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Improving the Dehydration of Dried Peach By Osmotic Method

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Abstract: Physicochemical properties of sliced peach during osmotic pretreatment and dehydration, the optimum condition of the osmotic dehydration and the sensory evaluation of dried products were investigated. This experiment was conducted based on statistical randomized complete block experimental design with three treatments: sucrose solution, glucose syrup and their mixture with salt. Results indicated that after 6 h the solutions of sucrose (50 and 60%), glucose syrup (60%) and their mixture with salt (40% sucrose, 20% glucose syrup and 3% NaCl) caused higher removal of water. The sensory experimental results (such as appearance, chew ability, transparency, taste and flavour and colour) showed that osmo-dried samples obtain better quality than traditional (sun-dried) samples.

Key words: Osmotic dehydration, peach, drying, process condition, water loss, solids gain

INTRODUCTION

Osmotic dehydration is one of the methods for food preservation that enables to obtain organoleptically attractive product[1]. This method is a water removal process, in which fruit or vegetables in a hypertonic solution, gets dehydrated and become a product with lower water activity and higher shelf life[2,3].

Traditional (sun-dried) products had numerous defects such as high microbial load requiring using SO_2, undesirable appearance, color and brightness and high shrinkage. During the last decades, much attention has been paid to the quality of dehydrated foods. The specific drying methods as well as the physicochemical changes that occur during processing seem to affect the quality of dehydrated products. Several types of pretreatment techniques have been used before the actual drying process and their effect on quality properties of dehydrated products have been investigated[4-6].

Osmotic pretreatment retains flavour and colour of the raw materials by minimizing thermal changes; it also prevents enzymatic browning and thus limits the use of SO_2. Osmotic pretreatment will, thus, lead to ready-to-eat products with higher acceptability[7]; improved nutrient retention during the subsequent convective drying process[8,9], additionally the chance to control the presented changes makes it possible, that this process be applied in new technologies in the food industry[10].

Two quantities represent adequately the osmotic dehydration process: The Water Loss (WL) and Solids Gain (SG). The first is the amount of water, which diffuses from the fruit to the solution due to differences in the osmotic pressures of fruit and solution and the second one indicates the solids which diffuse from the solution to the fruit less the solids of the fruit which are migrated to the solution[11,12]. The third stream is connected with the elution of low-molecular weight substances (saccharides, organic acids, vitamins, mineral salts). This stream, although quantitatively of no significant meaning in the mass exchange, can have an essential influence on final nutritive values and organoleptic properties of food[1,13].

The quantity and the rate of water removal depend on several variables and processing parameters: The weight loss in osmotic fruit was increased by increasing solid concentration of the osmotic solution, immersion time, solution stir up, temperature, solution/food ratio, specific surface area of the food and by using a low pressure system[3,14-16]. Glucose seems to be more effective than sucrose in the water loss from fruits and in the solids gain by fruits. The solids gain rate on a molal basis decreased as the molecular weight increased. The rate of water removal from the tissue was slower for larger molecules, but the total amount of water removal at equilibrium was slightly larger for larger molecules[11,12].

The objective of this study was to investigate the effect of different osmotic agents on osmotic pretreatment

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and dehydration and quality properties of osmo-dried Iranian peach products. This study has been undertaken at Tarbiat Modarres University.

MATERIALS AND METHODS

Sample preparation and treatments: Peach of the *Red haven* cultivars was purchased from local market in Iran and was transferred to the university laboratory in suitable panniers. The fruit (with normal ripeness) was washed, peeled, stoned and sliced in pieces (about 1cm) before placing them in different osmotic solution. All chemical reagents were of analytical grade.

Food grade sucrose, glucose syrup (DE= 42) were used to prepare different solutions (C= 40, 50 and 60% W/W) and multi component solutions with different compositions: 40% sucrose+20% glucose syrup; 20% sucrose+40% glucose syrup; 40% sucrose+20% glucose syrup+3% NaCl (W/W%). The weight ratio of the initial product/solution was chosen 1/10 and the osmotic dehydration was conducted in the same condition at room temperature (22°C).

Analysis of physicochemical properties

Water loss and solids gain: About 100 g samples that had been preserved in the solution for 1-10 h was rinsed with distilled water, dried with blotter paper and weighed again, then moisture and total solids measurements were conducted by vacuum oven at 70°C for 10 h. Water loss and solids gain were calculated as follows[3,12]:

$$WL = \frac{(M_o - m_o) - (M - m)}{M_o}; SG + \frac{m - m_o}{M_o}$$

(M_o=initial mass of fresh fruit prior the osmotic treatment, M = mass of fruit after time t of osmotic treatment, m = dry mass of fruit after time t of osmotic treatment,m_o= dry mass of fresh fruit). Finally the osmotic kinetics was determined.

