



Influence of Osmotic Dehydration and Method of Drying on the Quality of Aonla Fruit

Ambrish Ganachari^{1*}, P. F. Mathad², Mallikarjun Reddy¹ and Udaykumar Nidoni³

¹AC, Kalaburagi, UAS Raichur, India.

²AICRP on PHET, CAE, UAS, Raichur, India.

³Department of PFE, CAE, UAS, Raichur, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author AG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PFM and MR managed the analyses of the study. Author UN managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i830274

Editor(s):

(1) Dr. Adetunji Charles Oluwaseun, Edo University, Nigeria.

Reviewers:

(1) Sebastião David Santos-Filho, Federal University of Rio Grande do Norte, Brazil.

(2) Aparecida Leonir da Silva, Universidade de São Paulo, Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/59894>

Original Research Article

Received 05 June 2020
Accepted 11 August 2020
Published 20 August 2020

ABSTRACT

Osmotic dehydration of aonla fruit was carried out to determine the Influence of osmotic solution and method of drying on the quality of aonla fruit. The destined aonla fruits with and without blanching were immersed in the mixture of salt and sugar solution. The salt concentration of the osmotic solution was kept constant (100 g) and the sugar concentrations were varied to bring the concentrations to 35, 45 and 55°B maintaining a fruit to syrup ratio of 1:3 by weight. The observations were recorded to study the influence of osmotic solution and time on water loss and solid gain. The subsequent drying was carried in hot air and vacuum driers at 50±5°C to a safe storage moisture level of 0.35 kg of water per kg of dry matter. The results showed the maximum water loss of 48.55% recorded for blanched fruit osmosed at 55°B and the minimum (27.61%) in unblanched fruit osmosed at 35°B. The solid gain was observed to be maximum (23.4%) in the blanched fruit compared to unblanched fruit (9.94%) at respective concentrations. Subsequent drying showed that drying was in falling rate and time taken was higher for untreated compared to treated. The blanching and method of drying had a significant effect on the quality of fruit. Colour was found better (Bright greenish-yellow) in blanched vacuum dried fruit followed by unblanched

*Corresponding author: Email: ambrish001@gmail.com;

vacuum dried. The maximum amount of ascorbic acid was noticed in the freshly vacuum dried fruit (1780.2 mg/100 g) compared to osmosed fruits (534.8 to 1369.6 mg/100 g). Total sugar was found maximum in the osmosed vacuum dried fruit (82.2%) fruit compared to fresh once (24.6%) but the drying method had no significant effect on the retention of sugars. The mean scores for sensory showed that overall acceptability was higher for blanched vacuum dried fruit followed by unblanched vacuum dried fruits.

Keywords: Osmotic dehydration; Influence of osmosis; Aonla osmosis; Osmo-air drying of aonla.

1. INTRODUCTION

Aonla (*Phyllanthus Emblica* or *Embllica Officinalis*) also known as Indian gooseberry is an important fruit crop of India considered as “Wonder fruit for health” because of its unique qualities. It is a rich source of ascorbic acid (Vit. C) and tannins [1]. This indigenous fruit has extensive adaptability to grow in diverse climatic and soil conditions [2]. The area under amla (Indian gooseberry) has been expanding rapidly in the last couple of years. The total area under amla is estimated to be 93,000 ha with a production of 10.75 lakh tonnes for the year 2017-18 [3]. Aonla fruits are astringent, cooling anodyne, carminative, digestive, stomachic, laxative, alterant, aphrodisiac, diuretic antipyretic and trichogenous [4]. Aonla fruits are used in the traditional Indian system of medicines, like ayurvedic and unani, due to their therapeutic values [5]. Like many other herbs, amla has been useful in curing many diseases like diabetes, asthma, bronchitis, skin diseases, jaundice, scurvy and greyness of hair [6]. In view of its therapeutic properties, there is a great demand for the amla fruit.

