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Study on the Possibility of Eliminating Sulfuring Process in the Production of Dried Apricots

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Abstract: The rate of agricultural and horticultural waste is high in Iran, and one of the best preventive methods is to convert fruits and crops to the products which have long shelf life and high quality. Traditionally apricots are dried in front of sun with excessive sulfuring which is proved to be harmful for human. In the current study apricots were dried by either solar tunnel dryer or conventional sun drying. Ascorbic and citric acids with the concentrations of 0.3 and 0.5 percent and 3 and 5 minutes of dipping were used as a replacement of SO2. After drying the samples were analyzed for vitamin C, moisture and soluble solids content, pH and firmness. The results were analyzed with completely randomized design based on factorial test. Finally, the solar dryer and ascorbic acid with concentration of 0.3% and 3 minutes of dipping were preferred for producing dried apricots.

Keywords: Ascorbic Acid; Citric Acid; Dried Apricots; Solar Drying; Sun Drying

INTRODUCTION

According to FAO statistics, about 487333 MT of apricots were produced in Iran in 2008. In terms of exporting of dry apricots, Iran ranked 6th after Turkey, Afghanistan, Uzbekistan, Germany and France. The quantity of exports of this commodity was 1358 tones with the value of 2138000 dollars in 2008 (FAO, 2008). In the drying process of apricots, it is necessary to sulfur the fresh fruits to prevent discoloration and molding. In sensitive individuals (particularly asthmatics), ingestion of sulfur dioxide and sulfites in food can cause asthma attacks, skin rashes and upset stomach. In our study we tried to substitute appropriate chemicals for sulfur dioxide. Ullah et al. (1977) studied the effects of dipping dried bananas in 0.5% sodium metabisulfate, 0.5% tiosulfate and 0.1% citric acid on the sensory properties of the samples to reduce browning of bananas. Labell et al. (1983) used ascorbic acid alone or in combination with citric acid as a substitute of sodium bisulfate to prevent browning of different dried fruits and vegetables. In a research, mangoes were dipped for 18 hours in syrups with the Brix of 0, 20, 40 and 70 with or without sulfate or citric and ascorbic acids. Then thwere dried at 60ºC for 8 to 12 hours. Dried samples were packed in poly ethylene packages and were stored at room temperature. After 12 month the acidity, rehydration rate and the concentration of SO2 and ascorbic acid were determined (Teaoto et al., 1976). Makerjee et al (1979) used 0.1% to 0.5% citric acid to prevent browning reactions in foods. They reported that 0.3% citric acid can hinder browning better. Sperber et al. (1992) used sodium erythorbate, erythorbic acid and ascorbic acid alone or in combination with citric acid to inhibit browning of potatoes. Lambrecht et al. (1995) showed that erythorbate (0.3% for 2 minutes) is better than sulfates in inhibiting enzymatic browning. In another research the effects of storage temperature, light and SO_2 content on the quality of dehydrated apricots were investigated. The samples, with SO_2 contents, 300 and 1400 mg kg^{-1}, were stored for 9 months at 4, 11°C and at room temperature (20–25°C). Color, browning, texture, soluble sugars and protein content were periodically determined. In samples with high SO_2 content

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stored at different temperatures and samples with low SO_2 which were refrigerated, the quality remained almost constant, meeting market requirements at the end of 9 months storage. Non-refrigerated samples, with a low SO_2 content suffered intense browning reactions during storage, with losses of 15–26 units for *L*, *a* and *b*, as well as losses in soluble sugars (150 g kg^{-1}). Protein could not be detected at the end of the storage and furfural content was high (18–23 $mgkg^{-1}$). The presence or absence of light did not appear to influence the quality of the product (Rosselló et al., 1994). Effect of pretreatments, heat application, chemical dipping and sulfur fumigation, during drying of apricots to prevent discoloration was investigated. Maximum yield was recorded in control followed by steam-blanched fruits. Lye-peeled apricots retained lower moisture than steam-blanched fruits. Maximum and minimum browning was observed in untreated samples and the fruits subjected to sulfur fumigation, respectively. Non-enzymatic browning showed statistically significant differences among varieties and treatments. Among various pretreatments, sulfur fumigation and lye-peeling were more effective than the rest (Sharma et al., 1993). Mc Bean et al. (1991) reported that unripe fruits need more sulfuring time than ripe fruits, because the rate of sulfur absorption in unripe fruits is low due to its low sugar and high acid content. But in fruits with higher amounts of sugar the absorption rate of SO2 is higher due to more binding sites.

