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# Standardization of protocol for dragon fruit (*Hylocereus polyrhizus* L.) squash

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## Abstract
An experiment was conducted during 2019-2020 in the Department of Post Harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi (UHS, Bagalkot), Karnataka, India. The experiment on squash consisted with nine different treatments *viz*., dragon fruit juice concentration (25, 27.5 and 30%), TSS (40, 42.5 and 45º Brix) and acidity level (1.0%) are kept constant and each treatment was replicated thrice in completely randomized design. The results of dragon fruit squash shows that there was a marginal decreasing trend with respect to parameters like titratable acidity (1.15 to 1.12%), ascorbic acid (4.29 to 3.60 mg/100 ml) and betacyanin (4.16 to 2.46 mg/100 g), whereas, increasing trend observed with respect to TSS (42.50 to 43.32° Brix), total sugars (40.14 to 40.78%) and pH (3.95 to 4.01) during three months of storage.

**Keywords:** Dragon fruit squash, Betacyanin, titratable acidity

## Introduction
Underutilized fruits are those- potential largely remained untapped for variety of reasons. Unlike major fruits, their importance, despite of rich in nutritional and wide range of health benefits underwent unrecognized for long time. Growing awareness and health conscious in modern era coupled with drawing the attention of scientific community paved the way to recognize their importance. Dragon fruit is one such underutilized fruit with rich nutritional and medicinal qualities. Dragon fruit or pitaya is botanically known as *Hylocereus polyrhizus*, belongs to the family cactaceae as a perennial climbing plant (Britt and Rose, 1963) [2]. *Hylocereus* is one of the edible fruits of the promoter genus of this family. It originated in South America in Tropical and Subtropical Mexico. Dragon fruit plant is similar to many other cactus with an angular fleshy and thorny stem. Dragon fruit rich in nutritional and medicinal qualities. Fruit pulp is said to be rich in vitamin C, antioxidants, carotene, polyunsaturated fatty acids, protein and minerals such as calcium, sodium, potassium and iron. Besides pulp, its seeds are also rich in polyunsaturated fatty acids (omega-3 and omega-6 fatty acids) capable to lowering the risk of cardiovascular disease.

With a shelf life of up to 10 days, dragon fruit is extremely perishable (Hoa *et al*., 2006) [3]. Due to its non-climacteric nature, the best edible quality attained when harvested ripe and tend to decreases after storage. Although largely consumed as fresh, it can be processed into variety of products such as RTS, squash, wine, jam and jelly. There have been few studies focused on expanding the pitaya fruits post-harvest consistency as a newly cultivated crop (Nerd *et al*., 1999) [7]. Additional research-based knowledge is required to improve post-harvest techniques that preserve the quality and extend the availability. Moreover processed products of dragon fruits are rarely available in our markets and very little work has been done in our country on dragon fruit processing. Industries in food processing are rising in India, and the consumption of processed fruit products is becoming increasingly common. A variety of fruit products manufactured locally are now available in the market. So in India reach on dragon fruit utilization remains potentially untouched and value addition by processing could be a much needed solution for its distribution and utilization.

## Materials and Methods
An experiment was carried out in the laboratory of the Department of Post-Harvest Technology, Kittur Rani Channamma College of Horticulture (University of Horticultural sciences, Bagalkot), Arabhavi, Gokak taluk of Belagavi district, Karnataka state – India.

during 2018-19. The experiment was laid out in completely randomized design with 9 treatments and 3 replications, in which the treatment varies with fruit juice concentration (25, 27.5 and 30%), TSS (40, 42.5 and 45º B). Ripe dragon fruits were received from orchards located in chikkamagaluru in Karnataka. Fruits of uniform shape, size, ripened and free from fractural damage were selected. Fruits were washed in clean water to remove adhering dirt and crushed with the help of mixer jar for extraction of juice. The extracted juice was taken to prepare squash. Prepared squash was used for analysis of TSS by using an Erma Hand Refractometer, total sugar content, titratable acidity was determined by the procedure given by Ranganna (1997) [8], pH by using digital pH meter, ascorbic acid by using 2,6-dichlorophenol indophenols (2,6- DCPIP), betacyanin content was recorded by taking an absorbance (O.D) at 538 nm using colourimetric approach.

