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Development of osmo-convective dried shatavari root powder by using different osmotic agents

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Abstract
The aim of this paper is to study the effect of various osmotic agents (sugar, jaggery, honey and palm sugar) on shatavari roots in osmotic solution. The quality characteristics of the developed product such as colour characteristics, mass transfer properties and sensory evaluation was done. The shatavari roots were immersed in each osmotic agent for 180 min at 50°C. Higher water loss, solid gain and mass reduction were observed in the sample dipped sugar solution. Whereas palm sugar treated sample showed lowest mass transfer properties. The sugar treated samples had a higher L* value and lower a* value. The sensory attributes of osmo-convective dried shatavari root powder was found to be better in the case of sugar and jaggery treated samples as evidenced by colour, texture and overall acceptability scores.

Keywords: Osmotic dehydration**,** shatavari root powder, osmotic agents, mass transfer properties

Introduction
Shatavari *(Asparagus racemosus)*, is a perennial climbing shrub in the *Asparagaceae* family and *Liliaceae* sub family (Chadha, 2003) [3]. It is an indigenous medicinal plant originated to South Asian countries. The medicinal properties of shatavari roots have been reported in traditional systems of medicine such as Ayurveda, Siddha and Unani and have been utilized for primary health care of people since time immemorial (Alok *et al.*, 2013) [1]. It is grown in variety of soils such as red loamy, black soil to laterite soil having good drainage system. It is grown in warm tropical and humid climate. Shatavari is indigenous to tropical and sub-tropical parts of India (Sharma *et al.*, 2000) [17]. It is commercially cultivated in Madhya Pradesh, Uttar Pradesh and Uttrakhand. It is gaining popularity due to its texture and flavor. It includes about 300 species in the world and out of which the 22 species are recorded in India (Kohli *et al.*, 2018) [8]. The fresh Shatavari roots are fleshy and white in color; while on drying roots become shrinked, longitudinal ridges appear and the color turns light brown.

Outer surface of fresh root is soft and contains epidermal hairs. The shatavari roots are cylindrical, fleshy succulent tuberous straight or slightly curves, tapering towards the base and swollen in the middle; 5-30 cm in length, 1-2 cm diameter (Jarald and Jarald, 2007) [6]. These roots used in various medicinal preparations.

Asparagus *(Asparagus Racemosus* L.) is one of the most significant traditional medicinal plants containing phytochemicals that are non-nutritive but beneficial to health. It contains bioactive metabolites such as fructo-oligosaccharides, polysaccharides, asparosides, shatavarins, sapogenins, racemosols, isoflavones, glycosides, mucilage, and fatty acids, while saponin is one of the main active constituents of shatavari roots. Shatavari roots helps in fertility promotion, stress management, and hormone modulation. It also treats stomach ulcers, kidney disorders, and Alzheimer's disease. Substitution of shatavari root powder or extract for value addition of the food products (such as beverages, bakery, and milk) enhances the nutritional and functional properties. Currently, the plant is considered endangered in its natural habitat because of its destructive harvesting, habitat destruction, and deforestation. Kohli *et al.*, (2023) [7]. Since it is a highly perishable commodity, it needs proper handling, preservation, and storage. In recent years, osmotic dehydration has been popularly used as drying method for a number of food products. Osmotic dehydration is the incomplete removal of water from a food product by means of an osmotic agent (usually either sugar or salt solution). It is one of the potential preservation techniques for producing high quality products. This provides minimum thermal degradation of the nutrients due to low temperature water removal process (Shi *et al.*, 1995) [18].