Aonla fruit is available only for a short period (October to January) and is highly perishable in nature [1,2], and it is not consumed as fresh fruit due to its high acidic and astringent taste [7]. Hence processing and storage of aonla are essential [4]. Although many processing techniques can be employed to preserve the aonla fruits, drying is one of the important operations that is widely being practiced. There have been many advances in recent and past, for development of new dehydration technology that resulted in the production of enormous convenience and ready to eat products, which not only meet quality but also provide sufficient stability and economy. In all these processes, the food materials undergo phases of high-temperature and time combinations. This significant high temperature processing would impair fresh quality of the food and hence result

in the products without original flavour, colour and textural attributes after rehydration [8]. In such cases, osmotic dehydration is a challenging technique which can preserve these qualities to some extent [9].

Osmotic dehydration is one of the best techniques to lower the water activity of the foods, where the integrity of the product is kept unaffected, by soaking the slices of the fresh fruit in an appropriate solution to result in the final product having desired water activity [10]. Osmotic dehydration has also been found quite suitable pre-processing tool where foods are dehydrated partially followed by the conventional drying process. During the subsequent drying process, the product is exposed to shorter time and temperature combination thereby not only preserving the fresh like status of the fruit but also aid in a significant reduction in the energy requirements [11]. Further, in recent years, minimal processing of the food and development of ready to eat or convenience food for human consumption has received considerable attention that has given impetus attention to the application of the osmotic dehydration. This technology is applied to the aonla fruit with the intention to store the fruit with development of the new minimally processed ready to eat the osmotically dehydrated product. Hence, the optimisation of osmotic dehydration process for aonla fruit in salt and sugar solution was carried out to optimize the osmotic process parameters (concentration of a solution, blanching treatment and process time) on quality responses (water loss and solute gain).

2. MATERIALS AND METHODS

2.1 Preparation of Samples

Aonla fruits (*Embllica Officinalis*) of *Chakia* variety were procured from the farmer of Ketanur village in Coimbatore district since it is suitable for the dehydration and candy making [12]. Ripe fruits having an almost similar size and colour were chosen; washed with potable water to remove

any extraneous matter adhering to the fruits. The fruits were then deseeded using the hand-operated destoner developed by TNAU Coimbatore [4] (Ganachari et al., 2008). The deseeded fruits were used for osmotic dehydration with and without blanching (dipping in boiling water for 5 min) treatment to observe the effect.

2.2 Preparation of Osmotic Solution

The solute cost, organoleptic compatibility with the end product and additional preservation action by the solute are the factors considered in selecting osmotic agents. Sugar and salt solutions proved to be the best choices based on effectiveness, convenience and flavor [11]. In the present study osmotic dehydration of aonla was carried out in the mixed solution of sugar and salt since the fruit is being used as fruit as well as vegetable. The salt concentration of the osmotic solution was kept constant and the sugar concentration was varied (35, 45 and 55°B). For the preparation of syrup 100 g each of salt and 250, 350, and 450 g of sugar were dissolved into 650, 550 and 450 g of water respectively in 1000ml glass containers. Stirring and heating were done with a ladle to dissolve the salt and sugar completely. The syrup was filtered using a muslin cloth and its strength was checked using a refractometer.

2.3 Osmotic Dehydration Aonla Fruits

The osmotic dehydration of deseeded aonla fruit was carried out for unblanched and blanched fruits by dipping in the sugar-salt syrup concentrations of 35, 45 and 55°B. Approximately 300 g (10 No.s) of the fruits were weighed and dipped in the syrup maintaining a fruit to syrup ratio of 1:3 [11] (Tortoe, 2010) by weight at room temperature. To enhance the shelf life and to protect the fruits from microbial attack, potassium sorbate was added as a preservative [13] to the solution at 220 ppm. The weight of the fruit was recorded after draining and blotting of adhering syrup for every four-hour interval since it is a hardy fruit which takes more time to remove moisture.

2.4 Water Loss and Solute Gain during Osmotic Dehydration

The mass transfer parameters i.e water loss (WL) and solid gain (SG) reflecting as one of the quality attributes of aonla were calculated by the equations [14].

