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Development of spiced squash (appetizer) from wild prickly pear (*Opuntia dillenii* Haw.) and its quality evaluation during storage

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Abstract
Wild prickly pear (*Opuntia dillenii* Haw.) is one of the wild fruit with great importance because of its high antioxidants, colour pigments and other quality parameters besides its medicinal properties. In India, there are only a limited number of reports pertaining to utilization of this fruit which further lack the development of value added novel products. So, the present studies were carried out for the development of spiced squash or appetizer from wild prickly pear fruit and its quality evaluation during storage. Different combinations of fruit juice (25, 30, 35 and 40 %) and sugar syrup (40 and 45 °B) were tried to standardize a proper combination for appetizer. The appetizer prepared by using the best recipe with 35 % juice, 45 °B TSS (Total soluble solids) and 1.20 % acidity was packed in two packaging materials viz. glass and PET (Polyethylene terephthalate) bottles which were further stored for six months under ambient and refrigerated temperature conditions. Appetizer packed in glass as well as in PET packaging material can be stored successfully for a period of six months under both the temperature conditions. However, various quality parameters of appetizer were retained higher in glass bottles stored under refrigerated storage conditions.

Keywords: Appetizer, *Opuntia dillenii* Haw., Spiced squash, Storage, Wild prickly pear

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 centre of origin is in Mexico, from where it got distributed throughout American hemisphere, Mediterranean basin, Middle East, South Africa, Australia and India (Zorgui *et al*., 2008). The two species of cactus *viz. Opuntia dillenii* Haw. and *O. chlorotica* Engelm. are known as prickly pear which are found in abundance upto 1500 metres above mean sea level. The *O. dillenii* Haw. is known popularly for its fruits which are edible and sweet, containing sufficient quantity of sugars, with a pleasant blend of acidity (Parmar and Kaushal, 1982; Thakur *et al*., 2012). This fruit consists of various antioxidant compounds like ascorbic acid, phenolics, betalains, flavonoids, lactones, terpenoids and alkaloids which are well known for their health-related properties. Cactus fruit being rich source of antioxidant compounds helps in treating many diseases like diabetes, hypertension, hypercholesterolemic, rheumatic pain, gastric mucosa diseases and asthma (Osuna-Martínez *et al*., 2014). The juice of wild prickly pear fruits has high fibre content and it helps to reduce blood sugars and plasma cholesterol levels (Fernandez *et al*., 1992). So, keeping in view its availability in the barren land and importance with respect to its quality characteristics, the present studies were carried out for the development of appetizer from wild prickly pear, *O. dillenii* and its quality evaluation during storage.

MATERIALS AND METHODS

Raw materials and extraction of juice: The mature fruits of *O. 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 appetizer. 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 appetizer: For the preparation of appetizer eight different treatment combinations were tried by mixing wild prickly pear juice with sugar syrup in different concentrations (T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8) as given in Table 1. Constant amount of spice extract was used for the preparation of appetizer (Thakur *et al*., 2016). Citric acid was used as an acidulant in all the treatment combinations to get the desirable acidity level in the appetizer (1.20 %). At the end of product preparation sodium benzoate (600 ppm) was added as preservative in all the treatments.

Physico-chemical analysis: The Red and Yellow TCU (Tintometer colour units) of wild prickly pear appetizer was observed with Lovibond Tintometer whereas, the estimation of other physico-chemical characteristics (TSS, titratable acidity, sugars and ascorbic acid content) was carried out by standard procedures of Ranganna (1997). Ostwald viscometer was used for the determination of apparent viscosity of the appetizer (flow rate in minutes). Betalains were estimated photometrically according to Castellanos–Santiago and Yahia (2008). Total phenols content and antioxidant activity (Free radical scavenging activity) of the samples was measured as per Folin-Ciocalteu and spectrophotometric methods given by Singleton and Rossi (1965).

Sensory evaluation: The sensory evaluation of wild prickly pear appetizer was carried out by using nine point hedonic rating test (Amerine *et al*., 1965) and panel of ten judges (faculty members and students of the department of Food Science and Technology) was selected to evaluate the product for various sensory characteristics (Colour, body, taste, aroma and overall acceptability).

Statistical analysis: Completely Randomized Design (CRD) and Randomized Block Design (RBD) were followed for analyzing the data on physico-chemical characteristics and sensory evaluation of the wild prickly pear appetizer, respectively (Cochran and Cox, 1967; Mahony, 1985). The experiment for recipe standardization was replicated three times whereas; during storage studies it was replicated five times.