The osmotic process variables (pre-treatment, temperature, concentration of solution, agitation, additives, immersion time, etc) have been reported to have influence on mass transfer and on the product quality (Rastogi *et al.*, 2004) [15].
Some of the advantages of osmotic process are (1) minimized heat damage (2) least discoloration of product by enzymatic browning (3) increased retention of volatile matter, flavour and aroma (4) improved textural quality and (5) lower energy consumption. However, osmotic process does not give a product of sufficiently low moisture content to be considered as shelf stable and therefore, the osmosed product needs to be further dried through air drying, vacuum or freeze drying (Lazarides and Mavroudis, 1995) [9].
The main advantage of this process is its influence on the principal drying method, shortening of the drying process, resulting in lower energy requirements. Osmotic dehydration offers higher retention of initial food characteristics, such as colour, aroma, nutritional constituents, and flavour compounds. The osmotic agents such as fructose, corn syrup, glucose, jaggery, honey, stevia and sucrose are used as osmotic agent for osmotic dehydration. Low molar mass saccharides (sucrose, glucose and fructose) make easy the sugar uptake due to high diffusion of molecules (Solanke *et al.*, 2018*)* [19]. Other natural sweeteners like jaggery, honey and palm sugar used as osmotic agents for osmotic dehydration. It has proved to be a good quality method to get modestly processed food, due to the much sensory resemblance between the natural and dehydrated products. Therefore new healthy sweeteners could be suitable for any sector of the population, even for these with diabetes, obesity or with predisposition to dental caries.
The development of a simple osmotic dehydration process by using different osmotic agents for shatavari roots necessitates the study of the osmotic kinetics. So, considering above facts, there is a need for development of process of osmotic dehydration by using different osmotic agents for shatavari roots. In pandemic days there is a huge demand for immunity-positioned supplements, including *Ayurveda* medicines in the market and osmo- convective dried shatavari roots powder can be very appreciated by consumers.