## Results and Discussion

The dragon fruit squash recorded an increase in total soluble solids with the advancement of storage period (Fig 1). Among the treatments maximum TSS (45.54º Brix) was observed in $T_9$ (Dragon fruit juice 30% + TSS 45º B + Acidity 1%) followed by $T_6$ (45.50° Brix) and $T_3$ (45.33° Brix), while minimum TSS of 40.33° Brix was observed in both $T_1$ and $T_4$ at 2$^{nd}$ month of storage period (Table 1). The increase in reducing and total sugars corresponding to the increase in total soluble solids and ultimate decrease in non-reducing sugars, which might be due to hydrolysis of polysaccharides into reducing sugar (Jain *et al*., 1984) [4]. Gradual increase in total sugars over the storage could be due to inversion of polysaccharides like starch and cellulose substances in the presence of organic acids into simpler soluble molecules and also inversion of added sucrose into simpler soluble substance in the course of time (Fig 1).

The mean value for acidity of squash decreased during storage from 1.15 per cent to 1.12 per cent at the end of third month of storage (Table 2). Maximum value was recorded in treatment $T_9$ (Dragon fruit juice 30% + TSS 42.5º B + Acidity 1%) and minimum value was recorded in $T_1$ (Dragon fruit juice 25% + TSS 40º B + Acidity 1%). This might be due to co-polymerization of organic acids with sugars and amino acids or due to the chemical interaction between the organic constituents affected by the temperature and action of enzymes (Malav *et al.*, 2014) [6].

In the present study, the pH of the squash increased during the storage and maximum pH value was recorded in the treatment $T_1$ followed by $T_3$ and minimum pH was recorded in $T_9$ at the end of the storage (Table 2). The increase in pH may be due to acid hydrolysis of some polysaccharides into disaccharides like starch into sucrose, fructose and glucose *etc*. These reactions increase the sweetness and decreases sourness, as a result of which pH increases (Adil *et al.*, 2014) [1].

There was a significant reduction in vitamin C content of squash (Fig 1) during storage from 4.29 mg per 100 ml to 3.60 mg per 100 ml by the 3$^{rd}$ month after storage, among the different treatment maximum ascorbic acid content (4.01 mg/100 g) was observed in $T_9$ (Dragon fruit juice 30% + TSS 45º B + Acidity 1%) whereas minimum (3.21 mg/100 g) was recorded in $T_1$ (Dragon fruit juice 25% + TSS 40º B + Acidity 1%) at 3 months after storage (Table 3). It may be due to the strong antioxidant property of vitamin C, it might have oxidized itself resulting in rapid reduction of vitamin C during storage.

Dragon fruit is rich in betacyanin content, among the different treatment maximum betacyanin content was observed in $T_9$ (Dragon fruit juice 30% + TSS 45º B + Acidity 1%) that is (2.68 mg/100 ml) whereas minimum (2.19 mg/ 100 ml) was recorded in $T_1$ (Dragon fruit juice 25% + TSS 40º B + Acidity 1%) at 3 months after storage (Table 3). A significant decrease in betalains (betacyanins and betaxanthins) content of squash was recorded during the storage. Loss of betalains in squash might be due to their high susceptibility to photo oxidative degradation and poor stability during storage (Khan., 2016) [5].

