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The process optimization of osmo-dehydrtaed apple ber (*Ziziphus mauritiana* l) and its nutritional, functional and quality evaluation

Apsara V[1], Rudragoud P[2], Roopa N[2], Chauhan O P[2], Shekhar N[1], Devaki C S[1], Geethashree K[1*]

[1] Department of Food Science and Nutrition, Yuvaraja's College, University of Mysore, Mysuru, Karnataka, India

[2] Fruit and Vegetable Technology, Defense Food Research Laboratory, Defense Research and Development Organization, Mysuru, Karnataka, India

Abstract

Apple ber (*Ziziphus mauritiana* Lam), commonly called Indian jujube, is a highly nutritious fruit. It is rich in ascorbic acid and also contains good amount of protein and vitamins. The aim of the present study was to optimize and develop osmo-dehydrated apple ber and to evaluate its nutritional, functional and quality parameters. Osmotic dehydration is one of the preservative methods in which the food is dipped in concentrated sugar solutions which involve moisture removal to reduce the risk of microbial growth and proliferation and it helps to improve the quality. Optimization of the process parameters was carried out based on the organoleptic evaluation using 9 point hedonic scale. For the optimization of osmo-dehydrated Apple ber different concentration of sugar syrup *viz* 50º, 60ºand 70ºBrix and soaking time of 6,12,and 24 hours were used, followed by washing, blanching and drying in cabinet dryer. The dried samples were packed in metalized polyesters. Based on the sensory parameters, 50°Brix and 12 hours of soaking time was optimized for process parameters and was used for further evaluation of nutritional, functional and quality parameters The product was initially evaluated for sensory, physico-chemical, CIE colors quality, microbial and functional parameters. The osmo-dehydrated product was stabilized and they were kept for storage at both ambient temperature (25±2ºC) and refrigerated temperature (4ºC) and they were analyzed for every 15 days of Storage. During storage, functional and quality parameters decreased and the product was microbially safe. The Quality parameters indicated that Apple ber product were in good condition upto 45 days of storage.

Keywords: *Ziziphus mauritiana*, apple ber, osmo-dehydration, nutritional, storage stability

Introduction

Osmotic dehydration is one of the preservation method in which the food is dipped in concentrated salt or sugar solutions which involve water removal to reduce the risk of microbial growth and proliferation. Osmo-dehydrated fruits and vegetables prepared in this method can be added to foods such as desserts, yogurt, ice cream, confectionery, and bakery products. After additional drying, they can also be used as components of cereals or snacks for direct consumption (Lenart. 1996) [31]. During the osmotic process, water from the tissues flows out and simultaneous transfer of solute from the solution into the food occurs. Leaching of the product solutes (sugars, acids, minerals, vitamins, etc.) into the medium also takes place during this process. The effect of this transfer process on the organoleptic and nutritional characteristic of the product is considered to be quantitatively negligible. Sugar uptake results in the development of a concentrated solid layer under the surface of the fruit, decreasing the osmotic pressure gradient across the fruit-medium interface and, thereby, decreases the driving force for water flow. The rate of sugar penetration is also dependent on the molecular weight of the sugar and solution concentration (Chauhan *et al*., 2011) [15].

Apple ber (*Ziziphus mauritiana*L.) belongs to the family *rhamnaceae* that consists of 45 genera and 550 species. Ber has been recognized as a useful edible fruit since antiquity in India. Apple ber is one of the oldest Indian fruits and considered as *"Wonder fruit for health"* because of its unique qualities. It Plays an important therapeutic role from time immemorial and is frequently recommended for its synergistic effects in both the ayurvedic and unani systems of medicine (Meena *et al*., 2009) [33].

