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Effect of different levels of dilutions and pectinase enzyme on the quality of jackfruit (*Artocarpus heterophyllus* L.) must

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Abstract
An investigation was undertaken at Fruit Beverages Research Centre, Department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli to study the effect of different pectinase enzyme concentration and dilution levels of juice on quality of jackfruit wine by using factorial completely randomized design (FCRD). For this study, juice was extracted from jackfruits and analyzed for chemical composition. The jackfruit juice contained T.S.S., reducing sugars, total sugars, titratable acidity, pH, ascorbic acid, protein, tannins and pectin as 250B, 9.90%, 20.6%, 0.18 %, 4.8, 15 mg/100ml, 1.5%, 0.50%, 0.98% respectively. Must was prepared by diluting the juice as per the treatments (1:1, 1:2. 1:3 and 1:4) and adjusting pectinase enzyme concentration levels to 0.00%, 0.10%, 0.15% and 0.20%. The pH and T.S.S. was adjusted to 3.5 and 250Brix. The jackfruit must analyzed for chemical composition. The prepared must was used for the preparation of wine by fermenting with yeast culture (*Saccharomyces cerevisiae* var. bayanus).

Keywords: dilution, jackfruit, must, pectinase enzyme

Introduction
Jackfruit (*Artocarpus heterophyllus* Lam.) trees belong to the family Moraceae. They grow abundantly in India, Bangladesh, and in many parts of Southeast Asia (Rahaman *et al.*, 1999). The tree is valued for its money earning capacity and has a pride place in India. In India, the total area under jackfruit cultivation is approximately 1,02,552 hectares, of which, an estimated 1,00,000 trees are grown in back yards.

In India, the major area under jackfruit is in Kerala state and it was regarded as heavenly fruit in the ancient periods. It is grown in an area of 97,536 ha with annual production of 348 million fruits and productivity of 3,568 fruits per ha. As per 1996 data, it occupied an area of 26,000 ha having a production of 0.257 million tons (Anonymous, 1996) [1]. However, in 2010, Bangladesh produced 1.5 million tons of fruits from 1,60,000 hectares of land, with about 30% of fruits being produce from jackfruit plantation.

Jackfruit thrives in tropical warm and humid frost-free climates at elevations below 5000 feet. The trees have some salinity tolerance but poor drought and flooding tolerance. It will grow in a variety of well-drained soils with a pH between 5 and 7.5. The tree does not do well in exposed locations with strong, drying winds. It needs irrigation in times of drought in order to produce fruit. Growth habits vary from tall and straight with a thin trunk to short with a thick trunk, varying with soil type, environment, and cultivar 100-g edible portion; edible portion averages 28 % of fruit weight. moisture 72–77.2 %, calories 98, protein 1.3–1.9%, fat 0.2 %, carbohydrate 15.1–25 %, fibre 1.0–5 %, ash 0.8–2.2 %, Minerals (mg)- calcium 22-37%, iron 0.5–1.7 %, phosphorus 38%, potassium 292–407 mg 100-1gm, sodium 2–48 mg 100-1gm. Vitamins - vitamin C 8–10 mg 100-1gm, thiamine 0.03 mg 100-1gm, riboflavin 0.06 mg 100-1gm, niacin 0.4–4 mg 100-1gm, vitamin A 540 IU.

Wine is a food with flavour like the fresh fruit which could be stored and transported under the existing conditions. Wines reputedly aided in maintaining health, not only because of their nutritive value, but also because they replaced inadequate, impure or otherwise unsatisfactory water supplies. Wine has always been considered a safe and helpful beverage. Products like fermented beverages, especially fruit wine and vinegar from ripe jackfruit using food processing and biotechnological techniques, will not only reduce losses of fruit material but also make the fruit products available during the off season and generate income and also employment opportunities in rural areas.

