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Development and Quality Evaluation of Dragon Fruit (*Hylocereus undatus*) based Blended RTS Beverages

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ABSTRACT

Background: Dragon fruit is considered as a fruit crop for the future, having great potential for developing value-added products as the demand for natural and healthy beverages is increasing. The present study was undertaken to standardize blended Ready To Serve beverages from dragon fruit and to evaluate the product quality during storage.

Methods: Blended RTS beverages were prepared by mixing dragon fruit juice with that of three common tropical fruits *viz*., acid lime, pineapple and watermelon in nine different ratios, analyzed for various sensory attributes and compared with that of pure dragon fruit RTS beverage. The best blended beverage selected from each fruit was analyzed for chemical, nutritional and sensory parameters and were stored in transparent glass bottles under ambient storage conditions (27-32°C and 70-83% RH) for 60 days for assessing the shelf stability.

Result: TSS, acidity, reducing and total sugars had increased with storage period and ascorbic acid, β-carotene, antioxidant activity and overall acceptability scores had decreased. All the developed blended beverages were microbiologically safe during 60 days of storage with good acceptability. Blended beverages with pineapple or watermelon were economical compared to pure beverage. The study proved that blending of fruit juices in dragon fruit juice is a viable option which could improve the quality and sensory attributes.

Key words: Blended RTS beverages, Dragon fruit, *Hylocereus undatus*, Quality evaluation.

INTRODUCTION

Dragon fruit or pitaya (*Hylocereus undatus*), considered as a fruit crop for the future, is indigenous to Mexico, Central and South America. Dragon fruit belonging to cactaceae family has a bright red skin studded with green scales and white or red flesh with tiny black seeds. Dragon fruit is a rich source of nutrients and minerals such as vitamin B1, vitamin B2, vitamin B3 and vitamin C, protein, fat, carbohydrate, crude fiber, flavonoid, thiamin, niacin, pyridoxine, kobalamin, glucose, phenolic, betacyanins, polyphenol, carotene, phosphorus, iron and phytoalbumin (Le Bellac, 2006) and are highly valued for their antioxidant properties. The most common species are; *Hylocereus undatus* Britt and Rose, *H. polyrhizus*; *H. costaricencis* and *H.* (*Selenicerus*) *megalathus*.

The demand and popularity for dragon fruit have been extensively increased due to its attractive colour, sweet, juicy and pleasant taste and the fruit today can be found on almost all exotic fruit markets. Furthermore, given the antioxidant-rich nature of these fruits, there is a greater potential for developing value-added products, especially for the export markets, where the demand for exotic fruits has been growing in recent years (Siddiq and Nasir, 2012).

Fruit beverages are processed food products that are conveniently used and liked by all age group consumers and provide a better chance of meeting the daily requirement of nutrients in a healthy diet. With increase in health consciousness in the minds of people, consumption habits have been changed with great demand for fruit-based beverages in the market. Productions of RTS beverages have been increasingly gaining popularity throughout the country due to their health and nutritional benefits, apart from pleasant flavour and taste. Fruit based RTS beverages are not only rich in essential minerals, vitamins and other nutritive factors but also are delicious and have good appeal.Blended beverages have the option to provide the benefits of taste, nutrition and medicinal properties. There is always a demand from the consumers all over the world for new food products which are nutritious with delicate flavour. As the dragon fruit is gaining importance, the technology for value addition becomes need of the hour and hence the present study was undertaken to standardize quality blended RTS beverages from dragon fruit.

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MATERIALS AND METHODS

The experiment was conducted in the Department of Post Harvest Technology, College of Agriculture, Vellayani,

Thiruvananthapuram, Kerala during the period 2019-2021. Good quality uniform ripe dragon fruits (*Hylocereus undatus*) with white flesh with pink skin were procured from farmer's field, Thiruvananthapuram. The selected fruits had 24 to 32% juice content with 9.5 to 10.5°Brix and 0.20 to 0.30% acidity. Blended dragon fruit RTS beverages were prepared as per the FSSAI specification by mixing seedless juice of dragon fruit with juices of three common tropical fruits *viz*., acid lime (*Citrus aurantifolia*), pineapple (*Ananas comosus*) and watermelon (*Citrullus lanatus*) independently in nine different ratios *viz.,* 50:50, 60:40, 70:30, 80:20, 90:10, 10:90, 20:80, 30:70, 40:60 to form nine different blended RTS beverages. The prepared blended beverages were analyzed for various sensory attributes and compared with that of pure dragon fruit RTS beverage (11% fruit juice, 11% sugar content, 0.3% acidity and 70 ppm sulphur dioxide) to explore the possibility of efficient blending. Dragon fruit-based beverages were scored for sensory parameters *viz.,* appearance, color, flavor, texture, taste and overall acceptability by 30 member semi trained panel based on a 9-point hedonic scale (where 9= extremely like and 1=dislike extremely) (Ranganna, 1986).

