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STUDIES ON DEVELOPMENT AND STORAGE QUALITY EVALUATION OF BETALAINS RICH DRINK PREPARED FROM WILD PRICKLY PEAR (*OPUNTIA DILLENII* HAW.) FRUITS

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ABSTRACT
The present study was undertaken for the development of RTS from wild prickly pear fruit and its quality evaluation during storage for six months. Different combinations of juice (10, 12, 14 and 16%), sugar syrup (12 and 15 °B) and 0.30 per cent acidity were tried to standardize proper combination for RTS. The RTS prepared with 14 per cent juice, 12 °B TSS and 0.30 per cent acidity was packed in glass and PET (Polyethylene terephthalate) bottles and stored for six months under ambient and refrigerated temperature conditions. RTS could be safely stored for a period of six months under both the storage conditions without much change in various quality characteristics. Various physico-chemical characteristics increased/decreased like TSS (12.00 to 12.48 °B), reducing sugars (7.15 to 8.74%), titratable acidity (0.30 to 0.26%), ascorbic acid (2.48 to 0.76 mg/100 g), betacyanins (9.50 to 9.36 mg/100 ml), betaxanthins (2.06 to 0.53 mg/100 ml) and total phenols (11.22 to 3.89 mg/100 g). However, changes were slower in refrigerated storage conditions as compared to that under ambient conditions. Both the packaging materials viz. PET and glass bottles were found suitable, with comparatively less changes occurring in glass bottles stored under refrigerated conditions.

INTRODUCTION

The cactus (*Opuntia* spp.) - a xerophytic plant has about 130 genera and 1500 species, and belongs to family cactaceae and grows mainly in arid and semi-arid climate. The origin of cactus pear is in Mexico and later got distributed throughout American hemisphere, Mediterranean basin, Middle East, South Africa, Australia and India (Zorgui *et al.*, 2009). Among various species of cactus two species of cactus namely *Opuntia dillenii* Haw. and *Opuntia chlorotica* Engelm. are known as prickly pear which are found in abundance upto 1500 metres above mean sea level (Parmar and Kaushal, 1982). *Opuntia dillenii* Haw. is a non-climacteric, fleshy mucilaginous sweet fruit containing sufficient quantity of sugars, with a pleasant blend of acidity which is almost berry like, pyriform, depressed at the apex and containing pulp. This fruit consists of various antioxidant compounds like ascorbic acid, phenolics, betalains, flavonoids (Kampferrol, Quercetin, Narcissin and Toxifolin), lactones, terpenoids, alkaloids along with unsaturated alcohols and unsaturated aldehydes (Lee *et al.*, 2003; Tesoriere *et al.*, 2005; Saenz *et al.*, 2013). Fruits of prickly pear have diuretic effect, analgesics, anti-inflammatory effects, hypoglycemic effects, neuroprotective effects, anti-allergic activity, inhibition of stomach ulcerations, and to alleviate alcohol hangover symptoms (Kim *et al.*, 2006). The fruit juice-based beverage is a fast growing sector within the beverage market and ready- to- serve beverages are more popular among these beverages (Sangma *et al.*, 2018). So keeping in view nutritional importance with respect to betalains and antioxidant value of wild prickly pear (*Opuntia dillenii* Haw.) the present studies were carried out to standardize the recipe for RTS beverage and further study its quality characteristics during six months of storage.

MATERIALS AND METHODS

Raw material and extraction of juice

The mature fruits of *Opuntia dillenii* Haw. procured from Vaknaghat area of Solan district of HP were brought to the Department of Food Science and Technology, UHF, Nauni, Solan (HP), where they were used for various physico-chemical analysis, juice extraction and preparation of RTS beverage. The juice from the fruit was extracted with help of physical as well as enzymatic methods (Chauhan *et al.*, 2017).