Weight reduction (WR) in (%)

$$= \left(\frac{\text{InitialFruitweight} - \text{FinalFruitweight}}{\text{InitialFruitweight}} \right) \times 100 \quad (1)$$

Solid gain (SG) in (%)

$$= \left(\frac{\text{Totaklsolids} - \text{Initialsolids}}{\text{InitialFruitweight}} \right) \times 100 \quad (2)$$

$$\text{Water loss in (\%)} = (\text{WR} + \text{SG}) \quad (3)$$

2.5 Optimization of Osmotic Process Parameters

General factorial analysis was applied to the experimental data using a statistical package, Design-Expert version 7.0.0 (Statease Inc., Minneapolis, USA, Trial version). The osmotic process variables selected for the study were blanching treatment, the concentration of osmotic solution and immersion time. The blanched and unblanched aonla fruits were immersed in osmotic solution concentrations of 35, 45 and 55°B and the immersion time was up to 16 h at an interval of 4 h. The optimization of the osmotic dehydration process aimed at finding the effect of independent variables on water loss (WL) and solute gain (SG).

2.6 Drying of Aonla Fruit

The drying is the second step in the osmotic dehydration [15]. This is the process in which the remaining amount of moisture was removed to get good textured food with longer shelf life. The fruits were taken out from the mixed solution after completion of the osmosis process at the end of optimized time and blotted completely with a tissue paper to remove the syrup adhering to the fruits. The fruits were weighed and further dried in two types of driers namely hot air/cabinet and vacuum driers. The fruits were spread uniformly on the trays in a single layer and dried at 50°C in a hot air drier and 50°C with 600 mm of vacuum in a vacuum drier. The fruits were dried to a final moisture content of 0.35 kg of water per kg of dry matter at which the water activity of the product was less than 0.6 to prevent them from fungal attack during storage and palatable for eating as a dried fruit. The weight of the fruit was recorded at every two-hour interval and at the later stage, the water activity was also noted along with weight. In case of control, the fresh fruits after removal of seed were directly dehydrated in the drier.

2.7 Quality Evaluation of Dried Aonla Fruit

The osmo-dried aonla fruits in two different dryers were evaluated for biochemical, textural and sensory attributes in triplicate. The biochemical properties viz., moisture content [16], acidity [17], colour (Hunter Lab colour meter) in terms L^* , a^* and b^* , water activity, TSS (Abbe's refractometer), total sugars [18] and ascorbic acid [18] were analysed. The texture profile analysis was performed for osmo-dried aonla fruit samples using a texture analyzer (Model: TA-HDi, Make: Stable MicroSystems, U.K. The rehydration ratio as per the procedure reported [17] and the sensory and organoleptic evaluation using a 9 point hedonic rating test [19] (Ranganna, 1995).

3. RESULTS AND DISCUSSION

The osmosis of aonla fruits was carried out to determine the suitability of blanching treatment and the concentration of the osmotic medium on water loss and solid gain. The water loss increased with increase in osmosis time while the rate of water loss decreased, at all the concentrations. It was observed that more water loss was observed at a time interval of 16 h, after this time the water loss was very less which was found to be non-

significant. This might be due to the reduction in the osmotic pressure caused by dilution of the solution and similar results were reported for apple slices [20].

3.1 Effect of Blanching Treatment on Water Loss and Solid Gain

The effect of blanching treatment on water loss and solid gain in aonla fruit at three different concentrations is shown in Fig. 1. The data analyzed statistically showed the blanching treatment increased the osmosis, water loss and solid gain. The water loss was observed to be maximum in the blanched fruits (48.55%) as compared to unblanched (40.21%) at the same concentration. Blanching also was found to have a significant effect on the solid gain. Similar to water loss, the solid uptake was observed to be higher as compared to unblanched fruits at all concentrations. This solid gain was noticed to be maximum when blanched fruit was osmosed in 55°B while it was minimum in unblanched 35°B treatments. This might be due to removal of the natural wax coating present around the fruit during blanching by heat and softening of the tissues which allow the solids entry and water loss. Similar results were also observed for aonla fruits [10].