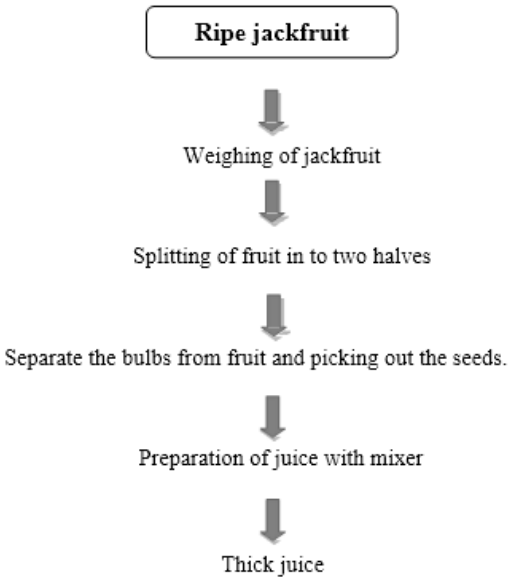
Experimental methods

Fruits

The fully ripe jackfruit of variety 'Baraka' was collected from 'horticultural unit, nursery no. 4, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli and immediately used for further experimentation.

Preparation of must

The clear and thick juice of jackfruit was mixed according to various treatment (1:1, 1:2, 1:3, 1:4) in fixed dilution levels. This juice was taken in different vessels and the T.S.S content of juice adjusted to 25 0C brix by addition of powdered sugar**.** The pH was adjusted to 3.5 by addition of citric acid (0.20%). The must was taken in fermentation flask (1 kg/flask) and used further for fermentation.



Flow 1: Extraction of juice from jackfruit

Treatment details

Factor A Dilution levels (Juice : Water)	Factor B Pectinase enzyme treatment
D1 : 1:1	M_1 : 0.0%
D2 : 1:2	M_2 : 0.10%
D3 : 1:3	M3 : 0.15%
D4 : 1:4	M4 : 0.20%

Fermentation

Must was inoculated with yeast culture (*Saccharomyces cerevisiae)* @ 0.30 g kg-1 and kept for fermentation at room temperature. The start of the fermentation was indicated by evolution of gas bubbles in the distilled water through rubber tubing. During active fermentation, foam formation was observed in the fermentation flasks. The end of fermentation was indicated by the cessation of foaming and bubbling and even constant T.S.S. recorded by the must during fermentation. After fermentation, the assembly was dismantled. The raw wine was filtered through double folded muslin cloth. Bentonite at the rate of 1g kg-1 was added to raw wine, mixed well and kept for 7days as such at cold storage (12 ± 1^0C) to separate colloidal material from wine. Siphoning was done to obtain clear wine from settled material, as mentioned in the flow sheet 2. The wine was filled in sterilized bottles, sealed and stored at cold storage (12 ± 1^0C) until used for chemical analysis and organoleptic evaluation.

Chemical analysis

The TSS content was determined with help of Erma hand refractometer (A.O.A.C., 1975). The pH of juice was measured by Lab-India µpH meter (Model PHAN). The crude protein, ascorbic acid, titratable acidity, sugar, pectin and tannins were determined as per the procedure described in Ranganna (1977) [6]. Experimental findings and analysis:

Jackfruit juice T.S.S. content was 25 (0Brix), 20.6% total sugar, 9.90% reducing sugar. The pH jackfruit juice was 4.8. The per cent acidity of the juice 0.18%. The ascorbic acid and protein content of jackfruit juice was 15 mg100-1 ml and 1.5%, respectively. The jackfruit juice contained 0.50% tannins and 0.98% pectin.

Results and Discussion

The reducing sugar content of must showed significant differences as affected by various treatment combination. Treatment combination with 0.15% pectinase enzyme treatment and 1:1 dilution level recorded highest (3.43 %) reducing sugars and it was significantly superior over rest of the treatment combination levels. Decrease in reducing sugars with increase in dilution levels may be the impact of juice before fermentation. The result of this investigation are in agreement with result recorded by Sapkal (2011) [7] and dilution levels showed significant results.

Interaction of pectinase enzyme concentration and dilution levels also showed significant results with respect to total sugars content. The interaction effect of both the factor with 0.10 percent pectinase enzyme concentration and 1:4 dilution recorded highest (23.37%) total sugars; which was significantly superior over all other treatment combination tried. The total sugar content showed increasing trend with increase in dilution, which was reverse to reducing sugar content. The increase in total sugars with increase in dilution may be due to addition of sugar in increasing amount with increase in dilution levels to maintain the T.S.S. level in the must reported by Pawaskar (2016) [4] in kokum must, while preparing wine from kokum fruit with different pH and dilution levels.

