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Development of osmo-convective drying of sweet orange slices by using different osmotic agents

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Abstract
The aim of this study was to study the effect of various sweetening agents on Sweet orange slices in osmotic solution and also the taste of sweet orange slices. Fresh juice of sweet orange is refreshing, thirst quenching and energizing drink that improves health and nutritional requirements. Fresh sweet oranges are purchased and were cut into 0.3 cm thick slices with peel using a sharp knife. Sugar, jaggery, honey, stevia was used as osmotic agents. Experiments were carried out with a product/solution ratio (1:5) such that the concentration of the solution remained approximately constant during the experiments. The quality characteristics of developed product such as moisture content, color, hardness and sensory evaluation was done. Osmo-convective dried sweet orange slices by using sugar osmotic solution gives good result as compared to honey and jaggery. Osmo-convective dried sweet orange slices by using stevia solution were not workable because of its shrinkage during drying.

Keywords: osmotic dehydration, sweet orange color, moisture content, hardness

Introduction
Sweet orange (*Citrus sinensis* L. Osbeck) commonly called orange. Sweet orange is one of the important citrus fruit crop juice processing. Excess bitterness affects the quality of grown throughout the world and contributes 71 per cent many processed juice products and results in a of the total citrus fruit production. It is food with high contents of healthy nutrients and it has great tradition and economic importance. The area and production of sweet orange in the India is about 275 thousand hectare and 4248 MT/hectare. Andhra Pradesh, Maharashtra, Karnataka, Punjab, Haryana and Rajasthan are main sweet orange growing, stages. Maximum area under sweet oranges is in Andhra Pradesh, followed by Maharashtra and Karnataka.

Sweet Oranges are rich in Vitamin C and potassium. Nutritionally, one orange supplies around 116.2% of the daily value for vitamin C. Its peel contains citral, an aldehyde that hassle the action of vitamin A. It consist of 198 I.U. vitamin A, 65.69 mg vitamin C, 12.67g carbohydrate, 0.8g fiber, 1.4g protein and 0.4g fat per 100g. Important phytochemicals like liminoids, synephrine, hesperidin flavonoid, polyphenols, pectin, and sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium are also present. The health benefits of sweet oranges are nutrients in oranges are plentiful and diverse. The fruit is low in calories, contains no saturated fats or cholesterol, but is rich in dietary fiber, *pectin.*

Different types of osmotic agents such as glucose, sorbitol, sucrose and salts are used according to the final products (Singh *et al*., 2008) [11]. However combination of different solutes can be used (Taiwo *et al*., 2003) [12]. Water loss from vegetables and fruits took place in first two hours and maximum sugar gain within 30 minutes (Conway *et al*., 1983) [4]. Osmotic dehydration is used with other drying methods such as freezing and deep fat frying to make available better quality final product. Temperature and concentration of osmotic syrups increased the rate of water loss during OD. However higher temperature has the significant effect on the structure of tissues (Lazarides, 2001) [6] and cause flavor deterioration and enzymatic browning at temperature above 45°C.

Osmotic dehydration (OD) is one of most important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decrease the energy costs (Alakali *et al*., 2006; Torres *et al*., 2006) [1, 13] (Lazarides, 2001) [7]. It has been reported that osmotic dehydration reduced up to 50% weight of. It results in increased shelf-life, little bit loss of aroma in dried and semidried food stuffs, lessening the load of freezing and to freeze the food without causing unnecessary changes in texture (Petrotos and Lazarides, 2001) [7]. It has been reported that osmotic dehydration reduced up to 50% weight of fresh vegetables and fruits (Rastogi and Raghavararo, 1997) [9]. It prevents the enzymatic browning and inhibits activities of polyphenol oxidases. It minimizes the effect of temperature on food quality and preserves the wholeness of the food, as no high temperature/phase change is required in the process. It improves the texture and rehydration properties. The process reduces volume of the products thereby saving in the cost of processing, storage and transport.

The solutes such as fructose, corn syrup, glucose, jaggery, honey, stevia and sucrose are used as osmotic agent for OD. Low molar mass saccharides (sucrose, glucose and fructose) make easy the sugar uptake due to high diffusion of molecules. Other natural sweeteners like jiggery, honey used as osmotic agents for osmotic dehydration. It has proved to be a good quality method to get modestly processed fruits, 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.

