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Effect of Osmotic Dehydration as Apre-treatment on some Characteristics of Ventilated Hot Air Drying (VHD) Kiwifruit Slices

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Abstract

Food dehydration of fruits is one of the most challenging processes in food technology. In order to optimize the quality of dehydrated fruits novel dry conservation procedures should be developed. Where ventilated hot air dryers'(VHD) produces poor fruit quality. So, different methods were applied to decrease the drawbacks of traditional methods. Kiwifruit slices submitted to steaming and osmotic dehydration (OD) in 60% sucrose solution as pre-treatment followed by VHD was studied. Results revealed that weight reduction (WR), water loss (WL) and solid gain (SG) of kiwifruit were significantly increased as extend of immersion period. Weight reduction (WR) was found to be lower than water loss (WL) during OD. On the other hand, WL was higher than that of SG. Steaming and/or OD as pre-treatment for kiwifruit drying increases the membrane permeability. Moreover, steaming process releases the trapped air from the kiwifruit tissue. Thus increase both water loss (WL) and dehydration efficiency index (DEI). Contrary, decrease moisture content (MC) in the final product. Steaming process is more pronouncing effect than that of OD. Rehydration capacity (RC) of dried kiwifruit slices improves by OD using osmotic solution (60% sucrose) at 40°C for 2 hrsas pre-treatment while steaming process has no remarkable effect.

Keywords: *Kiwifruit slices, Osmotic dehydration, Water loss, Solid gain, Dehydration efficiency index, Rehydration capacity.*

Introduction

Kiwifruit (*Actinidiadeliciosa*) is popularand widespread fruit belongs to *Actinidiaceae* family **(**Ferguson, 1990). The estimated world production is about 1.4 million metric tons per year, where Italy becoming the first producer country which produced 30% of the total world production (FAO, 2010). It is a highly nutritional fruit due to its high level of vitamin C and its strong antioxidant capacity because of a wide number of phytonutrients including carotenoids, lutein, phenolics, flavonoids, and chlorophyll (Cassano, *et al*., 2006). On the other hand, kiwifruit has a very short shelf-life due to its high moisture content which fluctuates between 80 - 86% (Fathi, *et al.,* 2011a; Hosseinzadeh, *et al*., 2013). Therefore it is necessary to dry the fruit to increase its shelf life at room temperature without deteriorations, reduction in weight and volume thereby minimize the cost of packaging, handling and transportation during storage orexport (Maskan, 2001; Senadeera, *et al*., 2005; Diamante, *et al*., 2010). Dried kiwifruits can be eaten as a snack or added to cereals, decorate desserts and ice cream (Etsey, *et al*., 2007; Reynolds, 2007; Chin, *et al*., 2015).

Osmotic dehydration (OD) is a technique used for different fruits including kiwifruit as a pre-treatment to many preservation processes such as freezing, ohmic heating, microwave, and hot air drying (Robbers, *et al.,* 1997; Allaeddini and Emam-Djomeh, 2004; Fathi, *et al.,* 2011b) to reduce the initial water content, energy consumption and total drying time (Escriche, *et al.,* 2000b; Gianotti, *et al.,* 2001; Bekele and Ramaswamy, 2010). At the same time, improves sensory, functional and nutritional properties including vitamins, phytochemicals and micro-elements of dried product without changing their integrity (Moreira and sereno, 2003; Sun, 2005; Osorio, *et al.*, 2007; Fathi, *et al.,* 2011a). So, OD is an effective technique to use for the partial removal of water from plant tissues by immersion in a hypertonic (osmotic) solution (Cao, *et al.,* 2006). Water removal is based on the natural and non-destructive phenomenon of osmosis across cell membranes. The diffusion of water out of the plant's tissues is accompanied by the simultaneous counter diffusion of solutes from the osmotic solution into the tissue. There may also be minor flow of other solutes from fruit to the solution (Torreggiani and Bertolo, 2001; Shi and xue, 2009). The OD is usually performed under ambient or modified environment conditions (Escriche, *et al.,* 2000a; Cao, *et al.,* 2006; Fazliand Ahani, 2010; Fasogbon, *et al.,* 2013).Conventional ventilated hot air drying (VHD) of fruit including kiwifruits leads to some disadvantages in the final products such as loss of volatiles and flavours, dark colour, leathery texture, shrinkage, decrease the rehydration rate, wettability, surface hardening and may decrease the nutritional value (Maskan, 2000; Singh, *et al.,* 2008b; Chin, *et al.,* 2015). Therefore OD could be applied to produce ready-to-eat dry foods or treated as secondary raw material to avoid the aforementioned drawbacks (Menges and Ertekin, 2006; Phisut, 2012). Because of cell membrane is semi-permeable permit water and acid to pass through more rapidly than sugar, therefore water and acid of fruit are flow out from the cell at first fast and then move slowly. Contrary to sugar which is penetrate the cell gradually and increases with prolonging immersion time. Therefore, the characteristics of the product and prompt of processing can be varied by controlling temperature, concentration of osmosis solution and time (Chavan, 2012). As a result, considerable amounts in the mass exchange can influence the final nutritive values and organoleptic properties of the dried food. Analogous, cellular membrane of fresh kiwifruit slices exerts high resistances to mass transfer and slows down the rate of OD (Erule and Shubert, 2001). Thus, a number of techniques include blanching, freezing, high pressure, ohmic heating, pulsed electric field and ultrasound have been tried to improve mass transfer rate during OD (Amami, *et al.,* 2006; Allali, *et al*., 2010; Bchir, *et al*., 2011). Blanching is one of the most widely used pre-treatments in the drying because of the resultant inactivation of enzymes, changes in tissue structure and shorter drying time (Latapi and