Treatment combination with 0.20 per cent pectinase enzyme treatment and 1:1 dilution level recorded highest (11.7 mg 100-1ml) ascorbic acid content. While the lower ascorbic acid content was recorded by treatment combination with 0.00 per cent pectinase enzyme treatment and 1:4 dilution level (6.1 mg 100-1). Ascorbic acid content of must showed specific trend with pectinase enzyme concentration levels. As the concentration of pectinase enzyme increases, the ascorbic acid content in must also increases. This is due to addition of pectinase enzyme leads to improvement in separation of juice from original pulp which release ascorbic acid in more amount. The ascorbic acid content of jackfruit must found to be decreased with increase in dilution levels.

The decrease in ascorbic acid may be due to dilution of original ascorbic acid content of jackfruit juice due to dilution levels.

The highest protein (0.18%) content was observed in the treatment combination with 0.10, 0.15, 0.20 per cent pectinase enzyme treatment respectively and 1:1 dilution level. The highest protein content is preferred, hence this treatment was superior over the rest of the treatments.

Considering the interaction effect, the lowest (0.14%) tannin content was observed in the treatment combination with 0.10 per cent pectinase enzyme concentration and 1:4 dilution level. This better than other treatments. Reduction in tannin is due to it hydrolyzed into components like sugar, acids and

other compounds due to addition of pectinase enzyme, Pawar (1988) [4]. Decrease in tannin content with increase in dilution levels was the impact of dilution levels which diluted native tannin content of jackfruit juice. These findings are in accordance with that of Sapkal (2011) [7] in ripe mango must.

While studying the interaction effect of pectinase enzyme concentration levels and dilution levels on pectin content of must observed that, treatment combination with 0.0 per cent pectinase enzyme treatment and 1:1 dilution level recorded highest pectin content (0.70%) in must of jackfruit which was significantly superior over rest of the combinations. The value of pectin content of must observed in the study agreed well with value reported by Shivanna *et al.,* (2010) [8] in jackfruit must. Pectin content of jackfruit must decreases significantly with increase in pectinase enzyme concentrations. Pectin content in jackfruit must showed the decreasing trend. It is effect of pectinase enzyme which degrade the pectin present in jackfruit must.

Conclusion

For the preparation of good quality wine juice and water ratio for preparation of must should be 1:1 and for obtaining the better recovery of wine pectinase enzyme quantity should be 0.10 per cent. Jackfruit which remained unexploited were found to be potential source for preparing wines of standard quality. The results are based on laboratory scale and study. It needs to be confirmed on pilot plant scale before the process of wine making from jackfruit is commercialized.

Table 1: Effect of different levels of pectinase enzyme and dilution levels on chemical composition of jackfruit must.

Sr No.	Treatment	Reducing sugar	Total sugar	Titratable acidity	Ascorbic acid	Protein	Tannin	Pectin
1	M1D1	3.21	10.2	0.81	9.1	0.21	0.35	0.70
2	M1D2	2.10	11.6	0.75	8.2	0.14	0.29	-
3	M1D3	1.82	13.4	0.69	6.8	0.11	0.21	-
4	M1D4	1.60	15.9	0.68	6.1	0.08	0.19	-
5	M2D1	3.20	12.7	0.82	9.5	0.18	0.40	0.40
6	M2D2	1.69	14.0	0.74	9.4	0.13	0.28	-
7	M2D3	1.67	19.8	0.67	8.6	0.09	0.16	-
8	M2D4	1.58	23.4	0.59	7.3	0.09	0.14	-
9	M3D1	3.43	11.4	0.85	10.9	0.18	0.32	0.30
10	M3D2	1.97	12.5	0.77	9.7	0.13	0.24	-
11	M3D3	1.87	16.2	0.68	8.7	0.10	0.20	-
12	M3D4	1.62	17.2	0.62	7.5	0.08	0.19	-
13	M4D1	3.32	8.4	0.84	11.7	0.18	0.36	-
14	M4D2	2.56	9.9	0.79	10.9	0.13	0.27	-
15	M4D3	2.06	16.0	0.66	8.9	0.10	0.23	-
16	M4D4	1.84	18.5	0.58	7.9	0.08	0.22	-
S. Em ±		0.043	0.282	0.033	0.069	0.01	0.024	0.02
C.D. at 1%		0.16	1.095	NS	NS	NS	NS	0.07

NOTE: M-Pectinase enzyme concentration levels: M1 -0.0%, M2 -0.10%, M3 -0.15%, M4 - 0.20%
D-Dilution levels (Juice: Water): D1-1:1, D2-1:2, D3-1:3, D4-1:4

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