Apple ber is relished for its sweet and sour fruits. It is mainly grown in India, as well as different countries in central Asia, China and Taiwan. It has been truly called as *'poor man's fruit or poor man's apple'*. According to an estimate, the cultivated area and production of ber in India is 65,000 ha and 584,000 MT in 2014-2015 (Anon, 2016) [3]. Apple ber fruit is a highly nutritious fruit, rich in ascorbic acid, vitamins A, B complex and contains good amount of protein and amino acids in comparison to other fruits. Ber fruits are also high in calorific value and ascorbic acid as compared to apple and orange (Bakshi and Singh, 1974) [14]**.** It is also rich source of different nutrients like calcium, phosphorus and iron. The ascorbic acid content in different ber cultivars ranged from 39-160 mg/g (Helmy *et al.*, 2012**)** [21].The Apple ber fruits are traditionally used for its Anticancer (Kim *et al*., 1998) [28],Anti-diabetic (Jarald *et al.*, 2009) [23], Anti-inflammatory (Huang *et al.*, 1990) [22],Antispastic (Huang *et al*., 1990) [22], Antifungal (Tanvir *et al.*2014) [46], antibacterial(Nyaberi *et al.* (2010) [37], antiulcer Cardio-tonic, antioxidant(Kavitha and Kuna,2014) [26]. Immune stimulant and wound healing properties **(**Nazni and Mythili, 2013) [36]; (Azam-Ali *et al.*, 2006) [13]. Fruit is employed as an antidote to aconite poisoning, abdominal pain in pregnancy and externally in poultice and applications for wounds (Preeti and Tripathi, 2014) [40]. In China, it is used as a taste enhancer and it is recommended for treating fatigue, loss of appetite and diarrhea. It is believed that the dried ber fruits are anodyne, anticancer, pectoral, refrigerant, stomachic, tonic and immune response

enhancer (Hasan *et al*., 2014) [20]. The mature green fruits are also occasionally used in India to prepare chutney, pickle and jelly (RakeshSharma and Rana, 2016) [41]. Powder is made from ripe fruits. A number of products such as murabba, candy are prepared from the fruits. Pulp made from ripe fruits is used to prepare products such as ready to serve beverage and squash (Rathore, 2009) [43]. The present study aimed to optimize the process parameters for development of osmo-dehydrated apple ber by varying sugar concentration and soaking time followed by cabinet drying. The optimized apple ber was subjected to evaluation of nutritional composition, functional components and to study the effect of storage on quality parameters.

Material and Methods

Materials

The experiment was conducted in the Department of Fruits and Vegetable Technology, DFRL, DRDO, Mysore, Karnataka. The fresh, Apple ber and sugar were brought from the local market of Mysore City and were used in the study. All the reagents used for the study were of analytical grade.

Methods

In the present study combination preservation technology such as blanching and osmo-dehydration were used for development of product.

Preparation of Osmo-dehydrated apple ber

To standardize the process parameters for osmo-dehydration of apple ber was carried by varying the concentration of sugar concentration and soaking time. The procedure for the development of Osmo-dehydrated apple ber is as follows (Figure 1).

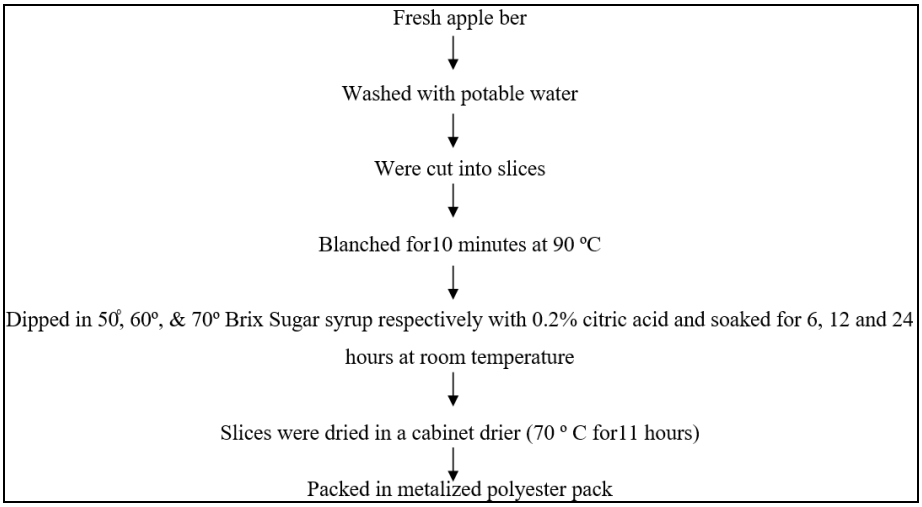

Fig 1: Process for preparation of Osmo-dehydrated apple ber

Organoleptic evaluation

The developed Osmodehydrated Apple ber with different concentration of sugar syrup and time of soaking were evaluated for sensory characteristics such as appearance, colour, texture, flavour, taste and overall acceptability, and were served to semi trained panelists for organoleptic evaluation on a nine point hedonic scale, with score 9 as excellent and score 1 as disliking.