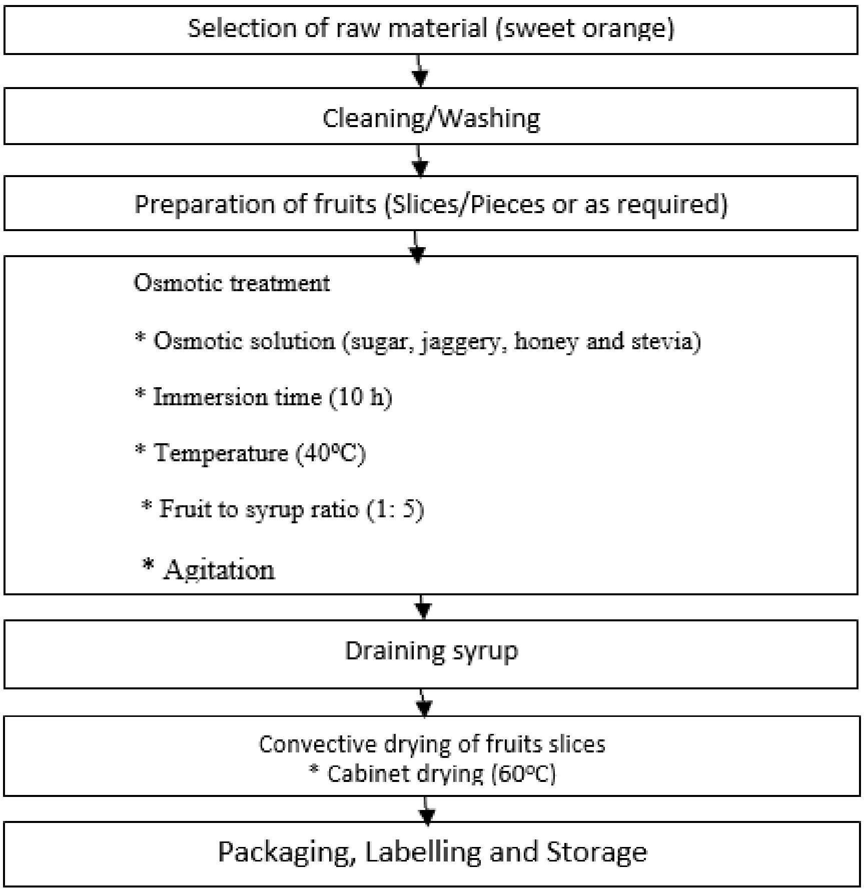
Material and Methods

Sample preparation

Fresh sweet oranges (*Citrus sinensis* L. Osbeck) are purchased locally; sweet oranges were used as raw material, selected with similar color, size and maturity stage. The sweet oranges were cut into 0.3 cm thick slices with peel using a sharp knife. Sugar, jaggery, honey, stevia was purchased from a local market.

Experimental procedure

Experiments were carried out with a product/solution ratio (1:5) such that the concentration of the solution remained approximately constant during the experiments. The samples were individually weighed and immersed in a selected temperature (40 °c) and osmotic solution concentration named like T1 as Sugar solution, T2 as Honey solution, T3 as Jaggery solution and T4 as Stevia solution. The agitation was necessary to improve mass transfer, main1tain uniform concentration, and prevent the formation of a dilute solution film around the sample



Flow chart of general method of osmotic dehydration process

Evaluation of quality attributes of sweet orange during osmotic dehydration and convective drying.

Color of osmo-convective dried sweet orange slice

Colour (L*, a*, b* values) of the osmo-convective dried sweet orange slice were determined 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. It was determined by Hunter Lab colorimeter.

Moisture content (%)

The moisture content was determined by drying at 110º C for 4 h. The percentage moisture content was calculated using the formula.

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight after drying}}{\text{Initial weight}} \times 100$$

Textural properties

Textural profile analysis was performed by puncture tests with a 2 mm diameter cylindrical stainless steel probe (p/2), HDP/90 platform monitored on a TA.XT plus Texture Analyser (Stable Micro Systems, Godalming, UK) equipped with XTRAD Dimensions software (Stable Micro Systems). The pre-test speed of the probe was 1.0 mm/s, the test speed was 2.0 mm/s and the post-test speed was 10.0 mm/s. The samples of osmo-dehydrated sweet orange slices prepared were supported using a hole twice the diameter of the punch. Then textural properties such as hardness of osmo-convective dried sweet orange slices were determined.

