analyzed for physicochemical parameters including pH, total soluble solids, total sugars, titratable acidity, alcohol and tannin content, and were subjected to sensory evaluation after three months of ageing. The pH of the wines ranged from 2.64 to 3.87, with alcohol content varying between 8.40 and 10.13 per cent. A reduction in total soluble solids and total sugars indicated efficient fermentation across treatments. Wines prepared with jaggery showed comparatively higher sensory acceptability than those made with sucrose. Among all treatments, wine produced using jaggery at an initial must pH of 3.0 recorded the highest sensory scores for colour, flavour, mouthfeel, aftertaste and overall acceptability, attributed to lower perceived astringency and balanced acidity. The study demonstrates the potential of tender arecanut as a novel substrate for wine production and highlights jaggery and pH 3.0 as optimal conditions for producing acceptable arecanut wine.

Keywords: Arecanut, wine, fermentation, pH

Introduction

Arecanut, also known as betelnut, comes from the fruit of the arecanut palm (*Areca catechu* L.). This crop is grown in West Bengal, Assam, Maharashtra, Tamil Nadu and Andaman on various types of soils. It is a popular choice for chewing in India, Myanmar, Malaysia and Sri Lanka. People usually chew it with betel leaves and a bit of slaked lime (Kaleemullah and Gunasekar, 2002) [8]. Arecanut is a significant economic crop in India and is included in Hindu religious ritual offerings. Indians have an ancient tradition of chewing arecanut with betel leaf (or paan) and additional elements. Additionally, it is utilized by the indigenous populace in traditional veterinary and medical systems (Bhat *et al.*, 2017) [4]. In India and throughout Southeast Asia, betel nut powder is used in traditional medicine to treat various conditions, including inflammation (such as gingivitis, conjunctivitis and edema), flatulence, diarrhea and dysentery, hyperemesis during pregnancy, dysuria and elevated blood pressure (Kozlakidis *et al.* 2022) [9]. *Areca catechu* powder has also been applied externally as an anti-inflammatory treatment or the nut is ground into ash and administered locally. In a more refined form, it is also used as collyrium to relieve epiphoria and conjunctivitis (Pinn, 2005) [15].

The arecanut kernels are chewed in both their raw and processed forms. For arecanut processing, the fruit is picked at different stages of maturity according to the nature of the end products. In food industry, the fat present in the kernel is extracted and used for confectionery purpose. Tannins obtained as a by-product from the processing of immature nuts are used as a food colour. However, arecanut is less explored as a food ingredient (Bhat *et al.* 2017) [4].

Fermentation process can be utilized to create novel products with altered physicochemical and sensory properties, particularly those related to flavour and nutritional value. Fermentation of alcohol, lactic and acetic acid are critical to production quality. Among

these, alcoholic fermentation is frequently used to prepare drinks that include a significant amount of alcohol (Amerine *et al.* 1980) [2].

Amongst various fruits, grapes are the most technically and commercially used substrates for winemaking. Apart from grapes, there are numerous fruits available that can be used as substrates for winemaking. Tender arecanuts which contain less fibre, moderate amount of sugar and polyphenols like tannin are also potential substrate for wine production. This research explores the process of making wine using arecanut. For the purpose of this research, different sources of sugars were used to increase the TSS level and the substrate was optimized at various pH levels in order to determine best pH level for wine making.

Materials and methods

Procurement of arecanut and yeast strain

Tender, six-month-old, disease-free arecanuts of a local cultivar were sourced from a farmer. A pure culture of *Saccharomyces cerevisiae* var. *ellipsoideus* (NCIM 3281) was procured from the National Chemical Laboratory, Pune. It was kept in refrigerator at 0 to 5 °C until use for inoculum preparation.

Pure culture was maintained on MGYB (malt extract-0.3%, glucose-1%, yeast extract-0.3%, peptone-0.5%, agar-2%) medium. The pH was adjusted between 6.4 and 6.8 and the medium was transferred to test tubes which were autoclaved at 15 psi for 20 minutes. After cooling, the slants were inoculated with a loopful of pure yeast culture and the slants were then incubated at 30 °C for 24 hours which were subsequently used as master culture. The pure culture was maintained on MGYB slants and were stored under refrigerated conditions i.e. 5-7 °C.

Inoculum preparation

Arecanuts were dehusked, washed, blended into a coarse paste, mixed with water (1:1), and boiled for three minutes. The must was then adjusted to pH 4.0 with lactic acid and to 24 °Brix by adding cane sugar, followed by the addition of 400 ppm potassium metabisulphite. After inoculation with a 24-hour-old active yeast culture, the flask was sealed and incubated at 28 °C for 24 hours. The actively bubbling inoculum obtained after incubation was used for further fermentation.