Packing and storage of Osmodehydrated apple ber

Dried apple ber were packed in metalized polyester (12µ) stored at ambient temperature (25±2) for shelf life evaluation. Dried Apple ber were studied for physico-chemical, sensory and microbial studies for initially, and at regular interval of time. Osmo-dehydrated Appe ber were analyzed for different physico-chemical parameters like TSS, Titrable acidity, CIE colors, sensory attributes and microbial studies**.**

Analytical profile

Water loss and soild gain of osmodehydrated apple ber were carried out as per the method of (Chauhan *et al*., 2011) [15]. Moisture and Ash content were measured as per AOAC (2005) [5]. Carbohydrates, protein, fibre and fat contents were carried out as per the method described by AOAC (1990) [6]. Vitamin B_1, B_2, B_6, were carried out as per the method by AOAC (1995) [7].Vit-B_3 by AOAC (1965) [9], Vit-C by AOAC (1984) [10]. Minerals such as Calcium and Iron by AOAC (2016) [8]. Phenolic content and total antioxidants content was carried out as per the method described by Anand T *et al.*, (2018) [1]. Titratable acidity expressed as Lactic acid (%) was carried out as per the method of AOCS (1999) [11].Total soluble solids (TSS) were determined with the help of Hand Refracto meter AOAC (1965) [9]. Water activity was measured by Aqualab 4TE water activity meter. The osmo-dehydrated products were subjected to shear vale analysis using a Texture analyzer (TAHiD Stable Microsystem, UK) loaded with texture expert software (Version 1.22, Stable Microsystem, UK). Surface colour of the samples were recorded using a colour meter (Mini Scan XE Plus, Model 45/0-S, Hunter Associates Laboratory, Inc., Reston, VA, USA) as reflected in CIELAB (L*a*b*) colour space. Microbiological analysis was carried according to APHA (1992) [12] and data were transformed into logarithms of the number of colony forming units (CFU/ml).

Statistical analysis

The data obtained for all the parameters and effect of storage on them was statistically analyzed through student t-test to see the critical difference at 5% level of significance using CPCS1 software.

Result and Discussion

The products were initially studied for nutritional composition, *Viz*., Macronutrients and Micronutrients

vitamins and minerals, physical for CIE color, functional for phenol and antioxidant activity, quality parameters-sensory and microbial analysis. Storage studies of the product were studied by storing at ambient temperature (25±2ºC) and refrigerated temperature (4ºC) and analyzed periodically for functional, CIE colors, quality parameters, sensory and microbial analysis.

Physical properties of osmodehydrated apple ber

The fresh apple ber and osmodehydrated Apple ber were initially analyzed for water loss, Solid gain and water activity which is represented in the Table1.The Osmotic process facilitates the uptake of low molecular weight solutes resulting in the spread of plasmolysis throughout the tissues and gradually dehydrating the different tissue layers. The molecular weight of the solute in the soaking solution influenced the rate of water transfer in a more complex manner than the simple law described by (Roult-Wack *et al*., 1991) [42]**.** In this study the water loss and solid gain of the apple ber during Osmo-dehydration was determined, the water loss of the Osmo-dehydrated Apple ber was 42.24% and solid gain is 18.8%. The water activity of Fresh Apple ber and its processed product was 0.85 and 0.35 respectively. The moisture content of the fresh Apple ber was 83% and it was reduced to 8% in the same way the water activity also reduced due to this the Osmo-dehydrated Apple ber can be stored for longer period of time. (Kaikadi *et al.* (2006) [25]; prepared *ber* candy from umran cultivar by slow syruping method. For this, mature *ber* fruits after pricking, destined and blanched in hot water for 5minutes. Sulphur fumigation was done @ 2g/kg for 2 hours. Then sugar syrup of 400° Brix was prepared and fruit was added to it. At this stage, 1 per cent citric acid was added and stored for 24 hours. Next day the strength was increased by 100°Brix with addition of 1 percent citric acid. The process was repeated till 700° Brix was reached with addition of 1 percent citric acid. The fruits were stored for 7-8 days. The fruits were washed quickly and dried in shade until the moisture content was below 18 per cent. The candy was packed in polythene bags or plastic boxes which were stored either at room or refrigerated temperature up to 6 months.

