J. Food and Dairy Sci., Mansoura Univ., Vol. 5 (12),: 973 - 990, 2014

READY-TO-EAT PRODUCTS FROM SWEET POTATO AND PUMPKIN

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ABSTRACT

In this study, sweet potato and pumpkin were pre-treated and dried to obtain ready-to-eat products. Four different pre-treatments were performed as follows, untreated as control (A), dipping in boiling water (B), dipping in 15% sugar solution at 70ºC (C) and dipping in 1% sodium metabisulphite solution (D). These pre-treatment samples were dried with different drying methods. These methods include solar drying, sun drying and oven air drying. The maximum temperature difference between inside and outside solar dryer was as high as 21.8 º C. Likewise, the inside relative humidity is lower than the outside solar dryer and maximum differences were as high as 19.4%. Solar drying period for all tested samples ranged between 52 to 58 hrs with 8-12% moisture content, while 63 to 97 hrs were needed to dry all tested samples by sun drying to reach the same moisture content. On the other hand, oven air dryer required only 6 hours for all tested samples.

Data given in this study showed the effect of pre-treatment, drying methods and storage period at ambient temperature for 6 months on moisture content, total sugars, reducing sugars and acidity as citric acid of dried samples. Results showed that pretreatment sample with 15% sugar solution and sodium metabisulphite increased water removal in all samples. Data represent indicated that more total sugars and reducing sugars were observed in untreated samples for all drying method. Also, data obtained showed that more increasing in acidity for samples were treated with sodium metabisulphite compared with the other samples. Solar drying was observed to product relatively better product in terms of nutrient composition compared to sun drying. Drying was faster with the use of the solar drier than sun drying. Solar drying produced samples with lower moisture content. Organoleptic evaluation of the dried samples was also performed, including of color, taste, odor, texture and acceptability.

Keywords: Ready-to-eat products, snack food and drying method

INTRODUCTION

Ready to eat snack is portion of food often times smaller than that of a regular meals, that is generally eaten between meals. Processed snack foods as designed to less perishable, more durable than prepared food. Snack foods play very important roles in the diet of the modern consumer. The snack food industry continually searches for products and processes that increasingly please consumers and addresses nutritional concerns, sometimes, only to find limited demand or acceptance in the marketplace. Such was the case for snacks with reduced salt content, use of non-caloric frying oils and low-fat/no-fat snacks (Lusan and Rooney, 2002).

Over 60% of consumers eat snacks purely for enjoyment. Healthier snack products continue to do well, increasing by 3% in 2009 over the

previous year, and up by 8% since 2005. In fact, 83% of consumers claim they eat snacks for their nutritional benefit and 40% seek benefits beyond basic nutrition.

Children are especially vulnerable to poor food choices and obesity is increasing at an alarming rate in children (Strauss and Pollack, 2001). Snack food consumption is increasing and may contribute to the obesity epidemic (Nielson *et al*., 2002). Sweet potatoes (*Ipomoea batatas*) are traditionally sun-dried in Africa for consumption in the dry season when fresh roots are not available. Dried pieces can be re-hydrated or milled into flour to be used in porridge. In urban areas, flour can also be used in a variety of baked products to partially replace wheat flour (Bechoff *et al*., 2009). Pumpkins (*Cucurbita mixta*) are relatively low in total solids, usually ranging between 7% and 10% (Are´valo-Pinedo and Fernanda, 2006). It is good sources of carotenoids, and some varieties are rich in provitamins A, mainly á-carotene and â-carotene (Marek *et al*., 2008). Thus maintaining pumpkin in a state that retains its actual nutrients, taste and color is a difficult task. Drying is the common method used for its preservation and it is commonly done by utilization of sun energy in places where pumpkin is being dried (Tunde-Akintunde and Ogunlakin, 2011). Guin'e *et al*. (2011) found that Fresh pumpkin contained 52.84% total sugar,(26.35% reducing sugar, 25.12 % non reducing sugars), 13.99% Ash and 12.24% fiber.

The objective drying is the removal of water to the level at which microbial spoilage and deterioration reactions are greatly minimized (Akpinar and Bicer, 2004). It is also provides longer shelf-life smaller space for storage and lighter weight for transportation (Ertekin and Yaldiz, 2004).

Jain and Tiwari (2004) reported that the convective mass transfer coefficient in greenhouse drying under forced mode is double that of natural convection in the initial stage of drying. Further, the electric power requirement of the fan in case of forced convection solar driers is very low and can be operated by one photovoltaic module independent of the electric grid (Bala *et al*., (2005), Chen *et al*., (2005) and Hossain & Bala, (2007).

Advantages of solar driers that enable them to compete with traditional open-air sun drying techniques and/ or artificial driers powered by energy from fossil fuels have been previously reported in the literature by many researchers (Hossain and bala, 2007). Further, more than 80% of food in developing countries is being produced by small farmers and design of most solar driers can fulfill their needs (Murthy, 2009)

Mechanical pretreatment might replace or complement chemical pretreatment, mainly because consumers hesitate to buy chemically treated fruits, and it has a profound effect on the later drying process. Mechanical pretreatment consists of peeling, surface abrasion, and cutting in various shapes, such as halves, cylinders, and cubes. A number of researchers (Shi and Maupoey, 1993; Jia *et al*., 1993 and Kiranoudis *et al*., 1997) used some kind of mechanical treatment to accelerate mass transfer in subsequent processing. There are several methods that can be applied (Beaudry, 2001), puncture the skin by a needle, cut the berry in halves or quarters, and abrade the skin surface. All these mechanical pretreatments are used to increase the "active" skin surface where water can penetrate. The objectives of this work

to make the available of snack foods on the market ready-to-eat and study the effect of pre-treatment and drying methods on characteristics of tested sweet potato and pumpkin

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MATERIALS AND METHODS

Sweet potato (*Ipomoea batatas*) and pumpkin (*cucurbita pepol*) were obtained from the local market in Tanta city, Gharbia Governorate, Egypt. Sweet Potato and pumpkin were washed with tap water and then hand peeled, cut into cubes of dimensions 15 × 10× 10 mm. Four different pretreatments were: Untreated as control (A), dipped in boiling water for 4-5 min (B), dipped in 15% sugar solution for 5 min at 70˚C (C) and dipped in 1% sodium metabisulphite solution for 2 min (D). Samples were drained well and blotted with absorbent paper to remove the excess solution. Samples were placed in a single layer on the drying trays before drying to final moisture content of 8-12% (Bilbao-Sainz *et al*., 2005).

