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Minimally Processed Foods: A Case Study on Orange and Kiwi Fruit

F. Amidi Fazli, M. Ahani

***Abstract*— This paper studies the osmosis characteristics of orange and kiwi fruit. Ring shaped slices of orange and kiwi were prepared and submerged in 40, 55 and 70% (w/w) concentration of sucrose syrups in 3 periods of time: 40, 80 and 120 min at 25 degree of centigrade, fruit to syrup ratio was 1 to 3. Dry matter, soluble solid content of raw and final product as well as weight reduction, solid gain and water loss were measured at the end of experiment for each treatment. Solid gain and water loss increased during process time but no significant difference was observed until 80 min. Higher syrup concentration in short time had no significant effect this may be caused by high syrup viscosity that prevents profit mass transfer. The highest level of weight reduction was observed in 70% concentration. Solid gain, water loss and weight reduction obtained for kiwi fruit were higher than obtained for orange in this case structural differences between two fruits seems be important. Brix increased by time in all concentration but 40% syrup concentration had no effect on kiwi fruit brix. The initial brix for orange and kiwi fruit were 9.5 and 15.5 respectively these values reached 35 and 39 respectively after 2 hours in 70% sucrose concentration the lowest brix obtained were 18 and 26 for orange and kiwi fruit respectively in shortest treatment time (40 min.) in 40% syrup concentration.**

***Index Terms*— kiwi fruit, orange, osmotic dehydration, sucrose, time**

I. Introduction

Osmosis process is based on emerging of food materials in hypertonic or high concentrated solutions to modify some food properties. The solution can b made of salt or different type of sugars sometimes the combined elements are used. After osmosis treatment the food is dehydrated partially to some degree depending on the food composition and characteristic. Main phenomena is observed during osmosis is mass transfer between food and surrounding solution. Water is removed from food to environment and solutes take counter current direct. Different researches have taken place to obtain osmotic characteristic of different fruits. Panagiotou, et al. studied mass transfer in osmotic dehydration of apple, banana and kiwi fruit in sucrose solution whit 30, 40 and 50% concentration. The osmosis treatment took place during 0.5, 2 and 6 hours and the process temperature was 20, 40 and 60 ˚C. they suggest a model equation for the osmotic dehydration of mentioned fruits in above condition [7].

Treatment of unpeeled orange samples in sucrose syrups whit concentration vary from 30 to 60 percentage in 55 to 90 ˚C temperature range showed higher water loss than solid gain in all samples the treatment longed 9 hours and the minimum water loss and solid gain were 0.07 (kg water loss/kg of fresh fruit) and 0.008 (kg solids gain/kg of fresh fruit) respectively in 30 percentage concentration and 55 ˚C temperature. An increase of the syrup concentration during osmotic processing of presoaked fruits also resulted in high sugar gain, low weight reduction and strengthened the structure [10].

To ensure nutritional value of different foods ascorbic acid is a reliable indicator as its degrading occurs before other nutritional components then preservation of this key component can prove the preservation of others. Treatment of whole peeled tomatoes in mixed sodium chloride and sucrose solutions causes low vitamin C degradation during next air drying although 45 percentage of vitamin C was lost during osmotic pretreatment [6].

Treatment of orange and kiwi fruit in 70 ˚Brix and 55 ˚Brix respectively for an hour at 30 ˚C temperature for jam making showed comparable or even better quality attributes than those of commercial products prepared by traditional thermal methods the measured parameters included soluble solids, water activity, pH, acidity, color attributes and mechanical properties [3].

The important parameters affecting osmosis treatment of kiwi fruit studied by Vial, et al. they investigated the effect of temperature, type and concentration of osmosis solution, adding bivalent cations on water loss, solid gain and changes of ascorbic acid and chlorophyll content of kiwi fruit osmosis process longed 210 minutes. During process time higher concentration of syrup and high temperature increased water loss without affecting solid gain. Applying 50 ˚C had undesirable effect on kiwi fruit color as well as ascorbic acid and chlorophyll content [11].