Barrett, 2006; Lewicki, 2006). The same results were achieved with blanched or steamed kiwifruit slices (Nadian, *et al.*, 2016; Llanoa, *et al.*, 2003). Rehydration of dried foods is a complex practice influenced by several factors such as chemical composition, physical structure, drying techniques, temperature of drying, conditions and composition of the immersion medium (Kaymak-Ertekin, 2002; Taiwo and Adeyemi, 2009) which play a major role on the quality attributes of the product . In this respect Maskan (2001) stated that dried kiwifruit slices by VHD pre-treated with microwave exhibited higher rehydration capacity and faster water absorption rate than those dried with microwave or VHD only. This work was carried out to investigate the influence of OD and/or steaming as pre-treatment on the dried kiwifruit slices characteristics using VHD including water loss (WL), weight reduction (WR) and solid gain (SG) during OD. Also moisture content (MC), mass loss (ML) of dried kiwifruit slices and their rehydration capacity (RC) were studied.

1. Materials and Methods

1.1. Materials

Fresh under ripe, free from physical defected, kiwifruits (*Actinidia delicious*var. Hayward) hadrefractive index 12.5°Brix and commercial sucrose were obtained from the local market of Tanta City, EL-Gharbia Governorate, Egypt, in the year 2014. The fruits were transferred to the Laboratory of Food Science and Technology Department, Faculty of Agriculture, Tanta University.

1.2. Methods

1.2.1. Sample preparation

Kiwifruits were washed under the tap water, sorted manually and drained using clean cloth. The fruits were divided randomly into 4 groups 3000g each. The fruits were peeled with sharp knife. Then the peeled fruits were cut into slices transversally to their axis (about 10 mm thickness cross sections to get equal size as much as possible and 40 mm diameter) by an electric cutting machine (Privileg Art. Nr. 273.0513, Germany). The surface of slices was dried gently by using tissue papers before measuring their dimensions and initial weight. Drying was performed in a laboratory using VHD at air velocity of 1.0 m/s. Before each drying experiment, the drier was run without sample for about 30 min to set desired temperature.

1.2.2. Drying process:

1.2.2.1. Ventilated hot-airoven drying (VHD)

The 1st group was dried by directly loaded onto stainless steel trays and subjected to drying using VHD at 50° C for 3 and 6 hrs at air velocity 1.0m/s. This represents control (C). The 2nd group was steamed at atmospheric pressure (100°C) for 5 min till inhibit peroxidases, immersed in an ice-water bath to stop heating and drained on tissue papers. The steamed sample was loaded onto stainless steel trays and subjected to drying using (VHD) at 50° C for 3 and 6 hrs at air velocity 1.0m/s. This represents treatment no. 1(T1).

