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Microbial Fermentation of Blended Jackfruit Juice for Quality Improvement of Jackfruit Wine

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Abstract

Jackfruit (*Artocarpus heterophyllus* Lam) is one of the important underutilized fruit which is known for its therapeutic and nutritive values and available plenty during season. The experiment on microbial fermentation jackfruit juice blending with different juices *viz.,* pineapple (20 and 25 %), amla (10 and 15 %) and aloevera (5 and 10 %) by yeast strain *Saccharomyces cereviceae* MTCC 170 was carried out for quality improvement of jack fruit wine. The results revealed that the jackfruit juice blending with amla juice (10 and 15 %) significantly influenced reduction of pH (3.16) and TSS (6.25), highest titrable acidity (0.52), vitamin C (193.3 mg), alcohol (12 %) and overall acceptability (16.33/ 20.0) compared to pine apple and aloevera blending. Jackfruit juice blending with 15 per cent amla juice improved the nutritional and sensory quality of jackfruit wine.

Keywords : Jackfruit juice, Blending, Yeast, Fermentation, Wine

Jackfruit (*Artocarpus heterophyllus* Lam) is one of the important underutilized fruit which is known for its therapeutic and nutritive values with an excellent flavor and attractive colour. It is widely cultivated in Malaysia, Myanmar, Bangladesh, Sri Lanka, Brazil, Phillipines, West Indies, Pakistan and other tropical countries. Jackfruit is grown throughout Karnataka especially in coffee and tea estates of Western Ghats, southern plains and Malnad region in an area of about 11,333 ha producing about 2.60 lakh tonnes of fruits per annum (Anonymous, 2000). There are several research reports on wine making process from different major and minor fruits by different research workers. In order to meet the diversity of consumer needs, extensive researches have been carried out to find other possible sources of wine making process from different fruits like banana, pineapple (Isitua and Ibeh, 2010), kiwi (Duarte *et al*., 2010), apple (Polychroniadou *et al*., 2013), orange (Selli *et al*., 2008), cashew apple (Attrii, 2009), pomegranate (Sevda and Rodrigues, 2011), jackfruit (Kumoro *et al*., 2012 and Dushyanth *et al*., 2006) and other fruit juices. The wine quality depends on variety, composition of fruits and efficiency of yeast strain used (Ethiraj and Suresh.,1993). However, there is paucity of information on processing of underutilized jackfruit for wine production. Good quality of wines can be prepared by blending with musts of different fruits or fruits of different cultivars of the same fruit (Timofeev and Krechetov, 1998). There are number of grape wine varieties with unique and distinct flavours. Ethiraj and Suresh (1993) prepared good quality of sweet wines by mixing mango pulp with seedless grape must in the ratio of 1:1 with pronounced mango flavour. Similarly, Suresh *et al*. (1983) reported that quality of blended wines from mixing of gulabi variety of grape with musts of rubi red, thompson seedless and anab-E-shahi in different ratios. Keeping in view of the above facts, the study was under taken to improve the quality of jackfruit wine by blending with other fruit juices.

Material and Methods

Preparation of Jackfruit Juice and Blended Juice

Well matured, ripe and healthy jack fruits of hard flesh jackfruits were procured from Doddaballapura, Bengaluru North. The selected fruits were cut along their equatorial axis with the help of a sharp knife smeared with edible oil. The bulbs were carefully separated from the rind and placenta. Care was taken to handle the bulbs with minimum damage. The bulbs were cut into small pieces and using a mixer grinder

made into fine slurry in the form of pulp. The pulp was blended by addition of water (1:3.5 ratio), sugar (TSS was adjusted to 20^0 Brix), potassium metabisulphite @ 200 ppm was added to suppress wild yeast present in the juice and homogenized juice was heated to 60 – 70 ^{0}C for five minutes and the same was used for further experiment.

Blending with other Fruits: Per cent pulp percentage was calculated for the preparation of blended jackfruit juice.

Amla Fruits: Fresh amla fruits measuring about 2.5 cm in diameter were collected from the local market and were washed in clean water and were processed into pulp.

*Aloevera***:** Aloevera leaves were collected from Regional Research Station, GKVK, Medicinal and Aromatic Garden and colourless gel was extracted from the leaves and the same was used for blending with jackfruit pulp.

Pineapple: Well ripe healthy pine apple fruit was procured from the local market and processed into pulp and same was used for the study.

