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Studies on processing and storage stability of litchi - beetroot blended RTS beverage

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Abstract
An experiment was carried out to study blended litchi-beetroot juice for the preparation of RTS beverage. In the present study, the litchi and beetroot juice were blended in the ratios of 100:00, 95:05, 90:10, 85:15, 80:20, 75:25, 70:30 for the preparation of ready to serve beverage as per FPO specifications. The processed products were stored at ambient conditions and subjected to chemical and sensory evaluation at an interval of 30 days for a period of 90 days. With the advancement of storage, an increasing trend was observed in reducing sugar and total sugar whereas ascorbic acid, anthocyanin, phosphorus and iron showed a decreasing trend. After three months of storage, sensory evaluation revealed that the treatment T_6 recorded the highest score for overall acceptability.

Keywords: Litchi, beetroot, processing, blended, ready to serve

Introduction
The litchi (*Litchi chinensis* Sonn.) is the most important sub-tropical evergreen fruit tree and belongs to the family Sapindaceae. It is highly prized fruit both in its fresh and preserved forms. India is the second largest producer of litchi in the world after china. It is grown in the states of Bihar, Tripura, West Bengal, Uttar Pradesh, Punjab and Haryana (Bhandari *et al.* 2018) [4]. It is well estimated that out of the total fruit harvested during the short peak season (May-June) more than 30% fruits (1.68 lac metric tonnes) are spoiled in the way of transportation and marketing due to more perishable, delicate and poor storage quality. The Litchi fruit contains 60 per cent juice, 8 per cent rag, 19 per cent seed and 13 per cent skin varying with climate and variety. It is also an excellent source of vitamin C (40-90mg/100g) but contains insignificant amount of protein (0.8-0.9%), pectin (0.43%), fat (0.3%) and minerals especially phosphorous and calcium (0.7%). The fruit is small, conical, heart shaped or spherical in shape and bright red in colour. The litchi pulp has milky white colour and contains pleasant aroma and flavour which makes it suitable for blending with other juices to improve their acceptability and make use of available nutrients (Khan *et al.* 1988).
Beetroot (*Beta vulgaris* L.) having bright crimson colour also known as beet, chard, spinach beet, sea beet, garden beet, white beet and Chukander (in Hindi) belongs to Chenopodiaceae family. It is famous for its high valued juice and medicinal properties. The beetroot can be kept for 4-5 days when refrigerated in the vegetable crisper (Chibber *et al*. 2019) [5]. *Beta vulgaris* roots contain significant amounts of vitamin C, whilst the leaves are an excellent source of vitamin A. It is among the sweetest of vegetables, containing more sugar even than carrots or sweet corn. Incorporation of beetroot in the juice, which contains considerable amount of nitrate helps to dilate and widen the blood vessels, thereby reducing the blood pressure and allowing more blood flow and it can also be effective to boost the athletes' performance (Lansley *et al*. 2011) [13]. Muddy flavour in fresh beetroot juice is due to presence of geosmin. A small increase in the habitual consumption of antioxidant and polyphenol-rich beverages such as beetroot juices blended with litchi juice may have significant positive effect on public health (Mahnoori *et al*. 2020a) [14]. Juice blending is one of the best methods to improve the nutritional quality of the juice. Thus blending of litchi and beetroot juice offers many opportunities to develop balanced health product high in quality with respect to both sensory and nutritional aspects.