**Table 1:** Effect of treatments and storage period on TSS and total sugar content of dragon fruit squash

| Treatments | TSS (° Brix) | | | | Total sugars (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Months after storage | | | | | | | |
| | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| $T_1$- Dragon fruit juice 25% + TSS 40º B + Acidity 1% | 40.00 | 40.33 | 40.50 | 40.83 | 37.77 | 37.93 | 38.01 | 38.14 |
| $T_2$- Dragon fruit juice 25% + TSS 42.5º B + Acidity 1% | 42.50 | 42.83 | 43.10 | 43.37 | 39.74 | 39.77 | 39.86 | 39.99 |
| $T_3$- Dragon fruit juice 25% + TSS 45º B + Acidity 1% | 45.00 | 45.33 | 45.40 | 45.70 | 42.15 | 42.28 | 42.32 | 42.55 |
| $T_4$- Dragon fruit juice 27.5% + TSS 40º B + Acidity 1% | 40.00 | 40.33 | 40.60 | 40.87 | 37.82 | 38.12 | 38.51 | 38.64 |
| $T_5$- Dragon fruit juice 27.5% + TSS 42.5º B + Acidity 1% | 42.50 | 42.84 | 43.12 | 43.48 | 40.14 | 40.10 | 40.44 | 40.58 |
| $T_6$- Dragon fruit juice 27.5% + TSS 45º B + Acidity 1% | 45.00 | 45.50 | 45.52 | 45.57 | 42.16 | 42.22 | 42.45 | 42.83 |
| $T_7$- Dragon fruit juice 30% + TSS 40º B + Acidity 1% | 40.00 | 40.36 | 40.62 | 40.85 | 38.71 | 38.87 | 38.90 | 39.14 |
| $T_8$- Dragon fruit juice 30% + TSS 42.5º B + Acidity 1% | 42.50 | 42.85 | 43.14 | 43.33 | 40.00 | 40.67 | 40.71 | 41.11 |
| $T_9$- Dragon fruit juice 30% + TSS 45º B + Acidity 1% | 45.00 | 45.54 | 45.67 | 45.87 | 42.81 | 43.14 | 43.95 | 44.03 |
| Mean | 42.50 | 42.88 | 43.07 | 43.32 | 40.14 | 40.34 | 40.57 | 40.78 |
| S.Em+ | 0.35 | 0.20 | 0.16 | 0.51 | 0.35 | 0.42 | 0.31 | 0.24 |
| C. D. @ 1% | 1.41 | 0.81 | 0.66 | 2.06 | 1.41 | 1.71 | 1.25 | 0.97 |

**Table 2:** Effect of treatments and storage period on titratable acidity and pH of dragon fruit squash

| Treatments | Titratable acidity (%) | | | | pH | | | |
|---|---|---|---|---|---|---|---|---|
| | Months after storage | | | | | | | |
| | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| $T_1$- Dragon fruit juice 25% + TSS 40º B + Acidity 1% | 1.12 | 1.11 | 1.10 | 1.09 | 4.04 | 4.06 | 4.08 | 4.09 |
| $T_2$- Dragon fruit juice 25% + TSS 42.5º B + Acidity 1% | 1.13 | 1.13 | 1.12 | 1.11 | 3.98 | 4.02 | 4.04 | 4.05 |
| $T_3$- Dragon fruit juice 25% + TSS 45º B + Acidity 1% | 1.12 | 1.11 | 1.10 | 1.10 | 3.99 | 4.01 | 4.03 | 4.06 |
| $T_4$- Dragon fruit juice 27.5% + TSS 40º B + Acidity 1% | 1.14 | 1.13 | 1.12 | 1.12 | 3.94 | 3.96 | 3.99 | 4.01 |
| $T_5$- Dragon fruit juice 27.5% + TSS 42.5º B + Acidity 1% | 1.15 | 1.15 | 1.14 | 1.13 | 3.95 | 3.97 | 3.99 | 4.01 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $T_6$- Dragon fruit juice 27.5% + TSS 45º B + Acidity 1% | 1.14 | 1.14 | 1.13 | 1.13 | 3.94 | 3.95 | 3.98 | 4.00 |
| $T_7$- Dragon fruit juice 30% + TSS 40º B + Acidity 1% | 1.17 | 1.16 | 1.16 | 1.14 | 3.92 | 3.94 | 3.96 | 3.98 |
| $T_8$- Dragon fruit juice 30% + TSS 42.5º B + Acidity 1% | 1.17 | 1.17 | 1.16 | 1.14 | 3.91 | 3.93 | 3.95 | 3.97 |
| $T_9$- Dragon fruit juice 30% + TSS 45º B + Acidity 1% | 1.18 | 1.16 | 1.15 | 1.14 | 3.90 | 3.92 | 3.94 | 3.95 |
| Mean | 1.15 | 1.14 | 1.13 | 1.12 | 3.95 | 3.97 | 4.00 | 4.01 |
| S.Em+ | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.19 | 0.19 | 0.01 |
| C. D. @ 1% | 0.05 | 0.04 | 0.03 | 0.04 | 0.07 | 0.78 | 0.75 | 0.04 |