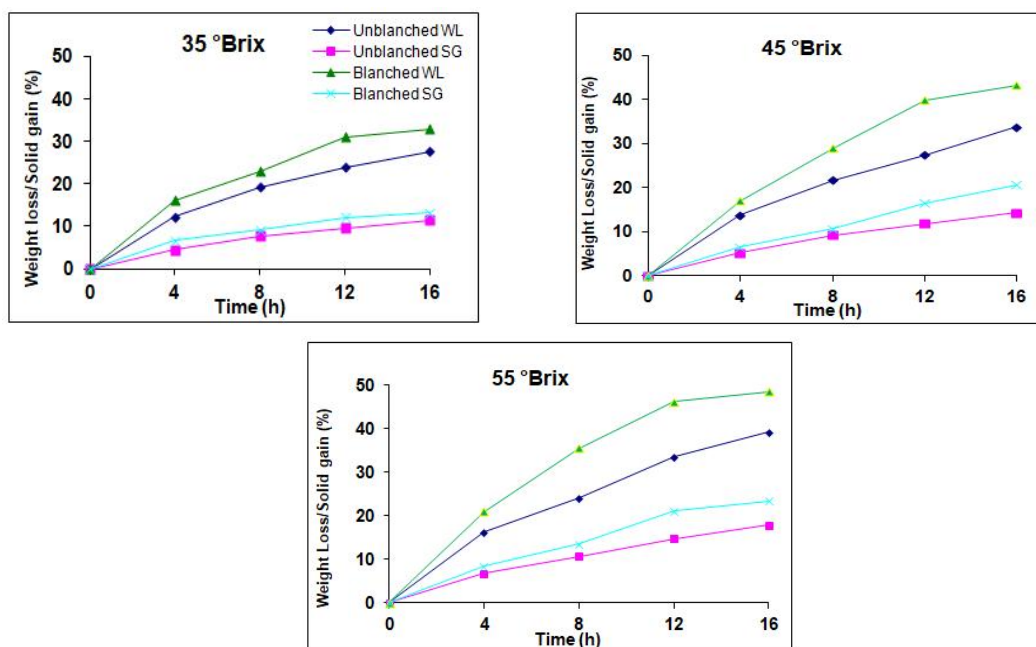


Fig.1. Effect of blanching on water loss and solid gain of aonla fruits at 35, 45 and 55°B concentrations of osmotic solution with time

3.2 Effect of Concentration on Water Loss and Solid Gain

The effect of concentration on water loss and solid gain in aonla fruit at three different concentrations is shown in Fig. 1. The statistical analysis of data showed that water loss and solid uptake have a significant effect on the concentration of the osmotic solution. The maximum water loss and solid gain were observed at 55°B concentration, compared to the other two concentrations. This higher concentration promoted the increase in water loss and solid gain during the process could be due to the increase of osmotic pressure outside the fruit [21,22]. This was consistent with the investigations reported for strawberry [23] and aonla fruits [10,24].

3.3 Optimization of Osmotic Treatment and Concentration

Numerical optimization was applied to determine the optimal osmotic treatment and concentration osmotic solution for maximizing the water loss and solid gain. Optimum points established 6 solutions, but only several points were chosen as optimum points, on condition that it satisfied the criteria mentioned. The optimum desirability of 0.785 was obtained for blanched aonla fruit osmosed at 55°B.

3.4 Drying of Aonla Fruit

The drying curves of fresh and osmosed aonla fruits for hot air and vacuum dryers are shown in Fig. 3. It was observed that the moisture reduction was rapid during the initial stages due to the presence of higher moisture. The drying curves also showed that the time required was higher for the fresh fruits as compared to osmosed due to presence of more moisture and solid particles in the fresh fruit which offered the resistance [25]. The time taken for drying the fresh aonla fruit in hot air and vacuum dryers were 32 and 28 h whereas, the osmosed fruits took 22 and 20 h, respectively. The reason might be due to the presence of wax layer and removal of more moisture during osmosis. It was also observed that the time taken for the vacuum drying was higher as compared to hot air drying even though it is dried at lower pressure. The reason might be due to lack of air circulation and the presence of higher humidity in an enclosed chamber. Similar results were observed for banana [26].

