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Changes in chemical constituents and overall acceptability of jackfruit nectar during storage

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Abstract
The investigation was undertaken at the Horticulture Processing Laboratory Department of Fruit Science, College of Agriculture, Indira Gandhi Agricultural University, Raipur (C.G.) during the year 2019-2020 and at Horticultural Laboratory, RMD CARS, Ambikapur (C.G.) during the year 2020-2021. The experiment consisted of ten treatments and three replications under completely randomized design. Among various recipe tried in this investigation, the nectar prepared from the treatment T8 (20% pulp + 18% TSS + 0.4% acidity) recorded highest organoleptic score with respect to colour and appearance, aroma, taste and overall acceptability as compared to other recipes during storage. During storage of nectar the acidity, TSS, total and reducing sugar showed an increasing trend with increasing period of storage while there was a decreasing trend of ascorbic acid, pH, non-reducing sugar and organoleptic score during storage period up to 90 days under ambient condition.

Keywords: Nectar, storage, organoleptic score, overall acceptability

Introduction
Jackfruit (*Artocarpus heterophyllus*) is one of the important fruits belonging to the family Moraceae and to the genus Artocarpus. It is highly nutritious and an excellent source of important minerals such as phosphorous, iron and calcium. It is reported that both the tender and ripe fruits as well as the seeds of jackfruit are rich in minerals and vitamins (Gopalan *et al*. 2000 and Jagadeesh *et al*. 2007) [3, 4]. So, it is highly useful to prevent many deficiency diseases. Hence, this is absolutely one of the delicious and cherished fruits of the world.
However, the fruit is perishable and cannot be stored for long time because of its inherent compositional and textural characteristics. In every year, a considerable amount of jackfruit, specially obtained in the glut season (June-July) in every year goes wasted due to lack of proper postharvest knowledge during harvesting, transporting and storing both in quality and quantity. Proper postharvest technology for prolonging shelf life is, therefore, necessary. Besides, alternate ways of using jackfruits in on-season plays significant roles in reducing postharvest losses. Among them, processing is important one. It adds diversified and attractive food items in dietary menu as well as contributes to income generation and employment.

Materials and Methods
Experimental site
The experiment was conducted at Horticulture processing laboratory, Department of Fruit Science, IGKV, Raipur (C.G.) during the year 2019-2020 and at Horticultural Laboratory, RMD CARS, Ambikapur (C.G.) during the year 2020-2021.

Experimental details
Firm ripe fruits were selected for the preparation of jackfruit nectar, damaged or decayed fruits were rejected. The peeling of fruit and separation of seed from the bulb was done manually and carefully to minimize pulp loss with the peels. The pulping was done using the domestic mixer grinder and the seeds was collected separately. After extraction of pulp, 20 percent pulp for nectar was taken. The volume of the final product was maintained by adding water to each recipe combination in each replication. A calculated amount of sugar was added in the pulp to adjust the total soluble solids as 16, 17, 18, 19 and 20 percent in the recipe for nectar. The acidity was maintained to 0.4 and 0.5 percent in the final product by the addition of required amount of citric acid. The prepared nectar was filtered by sieving through a muslin cloth to obtain a product of uniform consistency. The product was poured into hot, sterilized crown bottles of 200 ml capacity and corked air-tight. The filled bottles were pasteurized in boiling

water and it took about 15 minutes to attain required temperature. The bottles of nectar were kept at ambient condition for further studies up to acceptability.

Treatment details

T1 = 20% Pulp + 20% TSS + 0.5% acidity
T2 = 20% Pulp + 19% TSS + 0.5% acidity
T3 = 20% Pulp + 18% TSS + 0.5% acidity
T4 = 20% Pulp + 17% TSS + 0.5% acidity
T5 = 20% Pulp + 16% TSS + 0.5% acidity
T6 = 20% Pulp + 20% TSS + 0.4% acidity
T7 = 20% Pulp + 19% TSS + 0.4% acidity
T8 = 20% Pulp + 18% TSS + 0.4% acidity
T9 = 20% Pulp + 17% TSS + 0.4% acidity
T10 = 20% Pulp + 16% TSS + 0.4% acidity

Observation recorded

Ascorbic acid (mg/100ml)

The ascorbic acid of nectar were determined by the procedure given by Ranganna (1997) [8]. Standard ascorbic acid with HPO_3 solution was titrated against the dye solution till the pink colour appears.