Nutritional composition of osmodehydrated Apple ber

In the present study the nutritional components such as moisture, carbohydrates, protein, fat, ash and fiber were analyzed in fresh apple ber and osmodehydrated apple ber. The fresh Apple ber as shown in Figure 1, had moisture-85%, carbohydrates-12.9%, protein- 0.7%, fat 0.35%,ash-0.5%, dietary fiber 0.6%, and the osmodehydrated apple ber had moisture-8.83%,carbohydrates-84.82%,protein-1.24%, fat-2.10%,dietary fiber-0.50%, ash-2.50%. The combination preservation technologies used in the study helped to reduce the moisture content, which in turn helped to increase the keeping quality by increasing the shelf life. The changes in proximate composition also can be attributed by the addition of other ingredients in the processing stages. As seen by some of the studies carried out by researchers the fresh apple ber has moisture-81.6-83%, carbohydrates-17%,protien-0.8, fat-0.07%, fiber 0.60%and ash 0.3-0.59 % (Morton and Miami *et al*., 1987) [35] and (Keta, 2017)[27]. The results of the proximate analysis revealed the presence of moisture contents 50g ash contents 0.00616g, crude lipid 0.62g, crude fiber 0.00167g, crude protein 0.00618g as well as available carbohydrate 83.98g per 100g of the sample.

Mineral compostion osmodehydrated apple ber

The fresh and osmodehydrated apple ber were analysed for calcium and Iron and the results are shown in Table 2.The fruits contained the variable amount of minerals in that Apple ber also contain considerable amount of calcium and iron. The calcium and iron content of the Apple ber as reported by is 25.6 and 1.1mg/100g (Anon, 2015); (Morton and Miami,1987).[35]; also estimated the Calcium and iron content of fresh apple ber and found that they had calcium content of 25.6mg/100g and iron 0.76-1.8mg/100g.The present study revealed that fresh Apple ber and Osmo-dehydrated Apple ber had calcium and iron content of the 6.2mg and 9mg; and 15.6 mg and 25mg per 100g respectively. The change in the mineral composition of the product is attributed by the ingredients added while processing and also due to processing effect.

Vitamin content osmodehydrated apple ber.

The fresh Apple ber and osmo-dehydrated Apple ber were analyzed for vitamins such as thiamine, riboflavin, niacin, pyridoxine and Vitamin C. The fresh Apple beras shown in Table 3 had thiamine 0.01mg, riboflavin 0.04mg, niacin 0.5mg, pyridoxine 0.2mg and Vit C 17.14mg per 100 gm of sample. The osmodehydrated Apple ber had thiamine 0.01mg, riboflavin 0.05mg, niacin 0.7mg, pyridoxine 0.3mg and Vit C 3.32 mg/100g of the samples. Some researchers reported that Apple ber contained 0.22mg thiamine, 0.029mg riboflavin, and 0.78mg niacin. (Anon, 2015)[2]And; (Morton and Miami, 1987) [35].Also estimated vitamins and reported that the fresh apple ber contained thiamine 0.02mg, Riboflavin 0.02-0.04mg, niacin 0.7-0.88mg and Vitamin C 65.8-76.0 mg/100g of the sample.