3.5 Effect of Drying Method on the Quality of Osmo-Dehydrated Aonla Fruit

The effect of drying method on the quality of osmo-dehydrated aonla fruit is given in Table 1.

3.6 Titrable Acidity

It is observed that the effect of drying method on change in acidity was not significant. The acidity was found to be less in the osmotically dehydrated fruit as compared to freshly dried fruit. The reduction in acidity in osmo dried aonla might have been due to leaching of acids during osmosis process which has been reported by several workers [27].

3.7 Ascorbic Acid

Ascorbic acid content was observed to be higher for aonla fruits dried fresh compared to osmosed fruits due to losses during osmosis. It was also observed that vacuum dried fruit had a higher (675.3 mg/100 g) value as compared to the air-dried (534.8 mg/100 g). This might be because of drying at lower pressure. The blanching and osmosis had a drastic effect on the ascorbic acid content of aonla fruit [28].

3.8 Total Sugars

The total sugar was observed to be maximum for osmosed fruits compared to fruits dried fresh due to the infusion of the sugars during osmosis [12]. Among the dryers, the total sugars were higher (82.2 %) for vacuum dried fruits compared to hot air dried fruit (80.2 %). The drying method was found to be non-significant with respect to change in total sugars content of the fruit.

3.9 Colour

The difference in the colour of fruit after dehydrating in different driers was measured using Colour flex meter in terms of L^* , a^* and b^* values. It was observed that the L^* value is maximum for osmosed fruits (32.77) compared to freshly dried (30.75) due to inactivation of oxidative polyphenols by sugars coating in the osmosed fruit [29]. The a^* values showed a decreasing trend, which was less in case of osmosed fruit but the value of b^* showed an increasing trend. Blanching prevented non-enzymatic browning and retained the better colour of the processed product because of the higher degree of inactivation of polyphenol oxidase [30]. The a^* values were found to be less for the vacuum dried (3.92) fruit as compared to

hot air dried (5.05) which showed that the reduced pressure had a considerable effect on the retention of colour and prevention of browning. The overall colour was good for the osmosed vacuum dried fruit followed by the osmosed hot air.

3.10 Sensory and Organoleptic Qualities of Osmotically Dehydrated Aonla

The sensory quality parameters namely colour, flavor (aroma), taste, appearance, texture and overall acceptability of the fresh and osmotically dehydrated aonla fruits dried in hot air and

vacuum driers are presented in the Fig. 2. It was observed that the osmo-vacuum dried fruits obtained higher scores compared to osmo-air and fresh vacuum dried fruits. The highest mean score for overall acceptability was 7.82 for osmo-vacuum dried fruits followed by 593 for osmo-air dried fruits. This might be due to infusion of a higher amount of sugars and the reduced browning reaction improved the product quality in terms of colour, flavour and texture [25]. On the other hand, partial dehydration and solute uptake have prevented structural collapse during subsequent drying processes [31].