1.2.2.2. Drying of kiwifruit slices by combination of OD and VHD

The 3rd group of kiwifruit slices were immerged in osmotic solution (60°Brix sucrose) at fruit to solution ratio (1:4w/v) to avoid changes in the solution concentration at 40°C with occasionally shaking at 150 rpm for 2 hrs. The slices were removed from osmotic solution and gently blotted with tissue paper followed by drying using VHD at 50°C with air velocity at 1.0m/s for 3 and 6 hrs. This represents treatment no. 2 (T2). The 4th group of kiwifruit slices were steamed at atmospheric pressure (100° C) for 5 min till inhibit peroxidases and immersed in an ice-water bath to stop heating, drained on tissue papers, subjected to OD as described earlier and then dried by using VHD at 50°C with air velocity at 1.0m/s for 3 and 6 hrs. This step represents treatment no. 3 (T3).

1.2.3. Determination of moisture content (MC)

Moisture content (MC) using an electric oven at 105±5°C until constant weight (method no. 952.4) of sample was carried out according to AOAC (2003).

1.2.4. Determination of mass loss (ML)

Mass loss (ML) of dried kiwifruit sample was determined using the following equations:

$$\mathbf{ML} = \frac{m0-m}{m0} \times 100$$

Where:

m_0 Initialmass of sample

m Mass of sample after drying

1.2.5. Determination of mass transfer during OD

Mass transfer including solid gain (SG), weight reduction (WR) and water loss (WL) were determined according to (Mavroudis, *et al.*, 1998). While dehydration efficiency index (DEI) was determined as mentioned by (Tylewicz, *et al.*, 2010) using the following equations:

$$\mathbf{SG}\left(\frac{g}{g}\right) = \frac{St-S0}{W0}$$

$$\mathbf{WR}\left(\frac{g}{g}\right) = \frac{W0-Wt}{W0}$$

$$\mathbf{WL}\left(\frac{g}{g}\right) = WR+SG$$

$$\mathbf{DEI} = WL / SG$$

Where:

W_0= Initial weight of sample (g), W_t= sample weight after treatment (g)

S_0 =Initial solids content (g),

S_t= Total solid after treatment (g)

1.2.6. Determination of Rehydration Capacity (RC)

Rehydration capacity of dried kiwifruit sliceswas determined as described by Abano and Sam-Amoah, (2011) with slight modification as follows: About 5 g of the dried sample was placed in glass beakers containing distilled water in a ratio of 1:30 (w/v) at room temperature for 15, 30, 45 and 60 min. Sample was removed and blotted with the paper towels in order to eliminate the surface water then weighed. The mass of rehydrated and dried samples were measured by using an accurate electronic balance (Radwag Wagi, Elcktroniczne, Model WTB 200, Poland) to the third digital number. The rehydration capacity (RC) described as weight of water gained during rehydration to weight of water removed during drying and calculated according to (Lewicki,1998) as following equations:

$$\mathbf{RC} = \frac{Wr-Wd}{W-Wd} \times 100$$

Where:

W_d = weight of dried sample (g)

W_r = weight of rehydrated sample (g).

W = initial weight of sample (g).

1.3. Statistical Analyses

Results tabulated in this work are means and standard deviation of at least three successfully trails. Then the data were statistically analysed using Analysis of Variance (ANOVA) and means were separated by Duncan's at a probability level of 0.05% (SAS, 2004).

2. Result and Discussion

2.1. Effect of steaming process on osmotic dehydration of kiwifruit slices

Weight reduction (WR) of kiwifruit slices immerged in osmotic sucrose solution (OS) 60□Brix is 0.227 g/g after 1 hrs at 40°C, which increases to 0.349 g/g when the immerging time is extend to 2 hrs. This attributed to increase contact time of the sample with the OS, which gives a higher moisture loss due to increase in osmotic pressure, thereby increase WR (Nieuwenhuijzen, *et al.*, 2001). This result is disagreement with (Tylewicz, *et al.,*2010) who reported that OD using 61.5% as OS for 2 hrs led to 32%WR of dried Hayward kiwifruit slices. This could be attributed to different handling process and sucrose concentration of OS. By analogous, water loss (WL) and solid gain (SG) of kiwifruit slices increases as a result of extends the soaking time in the OS. It is noticed that WR of dried kiwifruit slices is significantly lower than that of WL, however WL is higher than SG along all experiments as the time is extend. These results could be explained by water and soluble compounds leach out from kiwifruit tissue to the OS faster than that the uptake of sugar and solutes from the OS during OD (Fito, *et al.,* 2001; Marani, *et al.,* 2007; Tortoe, 2010). Because of the cell membranes are semi-permeable natures they allow water and low molecules size to pass by a greater driving forcethrough them more rapidly than sucrose. Therefore water is removed at first and then moves slowly, while sugar penetration is very slight at first but increases with the time (Tylewicz, *et al.,* 2010; Chavan, 2012).