Storage Studies of Osmodehydrated Apple Ber

Shelf life of any product shows its potential for being stored for a definite period of time without any deteriorating effects on its quality parameters. Storage life indirectly shows the market life of the product. In the present study, Osmodehydrated apple ber was processed with multiple preservation technologies and were evaluated periodically for functional, CIE colours and quality parameters. Total phenols (mg/100ml gallic acid equivalents), anti-antioxidant(ascorbic acid equivalent/100g) were considered as functional parameters, Vitamin C (mg/100g) considered as nutritional parameters.CIE colours, TSS ºBrix, Titrable acidity (% of Citric acid) were considered as quality parameters. Sensory evaluation for overall acceptability and Microbiological studies was studied in the stored samples.

Functional parameters

Total phenols (mg/100ml Gallic acid equivalents) and anti-oxidants (mg/100g of ascorbic acid equivalent) were considered as functional Components. Changes during the storage period on functional components are presented in the Table 3.Initial total phenols of Osmo-dehydrated Apple ber was 160mg/100g. The total phenol content decreased from the level of 160mg to150, 130 and 128mg per100g of the sample in 15,30and 45 days of ambient storage, where as in refrigerated storage the total phenolic content was stable up to15 days after it was reduced to150mg both in case of 30 and 45 days. (Koley *et al*., (2011) [29]; reported that phenolic content of the apple ber extract was found 172 to be 328.6mg GAE/100g. (Lu *et al*., 2012)[32]. Studied on

the phenolic content of the apple ber during the advancement of the ripening stage and found that Total phenols increased from 40 to 48 days after petal fall, decreased from 48 to 56 days after petal fall, again increased between 56 and 64 days after petal fall and decreased steadily after 64 days to maturity. (Koley *et al.,* 2011)[29]. studied 12 commercial cultivar of *Z. mauritiana* and evaluated their, total phenolics, and Results indicated that Indian Ber contained total phenolics ranging from 172 to 328.6 mg GAE/100g.

The Osmo-dehydrated Apple ber stored at room temperature showed maximum decrease in the antioxidant activity which decreased from 96.61 to 96.22, 94.05 and 93.12 in 15,30 and 45days. In refrigerated storage antioxidant activity which is decreased from 96.61 to 96.1, 96.01 and 95.01 in 15, 30 and 45days.Compared to room temperature there was not much significant difference in refrigerated storage.(Dureja and Dhiman, 2012)[18].Studied on the anti-oxidant activity of apple ber and found that 79.5% at concentration of 250 µg mL^{-1}.(Cosmulescu *et al.,2018)* [17]. studied on the fruits of two jujube cultivar at four stages of ripening and analysed for anti-oxidant activity and reported that they ranged from 1154.6 to 1661.4 mgascorbic acid/100g and regarding the influence of ripening stage, the results showed that the highest antioxidant activity was recorded in the stage of 1.(Krishna and Parashar, 2012)[30];were also studied on Twenty-eight varieties of apple ber for total antioxidant activity by different methods such as cupric reducing antioxidant capacity (CUPRAC), ferric reducing antioxidant power (FRAP) and 1,1 diphenyl-2-picryl hydrazyl (DPPH) assays. The average antioxidant activities were 1.6–6.33 and 1.22–5.49µmolTE/g as the CUPRAC and FRAP assays respectively.

Nutritional parameters

Vitamin C (mg/100ml) was considered asone of the nutritional parameters. During the storage period Vitamin C content decreased from the level of 3.12mg to 2.72mg in ambient temperature (25±2ºC) storage and in refrigerated storage (4ºC) it got reduced from3.12mg to 2.85mg in 45 days of storage. Vitamin C is light and heat sensitive, the concentration of vitamin C follows first order kinetics and thus storage time affects Vitamin C content (Metlitsky *et al*., 1968) [34]; Pareek, (2013) [39]; reported that Vitamin C content of the apple ber ranged from 65.8 to 76.0mg/100g. (Jawanda and Bal, 1978) [24]. reported that the ascorbic acid content of ber fruit ranged from 70-165 mg/100 g pulp. Morton *et al.* (1987) [35]; reported that the ascorbic acid content of ber fruit ranged from 56.80 to 76.00 mg/100 g. From the present study, it can be observed that, the vitamin - C was very less stable in osmodehydrated apple ber.