Preparation of Blended Juices: Grinded and filtered juice from well ripen pineapple and amla were used for the study. Direct jelly extract of aloevera is used for blending.

Preparation of Starter Cultures of Yeast: A loop full of purified inoculum yeast culture was transferred to YEPDA broth containing in 250 ml conical flasks and were incubated overnight at 28 ^{0}C for growth. This yeast culture was containing 10^7 cfu/ml and same was used for inoculation.

Treatment details

Treatments	
T1	Jack fruit juice only (100 %) + yeast
T2	Jackfruit juice (80 %) + Pine apple juice (20 %) + yeast
T3	Jackfruit juice (75 %) + Pine apple juice (25 %) + yeast
T4	Jackfruit juice (90 %) + Amla juice (10 %) + yeast
T5	Jackfruit juice (85 %) + Amla juice (15 %) + yeast
T6	Jackfruit juice (95 %) + Aloevera juice (05 %) + yeast
T7	Jackfruit juice (90 %) + Aloevera juice (10 %) + yeast

Replications: 3

Fermentation

The starter culture of yeast strain containing 10^7 cfu/ml was inoculated at three per cent (v/v) for fermentation of different blended jackfruit juice of 300 ml contained in a 500 ml conical flasks. The inoculated flasks and control flasks were plugged with rubber cork with bent tube and kept for fermentation for six days under room temperature (27-30 ^{0}C).

Filtration

After six days of fermentation, the fermented juice was filtered through muslin cloth and the filtrate was kept in sterilized glass bottles. The filtrate fermented juice was subjected for biochemical and sensory analysis by following standard procedures

Biochemical Analysis

pH: The pH of the fermented jackfruit samples was determined using a digital pH meter (YORCO pH meter, model: YSI - 601). The pH meter was standardised with buffer solutions of different pH (4.0, 7.0, and 10.0) were used to calibrate the instrument. Each sample was replicated three times and its mean value was taken as pH of the sample (Sadasivam and Manickam, 1996).

Titrable acidity: Fresh filtered homogenised pulp10g was made up to 100 ml with distilled water. From this 10 ml of the prepared solution was titrated against 0.1N NaOH solution using phenolphthalein as indicator. The appearance of a light pink colour was the end-point that quantifies the NaOH required to neutralise the juice. The titrable acidity was calculated and expressed as per cent citric acid (Srivastava and

Kumar, 1993). Amount of titrable acidity present in 100 g of sample was calculated.

Total soluble solids: Total soluble solid (TSS) was measured using a hand refractometer. One or two drops of juice were placed on the hand refractometer for TSS measurement. It was expressed in degree Brix (Ranganna, 1995).

Ascorbic acid: Ascorbic acid was determined by dye method (Sadasivam and Manickam, 1992).

Estimation of reducing sugars: The reducing sugars was estimated by following the method as given by Shaffer-Somagyi micro method (A.O.A.C.,1980).

Estimation of total sugars: Twenty-five ml of filtrate was taken in a 50 ml volumetric flask. 5 ml of HCL and water in the ratio of 1:1 was added. The content were allowed to stand for 24 hr at room temperature. After 24 hr, the content were neutralized exactly with NaOH using Phenolphthalein as an indicator and the volume was made up with water. An aliquot was taken and the invert sugars as in case of reducing sugars were determined as per the method followed by (Sadasivam and Manickam, 1996).

Estimation of alcohol: Alcohol was estimated calorimetrically as described by Caputi *et al.* (1968).

Colour: Hunter Lab colourimeter (Mini Scan XE Plus) was used for the colour measurement in the study. It works on the principle of collecting the light and measures energy from the sample reflected across the entire visible spectrum. The sample colour was measured by filling the cut samples of fermented jackfruit juice in the transparent cup without any void space. The deviation of colour of samples from the standard were observed and recorded in the computer interface. Each sample was replicated three times and the average value of 'L', 'a' and 'b' were determined. (Clydesdale, F. M., 1978).

Organoleptic evaluation: The developed fermented beverage from blended jackfruit juices were evaluated by selected five panel members with 20 point hedonic scales (Amerine *et al.,* 1972) was taken into consideration, which was based mainly on the appearance, color, aroma, taste and acceptability.

Statistical analysis: The data obtained from the investigation was subjected to analysis of variance by completely randomized design, the treatment difference were separated at one per cent significance level using factorial Complete Block Design.

