Study on Standardization of Technology for Development of Preserve from Ripe Pumpkin (Cucurbita moschata)

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ABSTRACT

Two methods namely, slow and one period method was used to prepare preserve from four different treatments (P₁-Control, P₂-steam Blanching for 6 minutes, P₃- Steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min, and P₄- Steam blanching for 6 min + dip in 1.0 per cent calcium hydroxide for 60 min). The preserve prepared by slow method showed the higher values for chemical constituents’ viz. TSS, total sugars, reducing sugars, ascorbic acid and β-carotene as compared to one period method during storage. The preserve from cubes of treatment P₃ showed more retention of chemical components in both the preparation methods. However, higher sensory scores for texture, flavour and overall acceptability were awarded to P₄ (steam blanching for 6 min + dip in 1.0 per cent calcium hydroxide for 60 min) except for colour score which was higher in P₃ but the differences were found to be non-significant. A mean decrease in moisture, titratable acidity, ascorbic acid and β-carotene was recorded during six months of storage while an increase was...
found in TSS, total sugars and reducing sugars. The retention of ascorbic acid and \( \beta \)-carotene was found to be more in preserve of \( P_3 \) (steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min) treatment of slow cooking method than \( P_3 \) of one period method. Sensory evaluation of the preserve also reflected a mean decrease in score for colour, texture, flavour and overall acceptability during a period of six months which was higher in one period method as compared to slow method. The cost of production of unpacked ripe pumpkin preserve was found to be INR 132/kg while INR 76.84/250 g when packed in glass jars.

Keywords: Ripe pumpkin; preserve; standardization; method of preparation; \( \beta \)-carotene; storage stability; sensory quality.

1. INTRODUCTION

Pumpkin (\textit{Cucurbita moschata}) is one of the important cucurbitaceous vegetable grown all over India [1]. They are extensively grown in tropical and sub-tropical countries. The world production of pumpkins, squashes and gourds is estimated to be 27,643,932 tonnes from an area of 2,042,955 ha [2]. India is the second largest producer of pumpkin next to China and together they account for two-third of world production [2]. The total production of pumpkin and other squashes in India is 2030 '000MT from an area of 94,000 ha [3]. The major pumpkin producing states in India are Uttar Pradesh, Chhattisgarh, Jharkhand and Tamil Nadu. Pumpkin occupies a prominent place among vegetables owing to its high productivity, nutritive value, good storability, long period of availability and better transport qualities. During the storage of pumpkin, various changes in the chemical composition occur that are related to life processes such as respiration, transpiration and ageing which cause unfavourable changes in sensory qualities [4]. Public as well as private sector of food and pharmaceutical industries are now-a-days giving more emphasis on cultivation of pumpkin and to develop pumpkin products in this health conscious era [5].

Pumpkin, due to its unusual and extravagant characters, is considered as the marvels of vegetable world. Pumpkins are valuable sources of functional components mainly carotenoids, zeaxanthin, vitamin E, ascorbic acid, phytosterols, selenium and linoleic acids, which act as antioxidants in human nutrition. They are considered as the cheaper source of vitamins especially, carotenoid pigments, which have a major role in nutrition in the form of pro-vitamin A, when used at ripening stage [6]. Pumpkin is a widely consumed food and has vast scope for diversification for its application in the production of commercial products. It can be consumed in a variety of ways such as fresh or cooked vegetables as well as being stored frozen or canned [7]. Pumpkin can profitably be used in the production of various value added products such as jam, jelly, marmalade, candy, puree, sauce, chutney, pickle and halwa [8]. Keeping in view various nutritional, medicinal and functional benefits of pumpkin and demand of developing new product, the present study was undertaken to develop technology for standardization of method for preparation preserve from ripe pumpkin and study changes in its chemical and sensory characteristics during storage.

A preserve is made from properly matured fruit, by cooking it whole or in the form of large pieces in heavy sugar syrup, till it becomes tender and transparent. In its preparation not less than 45 kg of the fruits are used for every 55 kg of sugar and cooking is continued till a concentration of at least 68 per cent of soluble solids is reached [9]. There are three ways of cooking the fruit in syrup, and they are open kettle one-period process, open kettle slow process and vacuum cooking process. Preserve means the product prepared from suitable, sound whole or cut grated fruits, rhizome or vegetables, appropriately prepared, suitable for the purpose, singly or in combination by impregnating it with nutritive sweeteners to a concentration adequate to preserve it [10]. Preserves can add tang to meals and provide a profitable way to use fruits not suitable for canning or freezing.