Sensory evaluation

Organoleptic evaluation is the way of knowing acceptability of product using the senses, viz., sight, smell, touch, test and hearing. It is also a way of simulating the consumer response by a few experienced judges. A panel of ten judges comprising of faculty and students of the institute was formed. Sensory evaluation was carried out by the standard method.

All indexes were measured using a scale (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 sweet orange slices were evaluated in different sensory attributes by a panel of minimum 10 judges. Sensory attributes like color, texture, and overall acceptability were assessed using nine point hedonic scales for all samples.

Result and Discussion

The result on study of different process parameters on quality of osmo-convective dried sweet orange slice were discussed in this section. Sweet orange samples free from physical damage and disease were selected for experiment. Sweet orange slices dip in sugar solution, honey solution, jaggery and stevia solution by concentration (70%) and immersion time (10h) at 40^{o}C solution temperature. The samples were evaluated for quality parameter and sensory evaluation of developed product.

Physiochemical characteristics of sweet orange

Characteristics of sweet orange were determined during experiment by taking 10 samples and average values are presented in Table 1. It was observed that, average values of length, breath, weight, volume of juice, number of seed fruit^{-1}, moisture, total soluble solids and acidity were 6.1cm, 6.0 cm, 153 g, 62.15 ml, 7, 86.5%, 5.14 ^{o}Brix and 0.48%, respectively. Same results were observed by Khalid *et al*., (1993) for characteristics of sweet orange.

Table 1: Characteristics of sweet orange

Sr. No.	Parameters	Average value
1.	Length (cm)	6.1
2.	Breadth (cm)	6.0
3.	Weight (g)	153
4.	Volume of juice (ml)	62.15
5.	Number of seed fruit	7
6.	Moisture (%)	86.5
7.	Total soluble solids(^{o}Brix)	5.14
8.	Acidity (%)	0.48

Textural property

Hardness

Hardness is one of the important qualities for osmo-dehydrated sweet orange slices by using different osmotic agents. The measured values for hardness (N) of osmo-dehydrated sweet orange slices by using different osmotic agents are presented in Table 2.

Table 2: Textural analysis of osmo-dehydrated sweet orange slices by using different osmotic agents

Treatment	Hardness (N)
T1	78.4
T2	76.0
T3	73.2
T4	71.23

T1- Sugar solution, T2- Honey solution,
T3- Jaggery solution T4- Stevia solution

Hardness of osmo-dehydrated sweet orange slice with different osmotic agents prepared by indigenous method varied from 71.23 to 78.4 N. From Table 2, it was observed that the maximum hardness of osmo-dehydrated sweet orange slice prepared with sugar solution is 78.4 N while minimum in stevia solution is 71.23N. The values of hardness of osmo-dehydrated sweet orange slices with jaggery and honey solution were found as 76.0 and 73.2 N, respectively. A similar result was observed by Pinzon *et al*., (2013) [8].

Colour

Colour of sweet orange slices is very important characteristic which influences the consumer acceptability. Table 3 and Plate 1 shows the color of sweet orange slices by using different osmotic agent (L*, a, b, value). Table 3 revealed that there was significant difference in value of L*, a and b.

Maximum value of lightness of sweet orange slices was observed in sugar solution (50.79) while minimum lightness (L*) in jaggery solution (30.46) followed by honey osmotic solution (41.56).Sweet orange slices by using jaggery solution had highest redness (a) value (10.65). Whereas sweet orange slices by using sugar solution have lowest redness value (5.26) which shows the maximum acceptability. The redness value of honey solution is found to be 5.87. It was observed from Table 3 that higher yellowish (b*) color was found in sugar solution (40.37) while lower yellowish (27.63) color was found in jaggery osmotic solution sample. The (b*) value of honey and stevia was 28.69 and 29.63.