Physicochemical properties: Then according to WL% and SG% amounts and osmotic kinetics, the best solution and osmotic time were determined. Therefore, the effects of kind and concentration of solution, thickness of fruit slices, stir up of solution during osmotic dehydration with shaker (80 rpm) and shrinkage amount of samples were statistically analyzed. For shrinkage amount, samples were sliced as cubes with completely same dimensions and after 1-10 h immersing in determined solutions, their dimensions were measured again with micrometer (±0/05 mm). The difference between primary and secondary volume of each sample cubes, would be theirs shrinkage amount[17]. Each experiment was conducted in triplicate.

Sensory evaluation: The appearance, chew ability, transparency, taste and flavour and colour of osmotic and traditional (sun-dried) samples were evaluated by 11 trained taste panels, which ranges from 1 (dislike extremely) to 5 (like extremely). The sensory evaluation was conducted using the Hedonic test. Colour of samples was compared using Lovibond instrument (Tintometer model F, England; fitted for the presentation of solid samples) to detect the development of browning reactions[18].

Statistical analysis: The data were analyzed by statistical calculation (MSTAC) and comparisons of means were done by Multi- Rang Test of Duncan[19-22].

RESULTS AND DISCUSSION

The osmotic kinetics, the optimum time of dehydration and the effect of concentration and composition of solutions on equilibrium time during osmotic dehydration of peach slices are presented in Fig. 1. Depending on the kind and concentration of osmotic solution, the curve is seen to ascend up to 6 h osmotic dehydration time and flattens later. The statistical analysis of the physicochemical properties and the more acceptable solution and its concentration is presented in Table 1. In glucose syrup, based on the large molecule (i.e. dextrin, maltose) and its lower osmotic pressure, water was diffused and its equilibrium point was in lower WL% amount, but in multi solution of sucrose, glucose syrup and salt, based on the small molecule and its higher osmotic pressure, equilibrium point was in higher WL% amount. The sucrose WL% grade would be higher than glucose syrup and lower than salt[23]. In addition, in large molecular solution, the equilibrium time was longer and the rate of removal water from tissue was slower. Therefore, glucose syrup with large molecular weight needed longer equilibrium time. Salt had higher osmotic pressure than glusides, because one molecule of NaCl dissociates in two ions and its osmotic potential was twice as much of sucrose solution (in the same condition). In the osmotic dehydration, salt was, therefore used as an osmotic process activator. This result was in line with[3,11,12,24,25].

In this selection in addition to WL%, SG% was also taken in to consideration, because SG% process is considered as a negative factor when accompanied with a change in flavour of product. Results showed that sucrose solution of 50 and 60% and glucose syrup of 60%

Table 1:The statistical analysis of the physicochemical properties of sliced peach during osmotic dehydration

Shrinkage amount		Stir up				Thickness				Kind and concentration of solutions			
						%SG		%WL		%SG		%WL	
%SG	%WL	%SG	%WL	%SG	%WL								
Mean square	Degree of freedom	Mean square	Degree of freedom	Mean square	Degree of freedom	Mean square	Degree of freedom	Mean square	Degree of freedom	Mean square	Degree of freedom	Mean square	Degree of freedom	Source
902.23	4	2.31	3	7.05	3	0.54	4	139.04	4	1.89	3	0.35	3	Repetition
446.63*2		24.17**5		425.33**	5	0.1ns	2	248.30**	2	10.17**8		413.59**8		Blocks
122.3	8	1.96	15	7.81	15	0.17	8	5.83	8	0.57	24	1.25	24	Error
	14		23		23		14		14		35		35	Total

ns= Not significant at $p > 0.05$ ** Significant at $p<0.10$* Significant at $p<0.05$

Table 2: Measurement of the browning reaction development as determination of samples

Colour*			
Blue	Red	Yellow	Kind of product
5.3	7	10	Traditional sample (sun-dried)
0	2.2	10	Osmotic sample with sucrose solution
0	3.2	10	Osmotic sample with glucose syrup
0	2.3	10	Osmotic sample with mixture solution (40% sucrose, 20% glucose syrup and 3% NaCl)

*Colour of samples was compared using Lovibond instrument (Tintometer model F, England; fitted for the presentation of solid samples) to detect the development of browning reactions

Table 3: The results of organoleptic analysis from a 5 points hedonic scale, which ranges from 1 (dislike extremely) to 5 (like extremely) with a panel composede of 11 trained taste panels

Colour	Taste and flavour	Transparency	Chew ability	Appearance	Treatment
B	A	B	B	B	Traditional sample (sun-dried)
A	A	A	A	A	Osmotic sample with sucrose solution
A	A	A	B	A	Osmotic sample with glucose syrup
A	A	A	B	A	Osmotic sample with mixture solution (40% sucrose, 20% glucose syrup and 3% NaCl)