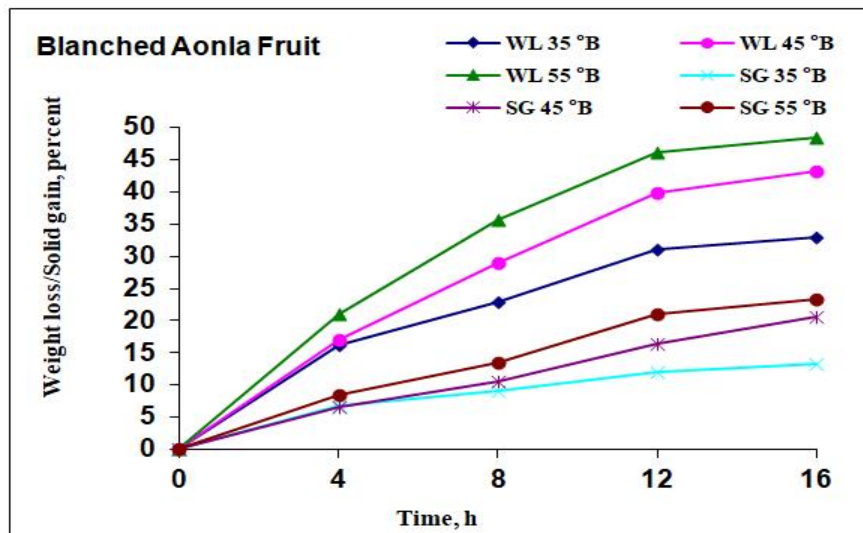


Fig. 2 Effect of concentration on water loss and solid gain in aonla fruits

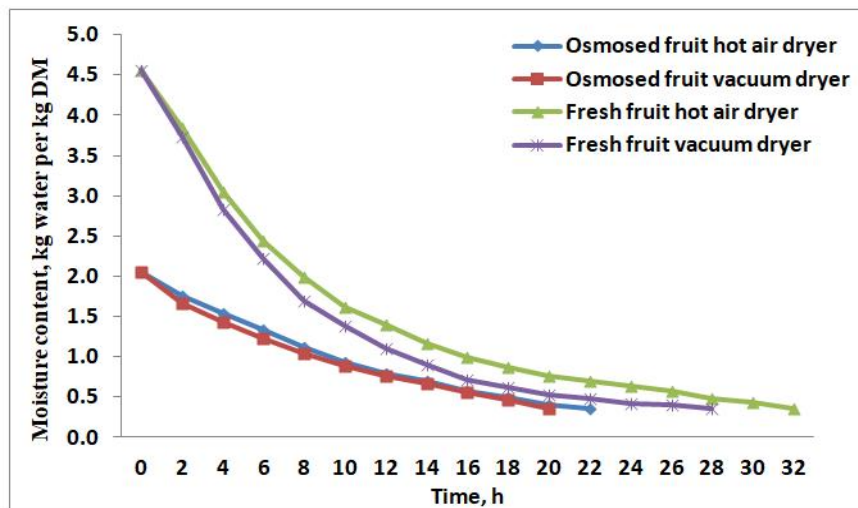


Fig. 3 Drying curves for fresh and osmosed fruits in hot air and vacuum dryer

Table 1. Effect of drying method on quality of osmo-dehydrated aonla fruit

Treatment	Drying method	Water activity	Titrable acidity, (%)	Ascorbic acid (mg/100g)	Total sugars (%)	Colour		
						L*	a*	b*
Fresh fruit	-	0.993	2.61	2430.0	9.5	68.26	1.91	23.42
Freshly dried	Hot air	0.552	0.0617	1638.7	24.6	24.15	9.67	8.17
	Vacuum	0.568	0.0602	1780.2	26.1	26.35	7.58	10.53
Osmo dried	Hot air	0.565	0.0231	534.8	80.2	30.75	5.05	14.28
	Vacuum	0.596	0.0223	675.3	82.2	32.77	3.92	14.49
CD@1%		0.002	NA	92.350	1.155	1.525	0.215	1.602
SE(m)±		0.001	0.135	22.906	0.286	0.378	0.053	0.397
CV		0.126	174.8	2.828	0.758	1.853	1.149	4.612
Significance		S	NS	S	S	S	S	S

*S- Significant NS- Nonsignificant;

L* - dark vs. light values between 0 and 100, a*- Red vs. green where a positive number indicates red and a negative number indicates green and b* - Yellow vs. blue where a positive number indicates yellow and a negative number indicates blue