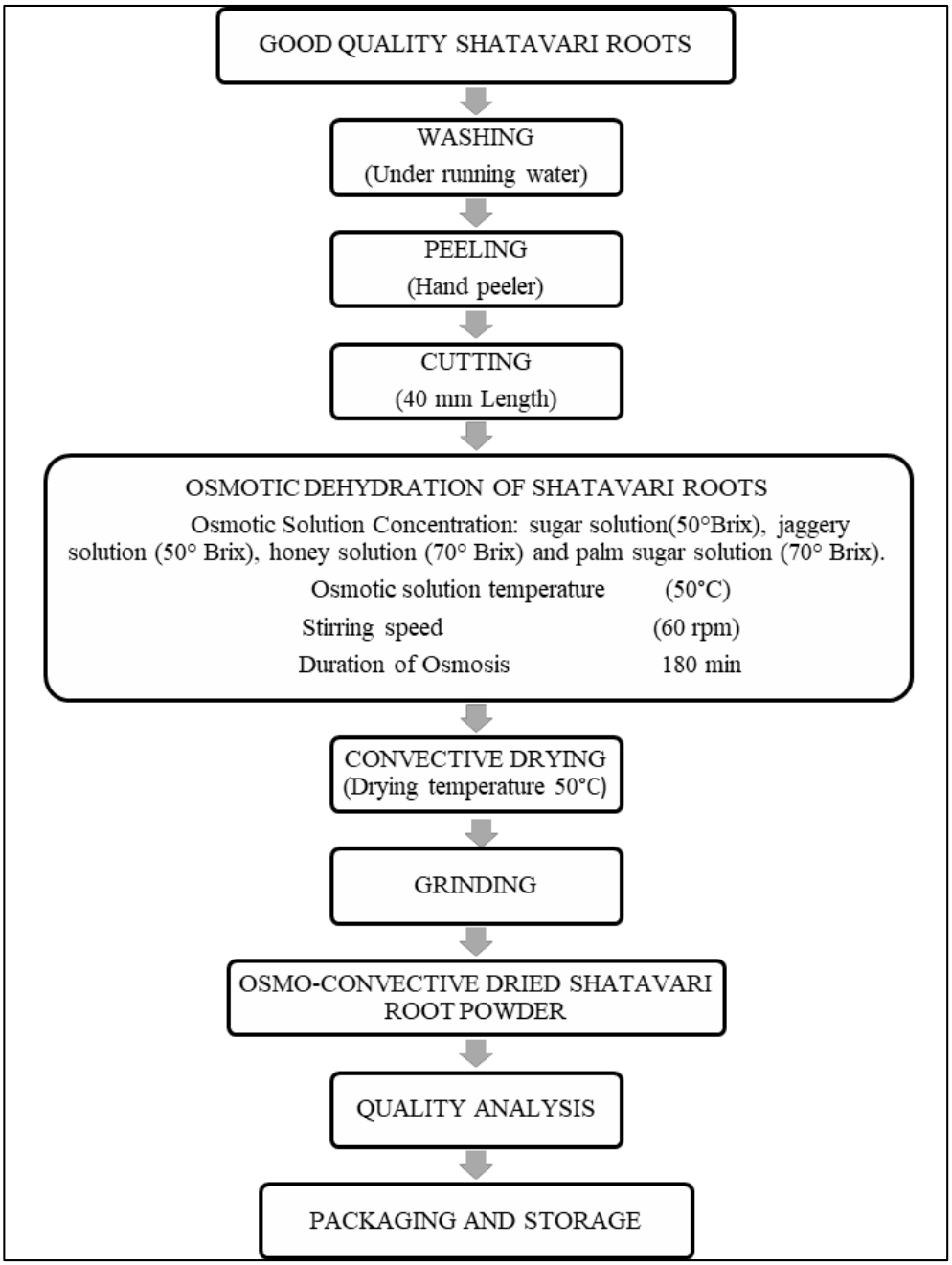

Fig 1: Flow chart of osmo-convective dehydration process for shatavari roots powder

Material and Methods: Sample Preparation

Fresh shatavari roots were washed with clean water to remove the dirt and other undesirable foreign particles from surface and wiped with muslin cloth to remove surface moisture. The cleaned fresh shatavari roots were weighed and then manually peeled with peeler and were cut in 40 mm thick slices with sharp knife. The osmotic agents sugar, jaggery, honey and palm sugar were purchased from local market. The osmotic solution was prepared by dissolving the osmotic agents in distilled water using glass rod stirrer. Concentration osmotic solution was checked by using digital refractometer.

Experimental procedure

A sample of shatavari roots slices of 40 mm thick weighing 50 g were prepared. Shatavari root slices to osmotic solution ratio was maintained (1:4). The samples were immersed in a selected osmotic temperature (50 °C) and osmotic solution *viz.* T1 as sugar solution (50° Brix), T2 as jaggery solution(50° Brix), T3 as honey solution (70° Brix) and T4 as palm sugar solution (70° Brix). The glass beakers containing osmotic solutions were placed inside the constant temperature water bath at constant temperature and shatavari root slices were put into the osmotic solution after attainment of desired temperature. The agitation was necessary to improve mass transfer property, maintain uniform concentration and prevent the formation of dilute solution film around the sample. All the root samples were kept in the osmotic solution till its equilibrium moisture content. The weight loss for each sample was recorded for every 10 min interval; one glass beaker was removed from the water bath and the shatavari root slices were taken out from the beaker and immediately rinsed with the distilled water as per procedure (Mundada *et al.*, 2011) [12] to remove the solute adhered to root surface. The slices were spread on the tissue paper for 5 min.

Evaluation of Quality Attributes of Shatavari Roots during Osmotic dehydration and Convective drying

Mass transfer properties

Water loss: Water loss is the quantity of water lost by product during osmotic dehydration. The water loss (WL) is defined as the net weight loss on an initial weight basis and is estimated as follows.

$$WL = \frac{W_i . X_i - W_\theta . X_\theta}{W_i}$$

Mass reduction: The overall exchange in the solid and liquid of the sample do affect the final weight of the sample.

$$MR = \frac{W_i - W_\theta}{W_i} \quad \textbf{1.}$$

Solid Gain: The solids from the osmotic solution get added in the sample of shatavari roots during osmotic dehydration. The loss of water from the sample takes place in osmotic dehydration consequently it increases the solid content. The solid gain is the net uptake of solids by the shatavari roots on an initial weight basis. It is computed using the following expression:

$$SG = \frac{W_\theta(1 - X_\theta) - W_i(1 - X_i)}{W_i}$$

Where,

WL= Water loss%, (g per 100 g mass of to remove surface moisture. The osmotically dehydrated shatavari root samples were further dried in the laboratory hot air dryer 70 °C drying air temperature at and constant air velocity (2 m/s). The osmo-convective dried roots were grounded by using hammer mill and pass through the 0.150 mm sieve to obtain osmo-convective dried shatavari root powder. The powder was stored in air tight aluminium plastic pack in the refrigerated storage (5 °C) sample)

SG = Solid gain%, (g per 100 g mass of sample

MR = Mass reduction%, (g per 100 g mass of sample)

$W\theta$ = mass of slices after time, g,

Wi = initial mass of slices, g,

$X\theta$ = water content as a fraction of the mass of slices at a time.