Table 3: Colour characteristics of sweet orange slices by using different sweeteners

Sample	L*	a*	b*
T1	50.79	5.26	40.37
T2	41.56	5.87	28.69
T3	30.46	10.65	27.43
T4	49.56	5.77	29.63
F Value	263.007	19.089	106.635

CD	1.912	1.912	1.912
SE	0.577	0.577	0.577

*Significant at 5% level

Sugar osmotic solution slices T_1

Honey osmotic solution slices T2

Jaggery osmotic solution slices T_3

Stevia osmotic solution slices T4

Plate 1: Samples of osmo-convective dried sweet orange slices by using different osmotic agents

Sensory evaluation

The osmotic solution is prepared by varying concentration (70%) and different osmotic agent (sugar, honey, jiggery and stevia) with proper amount of pure water and immersed in solution for the samples of sweet orange slices were subjected to evaluate colour and organoleptic properties to evaluate the best treatment.

The sensory attributes of osmo-convective dried sweet orange slices based on judge's opinion not differ significantly by the level of different concentration and different sweeteners (Table 4). The scores assign to sensory parameters like taste, flavor, colour, and appearance, texture and overall acceptability of sugar osmotic agent is best as compared to honey. And honey gives good result as compared to jaggery. Stevia is not workable. According to judges stevia is discarded. Based on these results following conclusions have been drawn from the present investigation.

Conclusion

Osmo-convective dried sweet orange slices by using sugar osmotic solution gives good result as compared to honey and jaggery. An Osmo-convective dried sweet orange slice by using stevia solution was not workable because of its shrinkage during drying.

Table 4: Sensory evaluation of developed osmo convective dried sweet orange slices.

Treatment	Colour and appearance	Flavour	Taste	Texture	Overall acceptability
T1	8.4	7.4	7	8.2	7.4
T2	7.8	6.3	7.1	7.4	6.6
T3	6.4	6.1	5.2	6.2	5.4
T4	4.8	3.8	3.6	5	3.2
F value	29.942	26.641	32.262	11.381	1003.113
CD	0.970	0.970	0.970	1.359	0.191
SE	0.293	0.293	0.293	0.410	0.058

*Significant at 5% level

References

1. Alakali JS, Ariahu CC, Nkpa NN. Kinetics of osmotic dehydration of mango. Journal of Food Processing and Preservation. 2006; 30:597-607.
2. Anonymous. Report of National Horticulture Board, 2015.
3. AOAC. Official methods of analysis, 18th edn. Association of official analytical chemists. Virginia, USA, 2005.
4. Conway J, Castaigne F, Picard G, Vovan X. Mass transfer consideration in the osmotic dehydration apples.

Can. Instute of Food Science and Technology Journal. 1983; 16:25-29.

5. Kedarnath, Nagajjanavar K, Patil SV. Osmotic dehydration characteristics of Sapota (Chikoo) slices. International Journal of Current Microbiology and Applied Sciences. 2014; 3(10):364-372.
6. Lazarides HN. Reasons and possibilities to control solids uptake during osmotic treatment of fruits and vegetables, 2001, 33-42.
7. Petrotos KB, Lazarides HN. Osmotic concentration of liquid foods. Journal of Food Engineering, 2001; 49:201-206.
8. Pinzon KM, Cortes-Rodriguez M Rodríguez-Sandoval E. Effect of drying conditions on the physical properties of impregnated orange peel, Brazilian Journal of Chemical Engineering. 2013; 30(03):667-676
9. Rastogi NK, Raghavarao K. Water and solute diffusion coefficients of carrot as a function of temperature and concentration during osmotic dehydration. Journal of Food Engineering. 1997; 34:429-440.
10. Rubio-Arraez S, Capella JV, Ortolá MD, Castelló M.L. Kinetics of osmotic dehydration of orange slices using healthy sweeteners. International Food Research Journal. 2015; 22(5):2162-2166.
11. Singh B, Panesar PS Nanda V. Osmotic dehydration kinetics of carrot cubes in sodium chloride solution. International Journal of Food Science and Technology. 2008; 43:1361-1370.
12. Taiwo KA, Eshtiaghi MN, Ade Omowaye BIO, Knorr D. Osmotic dehydration of strawberry halves: influence of osmotic agents and pretreatment methods on mass transfer and product characteristics. International Journal of Food Science and Technology. 2003; 38:693-707.
13. Torres JD, Talens P Pscriche I, Chiralt A. Influence of process conditions on mechanical properties of osmotically dehydrated mango. Journal of Food Engineering. 2006: 74:240-246.