Development of wild prickly pear drink

RTS drink was prepared according to the specifications of FSSAI by mixing the wild prickly pear juice and sugar syrup as per the different treatment combinations given in Table 1. To get the desirable concentration of acid (0.30%) in RTS, citric acid was added in all the treatment combinations. Sodium benzoate (120 ppm) was added in all the treatments as a preservative during product preparation. The RTS drink prepared by following the best selected combination on the basis of sensory evaluation was packed in pre-sterilised glass and PET bottles (transparent bottles of 200 ml capacity). All the packed products were properly labelled and stored at ambient (15-25 °C) and refrigerated (4-7 °C) conditions for six

months. The physico-chemical and sensory characteristics of all the products were analyzed at 0, 3 and 6 months of storage.

Physico-chemical analysis and sensory evaluation

The colour of RTS drink in terms of red, yellow and blue TCU (Tintometer color units) was observed with Tintometer (Lovibond Tintometer Model-E). TSS, sugars, titratable acidity and ascorbic acid content of RTS drink were determined according to the standard procedures (Ranganna, 1997). Betalains were estimated photometrically according to Castellanos–Santiago and Yahia (2008). Total phenols content and antioxidant activity (Free radical scavenging activity) were determined by Folin-Ciocalteu and spectrophotometric methods (Singleton and Rossi, 1965). Nine point hedonic rating test was followed for conducting the sensory evaluation of wild prickly pear RTS drink. The panel of ten judges comprising of faculty members and students of department of Food Science and Technology, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) were selected to evaluate the products for sensory parameters such as colour, body, taste, aroma and overall acceptability.

Statistical analysis

Data on physico-chemical characteristics of RTS drink was analysed by Completely Randomized Design (CRD) before and during storage, whereas, data pertaining to the sensory evaluation were analyzed by using Randomized Block Design (RBD). The experiment for recipe standardization was replicated three times and for storage studies five times.

RESULTS AND DISCUSSION

Standardization of recipe for the preparation of wild prickly pear drink

Data on sensory characteristics of different recipes of wild prickly pear drink given in Table 2 indicate that the highest (8.31) colour score was obtained in recipe T_8 which was statistically at par with T_3, T_4 and T_7 and lowest (7.99) in T_1. The recipe T_3 obtained maximum body score as 8.40 and minimum (7.01) in T_1 which was statistically at par with T_5. The highest score (8.66) of taste was also awarded to T_3 while T_7 got the lowest (6.43) which was statistically at par with T_1 and T_8. The maximum (7.37) score of aroma was obtained in recipe T_8 which was statistically at par with T_3, T_4 and T_7, and minimum score (7.13) was awarded to recipe T_1. The highest score (8.26) of overall acceptability was awarded to recipe T_3 and the lowest (6.63) to T_1. From the above results it was concluded that the recipe with 14 per cent juice and 12 °B TSS (T_3) was found to be best on the basis of sensory characteristics.

Storage of wild prickly pear drink

Physico-chemical characteristics

There was a significant decrease in red, yellow and blue TCU (Figure 1a, 1b and 1c) of wild prickly pear drink during storage which might be due to degradation of betalains (betacyanins and betaxanthins) pigment. However, these pigments degraded at slower rate in low temperature, hence less decrease was observed in refrigerated conditions. Less decrease in colour units of drink packed in glass bottle than PET bottle was observed because of slower rate of chemical reactions in product packed in glass bottle as a result of difference in their thermal conductance properties. Similar decreasing trend of red, yellow and blue colour units has been reported by Thakur *et al.* (2017) in box myrtle drink and Hamid *et al.* (2017) in mulberry drink during storage. Apparent viscosity of wild prickly pear drink in terms of flow rate increased (Figure 1d) significantly during the storage period. Increase in apparent viscosity may be due to the increase in strain and shearing rate and decrease in the flow index of the product as a result of increase in TSS and soluble sugars. As the flow index decreases it helps to develop pseudo plasticity and increased the apparent viscosity (Bal *et al.*, 2014). Other reason could be the precipitation of drink caused due to the interaction of sugars with phenols and proteins. Similar results have been reported by El-Mansy *et al.* (2005) in mango and papaya nectar and Thakur *et al.* (2018) in wild aonla RTS beverage.