RESULTS AND DISCUSSION

Standardization of recipe for the preparation of wild prickly pear appetizer: The mean colour score of appetizer was obtained highest (7.35) in recipe T_8 and T_4 which was statistically at par with T_3 and T_7, while the lowest (7.21) was awarded to T_1. The highest body score of 8.02 was obtained in the recipe T_7 and minimum (7.04) in T_8. The highest (8.13) taste score was awarded to the recipe T_7 while the recipe T_1 (7.03) got the lowest score. The maximum (7.40) score for aroma was recorded in recipe T_8 and minimum (7.20) was recorded in T_1 which was statistically at par with T_2, T_5 and T_6. The highest score (8.01) of overall acceptability was obtained in T_7 and lowest (6.81) in T_1. Data given in Table 2 shows a significant effect of juice-acid-syrup blend on sensory scores of different recipes of wild prickly pear appetizer. The higher colour and aroma scores for recipes T_8 might be due highest juice content as compared to other recipes, while recipe T_7 obtained highest taste and body score which might be due to best combination of juice-syrup and sugar-acid-spices-juice blend in this recipe. The higher overall acceptability scores for recipe T_7 might be due to better combination of juice-acid-spices-syrup blend coupled with attractive colour and body of the product.

Storage of wild prickly pear appetizer

Physico-chemical characteristics: There was a significant decrease in red and yellow TCU (Tintometer colour units) of wild prickly pear appetizer during storage (Fig. 1a and 1b) which might be due to degradation of betalains (betacyanins and betaxanthins) pigment. The higher degradation of betalains occurred at ambient storage conditions as compared to refrigerated conditions due to the light and high temperature. The higher retention of red and yellow colour units of appetizer packed in glass bottle was due to the slower rate of various degradation reactions and slower conduction of heat to the product as compared to the PET bottle. Suryawanshi *et al.* (2008), Thakur *et al.* (2016) and Thakur *et al*. (2018a) have reported a similar trend of decrease in TCU (red and yellow) during storage of pomegranate juice, box myrtle appetizer and wild prickly pear squash. Apparent viscosity of wild prickly pear appetizer increased (Fig. 1c) significantly during the storage. The increase in strain and shearing rate along with the decrease in the flow index of the product led to develop pseudo plasticity which ultimately increased the apparent viscosity of the product (Bal *et al.,* 2014). The other possible reason could be the formation of precipitates in appetizer which was caused due to the interaction of sugars with phenols and proteins. The increase in apparent viscosity of appetizer was observed higher in under ambient temperature conditions as compared to refrigerated conditions. Similar results of increase in apparent viscosity have been reported by El-Mansy *et al.* (2005) in mango and papaya nectar and Hamid and Thakur (2017) in mulberry appetizer during storage.

There was a slight increase in TSS content of appetizer during the storage period (Fig. 1d) which might be due to hydrolysis of various polysaccharides into simple monosaccharides and soluble disaccharides (Gould, 1983). The higher increase in TSS was found in appetizer stored under ambient conditions as compared to refrigerated which

Table 1. Treatment details of appetizer.

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Juice (%)	25	30	35	40	25	30	35	40
TSS (^oB)	40	40	40	40	45	45	45	45

TSS: Total soluble solids

Table 2. Sensory characteristics (scores) of different recipes of wild prickly pear appetizer.

Treatments	Colour	Body	Taste	Aroma	Overall acceptability
T_1	7.21	7.12	7.03	7.20	6.81
T_2	7.25	7.16	7.11	7.25	7.02
T_3	7.31	7.66	7.50	7.30	7.30
T_4	7.33	7.50	7.63	7.36	7.53
T_5	7.23	7.30	7.05	7.23	6.92
T_6	7.26	7.80	7.16	7.26	7.14
T_7	7.32	8.02	8.13	7.31	8.01
T_8	7.35	7.04	7.30	7.40	7.21
$CD_{0.05}$	0.07	0.13	0.12	0.07	0.10