Material and methods

The defected and injured fruits of litchi and beetroot were sorted out and healthy ones for retained for extraction of juice. The litchi and the beetroot juice were blended with each other in different ratios for developing RTS *i,e* T_1: 100:00, T_2:95:05, T_3:90:10, T_4:85:15, T_5:80:20, T_6:75:25, T_7:70:30. The desired quantity of sugar and citric acid was added in warm water and the solution is strained through muslin cloth. The solution is added in litchi-beetroot blend so as to maintain its total soluble solids and acidity of the blended RTS. Litchi-beetroot blended ready to serve beverage was packed in pre-sterilized 200ml glass bottles. The bottles were then sealed air tight, pasteurized, labelled and stored at a cool and dry place. The RTS was stored at ambient condition to study the storage behaviour of the product with respect to the changes in chemical and sensory qualities during storage. The product was evaluated immediately after preparation and then at an interval of 30 days up to 90 days of storage. Reducing sugar, total sugar and anthocyanin were determined as per the method suggested by Ranganna (1994) [17], ascorbic acid (AOAC, 2000) [2] phosphorus and iron content (Singh *et al*. 1999) [20]. The samples were evaluated on the basis of sensory evaluation by semi-trained taste panels of 6-7 judges using 9 point hedonic scale. A score of 5.5 and above was considered acceptable (Amerine *et al*. 1965) [1]. The lab experiment was carried out in completely randomized design with factorial concept for the interpretation of results through analysis of variance (Gomez and Gomez, 1984) [8].

Results and discussion

Reducing Sugar

The data pertaining to reducing sugar content of different treatments in Table-1 depicted a significant increase in reducing sugar content during storage. At initial day the highest value of reducing sugar 5.64 per cent was recorded in treatment T_1(100:0::litchi:beetroot) followed by 5.57 per cent in treatment T_2(95:05::litchi: beetroot). After 90 days of storage period, treatment T_1(100:0::litchi: beetroot) recorded highest value of 5.87 per cent followed by treatment T_2(95:05::litchi: beetroot) with reducing sugar content of 5.80 per cent. The reducing sugar content of RTS (ready to serve) beverage increased significantly with increase in storage period. On the basis of treatment mean values, it was observed that reducing sugars of 5.75 per cent were the highest in treatment T_1(100:0::litchi: beetroot) and lowest of 5.30 per cent in treatment T_7(70:30::litchi: beetroot). It is also clear from the table that interaction between treatments and storage period was significant in respect of reducing sugar. The mean values of storage period showed an increase from initial value of 5.39 to 5.65 per cent during 90 days of storage. The slight increase in reducing sugars might be due to the result of inversion of non- reducing sugars into reducing sugars. Increase in reducing sugars content during storage of RTS beverage prepared from guava papaya blends have been reported by Tiwari (2000) [22]. Similar findings have also been reported by Sharma and Singh (2005) [19] in lime juice and Gupta (2019) [9] in karonda-beetroot RTS beverage.

Table 1: Effect of treatments and storage period on reducing sugar (%) of litchi beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	5.64	5.71	5.79	5.87	5.75
T_2 (95:05 :: Litchi: Beetroot)	5.57	5.63	5.70	5.80	5.67
T_3 (90:10 :: Litchi: Beetroot)	5.46	5.55	5.65	5.75	5.60
T_4 (85:15 :: Litchi: Beetroot)	5.40	5.48	5.59	5.67	5.53
T_5 (80:20 :: Litchi: Beetroot)	5.31	5.39	5.47	5.56	5.43
T_6 (75:25 ::Litchi: Beetroot)	5.24	5.31	5.39	5.48	5.35
T_7 (70:30 ::Litchi: Beetroot)	5.17	5.28	5.36	5.42	5.30
Mean	5.39	5.47	5.56	5.65	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.02
Treatment X Storage (A X B)	N.S.

Total sugar

It is evident from Table-2 that treatments significantly influenced the total sugar content of RTS (ready to serve) beverage. Among the treatments, treatment T_1(100:00::litchi:beetroot) recorded the highest value of total sugars 13.05 per cent followed by treatment T_2(95:05::litchi: beetroot) with total sugar content of 12.95 per cent at initial day. After 90 days of storage, treatment T_1(100:00::litchi: beetroot) recorded highest value of 13.61 per cent followed by T_2(95:05::litchi: beetroot) having total sugar content of 13.55 per cent. The maximum mean value of total sugar content of 13.30 per cent was recorded in treatment T_1(100:00::litchi: beetroot) and the lowest mean value of total sugar content of 12.67 per cent was recorded in T_7 (70:30::litchi: beetroot). Significant increase in total sugar content was observed with the progress in storage period. The mean values of storage period showed an increase from initial value of 12.72 to 13.29 per cent during 90 days of storage. The slight increase in total sugars might be due to conversion of polysaccharides into monosaccharides. The increase might also be attributed to hydrolysis of starch in to sugars. Similar observations were made by Tandon *et al*. (2007) [21] in guava-aonla blended RTS beverage, Pangotra *et al*. 2019 [16] in phalsa-pear blended crush and Sharma *et al*. 2017 [18] in Jamun-mango RTS beverage.