Slight increase was experienced in TSS of wild prickly pear drink (Figure 1e) during storage which might be due to the hydrolysis of polysaccharides into monosaccharides and soluble disaccharides. There was a gradual increase in reducing sugars (Figure 1f) of wild prickly pear which might be attributed due to the hydrolysis of starch into sugars. However, more increase in reducing sugars was found in drink stored under ambient conditions as compared to refrigerated storage conditions due to the faster rate of reactions because of high temperature in ambient conditions. As far as the packaging material is concerned, more increase in sugars recorded in drink packed in PET bottle as compared to glass bottle might be due to faster rate of chemical reactions in the product packed in PET bottle as a result of their thermal conductance properties. The above results are similar to the findings of Satkar *et al.* (2013) in bitter gourd ready-to serve beverage, Dhiman *et al.* (2017) in pumpkin based RTS beverage and Bhatt *et al.* (2020) in wild jamun beverage.

The titratable acidity of drink (Figure 1g) showed a slight decrease during storage and this decrease might be due to co-polymerization of organic acids with sugars and amino acids. There was a continuous decrease in ascorbic acid content of drink with advancement of storage period (Figure 1h), however, decrease was significantly lower under refrigerated conditions as compared to ambient conditions. Decrease in ascorbic acid content during storage might be due to its degradation into dehydro-ascorbic acid or furfural. Ascorbic acid is highly sensitive to heat, therefore its degradation was more in ambient conditions. Similar findings have been reported by Sharma *et al.* (2019) in Apple-Whey Based RTS Beverage and Bhatt *et al.* (2020) in wild jamun beverage.

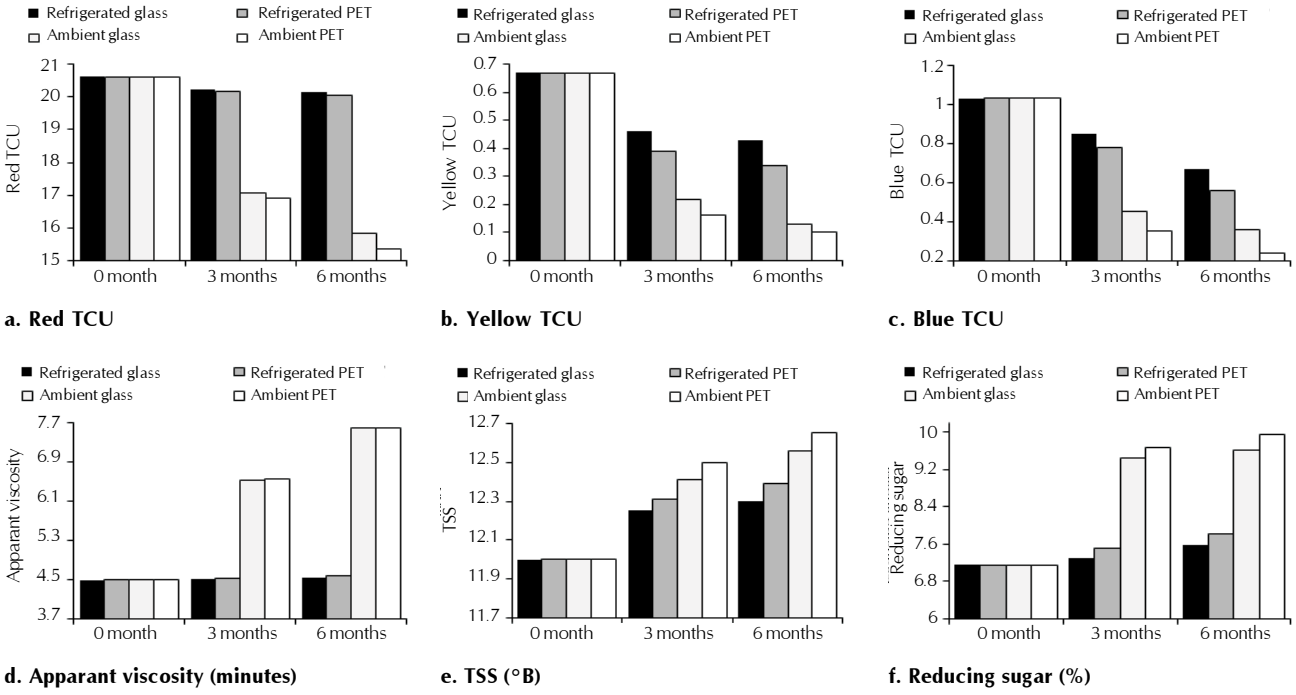
A significant decrease in betalains (betacyanins and betaxanthins) (Figure 1i and 1j) content of drink was recorded during the storage and more retention was observed under refrigerated storage conditions than ambient conditions. Loss of betalains in drink might be due to their high susceptibility to auto oxidative degradation and poor stability during storage. The possible changes that betalains may undergo during degeneration such as breakdown of the aldimine bond, dehydrogenation, deglycosylation and isomerisation which leads to decrease in the betalains content during storage (Khan, 2016). Similar observations have been reported by Herbach *et al.* (2007) in purple pitaya (*Hylocereus polyrhizus* L.) juice.