Table 1. Effect of steaming process on osmotic characteristics inkiwifruit (*Actinidiadeliciasa var. Hayward*) slices during OD at 40°C

Osmotic characteristics	**Fresh slices**		**Steamed slices**	
	60%		**60%**	
	1hr	**2hrs**	**1hr**	**2hrs**
Weight reduction (g/g)	0.227	0.349	0.403	0.502
Water loss (g/g)	0.289	0.435	0.475	0.608
Solid gain (g/g)	0.062	0.086	0.072	0.106

Steaming process before OD as a pre-treatment for the fresh kiwifruit slices is affected on the aforementioned parameters. Where WR, WL and SG of not steamed kiwifruit slices dried by OD using 60% sucrose as OS at 40°C for 1 hrs are 0.227, 0.289 and 0.062 g/g increased in the steamed ones to 0.403, 0.475 and 0.072g/g, respectively. The same trend is observed in the case of steamed kiwifruit slices after 2 hrs of contact between the fruit and OS under the same conditions. These results could be explained by the cellular membrane of non-steamed kiwifruit exerts high resistances to mass transfer and slows down the rate of diffusion (Erule and Shubert, 2001), while steaming modify the cell structure by increase the membrane permeability to water and sugar exchanges (Del valle, *et al.,* 1998; Kowalska, *et al.,* 2008). Moreover, kiwifruit tissues have a porous structure so that steaming would also release the trapped air from the tissue resulting in more effective to the removal of water by osmotic pressure enhances the removal of water and uptake of solids (Phisut, 2012).

Dehydration efficiency index (DEI) is expressed by the ratio between water loss and solute gain (WL/SG). The DEI is depends strongly on the processing objectives and on the desired characteristics of the final product. In OD process, the higher water loss is more favourable than solid gain. Moreover, high solid gain affects negatively the quality and sensory characteristics of the dehydrated fruit. When high levels of sugar are infiltrated into the fruit during OD, significant sensory alterations can occur and the osmotically dehydrated product may present a different taste from the fresh fruit (Rodrigues and Fernandes, 2007). Therefore, good OD has DEI higher than 1 (Tylewicz, *et al.,* 2010). The DEI of the dried kiwifruit slices is about 4.67 after 1hrs soaking in 60% OS at 40°C, whichaugments to 5.08g/g after 2 hrs (Fig.1). It is obvious that as the immersion time in OS is extend, kiwifruit slices loss more water than that of SG. As a result DEI increases. These results are in agreement with those reported by Tylewicz, *et al.* (2010) and Fathi, *et al.* (2011a), who reported that DEI for Hayward kiwifruit slices dried by OD were increased by extend the contact time between kiwifruit and OS.

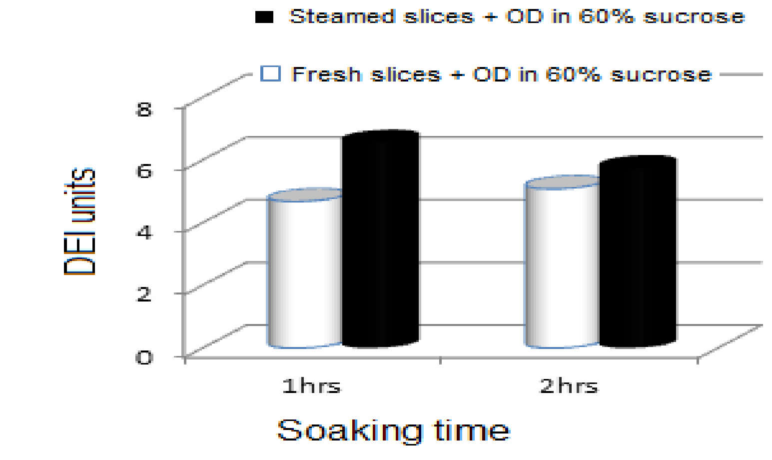

Fig.(1): Effect of OD at 40^{o}C and steaming process on Dehydration efficiency index (DEI) in kiwifruit (*Actinidiadeliciasa var. Hayward)* slices.