Effect of osmotic dehydration and freeze-thawing on mechanical characteristic as well as color and lightness of kiwi fruit slices were studied. Talens, et al. used 35, 45, 55 and 65 ˚brix solutions in 30 ˚C. The processed continued until total soluble solids of kiwi fruit reached 30 ˚brix experiment took place in atmospheric pressure and pulsed vacuum all experiments carried on fresh and dehydrated fruits as well as frozen samples after 1 and 30 days freeze

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F. Amidi Fazli is with the Food Science and Technology Department of IAU Soofian Branch, Iran. (phone: 914-414-7724; fax: 472-334-3556; e-mail: amidi_f@ yahoo.com).

M. Ahani is Food Science and Technology Student of IAU Soofian Branch.

preservation. The freezer temperature was seted on -18 ˚C. pulsed vacuum caused decreasing of lightness and color attributes. Samples treated in 45 ˚brix syrup in atmospheric pressure showed better mechanical properties [9].

During osmotic dehydration some physicochemical changes observed like texture and appearance of product these changes depend on product characteristic and treatment condition. In the case of some fruits osmotic treatment improves color and textural properties of fruits after freezing. This matter belongs to reduced water content of fruit and sugar gain which mostly occur in osmotic dehydration [2].

Kiwi fruit emerged in sucrose syrup (45 and 65 ˚brix) under atmospheric pressure and vacuum. Osmotic dehydration completed when kiwi total soluble solid reached 30 ˚brix. Samples were frozen and stored at -18 ˚C for one month. Volatile component of samples extracted by distillation and analyzed by gas chromatography technique. Talens, et al. [8] reported formation of sters and decreasing of aldehydes and alcohols during osmosis process like fruit ripening process. They also reported regardable decrease in volatile component of freeze stored kiwi samples after one month. Then osmotic treatment has no negative effect on the volatile properties of the fruit.

Ruız Dıaz et al. studied the effect of microwave power and combined microwave whit hot air drying on orange slices they used Five levels of micro wave power 0, 20, 40, 60 and 100 W and The temperature and velocity of the air were 60 ˚C and 2 m/s, respectively in combination treatment. They indicated that using low levels of microwave power causes a sharp reduction in drying time of orange slices when low energy applied in combination with air drying at 60 ˚C additionally, no differences in rehydrating behavior were observed as a function of the applied microwave power. So, the highest level, which was limited to avoid sample browning, will be recommended to reduce the drying time [4].

II. Materials And Methods

Kiwi fruit and orange were obtained from local market and peeled after washing by tap water. Kiwi fruit sliced oriental in pieces whit 1 centemetere thickness and 3 centemeter in diameter same shape of orange slices obtained but 7 centimeter in diameter. Sucrose as a common osmotic agent was used to prepare osmotic solutions in 3 different concentration: 40, 55 and 70% (w/w).

A meshed plate used to submerge the kiwi and orange slices. Osmosis process completed in 40, 80 and 120 minutes at the end of treatment fruit samples spred on mesh to eliminate extra syrup. Fruit to syrup ratio was 1 to 3 and experiment took place in ambient temperature (25˚C) whit three replications.

Dry matter content of all samples determined according to AOAC method in 100 ˚C oven [1]. Total soluble solids of samples determined by reflection method using a hand refractometer (Atago, Japan). Osmosis characteristic including solid gain, water loss and weight reduction obtained by below equations suggested by Mavroudis, Gekas and Sjoholm [5].

$$WR = (W_0 - W)/W_0$$
$$SG = (S - S_0)/W_0$$
$$WL = WR + SG$$

WR: Weight reduction
SG: solid gain

TABLE I EFFECT OF SYRUP CONCENTRATION AND TIME ON WEIGHT REDUCTION

Concemntration / Time	Orange			Kiwi fruit		
	40	55	70	40	55	70
40	1.48	1.28	4.34	6.76	9.22	7.09
80	0.11	2.94	3.64	1.85	6.57	10.52
120	3.29	3.66	0.31	1.45	8.75	12.29

WL: water loss
W and W_0 are final (time t) and initial sample weights,
S and S_0 are final (time t) and initial weights of solid in the sample.