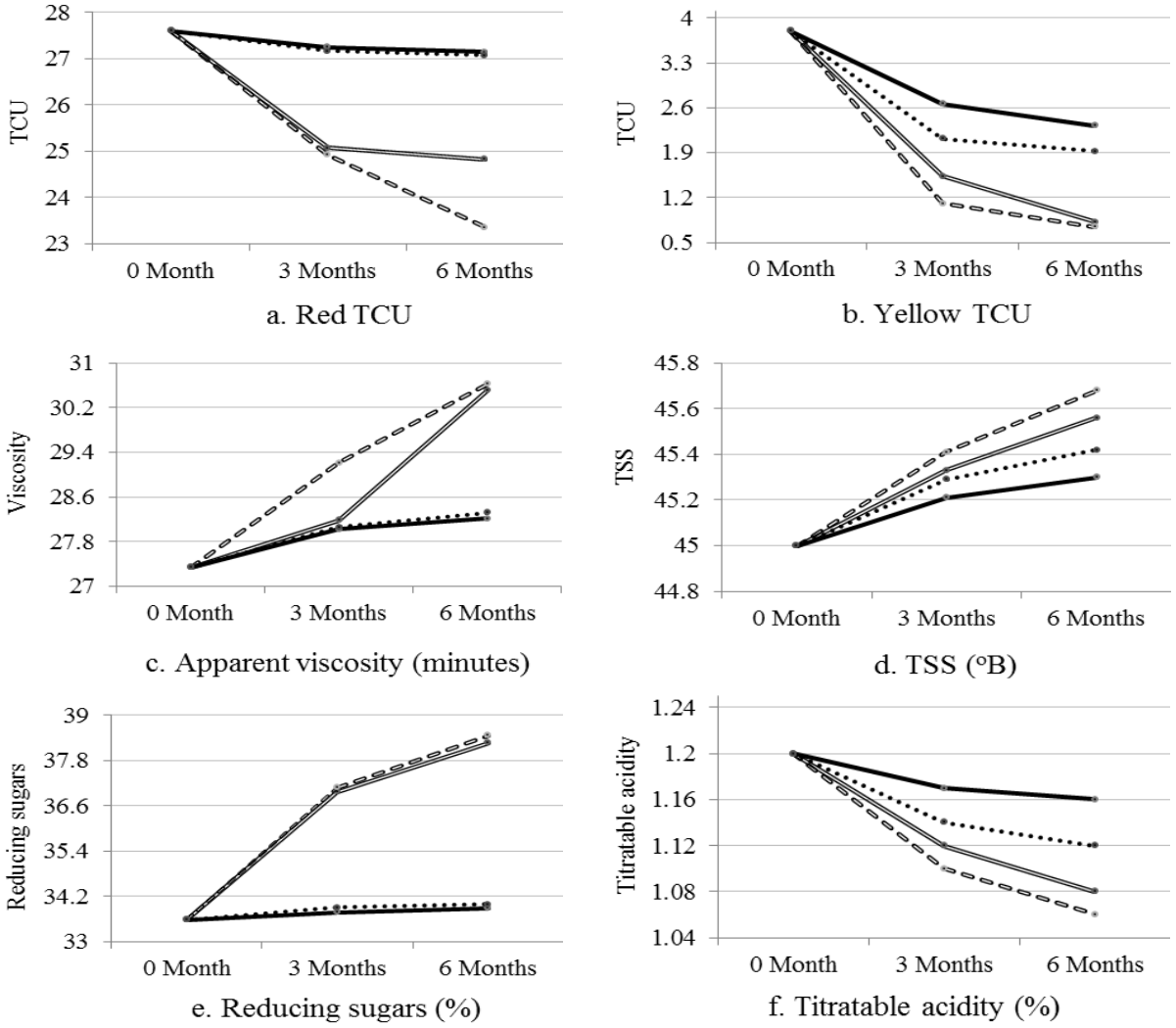

Fig. 1 (a-f). *Effect of storage on physico-chemical characteristics of wild prickly pear appetizer.*

might be due to the faster reaction rates because of the high temperature in ambient conditions. The reducing sugars content of appetizer (Fig. 1e) increased significantly during storage, which was comparatively less in refrigerated storage conditions than in ambient conditions. The possible reason for this increase in reducing sugars content might be due to hydrolysis of starch into sugars.