Xi= water content as a fraction of initial mass of slices, fraction.

Moisture Content

The moisture content was determined by using hot air oven at 110 °C for 5 hrs. The percentage moisture was calculated using the following formula

$$\text{Moisture content, \%} = \frac{\text{Initial weight (g)} - \text{weight (g)}}{\text{Initial weight (g)}} \times 100$$

Colour

Colour (L*, a*, b* values) of osmo- convective dried shatavari root powder was measured by using Hunter lab colorimeter. L* is known as the lightness and extends from 0 (black) to 100 (white). The other two coordinates a* and b* represents redness (+a) to greenness (-a) and yellowness (+b) to blueness (-b), respectively were recorded.

Sensory analysis

Organoleptic evaluation is the way of knowing acceptability of product using the senses, *viz*., sight, smell, touch, taste and hearing. A panel of 10 judges comprising of faculty and students of the institute were formed. All indexes were measured using a 9 point hedonic scale from 0 to 9, where a score of 9 represents excellent quality and a score of 0 represents the lowest quality level. Osmo-convective dried shatavari root powder prepared by using different osmotic agents where evaluated in different sensory attributes like colour, texture, taste and over all acceptability were assessed using 9 point hedonic scale for all samples.

Result and Discussion

Physico-chemical properties of shatavari roots

The fresh shatavari roots were harvested after 20 months of transplantation. Fresh shatavari roots were subjected to determine physico-chemical and phytochemical properties. Determination of these properties of fresh shatavari roots were carried out as per the standard procedures. The study of these properties served as an important base to study the quality of shatavari roots and it's processing in to osmo-convective dried shatavari root powder.

Table 1: Physical properties of fresh shatavari roots.

Sr. No.	Parameters	Average Value
1.	Root length (cm)	28.3
2.	Root Diameter (cm)	0.78
3.	Root Weight (g)	6.83
4.	Root pulp to peel ratio	2.7:1

Table. 1 exhibits the physical properties of fresh shatavari roots used during experiment. The data from Table. 1 indicates the length of the shatavari roots ranged from 20.5 to 40.1cm with an average of 28.3 cm. The diameter of the roots ranged from 0.33 to 1.30 cm with an average value of 0.782 cm. The weight of roots ranged from 6.5 to 7g with an average of 6.837. The pulp to peel ratio of shatavari roots was about 2.7:1. Jarald and Jarald (2007) [6] reported the 5-30 cm length, 0.5-2 cm diameter of fresh shatavari roots.

Proximate composition

The data pertaining to proximate composition of fresh shatavari root is presented in Table 2. Moisture content of fresh shatavari roots ranged from 80.66 to 85.48% with an average value of 84.50% (w.b). Bala *et al.,* (2010) [2] reported the moisture content of fresh shatavari roots was 86.00% on fresh weight basis. Protein content of fresh shatavari roots ranged from 2.56 to 3.45% with an average value of 3.06%. The fat content of fresh shatavari roots was in the range 0.17 to 0.33% with an average value of 0.2%. Leung and Foster (1996) [10] also reported 0.2% fat in shatavari roots. The total carbohydrate content of fresh shatavari roots was 11.78%.

The fresh shatavari roots had ash in the range of 0.33 to 0.58% with an average value of 0.46%. These values are in consonance with the earlier results obtained by Leung and Foster (1996) [10].

1.

Table 2: Proximate composition of fresh

Sr. No.	Parameters	Average Value%
1.	Moisture	84.50
2.	Protein	3.06
3.	Fat	0.2
4.	Carbohydrates	11.78
5.	Ash	0.46

Phytochemical properties of fresh shatavari roots

Table 3: Phytochemical properties of fresh shatavari roots

Sr. No.	Parameters	Average value
1.	Saponins (%)	5.74
2.	Total alkaloids (%)	2.94
3.	Tannins (mg TAE/100g)	6.18
4.	Total Phenol (mg GAE/100g)	5.65

From Table 3, it is observed that the saponin content of fresh shatavari roots was 5.74%. Negi *et al.,* (2010) [13] reported the saponins content of fresh shatavari roots was 5.44%. Mahantesh *et al.,* (2022) [11] also reported the saponin content of shatavari roots was 6.30%. The total alkaloids present in fresh shatavari roots was 2.94%. Similar observation 2.93% of total alkaloids were reported by Devesh *et al.,* (2015) [4] Total phenol content and tannin content of fresh shatavari roots was 5.65 mg GAE/100g and 6.18 mg TAE/100g. The similar findings for total phenol content and tannin content were reported by Saini and Singh (2015) [16].