III. Results

Results obtained for solid gain and water loss are shown in figure 1 and 2 for orange and kiwi fruit respectively. Table I shows data obtained for weight reduction. By increasing treatment time the solid gain and water loss increased in all concentration about orange and kiwi fruit. Increasing until 80 minuets is not significant but after 120 minuets significant difference was observed then it will be reasonable stop process in 40 minuets if higher solid gain and water loss are not aimed. Concentration increase had not desirable effect in short time, this may be due to higher viscosity of concentrated syrup but passing time had synergistic effect. 55% syrup concentration seems to be suitable but if the aim of process set on weight reduction the 70% syrup will be so useful at this concentration the greatest weight reduction obtained.

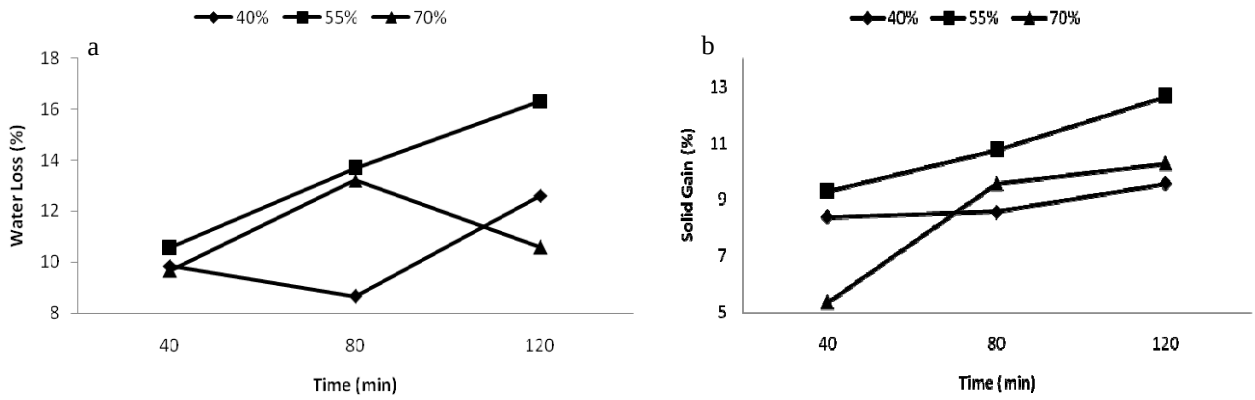

Fig1 effect of sucrose concentration and time on orange solid gain (a) and water loss (b)

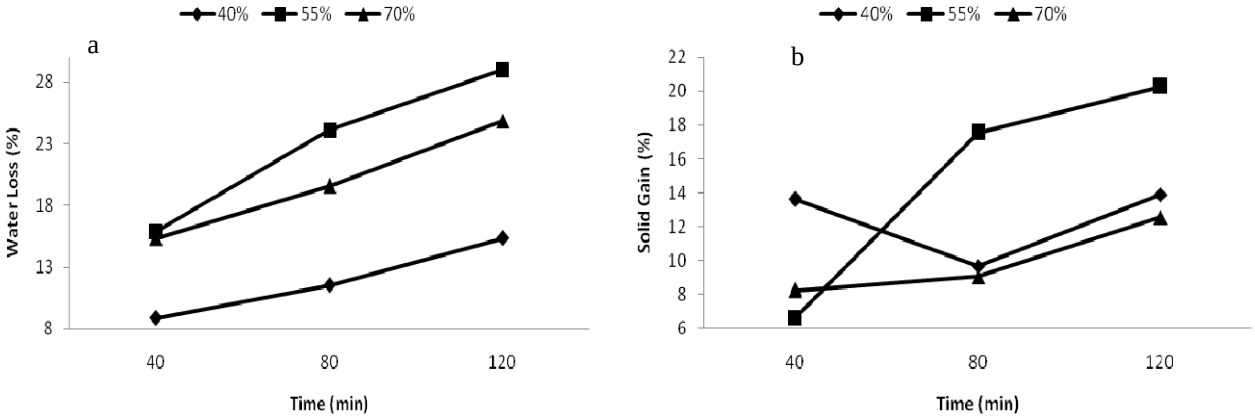

Fig2 effect of sucrose concentration and time on kiwi fruit solid gain (a) and water loss (b)