All treated samples were dried by using oven air drier, sun and solar dryer. The solar dried used was a direct cabinet type with natural air circulation which are used generally for drying agricultural products (Reuss, 1993). The solar dryer was manually assembled from wood and polyethylene cover with five Seran shelves. The drying experiments were conducted during three days in July.

For comparison, an electrical oven air drier was used for seven hours, with a pre-set temperature of 60°C. After the drying process the samples were put into polyethylene bags and stored for six months (Rosa Hemphill1 and Lloyd W. Martin (1992).

Two dry and wet-bulb air temperature sensors were installed near the bottom and near the top inside the solar dryer as well as another set that was installed at 2 m height outside the dryer using type-T thermocouples (Medany *et al*., 1996). All sensors were connected to a 21X data logger (Camplle Scientific Inc., Utah, USA) which was programmed to store one reading at the top of each hour. The sensors were calibrated before and after the experiments. Hourly wet bulb readings were converted to relative humidity according to the methods described by ASAE (1991).

Determining the rate of drying (Rd) during the process based on moisture content level has given the relation:

$$Rd = \frac{Mi - Md}{T}$$

Whereas:

M_i and M_d are the initial and final moisture content, T is the drying time in hour (Wankhade, *et al.*, 2012).

Temperature difference, °C = °C inside – °C outside dryer

Relative humidity difference (RH) % = RH inside – RH outside dryer

Moisture content,total soluble solid, fat, protein fiber, total sugar, reducing sugar, ash and acidity as citric acid were determined according to the methods described by A.O.A.C (2000).

A trained 12 members panel of students in the faculty of home economics department of science and technology feed Al-Azhar University

evaluated the samples using a scale of 1 to10, where 1 were the lowest and 10 the highest intensity for all. The evaluated parameters taste, colour, flavor, texture and overall acceptability (McWilliams 1997).

The results were statistically analyzed by analysis of variances as described by SPSS (1997). Significant differences among individual means were analyzed by Duncan's multiple range tests (Duncan's, 1955).

RESULTS AND DISCUSSION

The chemical composition of sweet potato and pumpkin are given in Table 1. It was noticed that all chemical constituents were higher in sweet potato than pumpkin except moisture content. moisture contents were 70.8 % in sweet potato and 92.0 % in pumpkin.

From Table 1, it was observed that, total soluble solids recorded 27% meanwhile in pumpkin was 6.32%. Reducing and non-reducing sugar were 8.22 and 9.76% in sweet potato, but 2.79 and 2.40% in pumpkin, respectively.

Data showed that, sweet potato recorded higher values in ash (2.46%) than pumpkin (0.81%). The acidity measured as citric acid in sweet potato and pumpkin was 0.09 and 0.06 %. Protein recorded high in sweet potato and pumpkin; it was 2.13 and 1.3%, respectively. The previous results were in agreement with those found by Ishida *et al*. (2000); Rodrigues *et al*. (2003); D'ıaz-Medina *et al*. (2007) and Guin'e *et al*. (2011).

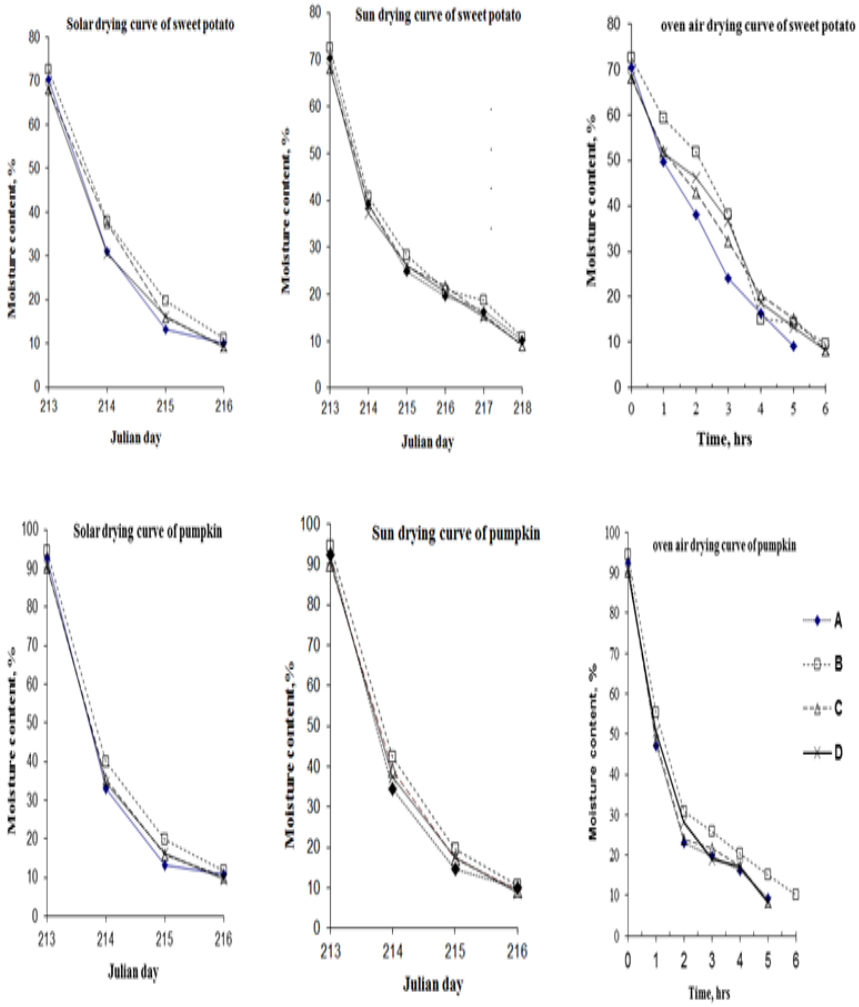
Table (1): Chemical composition (%) of fresh sweet potato and pumpkin (w/w)