Fermentation process

The arecanuts were ground into a coarse paste by blending them with water in 1:2 ratio. Then the paste was boiled for 3 minutes. TSS was adjusted by adding sucrose and jaggery syrup (S₁-Sucrose and S₂-Jaggery). The pH was adjusted (P₁-3.0, P₂-3.5 and P₃-4.0) by adding 10 per cent lactic acid. The details of treatments are as follows:

S₁P₁: Sucrose + 3.0 pH

S₁P₂: Sucrose + 3.5 pH

S₁P₃: Sucrose + 4.0 pH

S₂P₁: Jaggery + 3.0 pH

S₂P₂: Jaggery + 3.5 pH

S₂P₃: Jaggery + 4.0 pH

Potassium meta-bisulphite was added at 400 ppm per litre to inhibit the wild yeast and spoilage through microorganisms. This was treated as Must. For fermentation, the must was inoculated with yeast culture under aseptic conditions at the rate of 20ml/L. The must was allowed to ferment at 28 ± 2

°C. After completion of fermentation, clear, supernatant wine was siphoned off, clarified with the aid of bentonite (0.1g/L), decanted, pasteurized at 65 °C for 20 minutes, cooled and stored for ageing.

The experiment was laid out in factorial Completely Randomized Design (CRD) with three replications consisting of 6 treatments. The data has been analyzed statistically and reported at 5% significance level (Panse and Sukhatme, 1985) [14].

Quality Analysis

Quality parameters such as pH, Total soluble solids (TSS), total sugars, titratable acidity, alcohol and tannins were analyzed according to the standard procedures given by AOAC (2005) [1] and FSSAI (2019) [6].

Sensory Evaluation

Arecanut wine was evaluated for sensory qualities viz., colour, flavour, clarity, viscosity, mouth feel, after finish and overall acceptability after 3 months of aging. Each attribute was assessed using a 9-point hedonic scale according to the method reported by Amerine *et al.* (1980) [2].

Results and discussion

The results obtained from present investigation is summarized in table 1.

The pH of wine was found to range from 2.64 to 3.87. Maximum pH was found in wine made with jaggery and must of pH 4.0. When compared to the pH of their respective must, each treatment demonstrated a significant reduction in the pH. The decrease in pH was due to the increase in acidity of wine because of accumulation of organic acids during fermentation and it minimizes the influence of spoilage bacteria (Li, 2003) [11].

The TSS of the wine ranged from 8.25 to 9.97 °B. The low content of total soluble solids in the prepared wine indicates that almost all of the sugar present in the reconstituted must was used during fermentation. The decrease in total soluble solids during fermentation is attributed to the higher fermentability of sucrose and jaggery solution of different treatments.

The total sugar content of the wine ranged from 3.52 to 5.50 per cent. Low total sugar content after fermentation was observed in wine made with jaggery with must of pH 4.0. The decrease in the total sugar content suggested that yeast had used the sugar in the arecanut and the added sugar as a growing substrate to produce ethanol.

Titratable acidity of arecanut wine ranged from 0.41 to 0.69. Titratable acidity is attributed to the ionization process in wine which results in a low number of ions per mole of compound by common acids. Therefore, the pH of the wine will not be significantly lowered during storage. When present within acceptable levels, these acids improve the flavour of the wine and make it more palatable (Kyamuhangire *et al.* 2002) [10].

Alcohol content of arecanut wine ranged from 8.40 to 10.13 per cent. During fermentation, alcohols become a primary component of the wine matrix, following water, with concentrations ranging from 8.5 to 15 per cent in table wines (Robinson 1999). As the most prevalent volatile compound, alcohol plays a key role in shaping the taste and mouthfeel of wines (Fischer and Noble 1994; Nurgel and Pickering 2006) [5, 13]. The results of the present study

closely align with the findings of Badanaje (2008) ^[3] who reported the alcohol percentage of arecanut wine as 14.6 per cent.

In the present study, arecanut wines had tannin content in the range of 6.09 to 8.29 per cent which is less than the tannin content of the arecanuts used for wine making. However, interaction of sugar and pH levels of must has no significant effect on the tannin content of wine. During ageing, tannin levels in wines decrease as a result of oxidation and precipitation with proteins (Zoecklein *et al.* 1995) ^[17]. Similar results were reported by Joshi *et al.* (2012) ^[7] in jamun wine. Tannins contribute to perceived

astringency, which is the drying, puckering mouthfeel that results from increased friction between the tongue and the surfaces inside the mouth (Fischer and Noble, 1994) ^[5]. However, previous studies have shown that tannin concentration alone is not enough to explain the variation of astringency perception in wines (Landon, 2008) ^[12].

Arecanut wine made with jaggery and must of pH 3.0 obtained the highest mean sensory scores for clarity, colour, flavour, mouth feel, after finish and overall acceptability (Fig. 2). Panelists found the wine made with this treatment less astringent and more acceptable. Less astringency was due to less tannin content.