MATERIALS AND METHODS

Apricots (Ghorbane Maregheh variety) were harvested from the gardens of Agriculture research center of Shahrud. Apricots were washed, halved and de-stoned. After applying treatments, they were divided in to two portions. One portion dried by the sun and the other by the solar dryer (figures 1 and 2). Before drying the Brix value, vitamin C and moisture content of apricots were determined as 23, 5.244 mg Vit.C/100g and 75% respectively. Before drying, apricot halves were dipped in citric or ascorbic acids at concentrations of 0.3% and 0.5% for 3 or 5 minutes. All treatments were applied in 3 replications. Samples were dried up to about 12% to 18% moisture content and then packed in cellophane packages. Moisture content was measured by weighting 5g of each sample and drying it in a vacuum oven at 70ºC and 200 m bar to constant weight. Hunter Lab colorimeter model DP-900 was used to determine the color of the samples. The measurements were displayed in L, a, and b values which represents light–dark spectrum with a range from 0 (black) to 100 (white), the green–red spectrum with a range from -60 (green) to +60 (red), and the blue–yellow spectrum with a range from -60 (blue) to +60 (yellow) dimensions, respectively. The Hounsfield H5KS model of INSTRON and Kramer test was used for texture analysis. The force needed to rupture dried apricots and the distance the probe penetrated in to the samples was determined as Newton and millimeter respectively. Vitamin C, pH and Brix value of the samples were also determined. A portable refractometer was used for Brix reading and Vitamin C was determined by 2, 6-Dichlorophenol-Indophenol visual titration method according to Ranganna (1986). The results were analyzed by completely randomized design according to factorial test and the means were compared by Duncan's test. MSTATC and Excel soft wares were used for statistical analysis and drawing charts respectively.

Fig.1. solar dryer

Fig.2. conventional sun drying

RESULTS AND DISCUSSION

Results showed significant effects of drying method and type of acid on the vitamin C of the samples (p<0.01). The loss of vitamin C in conventional sun drying was more than in solar dryer. In the former method this vitamin degrades due to the longer time of drying, compared with the time of drying in the latter method. Also, the samples treated with citric acid had fewer vitamin C. As the samples absorb ascorbic acid, the amount of vitamin C in ascorbic acid treatment was higher than its amount in the citric acid treatment. This result is confirmed by Lombardi and Zaritzky (1996). They analyzed the individual or simultaneous diffusion of citric and ascorbic acids in pre-peeled potatoes.

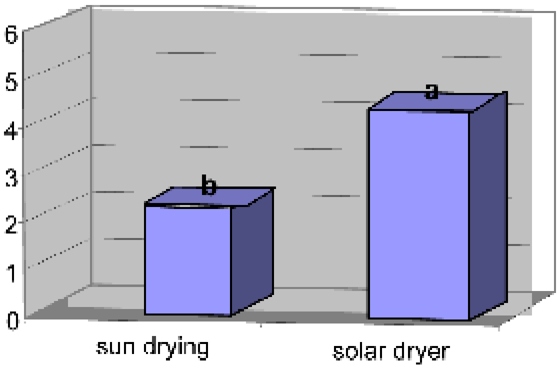

Fig.3. The effect of drying method on vitamin C content.

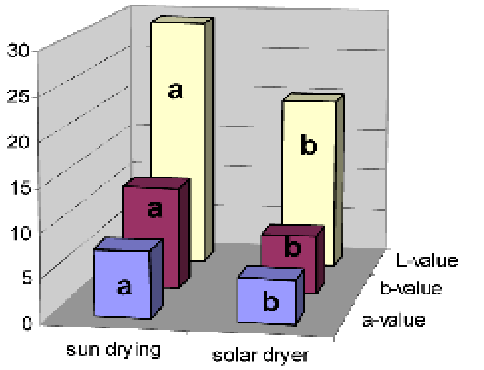

Fig.4. the effect of drying method on the color of dry apricots (L, a and b values)

As shown in table 1, the drying method significantly affected the color. In this regard, the samples produced by sun drying had L, a and b values higher than that of the samples produced in solar dryer. The color variables have been related to the types and quantities of some component present in foods (Ameny & Wilson, 1997; Sass-Kiss, Kiss, Milotay, Kerek, & Toth-Markus, 2005) and the moisture content of samples (Ozkan, Kirca, & Cemeroglu, 2003).