Chemical constituents	Sweet-potato	Pumpkin
Moisture	70.8	92.0
Total soluble solid	27.0	6.32
Fat	0.19	0.1
Protein	2.13	1.2
Fiber	5.97	0.7
Reducing sugar	8.22	2.79
Non reducing sugar	9.76	2.40
Ash	2.64	0.81
Acidity as citric acid	0.09	0.06

During Julian days (213 to 218), time needed to reach the moisture content to 8-12% of sun, solar and oven air dried of pumpkin and sweet potato showed in Table (2) and Figure (1). Data in Table (2) showed that sun drying time for sweet potato was 90-97 hrs for four treated samples (A, B, C and D). On the other hand, it was 53-56 hrs for solar drying (Fig. 1). Pumpkin drying time took 63-67 hrs in the sun (Fig. 1) and 52-58 hrs in solar dryer for four treated samples (A, B, C and D).

A sharp decrease in moisture content was noticed in the first day for all treatments however, in second and third day showed slow rate of dehydration (Fig. 1). It proved that solar dryer could speed up the removal of moisture content because of the existence of a collector which can increase the temperature inside the box (cabinet). It was found that all tested samples, dried by hot air drying were reported to take minimum time for drying. Figure

(1) showed that oven drying time was 5-6 hrs in order to reach 8-12% moisture content in the sweet potato and pumpkin samples at temperature of 60 ˚C, with a sharp decrease in the moisture content during the first 3 hours. These results were in agreement with those of Yousef and Medany (2007) who dried banana, mango, guava and carrot using sun, solar and hot air drying.



A= Untreated (control)
B = Blanched in boiling water for 4-5 min for 5 min at 70C
C = Dipped in 15% sugar solution
D = Dipped in 1% sodium metabisulphat for 2 min

Fig.(1):Drying methods curves of sweet potato and pumpkin

Table (2): Drying rate of different drying methods on respective moisture content of dried tested samples.

Drying methods	Treatments	M_i	M_d	t	R_d
Solar drying	Sweet potato				
	A	70.4	10.04	53	1.14
	B	72.6	11.2	56	1.10
	C	68.2	9.41	54	1.09
	D	68.4	9.24	55	1.08
	Pumpkin				
	A	92.6	10.92	52	1.57
	B	94.4	11.95	58	1.42
	C	90.2	10.29	54	1.48
	D	90.6	10.59	55	1.45
Sun drying	Sweet potato				
	A	70.4	10.11	90	0.67
	B	72.6	10.77	97	0.64
	C	68.2	9.03	93	0.64
	D	68.4	9.31	94	0.63
	Pumpkin				
	A	92.6	10.14	63	1.31
	B	94.4	11.56	67	1.24
	C	90.2	9.5	65	1.24
	D	90.6	8.74	64	1.28
Oven air drying	Sweet potato				
	A	70.4	9.24	5	12.23
	B	72.6	9.63	6	10.50
	C	68.2	8.32	6	9.98
	D	68.4	8.12	6	10.05
	Pumpkin				
	A	92.6	9.41	5	16.64
	B	94.4	10.19	6	14.04
	C	90.2	8.39	5	16.36
	D	90.6	8.33	5	16.45

M_i = initial moisture content, % **t = drying time in hour**
M_d = final moisture content, % **R_d = rate of drying (% m.c./hr)**

The amount of evaporated water during the night was lower than that during the day and this was due to the variations between the day and night temperatures (Fig. 2). The previous results were in agreement with those found by Ukegbu and Okereke (2013). The drying curves for all B samples are higher than A, C and D samples, because of blanching increased the initial moisture content of the sweet potato and pumpkin from 70.2 % to 72.4 % and 92.2% to 94.6%, respectively (Table 2). These results were in agreement with those of Tunde-Akintunde *et al*. (2005) who dried bell-pepper using sun, solar and hot air drying.

An examination of these curves indicate that the drying of control samples (A) is faster than treated samples B, C and D which is the same

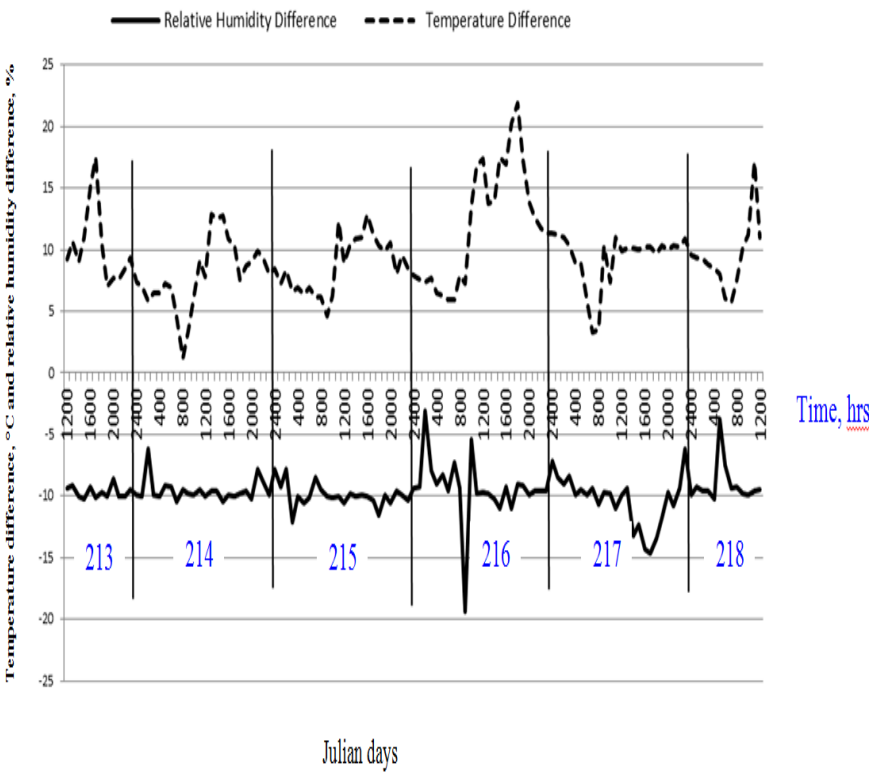


Fig.(2): Temperature and relative humidity difference inside and outside solar dryer during experiment Julian days