Results and Discussion

The results of the fermentation of jackfruit blended juices on quality with respect to pH, TSS, acidity, pattern of total sugars utilization and alcohol production, colour and sensory attributes is discussed here under.

pH: Changes in pH and TSS of the fermented blended jackfruit juice as influenced by with and without blending are presented in Table 1. The results revealed that the initial pH of the jackfruit juice was 5.18, when it was blended with different proportions of other fruit juices it varied from 4.96 to 5.18. Jackfruit juice blending with 15 per cent amla juice recorded lowest pH (4.96) compared to other treatments. After six days of fermentation, the change in pH varies from 3.16 to 4.1. The results indicating that jackfruit juice blending with amla juice significantly influences on pH in the fermented jackfruit juice. pH of wines depends upon the acids and sugar contents in the fruits which influences on fermentation. Jackfruit wine blended Amla showed a pH 3.16 indicating that organic acids present in the fruits and increase in the acidity. Fermentative activity of yeast only reduced the pH level compared to uninoculation, mainly due to the utilization of sugar to alcohol and acids in Amla wine and these results supports the work of Soni *et al.* (2009) reduction of pH by fermentation in amla wine.

TSS (°Brix): The initial TSS of the jackfruit juice with blending varies from 19.90 - 20.63. After six days of fermentation the change in TSS (brix) of the fermented jackfruit juice varies significantly from 6.25 - 7.70 between the treatments. Upon the fermentation the TSS of blended jackfruit juice decreases as shown in Table 1. The TSS of the fermented product with Amla 15 per cent blending (6.25 brix). Utilization of sugars

TABLE 1

Changes in pH and TSS of the fermented jackfruit juice as influenced by blending of other fruit juices

Treatments	pH		TSS (brix)	
	Initial	After fermentation	Initial	After fermentation
T1 - Jack fruit juice only + yeast	5.18	4.11	19.90	7.70
T2 - Jackfruit juice + pine apple juice (20%) + yeast	5.04	3.98	20.63	7.07
T3 - Jackfruit juice + pine apple juice (25%) + yeast	5.06	3.97	19.90	7.00
T4 - Jackfruit juice + amla juice (10%) + yeast	4.96	3.24	20.03	6.47
T5 - Jackfruit juice + amla juice (15%) + yeast	4.98	3.16	19.90	6.25
T6 - Jackfruit juice + aloevera juice (5%) + yeast	5.02	3.97	20.05	7.35
T7 - Jackfruit juice + aloevera juice (10%) + yeast	5.04	3.96	20.05	7.40
M	5.04	3.77	20.07	7.03
SEm±	0.019	0.044	0.148	0.193
CD (p=0.05)	0.058	0.134	0.450	0.585
CV%	0.661	2.038	1.280	4.751

by the yeasts in juice results in production of alcohol (8.5 %) and lowering of TSS (6.25 %) of the wine. This could be due to fermentation efficiency and sugar conversion capacity by the yeast (Vyas and Kochhar (1993) as observed in apricot wine.

Titrable acidity

The changes in titrable acidity (%) and vitamin C of the fermented jackfruit juice as influenced by blending of other juices are indicated in Table 2 . The initial titrable acidity of the jackfruit juice significantly blended with other juices varies between 0.14 to 0.38. After six days of yeast fermentation, acidity varies from 0.21

TABLE 2

Changes in titrable acidity and vitamin C of the fermented jackfruit juice as influenced by blending of other fruit juices.

Treatments	pH		TSS (brix)	
	Initial	After fermentation	Initial	After fermentation
T1 - Jack fruit juice only + yeast	0.18	0.29	1.10	0.95
T2 - Jackfruit juice + pine apple juice (20%) + yeast	0.24	0.38	1.95	1.79
T3 - Jackfruit juice + pine apple juice (25%) + yeast	0.30	0.41	1.60	1.17
T4 - Jackfruit juice + amla juice (10%) + yeast	0.38	0.52	22.33	19.33
T5 - Jackfruit juice + amla juice (15%) + yeast	0.37	0.52	20.67	17.53
T6 - Jackfruit juice + aloevera juice (5%) + yeast	0.18	0.24	1.60	1.37
T7 - Jackfruit juice + aloevera juice (10%) + yeast	0.14	0.21	1.50	1.13
M	0.25	0.37	7.25	6.18
SEm±	0.011	0.005	0.180	0.152
CD (p=0.05)	0.034	0.015	0.545	0.461
CV%	7.612	2.363	4.296	4.262