The best beverage selected from each fruit based on sensory scores were stored in transparent glass bottles under ambient storage conditions (27-32°C and 70-83% RH) for 60 days for the evaluation of shelf stability, quality parameters and microbiological safety. TSS of the beverages was assessed using hand refractometer (range 0-32°Brix) and was expressed in degree brix (°Brix). Titratable acidity, total sugar, reducing sugar, ascorbic acid and β-carotene content were determined as per Ranganna (1986). Total antioxidant activity of the beverages was determined using 2,2-diphenyl-1-picryhydrazyl (DPPH) radical scavenging assay (Sharma and Bhat, 2009). Cost of the beverage per one litre was calculated on the basis of market price of individual ingredients used.

The mean scores obtained for sensory parameters were statistically analyzed using Kruskall- Wallis Chi-square test (Shamrez *et al.,* 2013) and other data generated were analyzed using analysis of variance.

RESULTS AND DISCUSSION

Sensory evaluation

Blending could lead to the production of delightful and delicious beverages with improved organoleptic quality and hence the prepared blended beverages were compared for sensory parameters with the pure dragon fruit beverage. Though there was no significant difference between the sensory scores of blended beverages and pure dragon fruit beverage (Table 1); the blended beverage produced using dragon fruit: lime in 80:20 ratio recorded maximum mean score for flavour (7.26), texture (7.46), taste (7.53) and overall acceptability (7.53). RTS beverage prepared by blending dragon fruit: pineapple in the ratio 50:50 had maximum mean score of 7.68 (flavour), 7.65 (taste) and overall acceptability (7.86). Beverage produced by blending dragon fruit: watermelon in the ratio 10:90 had maximum mean score for appearance (8.0), colour (7.93), flavour (7.12), texture (7.68), taste (7.37) and overall acceptability (7.56). Compared to pure dragon fruit beverages, blended RTS beverages had higher overall acceptability scores and hence blending can be suggested as a viable option to improve acceptability of dragon fruit beverages. Similar findings have been reported by Jalgaonkar *et al*. (2020) in dragon fruit-grape blended beverages and Vishakha *et al*. (2021) in dragon fruit blended lemon and aonla juice. Based on high overall acceptability scores, dragon fruit: lime in 80:20 ratio, dragon fruit: pineapple in 50:50 ratio and dragon fruit: watermelon in 10:90 ratio were selected as the best blended RTS beverages and were subjected to quality evaluation.

Quality evaluation

The selected blended beverages were compared for chemical, nutritional and sensory quality parameters with the pure dragon fruit beverage. TSS of blended beverages was in the range of 11°Brix to 13.2°Brix (Fig 1a). Dragon fruit: pineapple RTS beverage recorded highest TSS (13.2°Brix) and lowest TSS was recorded for dragon fruit: lime RTS beverage. Minimum acidity (0.235%) was observed for dragon fruit: watermelon and pure dragon fruit RTS beverage and maximum acidity of 0.295 per cent was observed in dragon fruit: lime RTS beverage (Fig 1b). Dragon fruit: pineapple RTS beverage showed the maximum reducing sugar of 5.15 per cent and total sugar of 14.26 per cent (Fig 1c,1d). Dragon fruit: watermelon RTS beverage showed the minimum reducing sugar of 2.84 per cent and total sugar of 7.58 per cent.

Except ascorbic acid, all the nutritional quality parameters of RTS beverages were significantly influenced by blending, indicating that blending did not reduce the ascorbic acid of the dragon fruit. Instead, though not significant, dragon fruit: watermelon RTS beverage recorded the maximum ascorbic acid of 9.53 mg 100 g^{-1} (Fig 1e). β-carotene content was also highest for the dragon fruit: watermelon RTS beverage (0.193 mg 100 ml^{-1}) and pure dragon fruit RTS beverage recorded the minimum β-carotene content of 0.129 mg 100 ml^{-1} (Fig 1f). Owing to antioxidant-rich nature of dragon fruit, pure dragon fruit RTS beverage had recorded highest (63.8%) antioxidant activity (Fig 1g). Pineapple and watermelon blended beverages had next higher antioxidant activity. Compared to watermelon and pineapple, lime was proved to be a poor option for blending with dragon fruit in the present study. Vishakha *et al.* (2021) reported good nutritional properties having immense health benefits for the blended dragon fruit drink developed by them. The increased/ decreased nutritional quality obtained for blended beverages are due to the quality parameters of the individual fruits used for blending. Increase in nutritional value of the drinks by blending has been reported using bitter gourd with lemon (Singh and Gaikwad, 2012) and carrot juice with pineapple juice (Imitiyaz and Singh, 2018).