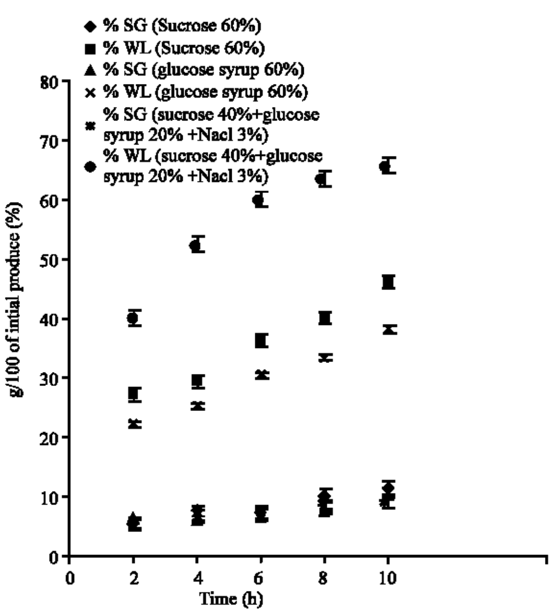

Fig. 1: The osmotic kinetics, the optimum time of dehydration and the effect of concentration and composition of solutions on equilibrium time during osmotic dehydration of peach slices (l=1 cm)

had a grater WL% in comparison with 40% solution and the multi solution of: Sucrose (40%), glucose syrup (20%), salt (3%); SG%, however didn't show significant differences in various concentrations of solutions. Therefore, according to SG% amounts, the mentioned solutions were selected, which corresponds with that of Panagiotou *et al.*,[12]. In addition, no significant difference was found between 50 and 60% sucrose solutions, which suggest 50% solution more economical. Based on concentration gradient increase between osmotic solution and fruit, WL% was increased[15], but statistical results showed no significant difference in SG% with concentration increase. These results were not in line with Hawkes and Flink[25] and Conway *et al.*[26]. It seems the difference lies in different nature of apple and peach tissues and their diffusion in to osmotic solution.

For industrial production, the optimized time of osmotic dehydration was basic factor and very important and could be used in the same conditions (temperature, thickness). Because in the fixed step time could be stopped this process. In the industry, decreasing the processing time and expenses are very important. Data of this research showed that WL% and SG% amounts increased up to special time (in this experiment 6 h) and then no significant difference was observed. In the other words, the curve of kinetic had a static state in which error range was minimized and comparison of curves was more logic[27].

The effects of the sample thickness and the stir up of solution in osmotic dehydration and the osmotic solution in shrinkage amount have been presented in Table 1. It seems that high thickness led to decreased WL%, due to decreased samples surface/volume ratio and, hence, osmotic equilibrium occurred in lower WL%. Therefore, the thickness should be suitable to customers' choice. The stir up of solution in osmotic dehydration had a significant effect in WL% and SG% amounts[23].

In addition, it seemed that increasing of SG% caused increasing in tissue resistance against shrinkage and solid elements diffused to interstitial space of fruit tissue and was prevented to tissue shrinkage. Analytical data showed that glucose syrup had lowest SG% and highest shrinkage and multi solution (sucrose 40%+ glucose syrup 20%+ salt 3%) was the best dehydration medium. These results were in line with Lozano *et al.*,[28].

Measurements of browning reaction development as determination of samples colour have been presented in Table 2. Immersed samples in osmotic solution did not have any contact with air, which protected the samples against browning reaction. In addition, unlike traditional method no SO_2 is used in the present processing method. This results in line with Ponting[8] and Krokida *et al.*,[5,6] .

The results of organoleptic analysis (appearance, chew ability, transparency, taste and flavour and colour) have been presented in Table 3. Comparison of data with Duncan test showed significant difference in traditional (sun-dried) and osmotic samples. This results were in line with Ponting[8]; Islam and Flink[9] and Krokida *et al.*,[5,6]; but taste and flavour of all the samples were similar, which didn't corresponds with that of Ponting[8]; Islam and Flink[9] and Krokida *et al.*,[5,6], which could be due to the difference in second drying method (here with free air and there with hot air). Data showed no sense of taste of sugar and salts in any of treatments.

CONCLUSION

In this study, it was demonstrated that using more concentrated solutions (50 and 60%) or adding salt (3% w/w) brought about higher water removal. Different factors such as sample thickness and agitation conditions contributed significantly to dehydration rate. The sensory analysis results indicated that osmo-dried samples had better colour, transparency and appearance and chew ability properties as compared with sun-dried samples. Therefore, osmotic dehydration could be used as a suitable processing method in order to improve the quality of sun-dried peaches.

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