Development of spiced seabuckthorn \([Elaeagnus\ rhamnoides\ (L.)\ A.\ Nelson\ syn.\ Hippophae\ rhamnoides\ L.]\) mixed fruit squash

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Spiced seabuckthorn mixed fruit squash was developed by blending seabuckthorn juice with pineapple and grapes in varying proportions maintaining a constant total soluble solids, juice and acidity contents in the final product. Among all the blends, the seabuckthorn-pineapple combination exhibited the highest sensory scores. The shelf stability of the spiced squash samples was evaluated under ambient as well as at 37°C temperature conditions upto a period of 6 months. The physico-chemical properties of the spiced seabuckthorn-pineapple mixed fruit squash such as total soluble solids, reducing sugars and browning significantly increased during storage, while vitamin C, vitamin E, total phenols, total carotenoids, total anthocyanins and acidity contents significantly decreased. Accelerated temperature storage condition, i.e. 37°C pronounced more effect in terms of physico-chemical changes when compared to ambient temperature condition of the stored products. The spiced seabuckthorn-pineapple mixed fruit squash was acceptable upto 6 months under ambient temperature conditions when packed in PET bottles. The TPC count, yeast and mould count significantly reduced during entire period of storage, while spores and coliform count was found to be non detectable at both the storage conditions. The microbial load of stored spiced squash under these conditions was found to be within the acceptable limits.

**Keywords:** Spiced squash, Seabuckthorn, Physico-chemical characteristics, Sensory score, Anthocyanins, Functional foods

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Seabuckthorn (\(Elaeagnus\ rhamnoides\) (L.) A. Nelson syn. \(Hippophae\ rhamnoides\) L., Elaeagnaceae) is a unique plant currently being domesticated in several parts of the world. In India, it is distributed wildly in various parts of the Himalayan region like Lahul and Spiti valley of Himachal Pradesh, in Uttarakhand Himalaya it is found mainly in Bhagirathi Ghat, Sukki Ghat, Harsil Ghat, Gangotri Ghat, Mandakini Ghat, Alknanda Ghat, Jamuna Ghat, etc. It also grows in several countries like China, Russia, Britain, Germany, Finland, Romania, France, Nepal, Bhutan and Pakistan at an altitude of 2500-4300 m height\(^1\,\text{2}\). The plant is reported to have considerable medical value\(^3\), being useful for the treatment of skin disorders resulting from bed confinement, stomach and duodenal ulcers, cardiovascular diseases and perhaps growth of some tumors.

It is a deciduous shrub with yellow or orange fruits\(^4\). The fruits have been used since ancient times as a source of herbal medicines, health food and natural skin care agent. These beneficial effects have made seabuckthorn products desirable for medicinal and cosmetic purposes. The flavor of the fruit is like a sharp lemon and two valuable products obtained from fruit are juice and the seeds.

The juice is rich in suspended solids as well as natural antioxidants, viz. vitamin C, vitamin E, carotenoids, phenols and anthocyanins. Seabuckthorn products based on fruit pulp or juices contain more of these phytochemical and therefore they are considered to have therapeutic and chemo preventive benefits\(^3,5\).

Inspite of all these immense benefits the fruit is not readily liked due to its highly acidic taste, astringent and ’whey-like’ unpleasant flavor\(^6\). Due to these reasons its utilization in the preparation of food products is also limited. In the present study squash was prepared with judicious blending of seabuckthorn juice with other fruit juices with a dash of spices to mask the unpleasant flavor and further sensory characteristics and nutritive quality of the developed mixed fruit product were also evaluated.

**Methodology**

**Raw materials**

Seabuckthorn (\(Elaeagnus\ rhamnoides\) (L.) A. Nelson syn. \(Hippophae\ rhamnoides\) L.), common
seabuckthorn, is a species of flowering plant in the family Elaeagnaceae, native to fixed dunes and sea cliffs in Europe and Asia. It is a spiny deciduous shrub. The oval or slightly roundish fruits grow in compact grapes varying from pale yellow to dark orange and weighing from 0.2-1 gm. The berries were traditionally used since ancient times as a source of herbal medicines, health food and natural skin care agent. They were brought from Field Research Laboratory (Leh, Himachal Pradesh, India), by airlifting and kept frozen at (-20 °C) until further studies.