experience in both solar, sun and oven air drying. In this direction Troeqer and Butler (1988) indicated that drying time depended primarily upon initial moisture content of products. Drying rate (Rd) in three drying methods was showed in Table (2). The highest drying rate noticed in oven air drying method for both sweet potato and pumpkin samples. Meanwhile, drying rate in sun drying recorded the lowest for sweet potato samples. Drying rate depends upon the rate of moisture migration from the interior of the product to the surface, which naturally depend on the type of material to be dried (Aboltins, 2013).

The maximum temperature reached during the three days of the trial period inside the solar dryer was 51.8°C compared to 40.1°C outside the dryer (Fig. 2). Meanwhile, the maximum relative humidity reached 78.7% inside the solar dryer during the three days of trial period compared to 88% outside the dryer (Fig. 2). These data were in agreement with those of Awady *et al* (1993) and Yousef and Medany (2007). Those authors reported an elevation in temperature inside the solar dryers from 11 to 28°C over the ambient temperatures outside the dryers when drying different types of fruits and vegetables

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During the experiment Julian day time, the inside solar temperature is higher than the outside solar dryer and the maximum temperature difference was as high as 21.8°C (Fig. 2). Likewise, the inside relative humidity is lower than the outside solar dryer and maximum difference was as high as 19.4% (Fig. 2). The higher inside temperature and lower relative humidity is the suitable condition for drying.

The three drying methods used greatly affected the drying characteristics of tested samples. The solar dryer was found to be more efficient than the open sun drying. In addition, the samples of solar dryer were completely protected from insects, birds and dusts. These results were in agreement with found by Wankhade *et al.* (2012).

Data given in (Table 3, 4, 5 and 6) showed the effect of pre-treatment, drying methods and storage period at ambient temperature(25˚C) for 6 months on moisture content , total sugar, reducing sugar and citric acid of dried sweet potato and pumpkin, respectively. Results in Table (3) showed that pre-treatment with 15% sugar solution (C) and 1% sodium metabisulfite (D) increased water removal and moisture mobility in sweet potato and pumpkin cubes during drying. Decreasing in moisture content of the pretreated sweet potato and pumpkin samples also due to the samples gained sugars and salts by the effect of osmotic dehydration, since the pre-treatment was done at 70 ˚C for 5 min similar observations were reported by Gierschner *et al*. (1995) and Olorunda *et al*.,(1990)

Results, also show that there were significantly increased in moisture content value of treatment B (blanching) compared with control. This increasing for blanching treatment probably occurred because the blanched samples gained moisture during blanching and cooling procedure. These results were in agreement with those found by Cano *et al*. (1997).

Data in Table (3) indicate that moisture content was lower in oven drying samples compared with sun drying tested samples, because hot air oven drier increased water removal. The results showed that moisture content was higher in solar drying samples compared with sun and solar drying tested samples. These results were in agreement with those of (Ukegbu and Okereke, 2013). The values for moisture contents of all samples were increased during storage period it may be due to absorption of water.

Total sugars are the major constitute of total soluble solids. These sugars are very important parameter in fruit since they directly affects their flavor and taste. Concerning the effect of drying method on the sugar contents of dried sweet potato and pumpkin samples, means of total sugars in Table (4) showed that, there were significant differences ($P \leq 0.05$) between pretreated and control samples of sweet potato and pumpkin. Total sugar contents were significantly decreased by increasing of storage period time for all samples. Percentages of decreasing of total sugars were higher in pumpkin samples than sweet potato samples. At the end of storage period (6 months), the means percentages of total sugars decreasing were 1.1, 1.7 and 1.14 % for sun, solar and oven dried sweet potato samples, respectively. On the other hand, the decreasing were 3.64, 2.74 and 3.07 % for sun, solar and oven dried pumpkin samples, respectively.

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Samples treated with sugars (C) were higher in total sugars content than control probably due to sugar gain from soaking solution; also samples treated with sulfating solution were higher in total sugars at zero time. These results may be due to the effect of sulfating treatment which prevents Maillard reaction these values were in agreement with (Bareh *et al*., 2011).

Differences in reducing sugars content observed during storage period in untreated samples (Table 5). Analysis carried out to test the effect of storage time on the reducing sugar content showed that decreasing reached to 2.5, 2.27 and 2.16 % for sun, solar oven dried sweet potato samples, respectively. While the reducing sugars were 7.23, 5.11 and 6.8 % for sun, solar oven dried pumpkin samples, respectively at the end of storage period. This may attributed to Milliard reaction during storage (Gallali *et al.,* 2000).

The acidity of fruits is considered one of the important quality factors which directly affect their taste through the sugar/acid ratio sugars provides sweet potato and the organic acids sourness. Data represent in Table(6)observed that samples treated with sodium metabisulphate showed more acidity as compared to the other treated samples, while samples treated by blanching had lower acidity for all samples which dried by different drying methods ($P \leq 0.05$). The increasing in acidity during storage period at ambient temperature (25°C) observed in dried sweet potato and pumpkin samples in all drying methods.

Organoleptic evaluation for dried sweet potato and pumpkin samples was shown in Table (7). There were highest significant ($P \leq 0.05$) differences in color scores between all treatment samples for all drying methods. Means of C treatment samples had the highest color score which recorded 8.3 followed by B, D and A treatment for dried sweet potato. Meanwhile, D and C treatment for dried pumpkin samples had the highest score which recorded 7.7 and 7.5.