Titrable acidity (%)

The titrable acidity of jackfruit nectar was estimated by titrating against 0.1N NaOH solution using phenolphthalein as an indicator, light pink colour is taken as donation of acid of jackfruit nectar (Ranganna, 1997) [8].

pH

The pH value of fruit pulp and nectar beverage were taken on digital pH meter.

TSS (°Brix)

The Total Soluble Solids (TSS) value of the jackfruit nectar was recorded by using hand refractometer (Erma, Japan) having range of 0-32 °Brix. In each treatment, three readings were taken and their average value was expressed in °Brix.

Sugars

Sugars was determined by the method of Lane and Eynon as described by Ranganna (1997) [8].

A. Reducing sugar

Reducing sugar was calculated as

$$\text{Reducing sugers (\%)} = \frac{\text{mg of invert suger} \times \text{Dilution} \times 100}{\text{Titre} \times \text{Wt. or Volume of the sample} \times 1000}$$

B. Total sugar

The total sugar was expressed in percent

Total sugar (%) = % reducing sugar (In which the titre is obtained after inversion) + % Sucrose

C. Non- reducing sugar

Non-reducing sugar was determined by subtracting the value of reducing sugar from total sugar.

Sensory evaluation

The sensory parameters of colour and appearance, aroma, taste and overall acceptability were evaluated with 10 panelist based on 9 point Hedonic rating scale with maximum score considered as the best (Ranganna, 1997) [8].

Statistical analysis

Data obtained were subjected to statistical analysis to find out the effect of different mango cultivars and storage period on physico-chemical and sensory characteristics of the product. The data were analyzed statistically in a Completely Randomized Design (CRD) with three replications done in OPSTAT and WASP - Web Agri Stat Package - ICARGOA.

Results and Discussion

Total soluble solids (%)

It is evident from the data in Table 1 that total soluble solids content in nectar showed an increasing trend with increasing period of storage (0 to 90 days). At the time of preparation, the total soluble solids content was found to be maximum (20.17 °Brix) under the treatment T_1 followed by T_6. Whereas, minimum TSS content was observed (16.10 °Brix) with the treatment T_{10}. After 30 to 90 days of storage, similar trend was observed. TSS increased from initial mean value of 18.09 to 18.15 ^{0}Brix after six months of storage. This might be due to conversion of left over polysaccharides into soluble sugars and formation of water soluble pectin from protopectin. These results are also in conformity with the findings of Mingire *et al.* (2016) [6] who reported that TSS of mango nectar increased with an increase in storage period up to 120 days.

Acidity (%)

In jackfruit nectar packed in glass bottles stored at room temperature, it was observed in Table 1 that there was increase in acidity during six months of storage. At the time of preparation the maximum acidity was observed (0.58) with the treatment T_5 followed by T_4. The minimum acidity was recorded (0.41) with the treatment T_6. Similar trend was observed after 30 to 90 days of storage. The increase in acidity of nectar during storage might be due to formation of organic acids by ascorbic acid degradation as well as progressive decrease in the pectin content. The results are also in conformity with the findings of Nidhi *et al*. (2007) [7] who reported an increase in acidity in RTS blends of bael-guava beverages during storage.

Ascorbic acid (mg/100ml)

Data pertaining to effect of different recipe treatments on the ascorbic acid content of jackfruit nectar under ambient storage condition are presented in Table 1. It is apparent from the data that ascorbic acid content in jackfruit nectar of all the treatments showed a decreasing trend with increasing period of storage (0 to 90 days). At the time of preparation the maximum ascorbic acid was observed (0.98 mg/100ml) with the treatment T_8 followed by T_7. The minimum ascorbic acid content was recorded (0.81 mg/100 ml) with the treatment T10. Similar trend was observed after 30 to 90 days of storage. The decrease in ascorbic acid in nectar during storage might be due to oxidation or irreversible conversion of L-ascorbic acid into de hydro ascorbic acid in the presence of enzyme ascorbic acid oxidase (ascorbinase) caused by trapped or residual oxygen in the glass bottles. The results are in conformity with the findings of Baramanray *et al.* (1995) who observed that ascorbic acid content (mg/100 g pulp) in guava nectar decreased significantly with increasing storage period.