**Ananas comosus** (L.) Merr., common pineapple, is a species of flowering plant in the family Bromeliaceae, native to tropical America. It is an herbaceous perennial with edible multiple fruit consisting of coalesced berries. It usually produces up to 200 flowers and each flower in the inflorescence produces a fruit, but these mature into a single mass and they may be cultivated from a crown cutting of the fruit. The fruit and roots are traditionally used by some peoples as anti-inflammatory, proteolytic agent, and a root decoction for diarrhea.

**Vitis vinifera** L., common grape, is a species of flowering plant in the family Vitaceae, native to Mediterranean and Central Asia. It is a deciduous fruit that grow in clusters of 15-300, and can be crimson, black, dark blue, yellow, green, orange and pink. They are typically of ellipsoid shape resembling a prolate spheroid. Traditionally grapes can be eaten raw or they can be used for making wine, jam, juice, jelly, grape seed extract, raisins, vinegar and grape seed oil. They can improve metabolism and have diuretic, anti inflammation, light laxative and inducing perspiration effect. These fruits were purchased locally.

**Extraction of juice from the fruits**

The seabuckthorn juice was obtained by crushing the seabuckthorn berries in a blender, squeezing in muslin cloth and sieving through 30 mesh. The other fruits were sorted, washed, peeled, sliced and cored (in case of pineapple) with stainless steel knives, crushed in blender and sieved through 30-mesh to get fine and clear juices.

**Development of spiced seabuckthorn mixed fruit squash**

The spiced seabuckthorn mixed fruit squash were developed as per the standard procedure, as given in the flow chart (Fig. 1). The seabuckthorn juice was blended with pineapple and grape juice at the ratio of 40:60, 50:50, 60:40, 70:30, 100:0 and 0:100 for making spiced squashes. The ingredients viz. acidified sugar syrup was prepared separately by incorporating required amount of citric acid to sugar syrup of 45 °brix, so that the final squash had constant acidity of 1.10% and it was then strained through muslin cloth, cooled and added to the requisite quantity of juice (i.e. 300 gm). Pre-determined quantities of spices, viz. cardamom powder, black pepper powder, cumin powder, black salt powder and common salt (@ 1.5% each) were processed by extracting them in water (125 ml), extracts were strained and added to the mixture of juice and sugar syrup and they were mixed up well. Finally mint and ginger extracts (10 & 15 ml) were added along with permitted levels of sodium benzoate (0.6 gm) to the squash and once again mixed thoroughly. The squash was hot filled in pre cleaned, sterilized PET bottles, capped, sealed, labeled and kept for further analysis. The organoleptically rated best blend was chosen for storage studies and kept under ambient and 37°C temperature conditions for a period of 6 months to evaluate its shelf stability.
Statistical analysis of means using Duncan’s test Redmond, WA, USA) and the paired comparisons Microsoft Excel (Office 2000, Microsoft Corporation, method enumerated by serial dilution as per the standard (TPC), coliform, spores, yeasts and moulds wereupto a period of 180 days. The total plate count samples was analyzed initially and once in 60 days, Microbial analysis evaluation extremely to 1 for dislike extremely was used for Hedonic quality assurance scale with 9 for like acceptability of the given products. A common evaluate for colour, taste, aroma, body and overall order to the judges. The judges were asked to samples were presented one at a time in random Physico-chemical analysis Proximate composition, viz. moisture, fat, protein, carbohydrate, fibre and minerals were estimated as per the standard method. Total soluble solids were determined using hand refractometer (Erma, Tokyo, Japan). The titrable acidity was estimated as per the standard method. The method of Lane and Eynon was followed for the determination of total and reducing sugar. The 2, 6-dichlorophenol-indophenol titration method was used for the estimation of ascorbic acid content. The total carotenoids were determined using an ultra violet–visible recording spectrophotometer at 450 nm (UV 1601, Shimadzu Corp, Columbia, USA) as per the standard method. The total anthocyanins were estimated as per the standard procedure, spectrophotometrically at 535 nm. The total phenol content was measured with the Folin-Ciocalteu’s reagent, spectrophotometrically according to the standard procedure. Vitamin E was estimated using Ferric Chloride-Dipyridyl, spectrophotometrically according to method. The degree of browning in the squash sample was estimated as per the standard method.