In addition, there were no significant different between solar and air drying method while, there is moderate significant different between solar, air and sun drying. The same results were also found for taste score to all treatments tested samples and drying methods.

Also, from the same table, there were moderate significant between all treatments for texture of dried sweet potato for all drying methods. Mean score of C treatments had the highest texture score followed by B, D and A treatments. On the other hand, solar and air drying method had the highest mean of texture score 7.4 and 7.1 followed by sun drying method with moderate significant differences. Sun drying method had the worst mean values of texture compared with the other methods. The same results were also found for odor and acceptability score to all treatments and drying methods. Furthermore, there were high significant to all treatment for acceptability, odor and texture score to dried pumpkin.

Sweet potato dipped in 15% sugar solution for 5 min (C) gave the highest mean score in color, taste, odor, texture and acceptability, for three different drying methods. On the other hand, untreated sweet potato gave the lowest mean score for all drying methods. These results agree with those

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obtained by (Sra and Sandhu, 2011) they reported that untreated dried carrot had the lowest score for sensory evaluation. .

No significant differences in sweet potato treated with blanching or sodium metabisulphite for sensory parameters. In addition, there were high significant differences between sun, solar and air drying methods for acceptability, odor and texture score.

Pumpkin dipped in 15% sugar solution for 5 min (C) which dried by air drying gave the highest score in color, taste, odor, texture, and acceptability. On the other hand, pumpkin without treated (A) gave the lowest score for color, taste, odor and acceptability. In addition, blanching had the lowest score for odor. These results are similar with those obtained by (Yousef and Medany, 2007) they reported that the solar dried fruit samples were better than oven drying. Solar and air drying methods were better than sun drying for sensory parameters. These results are similar with those obtained by (Yousef and Medany, 2007) they reported that the solar dried samples were better than oven drying.

Table (7): Effect of different treatments on sensory evaluation of dried sweet potato and pumpkin

Treatments	Dried sweet potato			Means	Dried pumpkin			Means
	Sun drying	Solar drying	Air drying		Sun drying	Solar drying	Air drying	
	Color							
A	6.4±0.516	7.6±0.516	6.8±0.789	6.9^{c}	7.7±0.674	6.5±0.671	6.4±1.06	6.9^{d}
B	7.1±0.568	7.7±0.823	8.1±0.876	7.6^{b}	7.0±0.789	7.6±0.738	7.3±0.675	7.3^{c}
C	7.9±0.316	8.3±0.675	8.9±0.568	8.3^{a}	6.2±0.816	8.0±816	8.3±0.823	7.5^{b}
D	6.6±0.516	7.3±0.949	7.4±0.843	7.1^{b}	7.2±0.738	7.9±0.316	8.0±1.42	7.7^{a}
Means	7.0^{b}	7.7^{a}	7.8^{a}		7.03^{b}	7.5^{a}	7.5^{a}	
	Taste							
A	6.5±0.849	7.3±0.483	7.0±0.816	6.9^{c}	5.8±0.632	5.6±0.527	5.3±0.823	5.57^{d}
B	6.6±0.699	6.6±0.699	7.1±0.738	6.7^{b}	5.9±0.316	6.2±0.527	6.4±0.515	6.17^{b}
C	7.0±0.667	8.3±0.671	8.3±0.675	7.8^{a}	8.1±0.316	8.3±0.816	8.5±0.527	8.3^{a}
D	6.4±0.516	7.3±0.738	6.7±0.823	6.7^{b}	5.9±0.568	6.2±0.823	6.3±0.483	6.13^{c}
Means	6.6^{b}	7.3^{a}	7.2^{a}		6.43^{c}	6.58^{b}	6.63^{a}	
	Odor							
A	6.2±0.632	7.2±0.789	6.4±1.17	6.6b	7.1±0.876	7.6±0.483	6.5±1.71	7.07b
B	6.4±0.699	7.1±0.568	7.2±0.788	6.9b	6.5±0.707	6.8±1.1	7.2±1.54	5.8d
C	7.6±0.516	8.1±0.568	8.0±0.667	7.9a	6.5±0.527	7.5±0.823	8.0±816	7.3 a
D	6.4±0.516	6.9±0.875	6.4±1.17	6.5b	6.6±0.699	7.3±0.713	6.5±1.35	6.8c
Means	6.6b	7.3a	7.0a		6.68c	7.3 a	7.05b	
	Texture							
A	6.0±0.66	7.2±0.788	7.1±1.1	6.7^{b}	7.3±0.483	7.2±0.788	7.1±1.1	7.2^{c}
B	6.4±0.692	6.9±0.737	7.3±0.823	6.8^{b}	7.1±0.527	7.5±0.788	6.9±1.1	7.17^{c}
C	6.8±0.632	7.5±0.849	8.3±0.823	7.5^{a}	7.5±0.527	7.9±0.849	7.7±0.823	7.7^{a}
D	6.1±0.316	7.1±0.316	7.0±1.6	6.7^{b}	7.3±0.823	7.5±0.483	7.4±0.966	7.4^{b}
Means	6.3^{b}	7.1^{a}	7.4^{a}		7.2^{c}	7.53^{a}	7.27^{b}	
	Acceptability							
A	6.8±0.666	7.5±0.788	7.3±1.10	7.2^{b}	6.8±0.483	7.4±0.783	7.5±1.19	7.2^{d}
B	6.7±0.699	7.7±0.737	7.8±0.823	7.4^{b}	6.5±0.876	7.6±0.823	7.9±1.10	7.3^{c}
C	7.8±0.632	7.9±0.844	8.9±0.823	8.2^{a}	6.6±0.527	8.6±.966	8.4±823	7.87^{a}
D	6.7±0.316	7.6±0.316	7.3±1.63	7.2^{b}	6.8±0.823	7.9±.866	8.1±.966	7.6^{b}
Means	7.0^{b}	7.6^{a}	7.8^{a}		6.67^{c}	7.87^{b}	7.97^{a}	

^{a,b} and ^{c} means in the same column within the same item followed by different superscripts differ significantly at p<0.05.