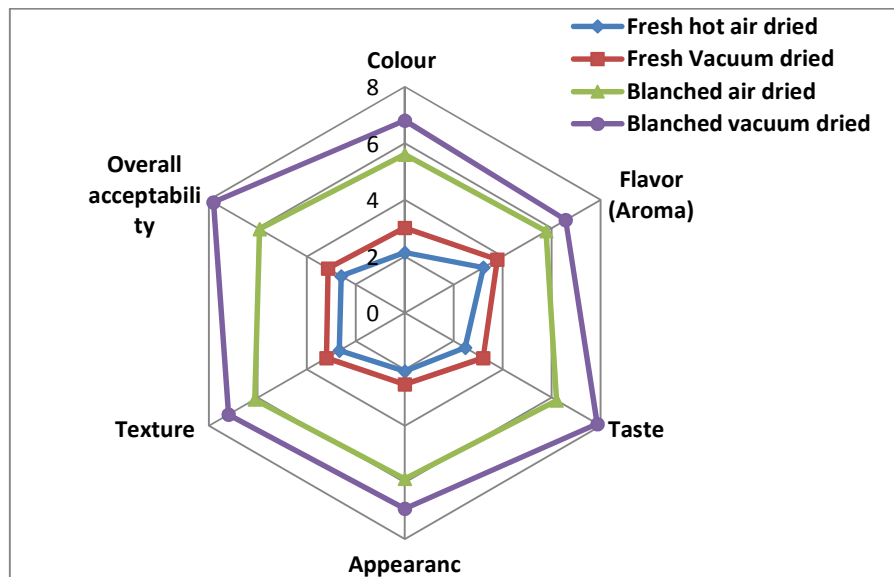


Fig. 4. Sensory evaluation scores for fresh and osmosed aonla fruits dried in hot air and vacuum driers

4. CONCLUSIONS

The osmotic concentration and blanching treatment were the factors that significantly affected the water loss and solid gain during osmotic dehydration of aonla fruits. The osmotic dehydration of aonla fruit by dipping the deseeded blanched aonla fruits in the mixture of a salt-sugar solution of 55°B for 16 h gave the highest desirability factor. The subsequent drying of osmotically dehydrated aonla fruits in vacuum dryer could retain 675.3 mg/100g of ascorbic acid, 82.2% total sugars and 0.022% titrable acidity. The color of the osmo vacuum dried fruit

was very good compared to aonla dried by other methods. The sensory analysis also scored highest for osmo-vacuum dried fruits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Goyal RK, Patil RT, Kingsly ARP, Walia H, Kumar P. Status of post-harvest technology of aonla in India-A