pH

Data pertaining to effect of different recipe treatments on the pH value of jackfruit nectar under ambient condition of

storage are presented in Table 1. It is evident from the data that the pH value in guava nectar showed a decreasing trend with increasing period of storage (0-90 days). At the time of preparation the maximum pH was observed (4.41) with the treatment T_6 followed by T_7. The minimum pH was recorded (3.24) with the treatment T_5. Similar trend was observed after 30 to 90 days of storage. Decrease in pH during storage was attributed to simultaneous increase in titratable acidity. Similar findings were also reported by Choudhary *et al.* (2006) [1] in guava RTS beverages.

Reducing sugar (%)

The data pertaining to effect of different recipe treatments on reducing sugar of jackfruit nectar under ambient storage condition are presented in Table 2. It is evident from the data that the different recipes influenced the reducing sugar content of jackfruit nectar and showed an increasing trend with increasing period of storage (0-90 days). The reducing sugar was recorded to be significant from 0 to 90 days of storage. At the time of preparation, the maximum (4.43%) reducing sugar was observed with the treatment T_6 followed by T_1. The minimum reducing sugar was recorded (3.53%) with the treatment T_5. After 30 to 90 days of storage, similar trend was observed. Increase in reducing sugars might be assigned to the partial acid hydrolysis of starch and disaccharide of nectar converted into invert sugar and also inversion of part of non-reducing sugars into glucose and fructose and gradual degradation of polysaccharides in pulp through acid hydrolysis. These results were similar with the investigation reported by Mall *et al*. 2007 [5] in guava-aonla blended beverage.

Non-reducing sugar (%)

The data pertaining to effect of different treatments on the non-reducing sugar of jackfruit nectar under ambient condition storage are presented in Table 2. It is evident from the data that the non-reducing sugar in jackfruit nectar showed a decreasing trend with increasing period of storage (0-90 days). The non-reducing sugar was found to be significant from 0 to 90 days of storage. At the time of preparation, maximum non-reducing sugar was recorded (16.53%) with the treatment T_6 followed by T_7. Whereas, the minimum (15.67%) non-reducing sugar was observed with the treatment T_8. Same trend was observed after 30 to 90 days of storage. Similar findings were reported by Saravanan *et al.* (2004) [9] in papaya RTS beverage.

Total sugar (%)

The data pertaining to effect of different recipe treatments on the total sugar of jackfruit nectar under ambient condition storage are presented in Table 2. It is evident from the data that the total sugar content in jackfruit nectar showed an increasing trend with increasing period of storage. The total sugar was recorded to be significant from 0 to 90 days of storage. At the time of preparation, the maximum total sugar content was observed (20.97%) with the treatment T_6 followed by T_1.The minimum total sugar content was recorded (19.41%) with the treatment T_5 After 30 to 60 days of storage same trend was observed. The increase in reducing sugar as well as total sugar corresponded to the increase in total soluble solids (TSS) and ultimate decrease in non-reducing sugar in nectar during storage period. The variation in different fractions of sugar might be due to hydrolysis of polysaccharides like starch, pectin and inversion of non-reducing sugar into reducing sugar, as increase in reducing sugar was correlated with the decrease in non-reducing sugar. The increased level of total sugar was probably due to conversion of starch and pectin into simple sugars. The present findings are in close conformity with the findings of Verma and Gehlot (2006) [10], reported that there was a continuous increase in the level of total sugar in bael beverages *viz*., RTS drink and nectar during storage.