Table 2: Effect of treatments and storage period on total sugar (%) of litchi-beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	13.05	13.14	13.4	13.61	13.30
T_2 (95:05 :: Litchi: Beetroot)	12.95	13.07	13.32	13.55	13.22
T_3 (90:10 :: Litchi: Beetroot)	12.83	12.96	13.21	13.46	13.11
T_4 (85:15 :: Litchi: Beetroot)	12.70	12.81	13.00	13.32	12.95
T_5 (80:20 :: Litchi: Beetroot)	12.59	12.69	12.90	13.12	12.82
T_6 (75:25 ::Litchi: Beetroot)	12.51	12.62	12.84	13.00	12.74
T_7 (70:30 ::Litchi: Beetroot)	12.42	12.53	12.77	12.98	12.67
Mean	12.72	12.83	13.06	13.29	

Factors C.D.	(P=0.05)
Treatment (A)	0.01
Storage (B)	0.02
Treatment X Storage (A X B)	0.03

Ascorbic acid

The data presented in Table-3 showed the effect of various treatments and storage period on ascorbic acid content of litchi-beetroot blended RTS (ready to serve) beverage. The data revealed that treatments significantly influenced the ascorbic acid content of litchi-beetroot blended RTS (ready to serve) beverage. At initial day of storage, the highest ascorbic acid content of (6.21 mg/100 ml) was recorded in treatment T_1 (100:0::litchi: beetroot) and lowest (5.89 mg/100ml) in treatment T_7 (70:30::litchi: beetroot). The values decreased to (5.34mg/100ml) in T_1 (100:0::litchi: beetroot) and (5.10 mg/100g) in T_7 (70:30::litchi:beetroot) after 90 days of storage. Overall mean highest ascorbic acid content (5.67

mg/100 ml) was recorded in treatment T_1(100:0::litchi: beetroot) and lowest (5.41 mg/100ml) was recorded in treatment T_7 (70:30::litchi: beetroot).. The mean values of storage period showed a decreasing trend from initial value of 6.04 to 5.21 (mg/100ml) after 90 days of storage. The decline in ascorbic acid during storage of the product might be due to the effect of temperature during the storage and greater catalytic activity of fructose in the catabolization of vitamin 'C'. Similar results were reported that ascorbic acid content decreased during three months of storage in Dhiman *et al*. 2017 [6].

Table 3: Effect of treatments and storage period on ascorbic acid (mg/100ml) of litchi-beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	6.21	5.61	5.55	5.34	5.67
T_2 (95:05 :: Litchi: Beetroot)	6.16	5.57	5.46	5.28	5.61
T_3 (90:10 :: Litchi: Beetroot)	6.11	5.60	5.44	5.24	5.59
T_4 (85:15 :: Litchi: Beetroot)	6.04	5.54	5.32	5.16	5.51
T_5 (80:20 :: Litchi: Beetroot)	5.97	5.44	5.30	5.18	5.47
T_6 (75:25 ::Litchi: Beetroot)	5.92	5.41	5.31	5.20	5.46
T_7 (70:30 ::Litchi: Beetroot)	5.89	5.38	5.30	5.10	5.41
Mean	6.04	5.50	5.38	5.21	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.01
Treatment X Storage (A X B)	0.033