On the other hand, DEI of steamed kiwifruit slices decreased as the immersion period extends. This could be related to the change in the cell membrane of kiwifruit tissue by heating process. The dried kiwifruit samples, treated with steam before OD using OS 60% sucrose at 40°C for 1 hrs, had the greatest DEI 6.56 to 5.74 after 2 hrs. This could be related to steaming modify the cell structure by increase the membrane permeability to allow water to pass from the cell membrane rapidly (Del Valle, *et al.,*1998) and by a greater driving force due to OD. Therefore water is removed more at first and then moves slowly, while sugar penetration is very slight at first but increases with the time (Chavan, 2012).

2.2. Effect of steaming and OD on the hot air drying of kiwifruit slice

Table (2) summarized the effect of steaming and OD as pre-treatments on mass loss (ML) and moisture content (MC) of dried kiwifruit slices by VHD**.** The results reveal that MC of fresh sample is decreases as the drying time is extend. At the meantime, ML increases. Where MC of fresh kiwifruit slices is 84.24% decreases to 51.31% and 28.09% after 3 and 6 hrs of drying in VHD at 50°C, respectively. But ML is 55.07% after 3 hrs increases to 79.74% after 6 hrs. This resultsimilarto those obtained by Chin *et al.*(2015), who reported that moisture of kiwifruit slices decreased with increasing of drying time, until it reached equilibrium status. As the kiwifruit slices exposed to steaming for 5 min before VHD, both MC and ML of the dried sample are changed. The MC deceases to 40.69% after 3 hrs and 25.14% after 6 hrs. Also, ML is amplified to reach 60.45% and 83.34% for 3 and 6 hrs, respectively. These high values could be explained by

Table 2. Effect of OD and steaming process as pre-treatment on drying Kiwifruit slices by ventilated hot-air oven drying (VHD) at 50°C.

Treatment	Time (hrs)	Moisture content (MC %)	Mass 1oss (ML %)
Fresh	-----	84.24^{a}±0.24	---------
Ventilated hot-air drying (VHD)	3	51.31^{b}±0.31	55.07^{bc}±1.89
	6	28.09^{f}±0.05	79.74^{a}±1.06
Steaming flowed by VHD	3	40.69^{c}±0.47	60.45^{b}±0.85
	6	25.14^{f}±0.13	83.34^{a}±0.28
OD in 60% followed by VHD	3	44.69^{c}±0.41	49.08^{c}±0.70
	6	27.54^{f}±0.83	59.56^{b}±1.31
Steaming, OD in 60% followed by VHD	3	34.83^{d}±0.72	56.57^{b}±0.80
	6	24.49^{f}±0.32	64.91^{a}±1.27
LSD		4.74	9.15

M±SD = means and standard deviation of three successful trials

In a column, means have the same superscript letter are not significantly different at 0.05% level the effect of heat on the cell wall of kiwifruit nature. Where, steaming process modifies or destruction the cell structure by loss the selective permeability. Therefore, the resistance to moisture diffusion decreases within the wall cell and water migrates to the surface of sample (Rocha, *et al.*, 1993; Kowalska, *et al.,* 2008). So, kiwifruit cells lost more water during VHD leading to decrease MC and increase ML. When the kiwifruit slices are exposed to OD by immersing in 60% sucrose of OS for 2 hrs at 40°C before VHD, MC and ML are 44.69% and 49.08% after 3 hrs, respectively. Where MC decreased to 27.54% and ML increased to 59.56% after 6 hrs of VHD. The MC of kiwifruit slices steamed for 5 min and soaked in 60% OS for 2 hrs at 40°C as pretreatment of VHD is 34.83% and 24.49% after 3 and 6 hrs, respectively. The corresponding values for ML are 56.57% and 64.91%, respectively. This result agrees with Simal, *et al.* (1997) who reported that pretreatment of fruits in OS usually reduces the convective drying rates. Similar results were reported in the literature (Karim, *et al.,* 2008; Karim, 2010) for steamed sample exposed to OD followed by VHD. It is clear that effect of steaming is more pronouncing on the permeability of cell walls in the kiwifruit slices rather than OD.