CIE colours

The effect of Osmo-dehydration on the colour profile of the Osmo-dehydrated apple ber was shown in the Table 4.The L* value which indicates the lightness of the Osmodehydratd apple ber the lightness of the product is decreased during storage of both room and refrigerated temperature. The *value indicates the redness of the product which was increased as the storage period increased both in room and refrigerated condition. b* value indicates the yellowness of the product which is decreased in Osmo-dehydrated apple ber duing storage both in room and refrigerated temperature.

Quality parameters

The changes in the quality parameters during the storage of osmodehydrated apple ber is given in the Table 5**.** As shown in the table it was found that the titrable acidity of Osmo-dehydrated apple ber varied significantly with different storage period and temperature. The variation in the titrable acidity of the osmo-dehydrated apple ber due to storage period was found significant. The mean acidity gradually increased with the advancement of the storage period. The maximum (0.5) mean acidity was observed at the initial, day i.e. 0 day of the storage, followed by (0.5) at 15^{th} day of storage and the maximum (0.6) mean acidity was observed at the end of both 30^{th} and 45^{th} day of storage under ambient conditions, means it was constant after 30 days of storage. In case of Refrigerated storage the acidity was same upto15th day later a very less amount is increased in 30^{th} and 45day that is 0.52 and 0.55.from this concluded that the acidity is stable in case of refrigerated storage compared to the ambient storage. (Jawanda and Bal, 1978) [24]. Observed that the titratable acidity of ber fruit was 0.2 to 0.8 per cent. According to Pareek, (1983) [38] reported that the acidity of ber fruit of different cultivars was 0.16-0.51, 0.19-0.35, 0.37-0.75 and 0.30-0.48 per cent in Kaithali, Umran, Gola and Karaka variety of ber, respectively.(Singh and Chaurasiya, 2016) [44]. observed that the titratable acidity of ber fruit of different cultivars ranged from 0.13 to 1.42 per cent.

As shown in the Table 4 the TSS content of the Osmodehydrated product during storage did not show any differences both in Room and Refrigerated temperature. (Jawanda and Bal, 1978)*[24]*; recorded the Total soluble solids of ber fruit as 13-20 per cent. (Singh and Chaurasiya, 2016) [44]. reported that the TSS of ber fruit of different cultivars ranged from 12 to 21ºB.

Sensory parameters

One of the most important criteria for evaluation of foods is their acceptability which is based on the sensory attributes. The sensory evaluation is a scientific discipline that measures, analyses and interprets reactions to those characteristics of food and materials as they are perceived by the senses of vision, odour, taste, touch and hearing (Sidel and Stone, 2006) [45]. The initial over all acceptability of Osmo-dehydrated apple ber was 7.83 based on the 9 hedonic scale rating. The sensory quality of the Osmo-dehydrated apple ber decreased due to storage. In general, any product with the score of below 6 is not-accepted. Though the product was acceptable during storage of ambient temperature and refrigerated temperature, the temperature of storage influenced the scores. As the storage period increased, overall acceptability decreased.

Changes in microbial quality

The Osmodehydrated apple ber samples were subjected to bacterial, yeast and mold count on every 15 days of interval for 1 and half month. (Chen, 1989) [16] ; reported that the candied products were predicted to have a longer shelf life with no microbial growth as they contain 65 to 70 per cent of sugar with water activity values at 0.6–0.8.Microbial growth during storage will be depended on the preservation conditions. (Gram and Dalgaard, 2002) [19]. The microbial load was very less in initial stages of product after 45 days of storage the growth of yeast and mould was noticed. As osmo-dehydrated apple ber is soaked in the sugar syrup the growth of yeast and is occurred. The microbial load was

very less in initial stages of product after 45 days of storage the growth of yeast and mould was noticed. As osmo dehydrated apple ber is soaked in the sugar syrup the growth of yeast and is occurred. The microbiological analysis clearly shows the sterilized condition of the product, coli forms was nil up to 45 days of storage period reflecting the safety of the product