Table 1: Treatment detail of wild prickly pear drink

Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Juice (%)	10	12	14	16	10	12	14	16
TSS (°B)	12	12	12	12	15	15	15	15

Table 2: Sensory characteristics (scores) of different recipes of wild prickly pear drink

Treatment	Colour	Body	Taste	Aroma	Overall acceptability
T_1	7.99	7.01	6.70	7.13	6.63
T_2	8.10	7.17	7.23	7.20	7.20
T_3	8.26	8.40	8.66	7.33	8.26
T_4	8.29	7.37	7.73	7.36	7.80
T_5	8.01	7.02	7.86	7.16	7.16
T_6	8.11	8.13	8.03	7.22	7.60
T_7	8.28	7.28	6.43	7.35	7.23
T_8	8.31	7.30	6.53	7.37	7.16
$CD_{0.05}$	0.07	0.08	0.41	0.14	0.89



a. Red TCU **b. Yellow TCU** **c. Blue TCU**

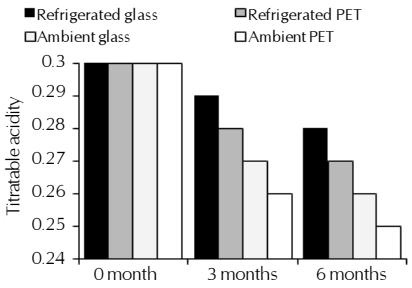
d. Apparant viscosity (minutes) **e. TSS (°B)** **f. Reducing sugar (%)**

Figure 1 (a-f): Effect of storage on physico-chemical characteristics of wild prickly pear drink

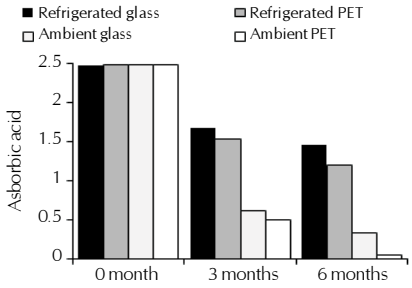
A gradual decrease in total phenols (Figure 1k) content of drink was observed during storage, which was slower under refrigerated storage conditions than ambient conditions. Significant decrease in total phenol content during storage might be due to their involvement in the formation of polymeric compounds complex formation of phenols with protein. A gradual decrease in antioxidant activity (Figure 1l) of drink was observed during storage, which was slower under refrigerated storage conditions than ambient conditions. Significant decrease in antioxidant activity during storage might be due to degradation of betalains and ascorbic acid during storage period as suggested by Mgaya-Kilima *et al.* (2015) in roselle-mango blended juice that loss in antioxidant activity might be due to degradation of anthocyanins. Nearly, similar observations for above parameters were recorded by Yadav *et al.* (2014) in guava-mango drink, Thakur and Thakur (2017) in box myrtle squash and Sharma *et al.* (2019) in Apple-Whey Based RTS Beverage.