**Table 3:** Effect of treatments and storage period on ascorbic acid and betacyanin content of dragon fruit squash

| **Treatments** | **Ascorbic acid (mg/100 ml)** | | | | **Betacyanin content (mg/100 ml)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Months after storage** | | | | | | | |
| | **0** | **1** | **2** | **3** | **0** | **1** | **2** | **3** |
| $T_1$- Dragon fruit juice 25% + TSS 40º B + Acidity 1% | 3.89 | 3.62 | 3.43 | 3.21 | 3.79 | 3.20 | 2.80 | 2.19 |
| $T_2$- Dragon fruit juice 25% + TSS 42.5º B + Acidity 1% | 3.91 | 3.71 | 3.45 | 3.24 | 3.81 | 3.31 | 2.82 | 2.23 |
| $T_3$- Dragon fruit juice 25% + TSS 45º B + Acidity 1% | 3.91 | 3.72 | 3.46 | 3.23 | 3.76 | 3.25 | 2.85 | 2.21 |
| $T_4$- Dragon fruit juice 27.5% + TSS 40º B + Acidity 1% | 4.26 | 4.00 | 3.75 | 3.57 | 4.20 | 3.62 | 2.95 | 2.47 |
| $T_5$- Dragon fruit juice 27.5% + TSS 42.5º B + Acidity 1% | 4.28 | 4.02 | 3.76 | 3.58 | 4.18 | 3.52 | 2.85 | 2.48 |
| $T_6$- Dragon fruit juice 27.5% + TSS 45º B + Acidity 1% | 4.29 | 4.04 | 3.80 | 3.61 | 4.21 | 3.65 | 2.80 | 2.51 |
| $T_7$- Dragon fruit juice 30% + TSS 40º B + Acidity 1% | 4.67 | 4.30 | 4.15 | 3.98 | 4.49 | 3.95 | 3.12 | 2.62 |
| $T_8$- Dragon fruit juice 30% + TSS 42.5º B + Acidity 1% | 4.68 | 4.45 | 4.24 | 3.99 | 4.51 | 3.97 | 3.35 | 2.68 |
| $T_9$- Dragon fruit juice 30% + TSS 45º B + Acidity 1% | 4.69 | 4.48 | 4.25 | 4.01 | 4.48 | 3.90 | 3.25 | 2.71 |
| Mean | 4.29 | 4.04 | 3.81 | 3.60 | 4.16 | 3.57 | 2.98 | 2.46 |
| S.Em+ | 0.07 | 0.06 | 0.06 | 0.05 | 0.07 | 0.08 | 0.06 | 0.07 |
| C. D. @ 1% | 0.27 | 0.25 | 0.24 | 0.22 | 0.27 | 0.33 | 0.24 | 0.30 |