A = Untreated (control)

B= Blanched for 4-5 min C= Dipped in sugar solution 15% for 5 min at 70 ^{o}C

D= Dipped in 1% sodium metabisulphite for 2 min

From the previous results, solar dryer has proven effective for drying the fresh produce since it has achieved considerable drying environment during day time environment to prevent condensation during the night time. Further, the dried products have retained some color and are safe from contamination of molds, dust, insects and birds.

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منتجات جاهزة للأكل من البطاطا والقرع العسلى

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في هذه الدراسة تم معاملة البطاطا والقرع العسلي وتجفيفهما للحصول على منتجات سريعة الأكل وتم إجراء أربعة معاملات منها عينة غير معاملة ككنترول **)** أ **,** **(**غمر فى ماء مغلى **)** ب **,** **(**غمر فى محلول سكرى **15%** وغمر فى محلول **1%** صوديوم ميتا باي سلفيت**.**

هذه العينات المعاملة تم تجفيفها بعدة طرق منها التجفيف بالطاقة الشمسية **,**التجفيف الشمسي و التجفيف بإستخدام أفران الهواء الكهربية **.**وكان اعلى فرق بين درجات الحرارة داخل وخارج افران الطاقة الشمسية **21,8** م **.**بالمثل كانت الرطوبة النسبية بداخل الافران اقل من مثيلتها بالخارج واقصى فرق بينهما كان **. 19,4%**

وإستغرق التجفيف بالطاقة الشمسية لكل العينات حوالي **58 -52** ساعة بمحتوى رطوبى للعينات **12% -8**بينما إستغرق التجفيف الشمسي لكل العينات **97 -63** ساعة للوصول لنفس المحتوي الرطوبى للعينات وعلي الجانب الآخر إستغرق التجفيف بالأفران الكهربية حوالي **6** ساعات لكل العينات المختبرة

أوضحت النتائج المتحصل عليها من هذه الدراسة تأثير المعاملات المختلفة وطرق التجفيف وفترات التخزين علي درجة حرارة الغرفة لمدة ستة اشهر علي كل من المحتوى الرطوبى السكريات الكلية والمختزلة وكذلك الحموضة الكلية والمقدرة علي أساس حمض ستريك للعينات المجففة

وأظهرت النتائج أن المعاملة بمحلول سكرى **15%** ومحلول صوديوم ميتا باى سلفيت أدى لزيادة الماء المزال فى كل العينات المعاملة **,**كما أوضحت النتائج زيادة فى السكريات الكلية والمختزلة فى العينات غير المعاملة والمجففة بكل طرق التجفيف

كذلك أوضحت النتائج المتحصل عليها زيادة فى حموضة العينات المعاملة بالصوديوم ميتا باى سلفيت مقارنة بالأخرى **.**التجفيف بالطاقة الشمسية أدى للحصول على منتجات أفضل نسبيا من حيث القيمة الغذائية كذلك معدل التجفيف كان أسرع مقارنة بالتجفيف الشمسى كما أعطى نتائج حسية أفضل من حيث اللون **,**الطعم **,**الرائحة **,**القوام والتقبل العام **.**

Table (3): Effect of drying methods, pre-treatments and storage periods at ambient temperature (25°C) on moisture content (%) of dried pumpkin and sweet potato samples

Treatments	Dried sweet potato				Means	Dried pumpkin				Means
	Storage period, month					Storage period, month				
	0	2	4	6		0	2	4	6	
Sun dried										
A	10.11±0.718	10.23±0.713	10.46±0.779	10.67±0.725	10.37^{b}	10.14±0.713	10.43±0.843	10.63±0.299	10.92±0.713	10.53^{b}
B	10.77±0.721	10.98±0.418	11.18±0.239	11.34±0.618	11.07^{a}	10.61±0.559	10.93±0.483	11.33±0.379	11.57±0.675	11.11^{a}
C	9.03±0.674	9.25±0.789	9.46±0.734	9.77±0.731	9.38^{d}	9.50±0.439	9.71±0.675	9.92±0.823	10.13±0.816	9.82^{c}
D	9.31±0.754	9.52±0.775	9.63±0.768	9.94±0.733	9.6^{c}	8.74±0.692	9.96±0.713	9.19±0.316	9.43±0.823	9.33^{d}
Means	9.81 ^{d}	9.99 ^{c}	10.18 ^{b}	10.43^{a}		9.75^{d}	10.26^{c}	10.31^{b}	10.5^{a}	
Solar dried										
A	10.44±0.711	10.36±0.512	10.75±0.567	10.94±0.647	10.62 ^{b}	10.29±0.816	10.53±0.619	10.79±0.649	10.92±0.713	10.36 ^{b}
B	11.20±0.754	11.36±0.617	11.5±0.527	11.68±0.644	11.44^{a}	10.84±0.689	11.07±0.675	11.35±0.816	11.65±0.483	11.23^{a}
C	9.41±0.773	9.57±0.713	9.74±0.675	9.95±0.647	9.67^{c}	9.62±0.483	9.82±0.599	10.05±0.713	10.29±0.499	9.94 ^{c}
D	9.24±0.767	9.43±0.671	9.59±0.555	9.8±0.623	9.52 ^{c}	8.86±0.699	9.12±0.823	9.36±0.675	9.59±0.629	9.23 ^{d}
Means	10.07^{d}	10.18^{c}	10.39^{b}	10.59^{a}		9.97^{d}	10.14^{c}	10.27^{b}	10.47^{a}	
Oven dried										
A	9.24±0.542	9.45±0.634	9.64±0.533	9.86±0.534	9.55^{b}	9.41±0.316	9.63±0.675	9.92±0.713	10.12±0.816	9.77^{b}
B	9.63±0.611	9.84±0.612	10.08±0.647	10.27±0.645	9.96^{a}	10.19±0.713	10.38±0.699	10.61±0.675	10.85±0.699	10.51^{a}
C	8.32±0.647	8.53±0.675	8.76±0.675	8.95±0.575	8.64^{c}	8.39±0.483	8.29±0.823	8.49±0.699	8.72±0.823	8.47^{c}
D	8.12±0.675	8.42±0.657	8.61±0.665	8.80±0.675	8.49^{d}	8.33±0.699	8.53±0.649	8.73±0.316	8.93±0.699	8.63^{d}
Means	8.83 ^{d}	9.06 ^{c}	9.3 ^{b}	9.47^{a}		9.08 ^{d}	9.21^{c}	9.44^{b}	9.66^{a}	

^{a,b,c} and ^{d} means in the same column and raw within the same item followed by different superscripts differ significantly at p<0.05.