Organoleptic evaluation of nectar during storage

The mean score for colour and appearance, aroma, taste and overall acceptability of different treatments were recorded at 0, 30, 60 and 90 days and observed that organoleptic score for colour and appearance, aroma, taste and overall acceptability continuously decreased with all the treatments up to 90 days of storage (Table 3). At the time of preparation, significantly higher value for colour and appearance was recorded (8.47) with the treatment T_8 followed by T_7. The minimum mean score was recorded (7.40) with the treatment T_{10}. In the same way, the maximum value for aroma score was recorded (8.24) with the treatment T8 followed by T_7. The minimum mean score was recorded (7.44) with the treatment T_{10}. Maximum value for taste score was recorded (8.53) with the treatment T_8 followed by T_7. The minimum mean score was observed (7.38) with the treatment T_{10}. Similar to above characters, the maximum value for overall acceptability score was recorded (8.27) with the treatment T8 followed by T_7. The minimum mean score was recorded (7.05) with the treatment T_{10}. After 30 to 90 days of storage, similar trend was observed. There are many extrinsic factors, which determines the storage stability of products, and temperature plays an important role among them. There are certain biochemical changes which occurs under low pH and high temperature that leads to the formation of brown pigments and produces off flavour in the beverages. The other possible reasons could be the loss of volatile aromatic substances responsible for flavour and taste which decreased acceptability in storage at ambient condition. The present findings are in accordance with the view of Dhawale *et al.* (2015) [2], who reported that the colour and appearance, flavour, taste and overall acceptability of mango nectar decreased significantly with the advancement in storage period, however, their overall rating remained above the acceptable level even after three months storage.

Table 1: Changes in total soluble solids, acidity and ascorbic acid of jackfruit nectar during storage (Pooled analysis)

Storage periods (0 days, 30 days, 60 days and 90 days)																
	TSS (^{0}Brix)				Acidity (%)				Ascorbic acid (mg/100ml)				pH			
Treatments	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**
T1	20.17	20.17	20.19	20.21	0.50	0.55	0.60	0.69	0.85	0.70	0.60	0.49	3.85	3.69	3.47	3.39
T2	19.10	19.11	19.13	19.14	0.52	0.58	0.62	0.71	0.88	0.73	0.61	0.53	3.74	3.56	3.36	3.23
T3	18.11	18.13	18.14	18.17	0.53	0.61	0.65	0.74	0.90	0.76	0.65	0.55	3.53	3.34	3.28	3.20
T4	17.09	17.11	17.13	17.15	0.55	0.62	0.67	0.75	0.84	0.68	0.57	0.47	3.40	3.30	3.19	3.10
T5	16.12	16.14	16.15	16.18	0.58	0.65	0.70	0.78	0.82	0.67	0.53	0.44	3.24	3.15	3.11	3.04

T6	20.14	20.15	20.17	20.18	0.41	0.44	0.48	0.58	0.94	0.82	0.70	0.61	4.41	4.33	4.18	4.10
T7	19.07	19.09	19.10	19.11	0.43	0.47	0.50	0.60	0.97	0.83	0.71	0.65	4.35	4.26	4.11	4.06
T8	18.04	18.07	18.09	18.12	0.45	0.48	0.53	0.62	0.98	0.87	0.76	0.67	4.20	4.13	3.96	3.86
T9	17.05	17.08	17.10	17.11	0.46	0.52	0.55	0.65	0.91	0.79	0.67	0.59	4.05	3.98	3.78	3.71
T10	16.10	16.11	16.12	16.15	0.48	0.54	0.58	0.68	0.81	0.64	0.51	0.41	4.01	3.81	3.58	3.46
S.Em+	0.018	0.015	0.01	0.013	0.006	0.005	0.007	0.008	0.014	0.009	0.011	0.01	0.01	0.01	0.014	0.018
CD at 5%	0.053	0.043	0.031	0.039	0.017	0.016	0.021	0.023	0.041	0.026	0.033	0.028	0.028	0.031	0.041	0.053
CV	0.171	0.139	0.098	0.127	1.977	1.682	2.091	1.923	2.69	1.995	3.002	3.04	0.426	0.481	0.661	0.887

Table 2: Changes in total sugar, reducing sugar and non-reducing sugar of jackfruit nectar during storage (Pooled analysis)