- Review. American Journal of Food Technology. 2008;3:13-23.
2. Sumitha N, Tiwari RB, Patil RA. Suitability of Packaging and Storage Conditions for Osmo-air Dried Aonla Segments. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences. 2013;85(1):203–209.
 3. Horticultural Statistics At A Glance. Horticulture Statistics Division Department of Agriculture, Cooperation & Farmers' Welfare Ministry of Agriculture and Farmers' Welfare Government of India; 2018.
Available: <http://agricoop.nic.in/sites/default/files/Horticulture%20Statistics%20at%20a%20Glance-2018.pdf>
Accessed 15 June 2020.
 4. Ganachari A, Thangavel K, Manohar JD, Vishwanathan R. Design and development of a machine for aonla seed removal. Agricultural mechanization in Asia, Africa and Latin America. 2008;39(2):80-82.
 5. Agarwal S, Chopra CS. Studies on changes in ascorbic acid and total phenols in making aonla products. Beverage and Food World. 2004;31(5):32–33.
 6. Ganachari A, Thangavel K, Ali S.M, Nidoni U, Ananthacharya. Physical properties of Aonla fruit relevant to the design of processing equipments. International Journal of Engineering Science and Technology. 2010;2:7562-7566.
 7. Goyal RK, Kingsly ARP, Kumar P, Walia H. Physical and mechanical properties of aonla fruits. Journal of Food Engineering. 2007;82(4):595–599.
 8. Alam MS, Kaur M, Ramya HG. Mass Transfer Kinetics for Osmotic Dehydration of Kinnow Fruit in Sugar Solution. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences; 2017.
DOI: 10.1007/s40011-017-0951-z
 9. Shi J, Maguer M. Osmotic dehydration of foods: Mass transfer and modeling aspects. Food Reviews International. 2002;18:305-336.
 10. Alam MS, Singh A. Optimization of osmotic dehydration process of aonla fruit in salt solution. International Journal of Food Engineering. 2010;6:1–22.
 11. Tortoe Ch. A review of osmo-dehydration for food industry. African Journal of Food Science. 2010;4(6):303–324.
 12. Pragati S, Dahiya, Dhawan SS. Effect of drying methods on nutritional composition of dehydrated aonla fruit (*Emblia officinalis* Garten) during storage. Journal of Plant Foods for Human Nutrition. 2003; 58(3):1-9.
 13. Moreno J, Simpson R, Pizarro N, Parada K, Pinilla N, Reyes JE, Almonacid S. Effect of ohmic heating and vacuum impregnation on the quality and microbial stability of osmotically dehydrated strawberries (cv. Camarosa). Journal of Food Engineering. 2012;110(2): 310–316.
 14. Aktas T, Fujii S, Kawano Y, Yamamoto S. Effects of pretreatments of sliced vegetables with trehalose on drying characteristics and quality of dried products. Food and Bioproducts Processing. 2007;85(3):178–183.
 15. Contreras JE, Smyrl TG. An evaluation of osmotic concentration of apple rings using corn syrup solids solutions. Can. Inst. Fd Sci. Technol. Journal. 1981;14(4):310-314.
 16. AOAC. Official methods of analysis of the Association of Official Analytical Chemists. USA; 1980.
 17. Ranganna S. Handbook of analysis and quality control for fruits and vegetable products, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi; 1986.
 18. Sadasivam S, Manickam A. Biochemical methods for agricultural science Willey Eastern Limited, New Delhi; 1992.
 19. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata Mc-Grawhill Publishing Company Limited. New Delhi; 1995.
 20. Lazarides HN. Osmotic pre-concentration: developments and prospects. In: Minimal processing of foods and process optimisation; an interface," Singh RP, Oliveira, F. AR (Eds.). CRC Press, London, UK; 1994.
 21. Mizkahi S, Eichler S, Ramon O. Osmotic dehydration phenomena in gel systems. Journal of Food Engineering. 2001;49:87-96.
 22. Mundada M, Hathan BS, Maske S. Mass transfer kinetics during osmotic dehydration of pomegranate arils. Journal of Food Science. 2010;76:31–39.
 23. Prinzivalli C, Brambilla A, Maffi D, Scalzo R, Torreggiani D. Effects of osmosis time on structure, texture and pectin composition of strawberry tissue. European Food Research Technology. 2007;224:119-127.

24. Ganachari A, Thangavel K, Nidoni U, Mathad PF, Reddy M. Optimisation of osmotic dehydration process for aonla (*Emblica officinalis*) fruit in the mixture of salt-sugar solution. *Journal of Pharmacognosy and Phytochemistry* 2020; 9(4):772-775.
25. Rahman MDS, Lamb J. Air drying behavior of fresh and osmotically dehydrated pineapple. *J. Fd Process Engg.* 1991;14: 163-171.
26. Heartwin Amala Dhas A. Studies on osmotic dehydration of banana. Unpublished ME. (Ag) Thesis, Tamilnadu Agricultural University, Coimbatore, India; 1997.
27. Pragati Dahiya S, Dhawan DS. Effect of drying methods on nutritional composition of dehydrated aonla fruit (*Emblica officinalis* Garten) during storage. *Plant Foods for Human Nutrition.* 2003;58:1-9.
28. Shikha Agarwal, Chopra CS. Studies on changes in ascorbic acid and total phenols in making aonla products. *Beverage and Food world.* 2004;31(5):32-34.
29. Yetenayet B, Hosahalli R. Going beyond conventional osmotic dehydration for quality advantage and energy savings, *Ethiopian Journal of Applied Sciences and Technology (EJAST).* 2010; 1(1):1-15.
30. Sethi V. Effect of blanching on drying of amla. *Indian Food Packer.* 1986;40(4):7-10.
31. Maestrelli A, Lo Scalzo R, Lupi D, Bertolo G, Torreggiani D. Partial removal of water before freezing: Cultivar and pre-treatments as quality factors of frozen muskmelon (*Cucumis melo*, cv *reticulatus* Naud.). *Journal of Food Engineering.* 2001;49(2-3):255-260. DOI: 10.1016/s0260-8774(00)00211-9

© 2020 Ganachari et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/59894>