2. MATERIALS AND METHODS

2.1 Preparation of Pumpkin Cubes

The ripe pumpkins were washed and cut into halves. After removing the fluffy portion and seeds, the halves were cut into slices. The slices were peeled and converted into cubes of uniform size (approx. 2.0 cm\(^3\)) with the help of a cutter. The cubes thus prepared were subjected to four different pre-treatments \textit{i.e.} \( P_1 \)-Control, \( P_2 \)-steam Blanching for 6 minutes, \( P_3 \)-Steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min, and \( P_4 \)-Steam blanching for 6 min + dip in 1.0
per cent calcium hydroxide for 60 min. After pre-treatment, the cubes were pricked with the help of fork and were used for preparing preserve. Two different methods were used to prepare preserve from ripe pumpkin.

### 2.2 Standardization of Methods for Preparation of Preserve from Ripe Pumpkin

#### 2.2.1 Slow method

The general method discussed by Lal et al. [9] was followed for standardization of method for preparation of preserve from ripe pumpkin. The pre-treated cubes were pricked by using stainless steel fork on the whole surface area. The method of preparation was standardized by applying required modifications under different unit operations in order to obtain a product of excellent quality. The method modified and standardized is depicted in Fig. 1.

#### 2.2.2 One period method

After conducting preliminary studies for preparation of preserve from ripe pumpkin cubes by using varied procedures, two different procedures were taken for finalization of the best one. In Procedure-I, pre-treated cubes were pricked on the whole surface with the help of stainless steel fork. The required quantity of sugar and water was mixed for preparation of sugar syrup of 40°B and citric acid at the rate of 0.5 per cent was added. The cubes were then added in to the sugar syrup. The mixture was heated on high flame with continuous stirring till concentration of syrup reached 70°B. In Procedure-II, the pre-treated cubes were pricked. The required quantity of sugar and water was mixed for preparation of sugar syrup of 40°B and citric acid was used at the rate of 0.5 per cent. The cubes were then added to the sugar syrup. The mass was boiled for about 5 minutes. After separating the cubes from syrup, the syrup

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**Fig. 1. Flow sheet for preparation of ripe pumpkin preserve by slow method**
strength was raised to 70°B with the addition of sugar. The cubes were then again added to the syrup and whole mass was heated for 2-3 minutes.

2.3 Packaging and Storage

For the storage studies, the preserve was packed in pre-sterilized glass jars of 250 g capacity. All the bottles were labeled and were stored at ambient temperature (11-30 °C) for further investigation at different storage intervals (0, 3 and 6 months). Changes in quality characteristics (i.e. nutritional and sensory quality) of preserve prepared with different method were estimated at each storage interval.

2.4 Physico-chemical Analysis

Pumpkin preserve was analyzed for different parameters. Moisture content was determined by measuring the weight loss due to evaporation of water [11]. Titrable acidity was estimated by titrating known volume of sample against standard 0.1 N NaOH using phenolphthalein as an indicator [12] while Total Soluble solids (TSS) of the samples were measured by hand refractometer of 0-32, 28-62 and 58-92° Brix [11]. Ascorbic acid content was determined by using 2-6 dichlorophenol indophenols dye [11]. Sugars and β-carotene were estimated as per the method described by Ranganna [12].

2.5 Sensory Evaluation

Nine point hedonic scale method [13] was followed for conducting the sensory evaluation of preserve. A panel of ten judges comprising of faculty members and post graduate students of Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) was selected with care to evaluate the products for various sensory parameters such as colour, texture, flavour and overall acceptability depending upon the type of the product.

2.6 Statistical Analysis

The data on chemical characteristics of preserve were analysed by using Completely Randomized Design [14] before and during product development and storage. However, data pertaining to sensory evaluation of pumpkin preserve was analyzed by using Randomized Block Design [15].

3. RESULTS AND DISCUSSION

3.1 Standardization of Methods for Preparation of Preserve from Ripe Pumpkin

3.1.1 Slow method

The method modified and standardized was used for the preparation of preserve. The amount of sugar, water and citric acid used for the preparation of preserve from one kg cubes is given in Table 1.

3.1.2 One period method

Two procedures namely, Procedure-I and Procedure-II were used for the preparation of pumpkin preserve by one period method. The preserve prepared by Procedure-II was discarded and was not subjected to sensory evaluation as a lot of shrinkages were observed in the final product. The detail of procedure modified and selected for preparation of pumpkin preserve is presented in Fig. 2. The amount of sugar, water and citric acid required to prepare the preserve from one kg of cubes was 2000g, 3000mL and 10g, respectively.