Sensory characteristics of wild prickly pear drink during storage

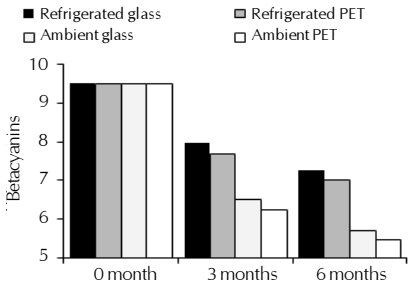
The colour, body, taste, aroma and overall acceptability (Figure 2 and 3) scores of drink decreased significantly during storage. Decrease in colour scores during storage might be due to degradation of betalains pigment (betacyanins and betaxanthins) and browning caused by co-polymerization of organic acids of the product and this might have led the judges to award the lower scores during storage. The possible reason for decrease in body scores might be due to the formation of precipitates in the product as a result of interactions between



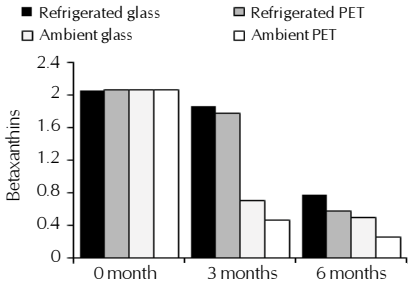
g. Titrable acidity (%)



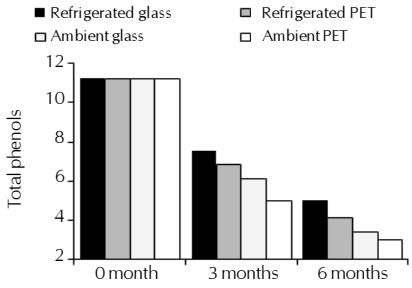
h. Ascorbic acid (mg/100 ml)



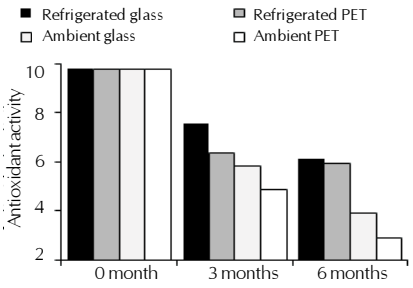
i. Betacyanins (mg/100 ml)



j. Betaxanthins (mg/100 ml)



k. Total phenols (mg/100 ml)



l. Antioxidant activity (%)

Figure 1 (g-l): Effect of storage on physico-chemical characteristics of wild prickly pear drink

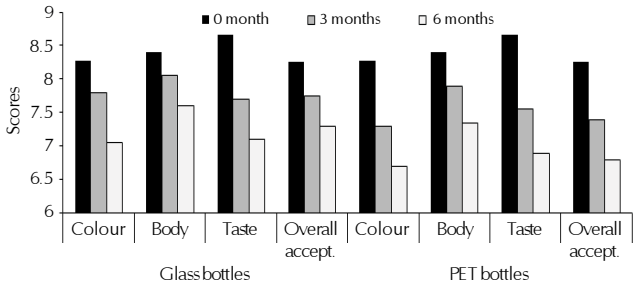


Figure 2: Effect of storage conditions on sensory characteristics of wild prickly pear drink under ambient temperature conditions

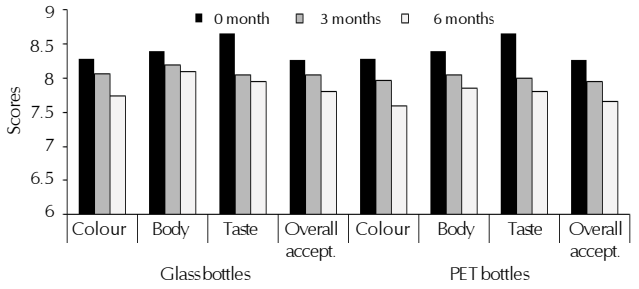


Figure 3: Effect of storage conditions on sensory characteristics of wild prickly pear drink under refrigerated temperature conditions

phenols and protein as well as the formation of cation complexes with phenols during storage. The possible reason for decrease in taste scores might be due to the loss of sugar-acid blend responsible for taste during storage. There was a decrease in overall acceptability scores of drink during storage, which might be due to the loss in appearance, flavour compounds and uniformity of the product. These above results are in conformity with the findings of Akhtar *et al.* (2013) in pomegranate drink, Dhiman *et al.* (2017) in pumpkin based RTS beverage, Thakur *et al.* (2018) in wild aonla RTS beverage and Sharma *et al.* (2020) in low calorie Apple-Whey Based RTS Beverage.

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