Table 3. Effect of different treatment on rehydration capacity (RC) of dried kiwifruit slices

Treatment	Rehydration ratio (RR)			
	15min	30min	45min	60min
Ventilated hot air drying (VHD)	5.05^c±0.33	10.54^c±0.69	13.84^b±0.31	18.29^b±0.39
Steaming flowed by VHD	9.32^b±0.21	11.47^c±0.24	18.32^b±1.19	21.23^b±1.40
OD in 60% followed by VHD	22.50^a±1.24	26.48^a±1.41	45.42^a±2.24	47.61^a±2.33
Steaming, OD in 60% followed by VHD	9.68^b±0.42	20.28^b±0.93	36.02^a±1.95	41.85^a±2.26
LSD	3.21	5.31	11.33	14.63

M±SD = means and standard deviation of three successful trials

In a column, means have the same superscript letter are not significantly different at 0.05% level

2.3. Rehydration Capacity (RC)

Dehydrated products often need to be rehydrated for utilization, where rehydration capacity (RC) is an important index of the quality of dried fruits (Aversa *et al.,* 2012). Safety, nutritional and sensory aspects of foods is usually related to the rehydration process as well as to the severity of the drying practice (Marabi and Saguy, 2009). Thus, rehydration can be considered as a measure of the damage to the product caused by dehydration since RC is related to modifications in food structure during processing (Garcia-Pascual, *et al.,* 2006; Moreira, *et al.*, 2008). Rehydration of dried food tissues is composed of three simultaneous processes: 1) the imbibition of water into dried material, 2) the swelling of the rehydrated products, and 3) the leaching of soluble solids to rehydration medium (Krokida and Marinos-Kouris, 2003). Poor rehydration caused by injuries to the plant tissue cells during pre-treatment and drying (Lewicki, 1998). So, good dehydration process has high RC. The RC of dehydrated samples after 15, 30, 45 and 60 min are shown in Table (3). The RC for kiwifruit slices dried by VHD is 5.05, 10.54, 13.84 and 18.29 after 15, 30, 45 and 60 min of rehydration in distilled water at room temperature, respectively. The same trend is noticed also for dried kiwifruit slices dried by VHD after steaming or OD in 60% sucrose and steaming followed by OD in 60% sucrose. However, the method of dehydration has an obvious effect on the RC, whereas kiwifruit slices dehydrated by OD in 60% sucrose as pre-treatment followed by VHD, which has the significantly (*p*> 0.05) highest RC among the other studied dehydration methods. On the other hand, RC of steamed samples is not significantly (*p*> 0.05) different than that of control. It is well known that poor rehydration capacity could be attributing to the collapse of cellular structure or the decrease of porosity lead to lower diffusion of water into kiwifruit tissue during rehydration. Similar trend was reported by Singh, *et al.*(2008 a) and Fathi, *et al.*(2011b) for rehydration capacity of chestnut and kiwifruit during hot air drying, respectively. These results are disagreement with Kaymak-Ertekin, 2002; Taiwo and Adeyemi, 2009) who showed that blanching didn't had any significant (*p*> 0.05) effect on the RC of the samples irrespective of the drying temperature. Fig. 2 shows the fresh, dried and rehydrated (after one hour) kiwifruit slices as affected by different drying methods.

The RC of kiwifruit slices exposed to OD before VHD had the highest significantly (*p*> 0.05) value among other studied treatments along the different rehydration time. The high RC% of ODkiwifruits slices may be explained by the pre-treated sample with OD had high percentage of sugar which leaches out into the rehydration solution and uptake more water amount due to the different solute concentration between the two sides of the cell membrane. This is conflicted with Singh *et al.*(2007) who reported that the RC is high for un-osmosed samples and lowest for the osmotically pre-treated carrot cubes with sucrose-salt mixture as OS.

However, results of Bhuvaneswari *et al.*(1999) supported our findings, who reported that RC of osmotically treated peas was higher than those of untreated samples. All the samples exhibited an initial high rate of moisture sorption and solute loss followed by slower water absorption and solute loss in the later stages of rehydration process. This is due to the fact that the capillary imbibitions are important at early stages, which leads to an almost instantaneous uptake of water. Similar results were reported by Sopade and Obekpa (1990).

3. Conclusion

In conclusion, OD as pre-treatment process followed by VHD an effective method which gives the best result for drying Kiwifruit slices. Since, RC of this treatment is the superior treatment. While steamed sample followed by OD before VHD had the intimidate quality. On the other hand, the inferior product is produced by VHD after steaming process.