Table 1. Ingredients used for the preparation of pumpkin preserve by slow method

<table>
<thead>
<tr>
<th>Detail of process</th>
<th>Sugar (g)</th>
<th>Water (mL)</th>
<th>Citric acid (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For initial syrup preparation (40°B)</td>
<td>1000</td>
<td>1500</td>
<td>5</td>
</tr>
<tr>
<td>To raise the TSS by 5°B (45°B) (1st day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>To raise the TSS by 5°B (50°B) (2nd day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>To raise the TSS by 5°B (55°B) (3rd day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>To raise the TSS by 5°B (60°B) (4th day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Keeping undisturbed for 24 hours and raising the TSS by 5°B (65°B) (6th day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>To raise the TSS by 5°B (70°B) (7th day)</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Keeping undisturbed for one week and raising the final TSS to 70°B</td>
<td>200</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>2100</td>
<td>1500</td>
<td>5</td>
</tr>
</tbody>
</table>
3.2 Effect of Treatments and Methods of Preparation on Chemical Characteristics of Pumpkin Preserve during Storage

Fig. 3a elucidate that there was a significant decrease in moisture content of pumpkin preserve during storage. The maximum moisture content was observed in P2 of slow (64.25 %) as well as one period (67.28 %) method while the minimum value was found to be 57.41 (slow method) and 60.34 (one period method) per cent, in P1 at 0 day of storage. The mean moisture content was seen to decrease from 61.35 per cent to 57.42 per cent in slow method and 64.36 to 60.30 per cent in one period method during 6 months of storage. A significant decrease in moisture may be attributed to the transfer of sugars from the syrup to preserve and the migration of moisture from fruit to the syrup as has been reported by [16]. A similar trend was also revealed in aonla preserve [17,18].

The data presented in Fig. 3b revealed that minimum TSS of 71.60°B and 70.50°B was recorded in P1 treatment of both the methods of preparation of preserve while maximum of 71.90 and 70.90°B in P3 at 0 day of storage. There was a significant increase in TSS of preserve and the mean value was found to increase from 71.76°B to 75.39°B in slow method while 70.73°B to 72.33°B in one period method during 6 months of storage. The combined effect of treatments, storage interval and method of preparation was found to be non-significant. The increase in TSS during storage might be due to imbibitions of sugars by the process of osmosis and reduction in water content. The results of increase in TSS are similar to the findings in bael [19], aonla [20], ber [21] and wild pear preserve [22] during storage.

The data (Fig. 3c) for titrable acidity of pumpkin preserve indicated a gradual decrease in values during storage. At 0 day of storage the maximum of 0.267 and 0.310 per cent was recorded in P3 whereas, minimum of 0.210 and 0.240 per cent in P2, respectively for preserve of slow and one period method. The mean titrable acidity was found to decrease from 0.230 to 0.190 per cent in slow method and 0.270 to 0.226 per cent in one period method during a period of six months. The decrease in titrable acidity might be due to the interaction of acids with other fruit components and leaching of acid into syrup during storage [23]. Similar trend in decrease of titrable acidity has been given in pear [24], ber [21] and wild pear preserve [22], whereas, carrot preserve [25] contradictory results for titrable acidity was found i.e. increase in titrable acidity during storage.

A critical look at Fig. 3d showed a significant increase in total sugars of pumpkin preserve of
different treatments prepared by slow method and one period method. At 0 day of storage, the maximum total sugars were noticed in P3 of both slow (53.58%) and one period (52.66%) method and minimum of 49.84 and 48.98% per cent, respectively in P1 at 0 day of storage. The total sugars of preserve prepared from both the methods were found to increase during six months of storage. The overall effect of method of preparation reflected that the increase was more (53.65%) in preserve of slow method as compared to one period method (52.52%). The increase in total sugar content during storage can be attributed to hydrolysis of polysaccharides resulting in conversion to soluble compounds like sugar [26]. The results conformed with the findings reported earlier in which they noticed a marked increase in total sugars of aonla [17] and ber preserve [21].

At 0 day of storage the highest reducing sugar content was recorded in P3 of slow (31.56%) and one period (29.45%) method and lowest in P1 of slow (27.46%) and one period (25.21%) method (Fig. 3e). The mean reducing sugars were increased from 29.87 to 33.52 per cent and from 27.66 to 31.55 per cent in preserve of slow method and one period method, respectively during a period of 6 months. The increase in reducing sugars of preserve might be due to inversion of non-reducing sugar into reducing sugars by hydrolysis during storage. An increase in reducing sugars during 6 months of storage has been observed in aonla [17] ber [21] and wild pear preserve [22].

Scrutiny of data presented in Fig. 3f highlights that the ascorbic acid content of cubes of different treatments and methods of preparation decreased significantly during storage up to a period of six months. At 0 day of preserve preparation by slow method the maximum ascorbic acid was recorded in P1 (11.77 mg/100 g) followed by P4 (10.50 mg/100 g), P3 (10.44 mg/100 g) and P2 (10.42 mg/100 g). In one period method, a similar trend was noticed with maximum value for P1 (8.22 mg/100 g) followed by P3 (7.95 mg/100 g), P4 (7.66 mg/100 g) and P2 (7.45 mg/100 g). The loss of ascorbic acid could be consequence of oxidation of ascorbic acid in the formation of dehydroascorbic acid in syrup [17]. The reduction was due to oxidation of ascorbic acid into dehydroascorbic acid by oxidase enzyme like ascorbic acid oxidase [26]. Similar findings were reported for amla preserve [27, 20].