- 0.52 between the treatments. Upon completion of yeast fermentation of blended jackfruit juice, the enhancement of titrable acidity is more important in the fermented products, the highest titrable acidity (0.52 %) was recorded in the jackfruit blended with Amla juice treatments, whereas least acidity enhanced in the treatments blended with Aloevera. This indicated the availability of fermentable sugar favouring yeast in Amla compared to other blended juices in which there was no significant variation in biochemical constituents. These results are in line with the observation made by Nandagopal and Nair (2013) in wine from ginger and Indian gooseberry.

Vitamin C

The initial vitamin C content of the jackfruit juice blending with other fruit juices varied from 5.10 to

223.3 mg/100g between the treatments, after six days of yeast fermentation. The reduction of vitamin C varied from 0.95 - 193.3 mg / 100 mg between the treatments which differed significantly. Upon completion of yeast fermentation of blended jackfruit juice, the vitamin C content varied from 11.13 to 193.3 mg/100g between the treatments (Table 2). The highest vitamin C (193.3 mg) was recorded in the jackfruit juice blended with 10 per cent Amla juice followed by treatment (175.3 mg). The least vitamin C content was observed in the jackfruit juice without blending and blend with aloevera juice. The reduction in vitamin C content indicates that yeast utilized vitamin C required for the metabolism and growth during fermentation which is observed by Nandagopal and Nair (2013) in the study of ginger and Indian gooseberry.

Total Sugar per cent and Alcohol per cent

The initial mean value of total sugar level was 19.37 per cent between the treatments. After six days of fermentation, total sugar content varied between the treatments in the range of 6.18 to 7.47 per cent which were found to be significant each other. Utilization of sugar is indicative of growth and fermentative efficiency of the yeast. Low total sugar per cent (6.18 %) in the treatment T5 *i.e.,* blended with 15 per cent Amla is due to high fermentative character of the yeast. however some amount of sugar was left in the fermentation juice after fermentation process where in the highest total sugar (7.47 %) was observed in the treatment without blending indicating the low sugar utilization efficiency when compared to blended juice fermentation.

The alcohol production in the blended jackfruit wine samples is presented in Fig. 1. The highest alcohol per cent (12 %) was obtained with jackfruit juice blended with 15 per cent amla juice followed by treatment (10 %). Alcohol content in the final product is an important factor in determining the quality of wine. The highest alcohol (12 %) was obtained with jackfruit juice blended with 15 per cent Amla juice followed by the treatment (10 per cent Amla) which is proportionate to decline in TSS brix (6.25) which showed a

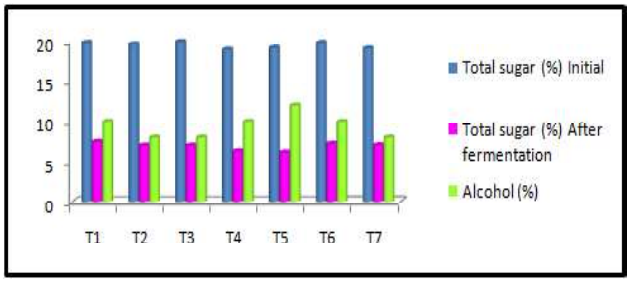

Fig. 1 : Total sugar utilization and alcohol production of the fermented jackfruit juice as influenced by with without blending of other fruit juices

favourable for fermentative yeasts in the mix. This observation is in agreement with reports of Borate *et al*. (2008), Ethiraj and Suresh (1987) in fermented blended grape juice and with data reported by Soni *et al.* (2009*)* in *Amla* wine.

The pattern of total sugar utilization and alcohol production in the fermented jackfruit juice with and without blending is presented in Fig.1.

Fig. 1 represents alcohol content has increased more in the JF blending with amla juice which is proportionate to decline in TSS brix in the final product is an indication of effective activity of yeasts during the fermentation process. The probable reason could be the fruit juices having relatively lower levels reducing sugars

Colour

The results for visual perception of colour is represented by three axes value (L), hue (a) and chroma (b) of hunter calorimeter, the L and b values decide the quality of the fermented products. The highest L and b values were recorded for the amla blended wine (88.28 and 8.69), followed by treatment only jackfruit wine (89.36 and 5.50) which indicate good quality of the product. Blending has increased the colour of wine that might be due to the combined effect of components of both the wines.This is supported by the work of Patil and Shibamoto (2003) in blended wines from pomegranate.