Effect of different osmotic agents on mass transfer properties during osmotic dehydration

Shatavari roots provides wide variety medicinal components and has commercial potential due to its medicinal value. During osmotic dehydration of shatavari roots using the various osmotic agents, water loss, solid gain and mass reduction were monitored as presented in Table 4. It was found that the immersion of shatavari roots in different osmotic agents for 180 min had significant effect on mass transfer properties. Water loss, solid gain and mass reduction during osmotic dehydration were found to be highest in case of sugar treatment , followed by jaggery, honey and lowest in case of palm sugar. Due to its low molecular weight, sugar is one of the osmotic agents. Sugar can readily diffuse and permeate into cells and tissues; thus it may protect the quality of food product by inhibiting many chemical processes including enzymatic browning and oxidation (Yadav and Singh, 2014) [20] Raja and Asaman, 2023) [14]. The effect of four different osmotic agents on the mass transfer of osmotically pre-treated apricots, sugar caused the better water loss. (Ispir and Togrul, 2009) [5].

Table 4: Mass transfer properties of osmotically dehydrated shatavari roots by varying osmotic agents

Treatments	Mass transfer properties		
	Water loss (WL)%	Solid gain (SG)%	Mass reduction (MR)%
Sugar	34.46	5.97	29.10
Jaggery	27.56	5.36	22.53
Palm sugar	18.49	4.03	13.51
Honey	22.46	4.71	17.62
SE	0.15	0.16	0.22
CD at 5%	0.33*	0.35*	0.50*

Effect of different osmotic agents on the color of osmo-convective dried shatavari root powder

The color of osmo-convective dried shatavari root powder by using different osmotic agent was measured as depicted in Table 1. It revealed that there was significant difference in value of L*, a* and b*. Maximum value of lightness of shatavari root powder was observed in sugar solution (62.82) while minimum lightness in jaggery solution (33.46). Osmotic dehydration of shatavari roots by using jaggery solution had highest redness (a) value (10.65). Whereas shatavari roots by using sugar solution have lowest redness value (4.59) which shows the maximum acceptability. The redness value of honey solution is found to be 502. It was observed from Table 2 that higher yellowish (b*) color was found in sugar solution (24.58) while lower yellowish (14.68) color was found in jaggery osmotic solution sample. The (b*) value of honey and palm sugar was 19.09 and 20.92.

Table 5: Color characteristics of osmo- convective shatavari roots powder by varying osmotic agents

Treatment	L*	a*	b*
Sugar	62.82	4.59	24.58
Jaggery	33.46	10.65	14.68
Palm sugar	47.84	6.507	20.92
Honey	51.24	5.02	19.09
SE	0.15	0.16	0.22
CD at 5%	0.33*	0.35*	0.50*

Sensory evaluation

The osmotic solution was prepared by varying different osmotic agent (sugar, honey, jaggery and palm sugar) with

proper amount of pure water and immersed in solution for the samples of shatavari roots were subjected to evaluate colour and organoleptic properties to evaluate the best treatment.

The sensory attributes of osmo-convective dried shatavari root powder based on judge's opinion not differ significantly by the level of and different osmotic agents (Table 4). The scores assigned to sensory parameters like taste, flavor, colour, and appearance, texture and overall acceptability of sugar osmotic agent is best as compared to jaggery. And jaggery gave good result as compared to honey. Palm sugar was not workable as was forming lumps in the powder. According to judges palm sugar was discarded. Based on these results following conclusions have been drawn from the present investigation

Table 6: Sensory evaluation of developed osmo-convective dried shatavari root powder

Treatments	Drying time (min)	Sensory properties				
		Color and appearance	Flavour	Texture	Taste	Overall acceptability
T1	390	8.4	7.4	7	8.2	7.4
T2	330	7.8	6.3	7.1	7.4	6.6
T3	270	6.4	6.1	5.2	6.2	5.4
T4	210	4.8	3.8	3.6	5	3.2
SE	0.017	0.293	0.293	0.293	0.410	0.058
CD	0.050	0.970	0.970	0.970	1.359	0.191