Table 1: Organoleptic scoring of blended dragon fruit RTS beverages.

Treatments	Mean score of sensory quality parameters					
	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Dragon fruit: Lime RTS beverages						
50D:50L (T_1)	7.23	7.23	7.03	7.07	5.6	6.84
60D:40L (T_2)	7.23	7.23	6.8	7.23	6.67	6.75
70D:30L (T_3)	7.80	7.65	7.15	7.15	6.65	7.12
80D:20L (T_4)	7.73	7.61	7.26	7.46	7.53	7.53
90D:10L (T_5)	7.23	7.23	6.84	7.11	7.23	7.1
10D:90L (T_6)	7.11	7.23	6.3	6.84	5.8	5.58
20D:80L (T_7)	7.11	7.15	5.69	6.57	5.2	6.0
30D:70L (T_8)	7.07	7.34	6.4	6.84	6.0	6.48
40D:60L (T_9)	7.15	7.26	6.76	6.92	6.61	6.7
100% D (T_{10})	7.3	7.34	6.84	6.92	6.88	6.86
KW value	13.91	5.36	12.84	11.18	14.93	11.89
Dragon fruit: Pineapple RTS beverages						
50D:50P (T_1)	7.43	7.56	7.68	7.12	7.65	7.86
60D:40P (T_2)	7.31	7.5	7.5	7.18	7.56	7.73
70D:30P (T_3)	7.37	7.43	7.31	7.25	7.4	7.65
80D:20P (T_4)	7.0	6.93	7.18	7.18	7.25	7.40
90D:10P (T_5)	7.06	7.0	6.5	7.25	6.62	7.25
10D:90P (T_6)	7.81	8.12	7.56	7.31	7.5	7.58
20D:80P (T_7)	7.5	7.18	7.37	7.12	7.45	7.31
30D:70P (T_8)	7.12	6.93	7.5	7.18	7.43	7.26
40D:60P (T_9)	6.81	6.75	7.12	6.93	7.12	6.96
100% D (T_{10})	7.31	7.18	6.62	6.43	6.93	6.95
KW value	12.79	8.56	14.56	7.11	10.90	14.96
Dragon fruit: Watermelon RTS beverages						
50D:50W (T_1)	7.68	7.93	6.87	7.00	7.00	6.69
60D:40W (T_2)	7.18	7.31	6.75	6.87	6.75	6.87
70D:30W (T_3)	6.68	6.75	6.37	6.5	6.68	6.53
80D:20W (T_4)	6.62	6.56	6.87	6.87	6.87	6.82
90D:10W (T_5)	7.00	7.12	7.00	6.93	7.18	7.02
10D:90W (T_6)	8.00	7.93	7.12	7.68	7.37	7.56
20D:80W (T_7)	6.75	6.5	6.43	6.68	6.5	6.51
30D:70W (T_8)	7.12	7.06	6.56	7.43	6.81	6.96
40D:60W (T_9)	6.75	6.81	7.06	7.06	7.06	6.96
100% D (T_{10})	7.00	6.68	5.93	7.06	6.43	6.51
KW value	14.49	13.3	15.38	16.10	10.71	10.40
χ^2	16.91					

D: Dragon fruit; L: Lime; P: Pineapple; W: Watermelon.

When the overall acceptability of the beverages was assessed, all the blended beverages had higher scores compared to pure dragon fruit beverage (Fig 1h). Beverage blended with watermelon had the highest score (7.56) and the pure beverage the least (6.95).

When the cost of production of one litre blended beverages was calculated, the cost of blended beverages with lime, pineapple and watermelon were Rs. 39/-, Rs. 32/- and Rs. 24/- respectively whereas the cost of pure dragon fruit beverage was Rs. 40/- indicating that blended beverages with pineapple or watermelon are economical compared to pure RTS beverage.

Storage stability

Any processed commodity should retain maximum quality parameters after storage. The selected blended RTS beverages were analyzed for chemical, nutritional, organoleptic and microbial qualities at monthly intervals for 60 days.