Table 1: Physical properties of osmodehydrated apple ber

Si.no	Samples	Water loss (%)	Solid gain (%)	Water activity (%)
1	Osmo-dehydrated Apple ber	42.24±2	18.8±057	0.35±0.009

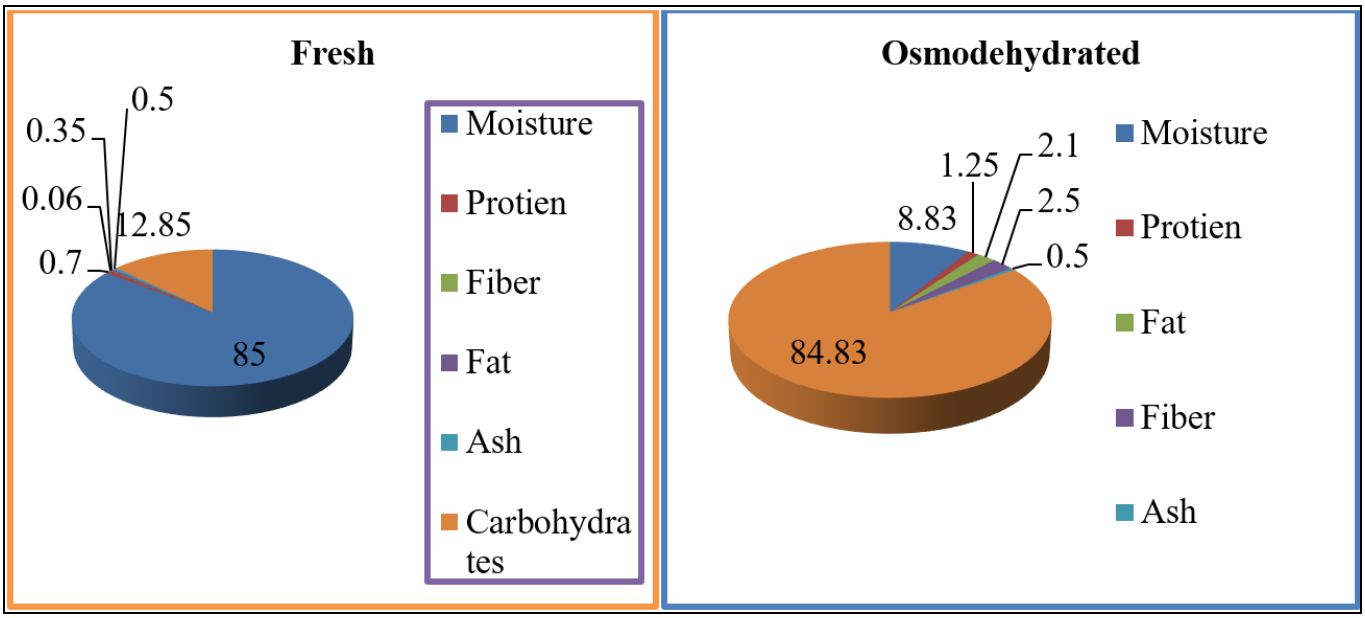

Fig 1: Nutritional composition of fresh and osmodehydrated apple ber

Table 2: Micronutrients content of osmodehydrated apple ber mg/100g

Micronutrients	Fresh Apple ber	Osmodehydrated Apple ber
Thiamin	0.01±0.009	0.01±0.009
Riboflavin	0.04±0.004	0.05±0.008
Niacin	0.5±0.04	0.7±0.08
Pyridoxine	0.2±0.01	0.3±0.04
Vitamin C	17.14±0.85	3.32±0.02
Calcium	6.2±0.5	15.6±0.05
Iron	9±0.3	25±0.05

Table 3: Storage stability study of osmodehydrated apple ber on functional Components and Vitamin C (n=3)