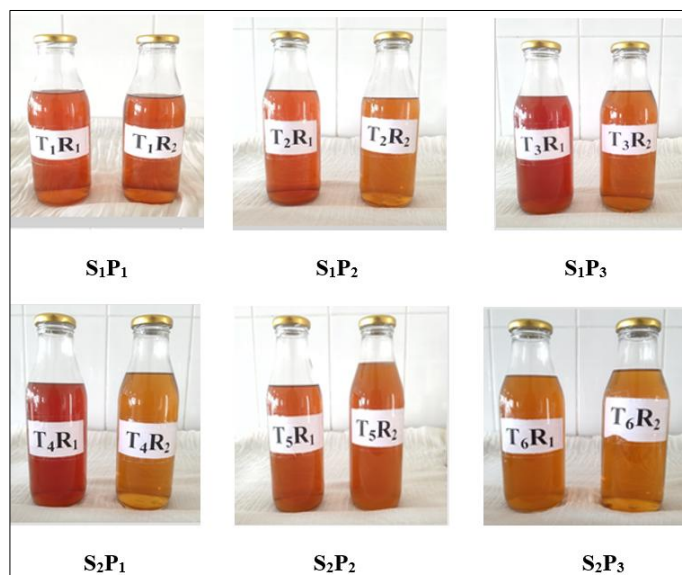


Fig 1: Arecanut wine

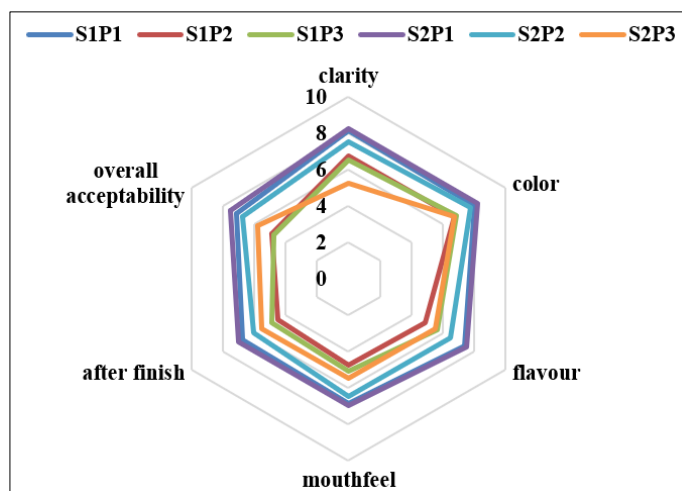


Fig 2: Mean sensory scores of arecanut wine

Conclusion

The present study was undertaken to develop good quality wine from arecanut. The fermentation studies demonstrated that a 15-day period was suitable for producing wine from diluted arecanut juice using *Saccharomyces cerevisiae* var. *ellipsoideus* (NCIM 3281). The wine prepared with jaggery using must of pH 3.0 was found to be the most acceptable as it was rated superior based on its sensory attributes. Considering the chemical composition and sensory

evaluation of wines prepared from different sources of sugar and pH of must, it can be concluded that jaggery as a source of sugar at pH 3.0 are the optimum conditions for the preparation of good quality arecanut wine. On the basis of this study, it can be concluded that arecanut being rich in tannins holds promise for production of good quality wine. However, these findings are from a laboratory-scale study and need to be validated on a pilot plant scale for commercial wine production.

Table 1: Quality parameters of arecanut wine

	pH		TSS (°B)		Total sugars (%)		Titratable acidity		Alcohol (%)		Tannins (%)	
S ₁ P ₁	2.64		9.46		5.50		0.63		8.40		6.15	
S ₁ P ₂	3.16		9.19		4.54		0.52		9.63		7.11	
S ₁ P ₃	3.58		8.74		3.98		0.41		10.13		8.21	
S ₂ P ₁	2.96		9.97		5.14		0.69		8.89		6.09	
S ₂ P ₂	3.15		9.19		4.37		0.56		9.22		7.24	
S ₂ P ₃	3.87		8.25		3.52		0.42		10.05		8.29	
Mean	3.22		9.13		4.50		0.53		9.38		7.18	
Comparing the means of treatments	S.E.±	CD (0.05)	S.E.±	CD (0.05)	S.E.±	CD (0.05)	S.E.±	CD (0.05)	S.E.±	CD (0.05)	S.E.±	CD (0.05)
Source of sugar (S)	0.002	0.008	0.014	0.045	0.008	0.024	0.002	0.008	0.015	0.049	0.029	NS
pH of must (P)	0.003	0.01	0.018	0.055	0.009	0.030	0.003	0.009	0.019	0.059	0.035	0.109
S X P	0.005	0.01	0.025	0.078	0.013	0.042	0.004	0.013	0.027	0.084	0.050	NS

S₁P₁: Sucrose + 3.0 pH; S₁P₂: Sucrose + 3.5 pH; S₁P₃: Sucrose + 4.0 pH; S₂P₁: Jaggery + 3.0 pH; S₂P₂: Jaggery + 3.5 pH; S₂P₃: Jaggery + 4.0 pH

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