There was significant increase of TSS from 12.55 to 13.69°Brix during storage period (Fig 2a). The gradual increase in TSS might be due to the co-polymerization of organic acids with sugars and amino acids (Malav *et al*., 2014). Acidity has vital importance in determining the quality of RTS beverages and was increased during storage.

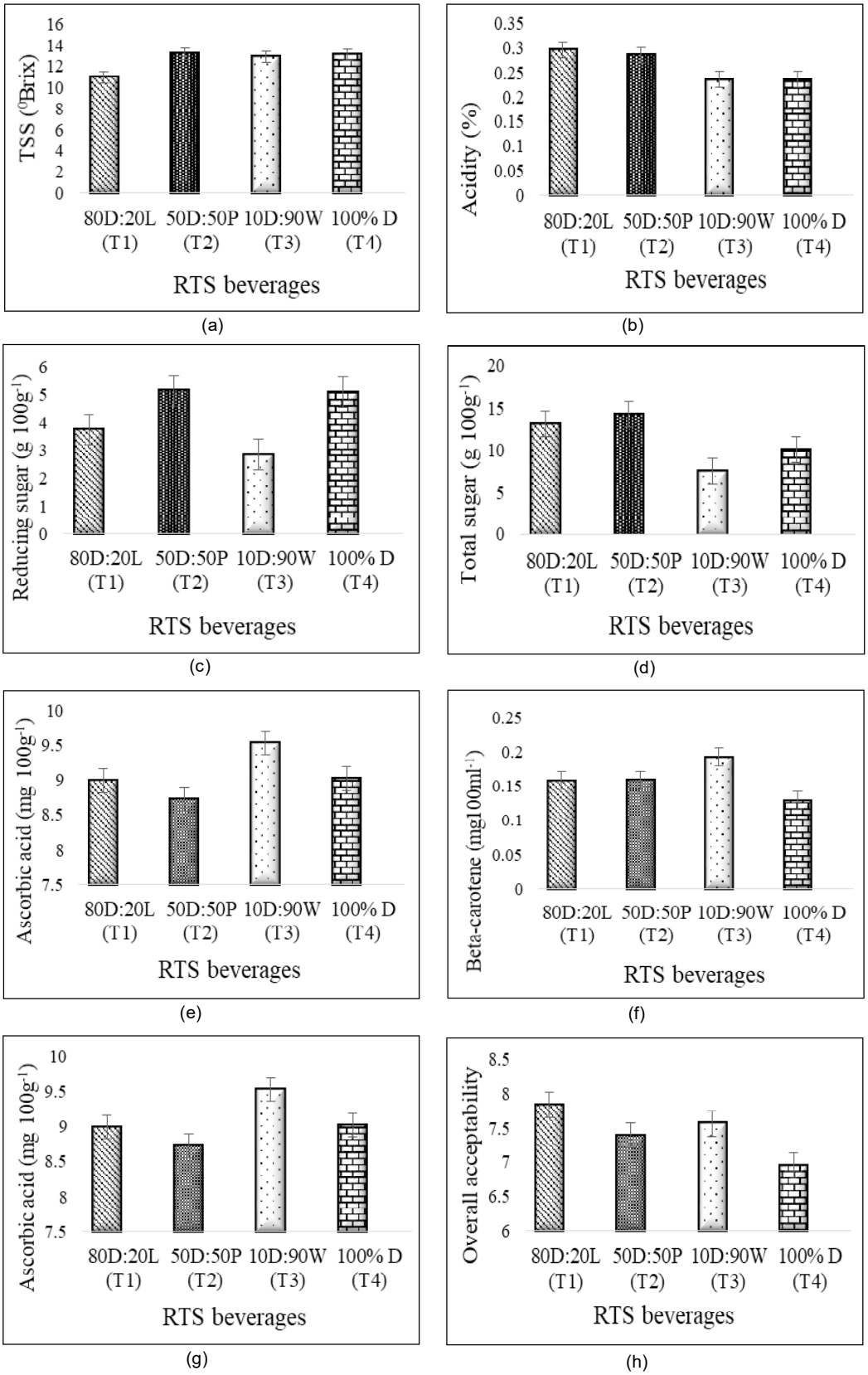


Fig 1: (a-h) Quality parameters of blended dragon fruit RTS beverages.
D: Dragon fruit; L: Lime; P: Pineapple; W: Watermelon.