Product	Storage temperature(°C)	Storage period	Vitamin C (mg/100g)	Total phenolic content mg/100g	Antioxidant activity(% of inhibition)
Osmodehydrated apple ber	4	0	3.12±0.12	160 ±0.47	96.61 ±0.01
		15	3.12 ± 0.45^{b}	160 ± 0.47^{b}	96.1 ± 0.45^{c}
		30	3.10 ± 0.78^{a}	150 ± 0.47^{c}	96.01 ± 0.03^{b}
		45	2.85 ± 0.33^{b}	150 ± 0.81^{a}	95.01 ± 0.03^{d}
	25±2	15	3.0 ± 0.45^{d}	150 ± 0.47^{a}	96.22 ± 0.47^{a}
		30	2.8 ± 0.38^{a}	130 ± 0.94^{c}	94.05 ± 0.02^{b}
		45	2.72 ± 0.34^{c}	128 ± 0.81^{d}	93.12 ± 0.02^{c}

***Note:** Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

Table 4: Storage stability study of osmodehydrated apple ber on CIE colours

SI.NO	Storage temperature(°c)	Storage period(Days)	CIE colour		
			L	A	B
1		0	50.33±0.31	0.0933±0.002	5.11±0.030
2	25±2	15	49.98 ± 0.80^{a}	0.82 ± 0.04^{a}	12.12 ± 0.02^{a}
		45	37.13 ± 0.91^{b}	0.75 ± 0.02^{b}	12.29 ± 0.55^{b}
3	4	15	50.06 ± 0.30^{a}	0.07 ± 0.008^{b}	7.89 ± 0.04^{c}
		45	50.85 ± 0.46^{b}	0.07 ± 0.008^{c}	8.15 ± 0.06^{c}

Table 5: Storage stability study of osmodehydrated apple ber on quality parameters (n=3)

Si.no	Storage temperature (ºC)	Storage period(Days)	TSS˚(Brix)	Titrable acidity (% of citric acid)
1		0	50± 1	0.5± 0.12
2	25±2	15	50 ±2 [a]	0.5±0.09[a]
		30	50 ±1 [a]	0.6 ± 0.21[d]
		45	51 ±1 [a]	0.6 ± 0.12[b]
3	4	15	50 ±2 [a]	0.5± 0.05[b]
		30	50 ±1 [b]	0.52± 0.02[b]
		45	50 ±1 [b]	0.55 ±0.12[c]

***Note:** Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

Table 6: Storage stability of Osmodehydrated apple ber on sensory score (n=25)

Product	Storage temperature(˚C)	Storage period	Colour	Aroma	Texture	Taste	OAA
Osmodehydrated apple ber	25±2	0	7.63±0.49	7.44±0.15	7.70±0.40	7.44±0.15	7.83±0.47
		15	7.35±0.73[b]	7.33±0.78[a]	7.38±0.31[b]	7.38±0.31[b]	7.66±0.70[b]
		30	7.30±0.73[d]	7.33±0.78[c]	7.34±0.31[a]	7.32±0.74[d]	7.61±0.73[d]
		45	7.30±0.81[a]	7.33±0.88d[c]	7.32±0.70[c]	7.16±0.62[a]	7.60±0.66[c]
	4	15	7.57±0.580[b]	7.38±0.80[a]	7.47±0.73[c]	7.644±0.516[b]	7.72±0.71[a]
		30	7.52±0.64[c]	7.32±0.76[b]	7.38±0.53[d]	7.53±0.53[d]	7.70±0.42[b]
		45	7.41±0.68[b]	7.30±0.76[d]	7.27±0.41[a]	7..42±0.47[c]	7.50±0.62[c]

Note: Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

Conclusion

The study brought up the Optimization of process parameters for the development of osmodehydrated apple ber using the preservation technology of osmodehydration. The 50º Brix and 12hours of Soaking, osmodehydrated product were highly acceptable and had good nutritional value. The Physico-chemical and sensory qualities indicated that the osmodehydrated apple ber were found to be in good condition up to 45 days of storage at both ambient (25±2 ºC) and refrigerated (4 ºC).As the storage period increased the quality, functional and nutritional value and sensory quality decreased both in ambient and refrigerated condition. It can be concluded that addition of Class 1 preservatives such as Sugar gives the preservative effect, therefore it can be recommended that, osmodehydrated apple ber not only increases the nutritional value but also improves the shelf life of products at ambient temperature as well as refrigerated temperature.

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