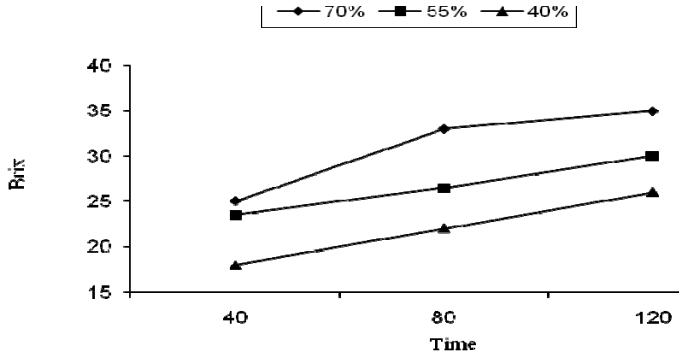

Fig3 effect of sucrose concentration and time on orange brix

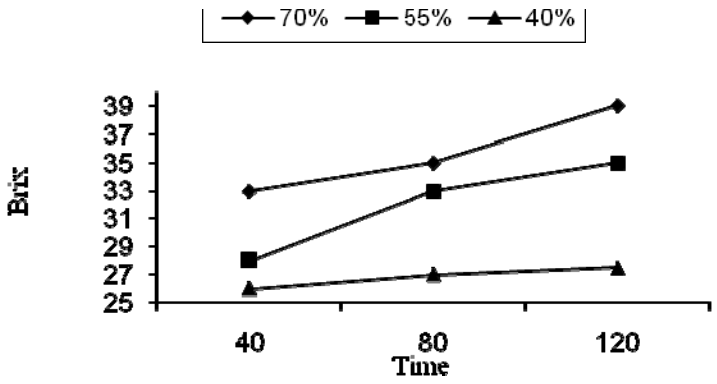

Fig4 effect of sucrose concentration and time on kiwi fruit brix

Very high viscosity of 70 % concentration syrup may be a negative factor on mass transfer after initial water migration from fruit to syrup may be the fruit is surrounded by a diluted syrup then solid uptake will be increased to 40 % syrup level on the other hand water loss will be stopped the interaction of these two factors lead to low weight reduction in 120 minute treatment comparing short time treatments (40 and 80 minutes).

Under experiment condition osmosis characteristic obtained for kiwi fruit were higher than those obtained for orange in this case the structural and microscopical properties of fruits play important role and need more investigation.

Total soluble solids (TTS) of kiwi fruit and orange are shown in figure 3 and 4. The initial TTS of kiwi fruit and orange were 15.5 and 9.5˚ brix respectively. Longer process time caused increasing of brix except in the case of kiwi fruit time had not regardable effect on TTS of sample in 40% syrup concentration just neglectable increase was observed. Syrup concentration increase lead to higher TTS content of treated samples in both fruits.

IV. Conclusion

Effect of syrup concentration on osmosis characteristic of orange and kiwi fruit needs more investigations; rheological experiments are suggested to determine effect of this factor on mass transfer (solid gain and water loss) especially in high concentrated syrups. To better compare on mass transfer between different fruits structural studies methods will be useful.

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F. Amidi Fazli borne 21 March 1979 in Tabriz, Iran. He graduated from Tabriz University in food science and technology then gained higher degree from Ferdowsi university of Mashhad.

Now He is an academic memeber of food science and technology department of IAU Soofian branch teaching food engineering course and doing different projects in that field as well as in other food technology fields.

Dr. Amidi is also member of IACSIT. He obtained Ferdowsi agriculture award in 2007.