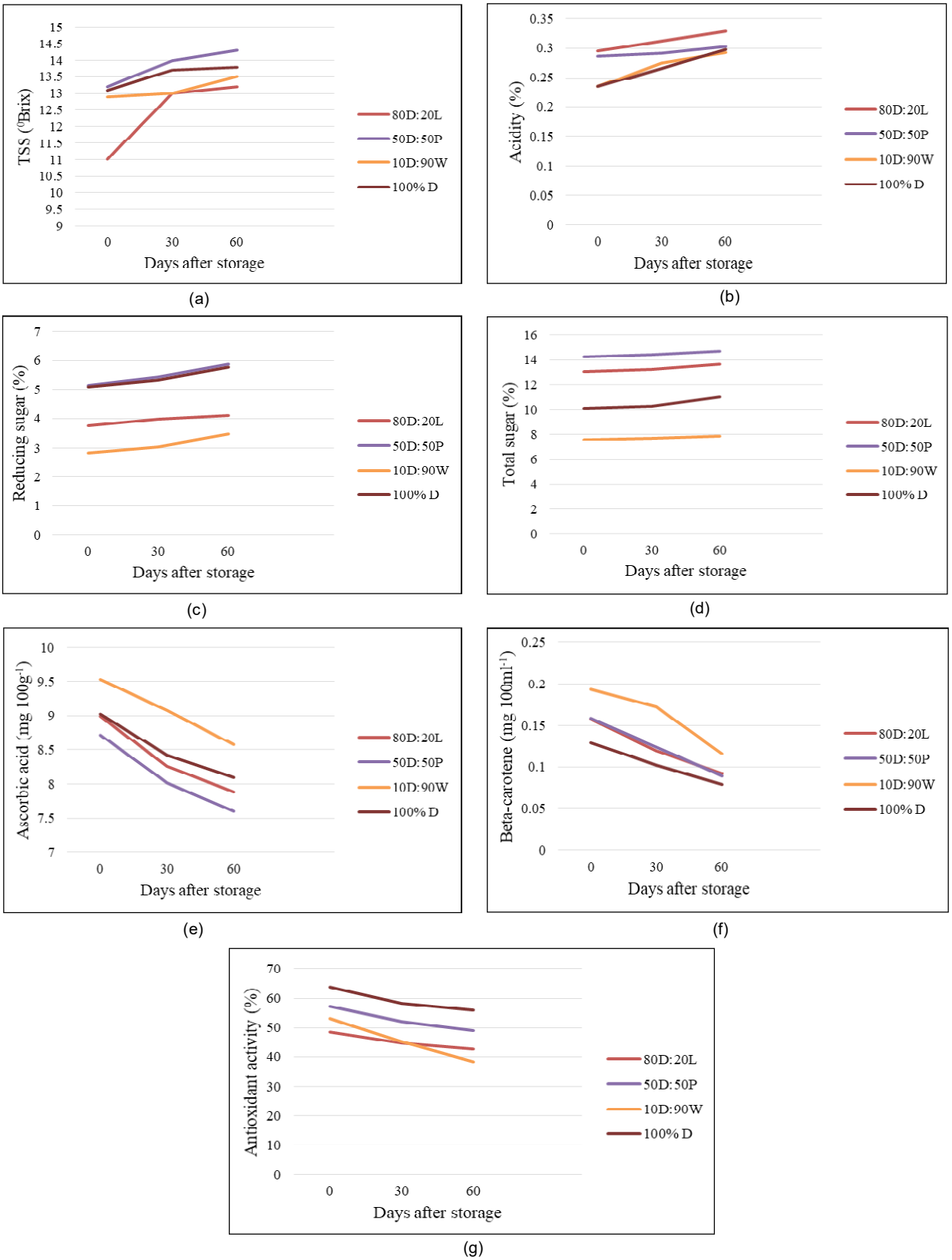


Fig 2: (a-g) Effect of storage on chemical quality parameters of blended RTS beverages.
D: Dragon fruit; L: Lime; P: Pineapple; W: Watermelon.