A= Untreated (control)

B = Blanched in boiling water for 4-5 min

C = Dipped in 15% sugar solution for 5 min at 70 °C

D = Dipped in 1% sodium metabisulphite for 2 min

Table (4): Effect of drying methods, pre-treatments and storage periods at ambient temperature(25^{o}C) on total sugar (%) of dried pumpkin and sweet potato

Treatments	Dried sweet potato				Means	Dried pumpkin				Means
	Storage period, month					Storage period, month				
	0	2	4	6		0	2	4	6	
Sun dried										
A	39.13±0.575	39.04±0.678	38.86±0.132	38.65±0.311	38.92^{c}	13.90±0.483	13.73±0.443	13.49±0.283	13.09±0.433	13.55^{c}
B	38.54±0.738	38.47±0.731	38.35±0.734	38.13±0.314	38.37^{d}	13.22±0.723	13.08±0.316	12.94±0.723	12.71±0.316	12.99^{d}
C	41.44±0.438	41.32±0.723	41.18±0.316	41.06±0.376	41.25^{a}	15.00±0.816	14.93±0.788	14.93±0.528	14.92±0.816	14.95^{a}
D	39.49±0.755	39.31±0.755	39.19±0.332	39.05±0.323	39.26^{b}	13.94±0.488	13.85±0.734	13.82±0.388	13.30±0.323	13.73^{b}
Means	39.65^{a}	39.54^{b}	39.40^{c}	39.22^{d}		14.01^{a}	13.89^{b}	13.79^{c}	13.5^{d}	
Solar dried										
A	39.76±0.311	39.67±0.676	39.51±0.438	39.31±0.645	39.56 ^{c}	13.94±0.527	13.78±0.316	13.62±0.118	13.42±0.218	13.69 ^{c}
B	39.04±0.632	38.95±0.612	38.77±0.652	38.57±0.644	38.83 ^{d}	13.4±0.227	13.26±0.427	13.14±0.547	13.06±0.788	13.22^{d}
C	41.80±0.645	41.71±0.652	41.57±0.615	41.41±0.635	41.62^{a}	15.41±0.554	15.32±0.816	15.27±0.627	15.09±0.316	15.27 ^{a}
D	39.88±0.675	39.69±0.734	39.51±0.732	39.30±	39.59 ^{b}	14.20±0.347	14.07±0.547	13.89±0.521	13.81±0.348	13.99 ^{b}
Means	40.12^{a}	40.00 ^{b}	39.84 ^{c}	39.65 ^{d}		14.24^{a}	14.11^{b}	13.98^{c}	13.85^{d}	
Ovendried										
A	39.04±0.527	38.96±0.575	38.79±0.637	38.47±0.527	38.82 ^{c}	13.39±0.427	13.27±0.617	13.16±0.127	13.14±0.723	13.24^{c}
B	38.32±0.530	38.15±0.524	37.87±0.563	37.99±0.501	38.08 ^{d}	12.92±0.527	12.74±0.511	12.46±0.812	12.29±0.483	12.60^{d}
C	40.88±0.544	40.80±0.687	40.63±0.577	40.43±0.537	40.69^{a}	14.80±0.621	14.74±0.527	14.58±0.443	14.39±0.518	14.63^{a}
D	39.20±0.532	39.01±0.575	38.87±0.607	38.75±0.514	38.96 ^{b}	13.57±0.463	13.37±0.543	13.25±0.462	13.20±0.523	13.35^{b}
Means	39.36^{a}	39.23 ^{b}	39.04 ^{c}	38.91 ^{d}		13.67^{a}	13.53^{b}	13.36^{c}	13.25^{d}	

^{a,b,c} and ^{d} means in the same column and raw within the same item followed by different superscripts differ significantly at p<0.05.

A= Untreated (control)

B = Blanched in boiling water for 4-5 min

C = Dipped in 15% sugar solution for 5 min at 70 ^{o}C

D = Dipped in 1% sodium metabisulphite for 2 min

Table (5): Effect of drying methods, pre-treatments and storage periods at ambient temperature (25°C) on reducing sugar (%) of dried sweet potato and pumpkin