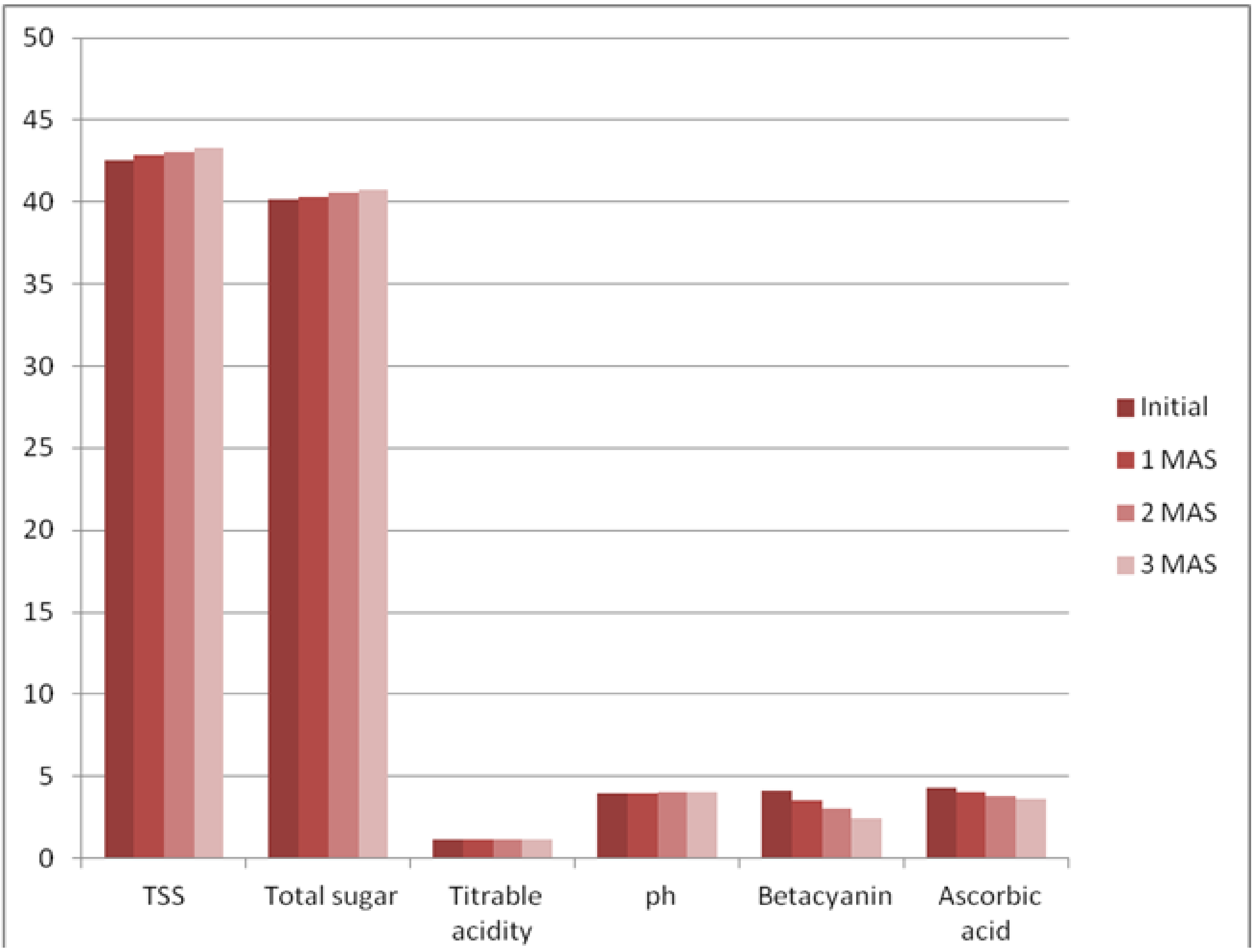


**Fig 1:** Changes in different parameters of dragon fruit squash as influenced by different treatments and storage

## Conclusion

It can be concluded from above discussion that the best organoleptically acceptable dragon fruit squash can be prepared by using 25% dragon fruit juice, 45º B of TSS and Acidity 1 per cent ($T_3$) and it was followed by dragon fruit juice 30% + TSS 45º B + Acidity 1% ($T_9$).

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