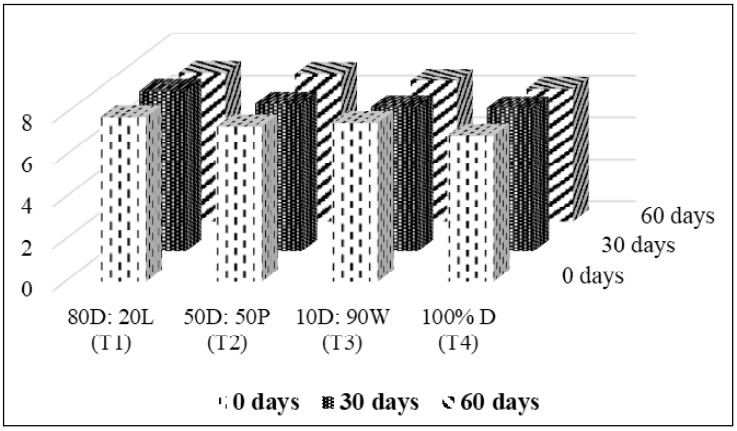


Fig 3: Effect of storage on sensory evaluation of blended RTS beverages.

Table 2: Microbial load of blended beverages during storage.

Treatments (T)	Microbial load (colony forming units/ml)					
	Bacteria (cfu/ml)			Fungi (cfu/ml)		
	Months after storage (S)					
	0	1	2	0	1	2
80D:20L (T_1)	TFTC	5	15	TFTC	2	9
50D:50P (T_2)		6	17		1.2	11
10D:90W (T_3)		5	9		2	12
100% D (T_4)		4	17		3	11
CD (0.05)		NS	2.13		NS	NS

D: Dragon fruit, L: Lime, P: Pineapple, W: Watermelon, TFTC: Too few to count.

Acidity had increased gradually from 0.262 per cent at the time of storage to 0.305 per cent at 60 days after storage (Fig 2b). Thirukkumar and Vennila (2019) reported that an increase in acidity during storage might be due to the formation of organic acids by the degradation of ascorbic acid. Storage, the sugar content of all the RTS beverages had increased (Fig 2c). Elbandy *et al*. (2014) reported that an increase in sugar content of mango nectar during storage was due to the inversion of sucrose into glucose and fructose under the acidic conditions of nectar.

All the nutritional quality parameters showed a decreasing trend during storage. Ascorbic acid of the RTS beverages decreased from 9.06 mg 100 g^{-1} to 8.03 mg 100^{-1} during storage (Fig 2d). Nagpal and Rajalakshi (2009) reported decrease in ascorbic acid content of beverages during storage due to oxidation, as ascorbic acid is sensitive to oxygen, light and heat by both enzymatic and non-enzymatic catalysts. β-carotene content of stored beverages decreased from 0.159 mg 100 ml^{-1} to 0.094 mg 100 ml^{-1} during storage (Fig 2e). Jan and Masih (2012) reported that gradual decrease in β-carotene value may be due to increasing temperature and heating time. During storage, antioxidant activity of stored beverages had decreased from 55.65% to 46.43% (Fig 2f). These results are in accordance with the findings of Gao and Rupasinghe (2012) who reported a decrease in antioxidant activity of apple carrot juice blends during storage. Tariq *et al.* (2020) reported that the decreasing trend of antioxidant activity during storage is linked with the fact of lower content of phenolic compounds and vitamin C that influence antioxidant activity directly.

The sensory quality profile is a prime factor to consider the marketability of any product (Boghani *et al*., 2012). Appearance and colour of beverages did not differ significantly during storage (Fig 3). Flavour and texture were significantly influenced during storage and the highest mean score for flavour and texture were recorded for dragon fruit: pineapple RTS beverage and dragon fruit: lime RTS beverage respectively throughout the storage period. Overall acceptability of beverages was decreased throughout the storage period. Similar decrease in overall sensorial quality profile were reported during storage in papaya-aloe RTS beverage for three months (Boghani *et al*., 2012) and in blended aloe, aonla and ginger therapeutic RTS beverages for four months (Sasikumar *et al.,* 2013). Though the sensory scores of the beverages were decreased during storage, microbial count was less than the safety limit of ⩾50 cfu/ml prescribed by Food safety and Standards Regulations, 2011, hence can be considered microbiologically safe (Table 2) for a period of 60 days.

CONCLUSION

The study conducted to standardize dragon fruit based blended RTS beverages revealed that though the pure dragon fruit beverage had highest antioxidant activity,

blending with juice of other tropical fruits *viz*., acid lime, pineapple and watermelon could be a viable option to yield quality beverages. Maximum β-carotene content was recorded in dragon fruit: watermelon blended beverage. Blended beverages with pineapple or watermelon were economical compared to pure beverage. Blending of fruits in dragon fruit juice could improve the quality and sensory attributes. When the developed beverages were subjected to storage stability studies, all the developed blended beverages were microbiologically safe during 60 days of storage with good acceptability.

Conflict of interest: None.

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