Storage periods (0 days, 30 days, 60 days and 90 days)												
	Total sugar (%)				Reducing sugar (%)				Non-reducing sugar (%)			
Treatments	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**
T1	20.84	20.95	21.12	21.26	4.37	4.53	4.71	4.87	16.46	16.42	16.41	16.39
T2	20.53	20.65	20.74	20.91	4.19	4.35	4.52	4.66	16.34	16.29	16.22	16.25
T3	19.75	19.82	19.95	20.15	3.84	3.95	4.17	4.36	15.90	15.87	15.78	15.78
T4	19.65	19.73	19.81	19.89	3.71	3.80	3.97	4.09	15.94	15.93	15.84	15.80
T5	19.41	19.56	19.64	19.72	3.53	3.67	3.79	3.92	15.88	15.89	15.84	15.80
T6	20.97	21.13	21.27	21.34	4.43	4.62	4.80	4.97	16.53	16.51	16.47	16.37
T7	20.77	20.82	20.97	21.14	4.26	4.41	4.60	4.76	16.51	16.41	16.36	16.38
T8	19.84	19.92	20.10	20.29	4.08	4.22	4.37	4.53	15.67	15.70	15.73	15.75
T9	19.69	19.78	19.85	19.94	3.75	3.85	4.05	4.24	15.94	15.92	15.79	15.70
T10	19.55	19.67	19.76	19.81	3.63	3.74	3.85	4.00	15.92	15.93	15.90	15.81
S.Em+	0.013	0.013	0.016	0.01	0.014	0.012	0.022	0.026	0.01	0.015	0.019	0.009
CD at 5%	0.037	0.039	0.048	0.029	0.042	0.037	0.065	0.077	0.029	0.044	0.056	0.028
CV	0.109	0.113	0.137	0.084	0.609	0.524	0.882	1.006	0.106	0.158	0.204	0.101

Table 3: Changes in organoleptic score viz. colour and appearance, aroma, taste and overall acceptability of jackfruit nectar during storage (Pooled analysis)

Storage periods (0 days, 30 days, 60 days and 90 days)																
	Colour and appearance				Aroma				Taste				Overall acceptability			
Treatments	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**	**0**	**30**	**60**	**90**
T1	7.67	7.38	6.85	6.04	7.71	7.45	7.36	6.79	7.71	7.56	7.20	6.42	7.56	7.46	7.29	6.43
T2	7.74	7.42	6.89	6.13	7.80	7.56	7.42	6.88	7.74	7.60	7.24	6.46	7.60	7.48	7.33	6.45
T3	7.83	7.52	6.96	6.26	7.87	7.62	7.49	6.97	7.81	7.68	7.34	6.55	7.72	7.65	7.47	6.57
T4	7.62	7.29	6.43	5.73	7.66	7.36	7.25	6.70	7.62	7.50	7.06	6.26	7.45	7.29	7.13	6.34
T5	7.50	7.20	6.34	5.68	7.54	7.32	7.16	6.63	7.52	7.39	6.97	6.18	7.41	7.19	7.01	6.24
T6	8.25	7.86	7.29	6.57	7.99	7.80	7.66	7.31	8.21	8.02	7.60	6.78	8.13	7.90	7.69	6.70
T7	8.40	7.93	7.40	6.69	8.14	7.89	7.75	7.37	8.33	8.15	7.68	6.85	8.19	8.03	7.75	6.74
T8	8.47	8.06	7.53	6.76	8.24	7.95	7.79	7.47	8.53	8.33	7.83	6.91	8.27	8.15	7.84	6.83
T9	8.19	7.79	7.20	6.45	7.91	7.68	7.59	7.19	7.91	7.75	7.47	6.66	7.85	7.78	7.54	6.63
T10	7.40	7.08	6.25	5.44	7.44	7.20	7.07	6.46	7.38	7.19	6.88	6.02	7.36	7.05	6.87	6.11
S.Em+	0.023	0.029	0.016	0.014	0.013	0.012	0.012	0.01	0.016	0.008	0.013	0.012	0.013	0.02	0.016	0.014
CD at 5%	0.067	0.086	0.047	0.042	0.038	0.035	0.036	0.03	0.048	0.024	0.038	0.035	0.039	0.06	0.046	0.04
CV	0.494	0.667	0.395	0.393	0.281	0.267	0.284	0.251	0.354	0.185	0.303	0.313	0.295	0.462	0.365	0.359

Conclusion

The jackfruit nectar prepared from the treatment T_8 with recipe 20% Pulp + 18% TSS + 0.4% acidity was found to be suitable for commercial scale. The taste, colour and appearance, aroma and overall acceptability were found decreased continuously during storage with the advancement of storage period. It could also generate opportunity for self-employment by starting small scale processing unit that could be lucrative to the growers and could make significant endowment to food processing industry.

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