Anthocyanin

A perusal of data in Table-4 showed the anthocyanin was significantly affected by treatments and storage durations. Among treatments, T_1 (100:0::litchi: beetroot) had maximum anthocyanin of 9.00 (mg/100 ml) however, the lowest anthocyanin content of 6.15 (mg/100ml) was noticed in treatment T_7 (70:30::litchi: beetroot) at initial day of storage. Maximum mean treatment values of anthocyanin content of 8.48 (mg/100 ml) was recorded in T_1 (100:00::litchi: beetroot) and minimum mean treatment values of anthocyanin content of 5.74 in T_7 (70:30::litchi: beetroot). Anthocyanin content was significantly affected by storage period which follows the decreasing trend. The mean values of storage period showed a decreasing trend from initial value of 7.56 to 6.59 (mg/100 ml) after 90 days of storage period. Bafna (2014) [3] reported 19.66 percent decrease in anthocyanin content in case of ready to serve beverage prepared from kokam juice. Kapoor and Ranote (2015) [10] while studying antioxidant potentials and quality of blended pear-jamun juice reported decrease in anthocyanin content during storage.

Table 4: Effect of treatments and storage period on total anthocyanin (mg/100ml) of litchi-beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	9.0	8.55	8.30	8.05	8.48
T_2 (95:05 :: Litchi: Beetroot)	8.55	8.30	7.90	7.50	8.06
T_3 (90:10 :: Litchi: Beetroot)	8.05	7.60	7.35	7.10	7.52
T_4 (85:15 :: Litchi: Beetroot)	7.55	7.25	6.10	6.55	6.86
T_5 (80:20 :: Litchi: Beetroot)	7.10	6.80	6.55	6.15	6.65
T_6 (75:25 ::Litchi: Beetroot)	6.54	6.35	6.10	5.50	6.12
T_7 (70:30 ::Litchi: Beetroot)	6.15	6.0	5.55	5.25	5.74
Mean	7.56	7.26	6.84	6.59	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.02
Treatment X Storage (A X B)	0.03

Phosphorus content

The data presented in Table-5 showed the effect of various treatments and storage period on phosphorous content of litchi-beetroot blended RTS (ready to serve) beverage. The data revealed that treatments significantly influenced the phosphorous content of litchi-beetroot blended RTS (ready to serve) beverage. At initial day of storage, the highest phosphorous content of (2.90 mg/100 ml) was recorded in treatment T_7 (100:0::litchi: beetroot) followed by T_6 (95:05::litchi: beetroot) and lowest (2.10 mg/100ml) in treatment T_1(100:0::litchi: beetroot). After 90 days of storage the values decreased to (2.40 mg/100g) in T_7 (70:30::litchi: beetroot) and (1.75 mg/100ml) in T_1 (100:0::litchi: beetroot). Phosphorous content was significantly affected by storage period. The mean values of storage period showed a decreasing trend from initial value of 2.54 to 2.07(mg/100ml) after 90 days of storage. The decrease could be due to chemical interaction between the organic constituents of the juice induced by temperature and action of enzymes. Kumar *et al*. (2012) [12] observed reduction in the minerals of guava blended ready-to-serve beverage and nectar at the end of 120 days of storage.

Table 5: Effect of treatments and storage period on phosphorous (mg/100ml) of litchi-beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	2.10	2.00	1.85	1.75	1.93
T_2 (95:05 :: Litchi: Beetroot)	2.30	2.15	2.05	1.90	2.10
T_3 (90:10 :: Litchi: Beetroot)	2.40	2.20	2.10	1.95	2.16
T_4 (85:15 :: Litchi: Beetroot)	2.55	2.35	2.20	2.05	2.29
T_5 (80:20 :: Litchi: Beetroot)	2.70	2.50	2.35	2.15	2.42
T_6 (75:25 ::Litchi: Beetroot)	2.85	2.65	2.50	2.35	2.59
T_7 (70:30 ::Litchi: Beetroot)	2.90	2.70	2.55	2.40	2.64
Mean	2.54	2.36	2.22	2.07	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.02
Treatment X Storage (A X B)	0.03