Sensory evaluation
A panel with 15 trained judges, aged 30-55 yrs, with sensory evaluation experience in fruit products, evaluated the different seabuckthorn squashes. The product was diluted with water at the ratio of 1:3 and converted into RTS form before conducting evaluation. The coded (3 digit) samples were presented one at a time in random order to the judges. The judges were asked to evaluate for colour, taste, aroma, body and overall acceptability of the given products. A common Hedonic quality assurance scale with 9 for like extremely to 1 for dislike extremely was used for evaluation.

Microbial analysis
The microbial load in the stored spiced squash samples was analyzed initially and once in 60 days, upto a period of 180 days. The total plate count (TPC), coliform, spores, yeasts and moulds were enumerated by serial dilution as per the standard method.

Statistical analysis
The results were subjected to ANOVA using the Microsoft Excel (Office 2000, Microsoft Corporation, Redmond, WA, USA) and the paired comparisons of means using Duncan's test.
Table 1—Physico-chemical characteristics of the different types of juice used for the preparation of spiced seabuckthorn mixed fruit squash

<table>
<thead>
<tr>
<th>Physico-chemical characteristics</th>
<th>SO</th>
<th>PO</th>
<th>GO</th>
<th>SP1</th>
<th>SG1</th>
<th>SP2</th>
<th>SG2</th>
<th>SP3</th>
<th>SG3</th>
<th>SP4</th>
<th>SG4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total soluble solids (% brix)</td>
<td>10.33±</td>
<td>14.06±</td>
<td>13.83±</td>
<td>12.50±</td>
<td>12.43±</td>
<td>12.16±</td>
<td>12.06±</td>
<td>11.76±</td>
<td>11.73±</td>
<td>11.40±</td>
<td>11.36±</td>
</tr>
<tr>
<td>Titratable acidity (%)</td>
<td>0.57±</td>
<td>0.11±</td>
<td>0.28±</td>
<td>0.50±</td>
<td>0.51±</td>
<td>0.28±</td>
<td>0.11±</td>
<td>0.46±</td>
<td>0.40±</td>
<td>0.36±</td>
<td>0.32±</td>
</tr>
<tr>
<td>Reducing sugars (%)</td>
<td>0.08±</td>
<td>0.32±</td>
<td>0.40±</td>
<td>0.17±</td>
<td>0.56±</td>
<td>0.23±</td>
<td>0.96±</td>
<td>0.27±</td>
<td>0.24±</td>
<td>0.43±</td>
<td>0.34±</td>
</tr>
<tr>
<td>Vitamin C (mg /100gm)</td>
<td>53.09±</td>
<td>11.98±</td>
<td>16.86±</td>
<td>28.42±</td>
<td>31.35±</td>
<td>32.53±</td>
<td>34.97±</td>
<td>36.64±</td>
<td>38.59±</td>
<td>40.75±</td>
<td>42.22±</td>
</tr>
<tr>
<td>Vitamin E (mg /100gm)</td>
<td>361.7±</td>
<td>0.7±</td>
<td>159.9±</td>
<td>144.6±</td>
<td>240.67±</td>
<td>180.86±</td>
<td>260.85±</td>
<td>217.03±</td>
<td>281.02±</td>
<td>253.20±</td>
<td>301.19±</td>
</tr>
<tr>
<td>Total carotenoids (µg /100gm)</td>
<td>±1.15±</td>
<td>±0.4±</td>
<td>±2.49±</td>
<td>±2.96±</td>
<td>±2.50±</td>
<td>±2.24±</td>
<td>±1.98±</td>
<td>±2.50±</td>
<td>±2.49±</td>
<td>±1.93±</td>
<td>±1.10±</td>
</tr>
<tr>
<td>Total anthocyanins (µg /100gm)</td>
<td>±0.51±</td>
<td>±0.63±</td>
<td>±1.60±</td>
<td>±0.68±</td>
<td>±0.82±</td>
<td>±0.79±</td>
<td>±0.96±</td>
<td>±1.02±</td>
<td>±1.43±</td>
<td>±0.85±</td>
<td>±1.91±</td>
</tr>
<tr>
<td>Total phenols (mg /100gm)</td>
<td>±3.49±</td>
<td>±1.97±</td>
<td>±2.32±</td>
<td>±3.13±</td>
<td>±1.92±</td>
<td>±2.40±</td>
<td>±2.49±</td>
<td>±2.01±</td>
<td>±2.15±</td>
<td>±2.00±</td>
<td>±2.22±</td>
</tr>
</tbody>
</table>