An appraisal of data in Fig. 3g depicts a significant difference in β-carotene content of preserve of different treatments with maximum (11.55 and 10.43 mg/100 g) value for P3 and minimum (9.61 and 8.41 mg/100 g) for P4 of slow as well as one period method at 0 day of storage. The overall effect of storage period recorded a significant decrease in β-carotene from 10.17 to 6.14 mg/100 g during 6 months storage. The mean β-carotene content was found to decrease from an initial value of 10.62 to 6.61 mg/100 g after 6 months of storage in slow. The decrease in β-carotene might be due to the thermolabile and photosensitive nature and oxidation of carotenoids during storage. These results conform to the findings in carrot candies [28,29].

### 3.3 Effect of Treatments and Methods of Preparation on Sensory Characteristics of Pumpkin Preserve during Storage

Data in Fig. 4a shows that there was a significant effect on the colour scores of different treatments. The highest sensory score for colour was noticed in P3 of slow (8.67) and one period (7.67) method and lowest in P1 of slow (7.00) and one period (6.00) method at 0 day of storage. Among different treatments mean maximum (8.00) scores for colour was recorded in preserve of P3 of slow method and minimum in P1 (5.00) in one period method. A significant decrease in the scores of colour was observed throughout the storage. The decrease in colour scores during storage might be due to enzymatic and non-enzymatic oxidation process. Similar decreasing trend in colour of aonla [30] and pineapple preserve [31] was reported.

A significant decrease in texture scores of preserve of different treatments prepared by both slow and one period method can be seen from the data given in Fig. 4b. At 0 day of storage the highest scores for texture was recorded in P4 of slow (8.50) and one period (8.00) method and lowest in P1 of slow (7.33) and one period (6.00) method. Among different treatments mean maximum (7.94) scores for texture was recorded in preserve of P3 prepared by slow method and minimum in P1 (5.22) in one period method. The differences in the texture may be due to variation in the preparation method and treatments as the calcium hydroxide was used in P3 treatments which may act as a firming [32]. Similar observations of decrease in texture scores were reported in wild pear preserve [22].
Fig. 3. Effect of treatments and methods of preparation on chemical characteristics of pumpkin preserve during storage (P1-Control, P2-steam Blanching for 6 minutes, P3- Steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min, and P4- Steam blanching for 6 min + dip in 1.0 per cent calcium hydroxide for 60 min)
Fig. 4. Effect of treatments and methods of preparation on Sensory characteristics of pumpkin preserve during storage (P₁- Control, P₂- Steam Blanching for 6 minutes, P₃- Steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min, and P₄- Steam blanching for 6 min + dip in 1.0 per cent calcium hydroxide for 60 min)
Fig. 4c represents the significant difference among the preserve of various treatments, but overall interaction of treatments, method of preparation and storage was found to be non-significant. At 0 day of storage, the highest (8.67) score for flavour was recorded in P4 and lowest (7.00) for P1 of slow method and similar trend was observed in one period method. Among different treatments mean maximum (8.00) score for flavour was recorded in preserve of P4 prepared by slow method and minimum in P1 (5.44) of one period method. Decomposition of biochemical and aromatic compounds that impart characteristic flavour may be the cause for decrease in flavour score during storage [30]. The results for decrease in flavour are similar to the findings in aonla [17] and wild pear preserves [22].

Fig. 4d shows the data for overall acceptability of preserve of different treatments prepared by slow and one period method during six months of storage. It is evident from the data that at 0 day of preserve preparation by slow method the highest overall acceptability score was recorded in P4 (8.67) followed by P3 (8.33), P2 (7.67) and P1 (7.33). Similar trend was noticed in one period method with maximum value for P4 (7.67) followed by P3 (7.33), P2 (6.67) and P1 (6.00). However, preserve of different treatments exhibited a significant decrease in overall acceptability during storage. A decreasing trend in overall acceptability might be attributed to the enzymatic and non enzymatic oxidation processes [22]. The findings were also similar for pineapple [31] and aonla preserve [30].

4. CONCLUSION

The present investigation reveals that among different treatments of pumpkin cubes, P3 (steam blanching for 6 min + dip in 1.0 per cent citric acid for 10 min) was found to be the best for preparation preserve with higher value for chemical attributes. During storage the maximum retention of chemical and sensory quality was observed in preserve prepared by slow method as compared to one period method. Henceforth, it is concluded that ripe pumpkin which otherwise is processed to a limited extent, can be successfully utilized for the production of good quality and nutritionally enriched intermediate moisture foods of remunerative cost.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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