*Significant at 5% level

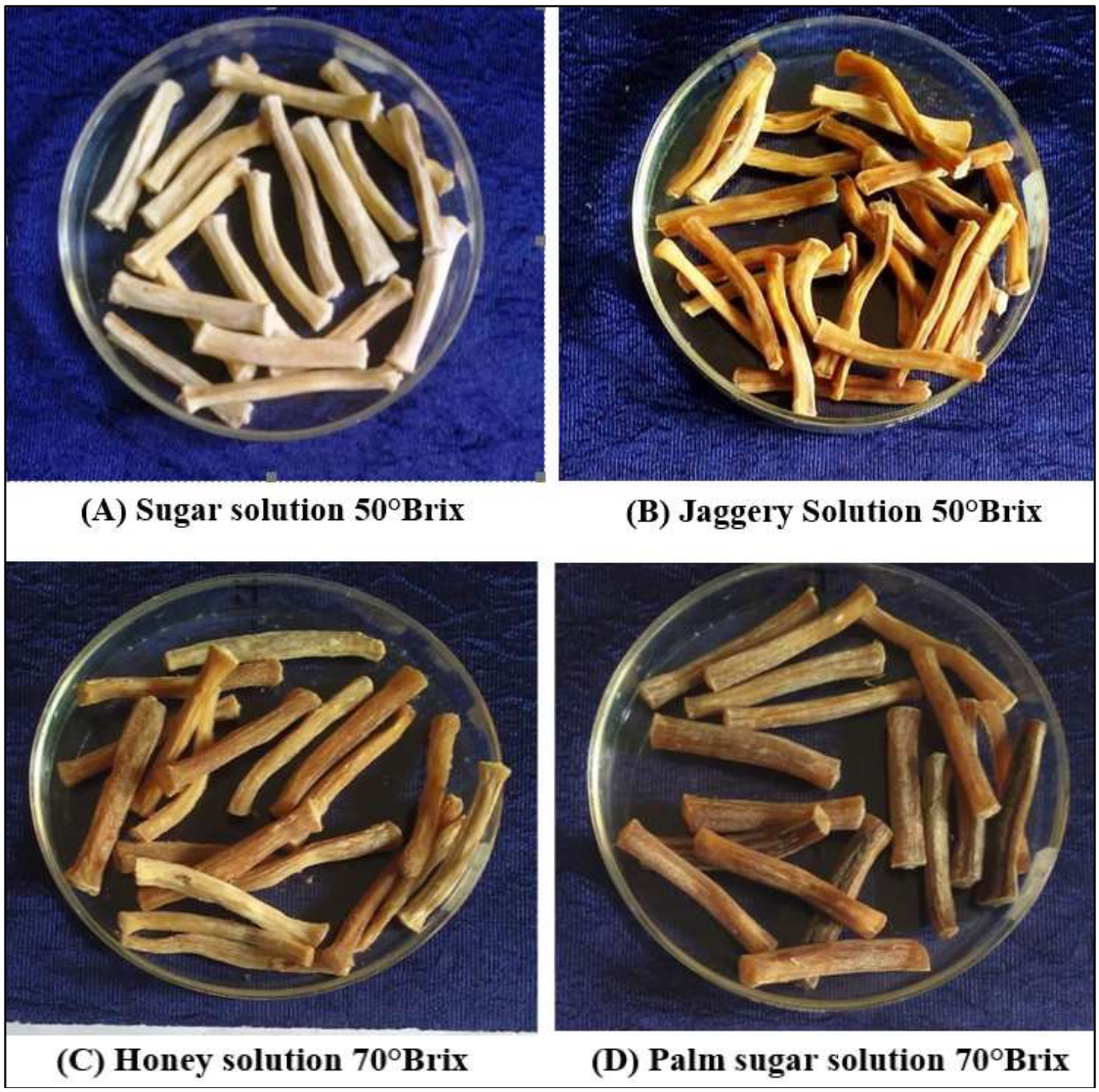

Plate 1: Osmo-convectively dried Shatavari roots in different osmotic solutions

Conclusion

The type of osmotic agents used during the osmotic dehydration process in the development of osmo-convective dried shatavari root powder had significant effect on mass transfer, colour and sensory properties of the finished product. Water loss, solid gain and mass reduction during osmotic dehydration were higher in sugar treated samples compared to other osmotic agents. The use of sugar could reduce the brown colour of the finished product. The use of other osmotic agents such as jaggery, honey and palm sugar reduced mass transfer properties, however browner colour was formed, hence decreasing the acceptability of the product. Thus sugar was the best osmotic agent for the osmotic dehydration of shatavari root for the preparation of osmo-convective dried shatavari root powder.