SO, 100% Seabuckthorn juice; PO, 100% Pineapple juice; GO, 100% Grape juice; SP1, 40% Seabuckthorn juice + 60% pineapple juice; SG1, 40% Seabuckthorn + 60% grape juice; SP2, 50% Seabuckthorn juice + 50% pineapple juice; SG2, 50% Seabuckthorn juice + 50% grape juice; SP3, 60% Seabuckthorn juice + 40% pineapple juice; SG3, 60% Seabuckthorn juice + 40% grape juice; SP4, 70% Seabuckthorn juice + 30% pineapple juice; SG4, 70% Seabuckthorn juice + 30% grape juice. Mean ± SD of triplicate analysis. Mean values in the same row bearing a common superscript do not differ significantly (P>0.05).

Sensory evaluation of spiced seabuckthorn mixed fruit squash

Mean scores of the organoleptic assessment (Table 2) showed that the spiced squash made from 70% seabuckthorn + 30% pineapple blend (SPS2) had the highest organoleptic values. In contrast, the spiced squash made from 100% seabuckthorn (SSO) recorded the lowest values, this might be due to astringency and sourness which characterize the low sensory scores for taste, aroma, body and overall acceptability in the final product. Spiced 100% grape squash (SGO) exhibited the lowest score in colour. No significant differences in organoleptic characteristics were
found (p > 0.05) among spiced 40% seabuckthorn squash + 60% pineapple squash (SPS₁), spiced 40% seabuckthorn squash + 60% grape squash (SGS₁), spiced 100% pineapple squash (PSO) and spiced 100% grape squash (GSO), spiced 50% seabuckthorn squash + 50% pineapple squash (SGS₂), spiced 50% seabuckthorn squash + 50% grape squash; SPS₂, Spiced 40% seabuckthorn squash + 40% pineapple squash; SPS₃, Spiced 50% seabuckthorn squash + 50% grape squash; SPS₃, Spiced 60% seabuckthorn squash + 40% pineapple squash; SPS₄, Spiced 70% seabuckthorn squash + 30% pineapple squash; SGS₄, Spiced 70% seabuckthorn squash + 30% grape squash. Mean ± SD of triplicate analysis. Mean values in the same row bearing a common superscript do not differ significantly (P>0.05).

Storage of the spiced seabuckthorn-pineapple mixed fruit squash (70:30)

Total soluble solids
The total soluble solids of the spiced squash increased to 40.68 and 41.02 °brix, after 6 months of storage at ambient temperature and at 37 °C, from an initial value of 40.16 °brix, respectively (Fig. 2a). The significant increase (p<0.05) in TSS could be due to the conversion of polysaccharides into simple sugars during storage. Sogi and Singh also reported an increasing trend in total soluble solids of kinnow squash during a period of 4 months storage under 37 °C temperature conditions.

Acidity
The initial acidity of the spiced squash was 1.17% and this decreased to 0.57 and 0.41%, after 6 months of storage at ambient temperature and 37 °C, respectively (Fig. 2b). This observation is in agreement with the results of Jain et al. who have also reported a decrease in acidity of litchi squash during period of nine months storage at ambient temperature. The decrease in acid content of the squash may be due to copolymerization of organic acids and loss of organic acids during storage. Decrease in acidity of the stored product at both the temperatures was significant at (p<0.05).