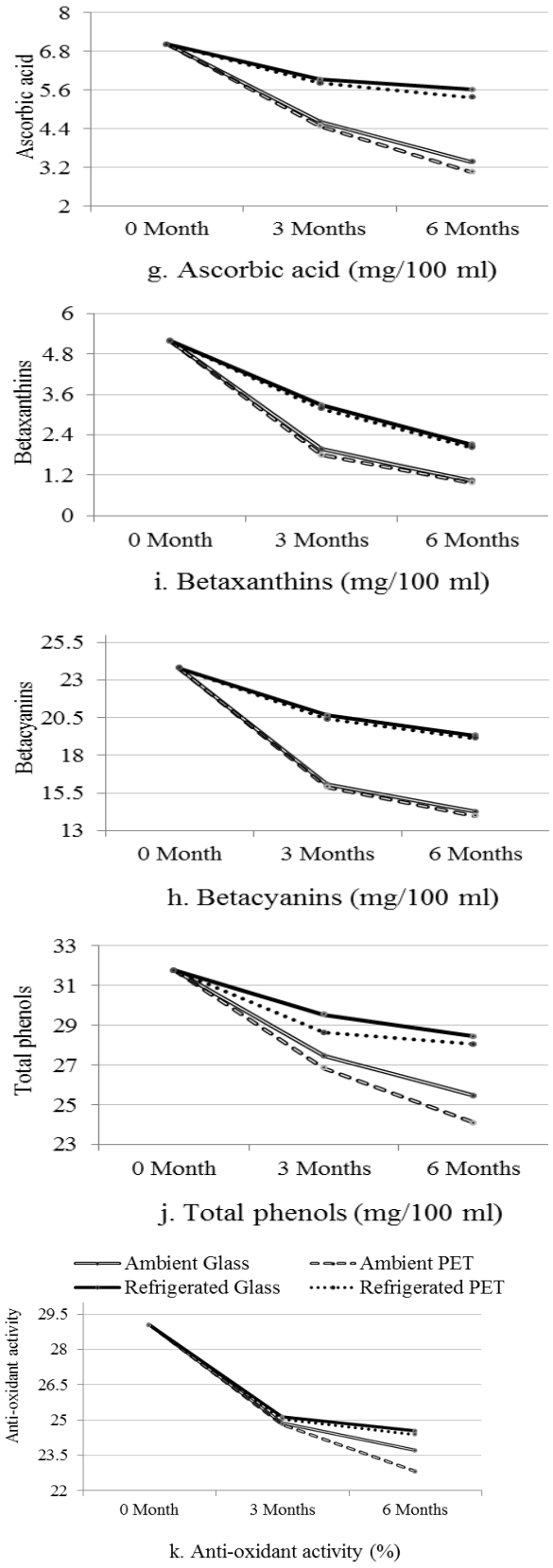

Fig. 1 (g-k). *Effect of storage on physico-chemical characteristics of wild prickly pear appetizer.*

The increase in reducing sugars was recorded higher under ambient conditions which might be due to the faster rate of reactions due to the prevalence of high temperature in ambient conditions. Similar trend of increase in TSS and reducing sugars content has been reported by Sharma *et al.* (2002), Selvamuthukumaran and Khanum (2013) and Thakur *et al*. (2018b) in plum appetizer, spiced seabuckthorn squash and wild aonla appetizer, respectively.

The titratable acidity of appetizer decreased slightly during storage (Fig. 1f) and this decrease could be attributed to the chemical interactions of organic acids of appetizer with sugars and amino acids. There was a continuous decrease in ascorbic acid content of appetizer with advancement of storage period (Fig. 1g), which might be due to its degradation into dehydro-ascorbic acid or furfural. As the ascorbic acid is highly sensitive to heat, therefore its degradation was reported higher in ambient conditions than refrigerated conditions. The results for above parameters during storage of appetizer are in accordance with the findings of Sharma *et al.,* (2002) in plum appetizer, Deka *et al*., (2004) in lime-aonla appetizer, Selvamuthukumaran and Khanum (2013) in seabuckthorn appetizer and Thakur *et al.,* (2016) in box myrtle appetizer.

A significant decrease in betalains (betacyanins and betaxanthins) content of appetizer was recorded during the storage (Fig. 1h and 1i) higher retention was observed under low temperature storage conditions. The loss of betalains in appetizer might be due to their high susceptibility to photo oxidative degradation and poor stability during storage. The possible changes that betalains may undergo during storage might be due to the breakdown of the aldimine bond, dehydrogenation, deglycosylation and isomerisation which lead to decrease in the betalains content during storage (Khan, 2016). Similar observations have been reported by Kathiravan *et al*. (2014) in beet root juice, Kathiravan *et al*. (2015) in beet root-passion blended juice.