Organoleptic Evaluation

Fermented beverage used for human consumption should be evaluated by organoleptic procedure as they have pleasant aesthetic refreshing qualities due to their

TABLE 3

Colour variation of the fermented jackfruit juice as influenced by with and without blending of other fruit juices

Treatments	colour		
	L*	a*	b*
Jack fruit juice only + yeast	89.36	-0.20	5.51
Jackfruit juice + pine apple juice (20%) + yeast	82.36	0.63	14.3
Jackfruit juice + pine apple juice (25%) + yeast	86.73	-0.18	9.73
Jackfruit juice + amla juice (10%) + yeast	88.28	-0.41	8.69
Jackfruit juice + amla juice (15%) + yeast	88.28	-0.08	8.50
Jackfruit juice + aloevera juice (5%) + yeast	85.35	-0.54	5.00
Jackfruit juice + aloevera juice (10%) + yeast	87.32	-0.52	4.03

color and tactile sensation. Therefore it is essential to go for organoleptic evaluation. Taste varies from person to person some people may like fermented beverage with more alcohol content, some may like fermented beverage having more sweet taste. Based on that, the taste of fermented beverage prepared from with and without blended jackfruit juice was analysed for organoleptic evaluation on different parameters.

Organoleptic evaluation of fermented jackfruit product indicated that in general, the products acceptance is good with blending of Amla at 15 and 10 per cent. Jackfruit juice blending with Amla with 15 per cent had highest score (16.33 out of 20.0) followed by jackfruit juice blending with 10 per cent Amla with 15.34 out of 20. The least score was recorded in the juice without blending and with aloevera blending. Amla may be helping in modulating acidity as well as alcohol production and creating sweetness for better acceptability. Jackfruit juice blending with Amla fermented by yeast was found to be very superior in characteristics like appearance, aroma, colour, flavour and general quality.

TABLE 4

Organoleptic evaluation of fermented jackfruit juice as influenced by blending of other fruit juices (mean average of 10 judges)

Treatment	Appearanc (2)	Colour (2)	Aroma (2)	Bouquet (1)	Vinegar (2)	Total acidity (2)	Sweetness (2)	Body (1)	Alcohol (2)	Astringenc (2)	General quality (2)	Overall acceptability (20)
T1	1.50	1.50	1.95	0.9	1.0	1.75	1.2	0.75	1.25	1.25	1.25	14.55
T2	1.85	1.95	1.75	1.0	1.0	1.45	1.0	0.70	1.00	1.5	1.0	13.72
T3	1.80	1.75	1.75	1.0	1.0	1.45	1.0	0.70	1.00	1.5	1.0	13.45
T4	2.0	2.0	2.0	1.0	0.5	2.0	1.2	0.90	1.50	1.0	1.5	16.33
T5	1.62	2.0	1.62	1.0	0.5	2.0	1.2	0.90	1.50	1.0	1.5	15.34
T6	1.50	1.7	1.47	1.0	0.75	1.5	0.9	0.85	1.00	1.5	0.75	12.92
T7	1.60	1.5	1.65	0.9	0.75	1.25	0.95	0.85	1.00	1.5	0.75	12.71

T1 - Jack fruit juice only + yeast : T2 - Jackfruit juice +pine apple juice (20%) + yeast : T3 - Jackfruit juice +pine apple juice (25%) + yeast
T4 - Jackfruit juice +amla juice (10%) + yeast : T5 - Jackfruit juice +amla juice (15%) + yeast : T6 - Jackfruit juice + aloevera juice (5%) + yeast
T7 - Jackfruit juice + aloevera juice (10%) + yeast

The results clearly indicated that the jackfruit juice blending with Amla has improved all sensory attributes of colour, appearance, taste, aroma, body, alcohol, general quality and overall acceptability of wine, this might be due to the combined effect of chemical components of jackfruit and Amla fruits. Similar results were reported by Patil and Shibamoto (2003) in blended wines from pomegranate. Blended wine of mango pulp (Suresh and Ethiraj ,1983) and Thompson seedless grapes, (Chowdhury and Ray, 2007) in jamun wine.

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