Total sugars and reducing sugars
The initial total sugar content of the spiced squash 32.09% decreased to 30.91 and 30.41% after 6 month of storage at ambient temperature and 37 °C, respectively, (Fig. 2c). This might be due to the reaction of sugars with amino acids and co-polymerization of sugars in the presence of acids which might slightly decrease the total sugar content in the stored product. Sharma et al. also reported a slight decrease in total sugar of the spiced plum squash during the period of 6 months storage at ambient temperature. The decrease was not significant at level of (p>0.05). The initial reducing sugar content of the spiced squash was 18.05% and it increased to 19.78 and 20.26% after 6 month of storage at ambient temperature and 37 °C, respectively (p<0.05) (Fig. 2d). The increase in reducing sugars might be due to hydrolysis or inversion of non-reducing sugars to reducing sugars. Sharma et al. also observed an increasing trend of reducing sugars in spiced plum squash during the period of 6 months storage at ambient conditions.
in reducing sugar (p<0.05) of the stored product at both the temperatures were noted.

**Vitamin C content**

Vitamin C is one of the important vitamins and it is required for the growth and maintenance of good health in human beings. The initial vitamin C content of the spiced squash was 6.72 mg/100 gm, which significantly decreased (p<0.05) to 3.15 and 2.23 mg /100 gm, after 6 months of storage at ambient temperature and at 37°C, respectively (Fig. 3a). This could be due to oxidation or degradation of ascorbic acid into dehydroascorbic acid, furfural and hydroxy furfural at above temperatures. The vitamin C loss accounted to 53% at ambient temperature after 6 months of storage, however when the storage temperature increased from ambient temperature to 37°C the loss also increased to 66.7% after 6 months storage period showing the least stability of vitamin C. Barwal et al.\(^\text{25}\) who have also reported an decreasing trend of vitamin C in plum seasoned squash at ambient temperature during period of 6 months storage.

**Vitamin E**

Vitamin E is an important dietary constituent, as it is essential in maintaining the stability and integrity of the cell membrane. This is an antioxidant and free radical scavenger and its presence has been linked to prevention of chronic diseases and premature ageing, cancer, cardiovascular diseases and strokes\(^\text{26}\). The initial vitamin E content of spiced squash sample was 64.56 mg /100 gm, which significantly decreased (P<0.05) to 38.73 and 21.95 mg /100 gm, after 6 months of storage at ambient temperature and 37°C, respectively (Fig. 3b). The loss of vitamin E accounts for 40% and 66% at ambient temperature and at 37°C, respectively after 6 months of storage. Ruiz and Medrano\(^\text{27}\) also reported the losses in the concentration of vitamin E during the storage of UHT- Processed milk at 30 and 40 °C after 3 months. This might be due to degradation, its sensitivity to oxidation, heat, its susceptibility to lipid auto oxidation and formation of hydroxymethyl furfural in the product might have contributed to the depletion of vitamin E content in stored product.

**Total carotenoids**

Carotenoids are important food constituents, owing to their colour and nutritional value as provitamin A apart from being strong antioxidants. The total carotenoids content of spiced squash 420.68 µg /100 gm initially decreased significantly (P<0.05) to 164.06 and 134.61 µg /100 gm, after 6 months of storage...
storage at ambient temperature and 37°C, respectively (Fig. 3c). These results indicate that a considerable loss in total carotenoids occurred during the storage period of 6 months. The loss in total carotenoids accounted for 61% under ambient and 68% under 37°C temperature conditions after 6 months of storage. Verma and Sastry\textsuperscript{14} also reported a loss in total carotenoids during the 6 months storage period of orange squash at similar temperatures.