A gradual decrease in total phenols content of appetizer was observed during storage (Fig. 1j) and the total phenols were retained higher under low temperature storage conditions. This decrease in total phenols content during storage might be due to the complexing of phenolic compounds with proteins which led to the subsequent precipitation and formation of polymeric compounds (Abers and Wrolstad, 1979). Similar observations for decrease in total phenols have also been reported by Selvamuthukumaran and Khanum (2013) in seabuckthorn appetizer and Thakur and Thakur (2017) in box myrtle squash during storage. The antioxidant activity of appetizer decreased significantly (Fig. 1k) during storage which might be due to the degradation of betalains

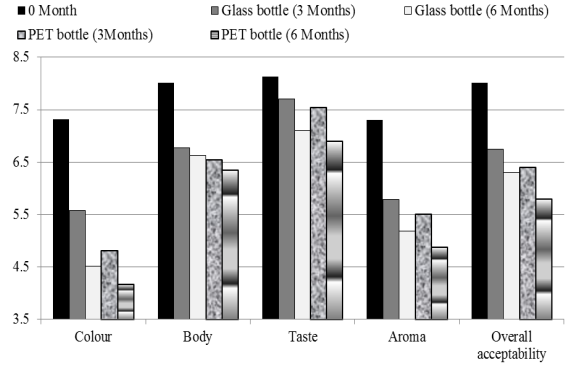

Fig. 2. *Effect of storage conditions on sensory characteristics of wild prickly pear appetizer under ambient temperature conditions.*

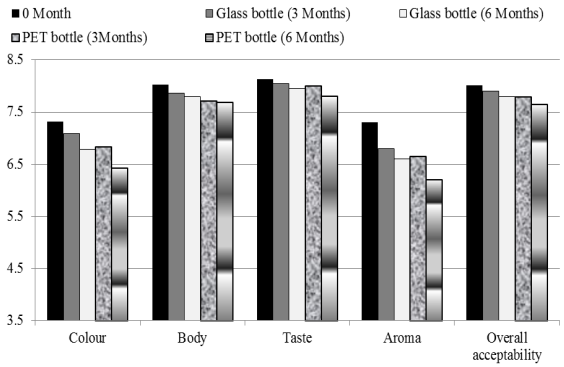

Fig. 3. *Effect of storage conditions on sensory characteristics of wild prickly pear appetizer under refrigerated temperature conditions.*

and ascorbic acid during storage period as reported by Mgaya-Kilima *et al.* (2015) in roselle-mango blended juice. Nearly, similar observations were recorded by Elez-Martinez *et al*. (2006) in thermally treated orange juice and Kathiravan *et al*. (2015) in beetroot-passion blended juice.

Sensory characteristics: The colour, body, taste, aroma and overall acceptability scores of appetizer decreased significantly during storage (Fig. 2 and 3). The various browning reactions and copolymerization of organic acids of the product led to decrease in colour scores which might have led the judges to award the lower scores of colour during storage. The formation of precipitates in the product as a result of interactions between phenols and proteins decreased the body scores of the product during storage. There was a continuous decrease in taste scores of wild prickly pear appetizer during storage and the loss of sugar-acid-salt blend might be responsible for this decrease in the taste of the product. The taste scores were retained higher in appetizer stored under low temperature conditions which might be due to slow reaction rates which contributes towards the change in original sugar-acid-salt blend. The loss of various volatile aromatic compounds during storage might have led the judges to award the lower aroma scores to the product with respective storage intervals. The appetizer packed in glass bottle retained higher aroma scores than PET bottle during storage which might be due to slower degradation of volatile aromatic compounds in glass bottles. The overall acceptability scores of appetizer decreased with the advancement of storage period which might be due to the loss in colour, body, flavour compounds and uniformity of the product during storage. The decrease in various sensory characteristics scores was more pronounced under ambient storage conditions than refrigerated storage conditions which might be due to the better quality of the appetizer during storage as a result of slower rate of deteriorative chemical reactions. These above results for various sensory parameters are in conformity with the findings of Sharma *et al*. (2002) in plum appetizer, Hamid and Thakur (2017) in mulberry appetizer and Thakur *et al.* (2017) in wild pomegranate appetizer.

Conclusion

Wild prickly pear appetizer was developed by mixing 35 per cent juice, 45 ^{o}B TSS and with a spice extract of cardamom (1 g), cumin (2.5 g), black pepper (2.5 g), common salt (5 g), black salt (5 g) then straining and mixing the extract in 200 ml of water, along with mint extract (10 ml) and ginger juice (15 ml). During six months of storage no much changes were observed in various physico-chemical and sensory parameters of appetizer. The wild prickly pear appetizer could be stored safely for a period of six months under both storage conditions (ambient and refrigerated) and packaging materials like PET and glass bottles. However, the best quality of this beverage could be maintained in glass bottle stored under refrigerated storage conditions as compared to PET bottle.

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