References

1. Bala BK, Hoque MA, Hossain MA, Uddin MB. Drying Characteristics of *Asparagus* Roots (*Asparagus racemosus* Wild.). Drying Technology: An International Journal. 2010;28(4):533-541.
2. Chadha YR. The wealth of India: A dictionary of Indian raw materials and industrial products, National Institute of Science Communication and Information Resources, Council of Scientific & Industrial Research, New Delhi; c2003. p. 470-471.
3. Devesh T, Tripathi YC, Tiwari S, Nishant A. Phytochemical, antioxidant and antimicrobial screening of roots of *Asparagus racemosus* Willd. World Journal of Pharmaceutical Research. 2015;4(4):709-722.
4. Ispir A, Togrul T. Osmotic dehydration of apricot: Kinetics and the effect of process parameters. Chemical Engineering Research and Design. 2009;87:166-180.
5. Jarald EE, Jarald ES. Textbook of Pharmacognosy and Phytochemistry First Edition (New Delhi); c2007. p. 33-34.
6. Kohli D, Champawat PS, Mudgal VD. *Asparagus* roots: nutritional profile, medicinal profile, preservation and value addition. Journal of Food Science and Agriculture. 2023;103(5):2239-2250.
7. Kohli D, Shahi NC, Kumar A. Drying Kinetics and Activation Energy of *Asparagus* Root (*Asparagus racemosus* Wild.) for Different Methods of Drying. Current Research in Nutrition and Food Science. 2018; 6(1).
8. Lazarides HN, Mavroudis N. Freeze/thaw effect on mass transfer rates during osmotic dehydration. Journal of Food Science. 1995;60(4):826-829.
9. Leung AY, Foster S. Encyclopedia of Common Natural Ingredients Used in Food, Drugs and Cosmetics, 2nd edition New York: John Wiley & Sons; c1996. p. 85-87.
10. Mahantesh I, Hiremath JS, Shrikantaprasad DS, Vijaykumar N, Patil RT, Sachinkumar TN. Root development, root yield and quality parameters as influenced by plant density and harvesting stages in shatavari (*Asparagus racemosus* Willd). Journal of farm science. 2022; 35(2):259-265.
11. Mundada M, Hathan SB, Maske S. Mass transfer kinetics during osmotic dehydration of pomegranate arils. Journal of Food Science. 2011;76:31-39.
12. Negi JS, Singh P, Joshi GP, Rawat MS, Bisht VK. Short review: Chemical constituents of *Asparagus*. Pharmacognosy Reviews. 2010;4(8):215-220.
13. Raja S, Asaman S. Effect of pretreatment on the impregnation of osmotically dehydrated fruits: A review Borneo Journal of Resource Science and Technology. 2023;13:1-21.
14. Rastogi NK, Nayak CA, Raghavrao KS. Influence of osmotic pre-treatments on rehydration characteristics of carrots. Journal of Food Engineering. 2004;65(2):287-292.
15. Saini P, Singh P. Antioxidant activity and antimicrobial property of some Indian Spices. Trends in Biosciences. 2015;8(19):5261-5267.
16. Sharma PC, Yelne MB, Dennis TJ. Database on Medicinal Plant. 2000;1:418.
17. Shi XQ, Fito P, Chiralt A. Influence of vacuum treatment on mass transfer during osmotic dehydration of fruits. Food Research International. 1995;28:445-454.
18. Solanke S, Deshmukh S, Patil BN. Development of osmo-convective drying of sweet orange slices by using different osmotic agents. International Journal of Chemical Studies. 2018;6(5):838-842.
19. Yadav AK, Singh SV. Osmotic dehydration of fruits and vegetables: A review. Journal of Food Science and Technology. 2014;51:1654-1673.