**Total anthocyanins**

Anthocyanins are responsible for the attractive colour of the product and they have been recognized as important antioxidants\textsuperscript{28}. The initial total anthocyanins content of spiced squash 15.29 µg /100 gm decreased significantly (P<0.05) to 7.64 and 3.82 µg /100 gm, after 6 months of storage under ambient temperature and 37 °C, respectively (Fig. 3d). The loss in total anthocyanins accounted for 50% and 75% under ambient and at 37 °C temperature conditions respectively, after 6 months of storage period. This might be due to hydrolysis of anthocyanins at above storage conditions\textsuperscript{29}. Kannan and Susheela\textsuperscript{30} also reported a decreasing trend of anthocyanins in jamun squash during the storage period of 6 months at ambient temperature.

**Total phenols**

The total phenols content of the spiced squash was estimated to be 125.67 mg /100 gm initially and this was found to decrease significantly (p<0.05) to 62.83 and 28.90 mg /100 gm, after 6 months of storage at ambient temperature and 37°C, respectively (Fig. 3e). This data indicates that a considerable loss in total
phenols occurred during the storage period. The loss in total phenols accounted for 50% and 77% under ambient temperature and at 37°C, respectively, after 6 months of storage. Kannan & Susheela\textsuperscript{30} who have also reported a decreasing trend of total phenols in jamun squash during the period of 6 months storage at ambient temperature. This might be due to the sensitivity of the phenolic components to oxidation at these storage conditions.

**Browning**

Colour intensity (OD), a measure of degree of browning, increased significantly (p<0.05) from 0.124 to 0.372 and 1.029 OD, after 6 months of storage at ambient temperature and 37 °C, respectively (Fig. 3f). The increase in optical density indicated browning with advancement of storage period, which could be ascribed to oxidation and development of non-enzymatic browning (an amino acid sugar interaction) resulting in the formation of the dark pigment\textsuperscript{31,32}. Jain et al.\textsuperscript{31} also observed an increase in optical density of different fruit squashes during the period of 12 months storage at ambient temperature.

**Sensory evaluation of stored spiced seabuckthorn-pineapple mixed fruit squash**

The sensory scores of spiced seabuckthorn pineapple mixed fruit squash samples stored at ambient temperature and 37 °C in PET bottles are presented in Table 3. Initially the spiced seabuckthorn-pineapple mixed fruit squash had an overall acceptability score of 7.76, on a nine-point Hedonic scale and a score of 6.92, liked slightly was taken as the limit of shelf life in the storage studies. Spiced seabuckthorn pineapple mixed fruit squash remained acceptable to a selected panel of judges for up to 6 months of storage at ambient temperature. However, colour, aroma, taste, body and overall acceptability were found to reduce after 2 months of storage at 37 °C. This might be due to chemical reactions which leads to the formation of brown pigments\textsuperscript{33} which might have decreased the colour score, loss of volatile aromatic substances during storage period at above condition might have decreased the aroma and taste score\textsuperscript{32}. The decrease in colour and body score during storage might be due to copolymerisation, interaction between phenolics and proteins as well as the formation of cation complexes with pectins during storage\textsuperscript{35}. The decrease in overall acceptability score might be due to the certain induced biochemical changes in the product by elevated temperature storage. Similar reduction in organoleptic quality during storage has been reported in spiced plum squash\textsuperscript{7}, and in kinnow squash\textsuperscript{20}. Changes in the spiced seabuckthorn-pineapple mixed fruit squash have a significant effect (p<0.05) on colour, aroma, taste, body and overall acceptability during storage period for 6 months.

**Microbial analysis**

The microbial population of spiced seabuckthorn-pineapple mixed fruit squash during storage is provided in Table 4. The freshly prepared spiced squash contains 3.50 log\textsubscript{10} cfu/ ml of TPC, which decreased to 1.87 and 0.75 log\textsubscript{10} cfu/ ml after 6 months of storage at ambient temperature and 37°C, respectively. Significant decrease (P<0.05) of TPC of the stored spiced squash samples at different temperatures were observed. The coliform bacteria and spores were not found in the stored squash samples, which show that the hygienic method of handling during processing and storage might have restricted their growth. The yeast count of the developed sample diminished from 2.37 log\textsubscript{10} cfu/ ml to 0.62 and 0.37 log\textsubscript{10} cfu/ ml at ambient temperature.