Treatments	Dried sweet potato				Means	Dried pumpkin				Means
	Storage period, month					Storage period, month				
	0	2	4	6		0	2	4	6	
Sun dried										
A	24.56±0.674	24.37±0.453	24.20±0.554	23.99±0.621	24.28^{c}	9.20±0.836	9.01±0.472	8.86±0.422	8.63±0.463	8.93 ^{c}
B	24.44±0.454	24.24±0.647	24.05±0.632	23.89±0.675	24.16^{d}	8.23±0.826	7.80±0.776	7.67±0.323	7.42±0.844	7.78^{d}
C	25.24±0.604	25.05±0.644	24.89±0.671	24.72±0.611	24.98^{a}	10.23±0.846	10.11±0.427	9.88±0.846	9.62±0.966	9.96^{a}
D	24.72±0.622	24.53±0.614	24.39±0.744	24.19±0.624	24.46^{b}	9.43±0.921	9.21±0.846	9.00±0.126	8.74±0.934	9.09 ^{b}
Means	24.74^{a}	24.55^{b}	24.40^{c}	24.12^{d}		9.27^{a}	9.03 ^{b}	8.85 ^{c}	8.60 ^{d}	
Solar dried										
A	24.26±0.624	24.07±0.114	23.85±0.675	23.66±0.632	23.96^{c}	9.29±0.966	9.06±0.755	8.97±0.788	8.81±0.726	9.03 ^{c}
B	24.16±0.632	23.97±0.572	23.81±0.604	23.59±0.675	23.88^{d}	9.00±0.510	8.79±0.214	8.63±0.762	8.54±0.348	8.74^{d}
C	25.72±0.621	25.51±0.642	25.35±0.752	25.17±0.332	25.44^{a}	10.53±0.816	10.34±0.516	10.17±0.849	10.03±0.816	10.27 ^{a}
D	24.37±0.644	24.18±0.672	24.02±0.685	23.85±0.622	24.12^{b}	9.48±0.716	9.32±0.816	9.15±0.729	8.99±0.816	9.24 ^{b}
Means	24.63^{a}	24.43^{b}	24.26^{c}	24.07^{d}		9.58^{a}	9.38^{b}	9.23^{c}	9.09^{d}	
Oven dried										
A	24.29±0.632	24.10±0.866	23.94±0.814	23.73±0.716	24.02^{c}	9.02±0.701	8.82±0.697	8.59±0.617	8.36±0.849	8.69 ^{c}
B	24.22±0.816	24.03±0.716	23.86±0.726	23.65±0.845	23.94^{d}	8.03±0.824	7.69±0.829	7.43±0.637	7.22±0.714	7.60 ^{d}
C	25.08±0.616	24.89±0.876	24.73±0.845	24.64±0.632	24.84^{a}	10.03±0.407	9.90±0.417	9.67±0.407	9.51±0.749	9.78 ^{a}
D	24.62±0.546	24.43±0.864	24.27±0.875	24.06±0.813	24.34^{b}	9.35±0.721	9.09±0.713	8.96±0.693	8.77±0.715	9.04 ^{b}
Means	24.55^{a}	24.36^{b}	24.20^{c}	24.02^{d}		9.12^{a}	8.88^{b}	8.66^{c}	8.5^{d}	

^{a,b,c} and ^{d} means in the same column and raw within the same item followed by different superscripts differ significantly at p<0.05.

A= Untreated (control)

B = Blanched in boiling water for 4-5 min

C = Dipped in 15% sugar solution for 5 min at 70 °C

D = Dipped in 1% sodium metabisulphite for 2 min

Table (6): Effect of drying methods, pre-treatments and storage periods at ambient temperature (25°C))on acidity (%) as citric acid of dried sweet potato and pumpkin

Treatments	Dried sweet potato				Means	Dried pumpkin				Means
	Storage period, month					Storage period, month				
	0	2	4	6		0	2	4	6	
Sun dried										
A	0.29±0.716	0.50±0.616	0.58±0.704	0.66±0.774	0.51^{c}	0.29±0.718	0.43±0.548	0.63±0.724	0.81±0.776	0.52^{c}
B	0.19±0.547	0.34±0.714	0.52±0.775	0.60±0.734	0.41^{d}	0.21±0.811	0.39±0.823	0.59±0.481	0.77±0.788	0.49^{d}
C	0.31±0.526	0.52±0.744	0.59±0.765	0.70±0.321	0.53^{b}	0.26±0.515	0.44±0.473	0.69±0.514	0.88±0.853	0.57^{b}
D	0.39±0.723	0.56±0.766	0.65±0.721	0.74±0.845	0.59^{a}	0.39±0.713	0.56±0.524	0.76±0.215	0.93±0.514	0.66^{a}
Means	0.29^{d}	0.48^{c}	0.59^{b}	0.68^{a}		0.29^{d}	0.46^{c}	0.68^{b}	0.85^{a}	
Solar dried										
A	0.22±0.635	0.34±0.723	0.48±0.695	0.64±0.732	0.42^{c}	0.22±0.383	0.38±0.123	0.58±0.713	0.73±0.855	0.48^{c}
B	0.16±0.745	0.27±0.714	0.39±0.567	0.52±0.778	0.34^{d}	0.18±0.778	0.34±0.788	0.48±0.723	0.67±0.422	0.42^{d}
C	0.23±0.744	0.38±0.756	0.52±0.774	0.73±0.356	0.47^{b}	0.24±0.783	0.46±0.413	0.58±0.784	0.74±0.523	0.52^{b}
D	0.28±0.747	0.47±0.706	0.64±0.775	0.83±0.756	0.56^{a}	0.40±0.668	0.47±0.658	0.66±0.678	0.94±0.798	0.62^{a}
Means	0.22^{d}	0.37^{c}	0.51^{b}	0.68^{a}		0.26^{d}	0.41^{c}	0.57^{b}	0.77^{a}	
Oven dried										
A	0.16±0.236	0.27±0.715	0.45±0.614	0.62±0.775	0.38^{c}	0.19±0.544	0.36±0.743	0.56±0.713	0.71±0.876	0.46^{b}
B	0.11±0.777	0.21±0.775	0.40±0.644	0.52±0.747	0.31^{d}	0.16±0.445	0.33±0.776	0.43±0.832	0.61±0.830	0.38^{c}
C	0.19±0.706	0.32±0.767	0.48±0.563	0.64±0.714	0.41^{b}	0.21±0.713	0.39±0.523	0.58±0.847	0.72±0.516	0.48^{b}
D	0.22±0.694	0.38±0.634	0.54±0.506	0.69±0.722	0.48^{a}	0.28±0.417	0.42±0.854	0.63±0.802	0.78±0.875	0.53^{a}
Means	0.17^{d}	0.29^{c}	0.47^{b}	0.62^{a}		0.21^{a}	0.38^{b}	0.55^{c}	0.71^{d}	

^{a,b,c} and ^{d} means in the same column and raw within the same item followed by different superscripts differ significantly at $p<0.05$.

A= Untreated (control)

B = Blanched in boiling water for 4-5 min

C = Dipped in 15% sugar solution for 5 min at 70 °C

D = Dipped in 1% sodium metabisulphite for 2 min