Iron content

The data presented in Table-6 showed the effect of various treatments and storage period on iron content of litchi-beetroot blended RTS (ready to serve) beverage. The data revealed that treatments significantly influenced the iron content of litchi-beetroot blended RTS beverage. At initial day of storage, the highest Iron content of (0.12 mg/100 ml) was recorded in treatment T_7 (100:0::litchi: beetroot) and lowest (0.04 mg/100ml) in treatment T_1(100:0::litchi: beetroot). After 90 days of storage the values decreased to (0.08 mg/100g) in T_7 (70:30::litchi: beetroot) and (0.02 mg/100ml) in T_1 (100:0::litchi: beetroot). Iron content was significantly affected by storage period. There was significant decrease in Iron content of litchi-beetroot blended RTS (ready to serve) beverage during 90 days of storage. The mean values of storage period showed a decreasing trend from initial value of 0.08 to 0.05(mg/100 ml) after 90 days of storage. The decrease could be due to chemical interaction between the organic constituents of the juice induced by temperature and action of enzymes. Similar findings have been observed by Mahnoori *et al*. 2020b [15] in litchi-beetroot blended leather.

Table 6: Effect of treatments and storage period on iron content (mg/100ml) of litchi - beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	0.04	0.03	0.03	0.02	0.03
T_2 (95:05 :: Litchi: Beetroot)	0.05	0.05	0.04	0.03	0.04
T_3 (90:10 :: Litchi: Beetroot)	0.06	0.05	0.05	0.04	0.05
T_4 (85:15 :: Litchi: Beetroot)	0.07	0.07	0.06	0.05	0.06
T_5 (80:20 :: Litchi: Beetroot)	0.09	0.08	0.07	0.06	0.07
T_6 (75:25::Litchi: Beetroot)	0.10	0.09	0.07	0.06	0.08
T_7 (70:30 ::Litchi: Beetroot)	0.12	0.10	0.09	0.08	0.09
Mean	0.08	0.07	0.06	0.05	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.01
Treatment X Storage (A X B)	0.03

Overall acceptability

Table-7 pertaining to score of overall acceptability revealed that at initial day, the highest score of 8.53 was recorded in treatment T_6 (75:25::litchi: beetroot) followed by 8.00 in T_5 (80:20::litchi: beetroot). After 90 days of storage the values decreased to 7.60 in treatment T_6 (75:25::litchi: beetroot) and 7.27 in T_5 (80:20::litchi: beetroot). The mean value of treatments varied significantly and the highest mean score of 8.03 was assigned to T_6 (75:25::litchi: beetroot) followed by T_5 (80:20::litchi: beetroot).During storage period, there was significant decrease in mean score from 7.75 at initial day to 6.91 at the end of 90 days of storage period. The effect of interaction between treatment and storage period was found to differ significantly at 5% level of significance. The decrease in overall acceptability scores in products may be due to reduction of SO_2 content resulting in non-enzymatic browning to some extent, change in chemical composition of the product and loss of colour and flavour during storage period of 90 days Similar observations of decrease in overall acceptability score was reported by Gehlot *et al.* (2009) [7] in bael mango beverage.

Table 7: Effect of treatments and storage period on mean score evaluation of overall acceptability of litchi-beetroot blended RTS beverage

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (100:0 :: litchi: Beetroot)	7.60	7.10	6.77	6.50	6.99
T_2 (95:05 :: Litchi: Beetroot)	7.13	6.97	6.60	6.43	6.78
T_3 (90:10 :: Litchi: Beetroot)	7.52	7.23	7.00	6.83	7.15
T_4 (85:15 :: Litchi: Beetroot)	7.70	7.40	7.13	6.80	7.26
T_5 (80:20 :: Litchi: Beetroot)	8.00	7.73	7.40	7.27	7.60
T_6 (75:25 ::Litchi: Beetroot)	8.53	8.13	7.87	7.60	8.03
T_7 (70:30::Litchi: Beetroot)	7.77	7.47	7.33	6.93	7.38
Mean	7.75	7.43	7.16	6.91	

Factors	C.D.(P=0.05)
Treatment (A)	0.01
Storage (B)	0.01
Treatment X Storage (A X B)	0.03

Conclusion

On the basis of overall acceptability, it was found that treatment T_6 rated the best followed by treatment T_5.

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