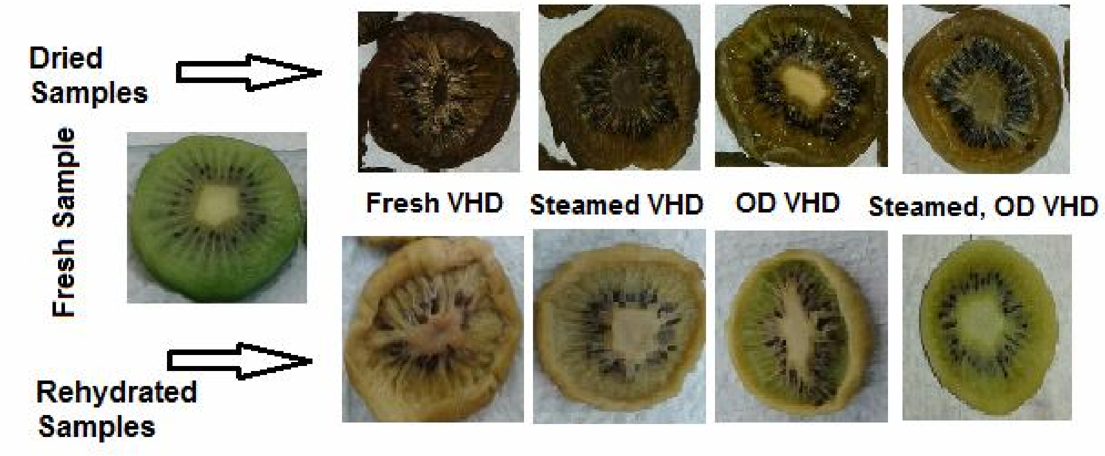

Fig. (2): Dried and rehydrated (after one hour) kiwifruit slices as affected by different methods of rehydration process

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تأثير التجفيف الاسموزى كمعامله مبدئيه على بعض خصائص شرائح فاكهة الكيوى المجففة بفرن التهوية بالهواء الساخن

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الملخص

يعتبر تجفيف الأغذيه خاصة الفواكة إحدى العمليات الأكثر تحديا فى تكنولوجيا الأغذيه. ولكى نحسن من جوده الفواكه المجففه ينبغى أن نطور أساليب التجفيف التقليدية لطرق جديده. حيث أن مجففات الهواء الساخن تنتج فواكه مجففه ذات جوده رديئة لذلك طبقت أساليب مختلفة لتقليل عيوب الطرق التقليدية. من أجل ذلك تمت دراسة تجفيف شرائح فاكهة الكيوي المعرضه للبخار والتجفيف الأسموزى (OD) فى محلول سكروز ٦٠% كمعامله مبدئيه متبوعه بالتجفيف بالهواء الساخن(VHD) .

أوضحت النتائج أن الفقد في كل من الوزن (ML) و الرطوبة (WL) وكذلك المواد الصلبه المكتسبه (SG) لشرائح الكيوى تزداد معنويا بزياده وقت الغمر في المحلول السكري. وكان الفقد في الوزن (ML) أقل من فقد الرطوبة (WL) خلال التجفيف الاسموزى (OD). ولوحظ أن الفقد في الرطوبة (WL) كان أعلى من أكتساب المواد الصلبه (SG). كل من المعاملة الحرارية بالبخار والتجفيف الاسموزى لشرائح فاكهة الكيوي كمعامله مبدئيه قبل التجفيف بالهواء الساخن في الفرن يزيد من نفاذية أغشيه الخلايا و تميزت المعاملة الحرارية بقدرتها علي طرد الهواء المحبوس بين أنسجة الفاكهة مما ادي الي زيادة الفقد في الوزن(ML) والنسبة المئوية للرطوبة (MC%) .، وارتفاع مؤشر كفاءة التجفيف (DEI) في المنتج النهائي وكانت المعاملة الحرارية بالبخار لها تأثير أكثرفاعليه من التجفيف الاسموزىOD. كما وجد تحسن في خاصيه إعادة التشرب (RC) لشرائح فاكهة الكيوي المجففة بواسطة التجفيف الأسموزي OD كمعامله مبدئية عن طريق الغمر في محلول سكروز بتركيز ٦٠٪ على درجة ٤٠م° لمدة ساعتين لها تأثير إيجابي علي شرائح فاكهة الكيوي المجففة بينما عملية المعاملة الحراريةبالبخار ليس له تأثير ملحوظ.