<table>
<thead>
<tr>
<th>Storage period (months)</th>
<th>Colour AT 37°C</th>
<th>Aroma AT 37°C</th>
<th>Taste AT 37°C</th>
<th>Body AT 37°C</th>
<th>Overall acceptability AT 37°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 7.73±0.38</td>
<td>7.73±0.38</td>
<td>7.34±0.22</td>
<td>7.34±0.22</td>
<td>8.10±0.19</td>
<td>7.90±0.63</td>
</tr>
<tr>
<td>1 7.62±0.54</td>
<td>6.19±0.78</td>
<td>7.27±0.50</td>
<td>6.75±0.26</td>
<td>8.04±0.31</td>
<td>7.82±0.49</td>
</tr>
<tr>
<td>2 7.54±0.48</td>
<td>5.90±0.79</td>
<td>7.16±0.51</td>
<td>5.82±0.82</td>
<td>7.91±0.47</td>
<td>6.05±0.45</td>
</tr>
<tr>
<td>3 7.35±0.37</td>
<td>5.72±0.62</td>
<td>7.05±0.25</td>
<td>4.93±0.45</td>
<td>7.72±0.38</td>
<td>5.84±0.79</td>
</tr>
<tr>
<td>4 7.46±0.44</td>
<td>4.92±0.36</td>
<td>6.97±0.68</td>
<td>4.50±0.54</td>
<td>7.60±0.56</td>
<td>4.86±0.30</td>
</tr>
<tr>
<td>5 7.29±0.51</td>
<td>4.26±0.35</td>
<td>6.91±0.67</td>
<td>4.17±0.37</td>
<td>7.52±0.49</td>
<td>4.40±0.48</td>
</tr>
<tr>
<td>6 6.93±0.65</td>
<td>3.90±0.44</td>
<td>6.50±0.71</td>
<td>3.84±0.58</td>
<td>7.12±0.39</td>
<td>3.97±0.53</td>
</tr>
</tbody>
</table>

AT: Ambient temperature. Mean ±SD of triplicate analysis.

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**Table 3—Mean sensory scores of spiced seabuckthorn-pineapple mixed fruit squash during storage**

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and 37 °C, respectively after 4 months storage period and it was not detectable at above conditions after 6 months storage. Significant decrease (p<0.05) in yeast count of the stored spiced squash samples at different temperatures was noted. The mould count of the sample was initially 1.00 log 10 cfu/ ml, which declined to 0.60 and 0.37 log 10 cfu/ ml after two months storage period at ambient temperature and 37°C, respectively. The count was found to be not detectable during the period of 4 months storage. Significant decrease (p<0.05) of mould count was found at different temperature storage period. Decrease in microbial load of the spiced squash samples were identified, this might be due to the inhibitory effect of the added spices in the squash. The microbial load of the stored squash samples are also within the acceptable limits.

Significance of study

The seabuckthorn fruit found to contain several natural antioxidants and inspite of these benefits, the fruits are underutilized due to its highly acidic taste and astringent flavour. Therefore, blending of such fruit juice with other fruit juices will enhance the product acceptability to a greater extent. This study will successfully utilize this fruit by converting into a processed form by means of value addition and it also increase the market potential of the product during peak season period also. In a nutshell this study will help the entrepreneur to successfully launch this product in various market segments.

Conclusion

The judicious blending of seabuckthorn juice with other fruit juices with added spices could lead to the production of delightful and delicious squash with improved sensory quality having high nutritive value. It also helped in removal of astringency in the final product and led to the enhancement in overall acceptability of the final product. The added spices in these squashes enriched the products with more natural antioxidant and improved shelf stability as compared to commercially available squashes. The spiced seabuckthorn pineapple mixed fruit squash blend combination exhibited good organoleptic characteristics. They had a shelf life of 6 months under ambient temperature conditions when packed in PET bottles. The microbial loads in stored spiced squash were also within the acceptable limits.

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