The higher L value of sun dried apricots means that these samples are lighter in color than the apricots dried in solar dryer. This may be related to the lower temperature of drying and higher final moisture of the samples dried by conventional sun drying. These results are confirmed by Karabulut et al. (2006). They also reported that color parameters were affected significantly from drying temperatures.

Table 1-Analisis of variance of the studied parameters (mean squares)

Source of variation	Degree of freedom	Vitamin C	L	a	b	N	Moisture	pH	Brix
A	1	207.421**	1503.804**	131.139**	463.408**	574609.868**	945.255**	0.384**	17.014**
B	1	12.372**	0.293	0.914^{ns}	0.538	10660.436^{ns}	12.718*	0.020	0.014
A×B	1	3.988^{ns}	1.068	0.686^{ns}	1.561^{ns}	5289.062^{ns}	1.584	0.031^{ns}	1.681^{ns}
C	1	3.4829 ^{ns}	9.224^{ns}	0.987^{ns}	0.753	8456.502^{ns}	92.027**	0.014	11.681**
A×C	1	3.738**	1.777	4.585**	2.621^{ns}	8877.782^{ns}	40.290**	0.071^{ns}	0.681
B×C	1	9.728*	3.146^{ns}	1.528^{ns}	0.151	3434.822^{ns}	40.440**	0.011	0.125
A×B×C	1	6.780	1.605	1.348^{ns}	1.537^{ns}	456.524	7.106^{ns}	0.012	0.125
D	2	0.430^{ns}	2.389	0.665^{ns}	0.664	483.200	0.956	0.027^{ns}	1.347^{ns}
A×D	2	3.066^{ns}	1.843	0.923^{ns}	0.382	2336.576	47.696**	0.004	2.264^{ns}
B×D	2	1.416	1.016	0.164	0.042	5483.566^{ns}	11.873*	0.024^{ns}	1.681^{ns}
A×B×D	2	0.471*	3.125^{ns}	0.037	1.579^{ns}	2090.571	2.148	0.009	0.097
C×D	2	5.084^{ns}	2.663^{ns}	0.285	0.684	198.016	7.402^{ns}	0.009	0.931
A×C×D	2	0.411	2.410	0.399	1.528^{ns}	4175.256^{ns}	18.812**	0.044 ^{ns}	2.347^{ns}
B×C×D	2	1.558^{ns}	4.058^{ns}	1.330^{ns}	0.872	10800.284^{ns}	8.004*	0.026^{ns}	0.042
A×B×C×D	2	3.257^{ns}	3.549^{ns}	0.405	0.715	4084.338^{ns}	12.412*	0.024^{ns}	1.292^{ns}
Error	48	1.073	2.595	0.529	0.921	3414.645	2.490	0.022	1.250
C.V.		26.15%	6.53%	11.54%	10.34%	18.93%	14.39%	3.04%	13.33%

L= light–dark spectrum, a= green–red spectrum, b= blue–yellow spectrum, N= The force needed to rupture dried apricots
* significant at statistical level of 5%, ** significant at statistical level of 1%, ^{ns} not significant

Analysis of variance showed that the texture of the samples is significantly affected by drying method, as the required force for the load cell of the INSTRON to go through the flesh of apricots dried by solar dryer was greater than that of conventional sun drying. In our study, the temperature of the solar dryer was more than 70ºC. Goodarzi (2004) obtained similar results. He concluded that low drying temperatures can produce dry apricots with softer texture than high temperatures.

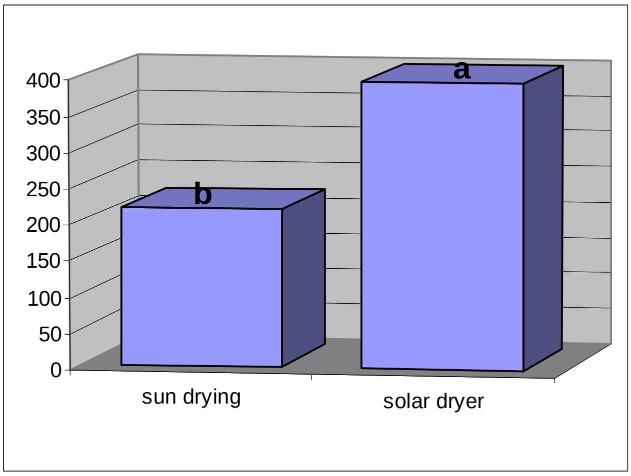

Fig.5. The effect of drying method on the firmness of dry apricots

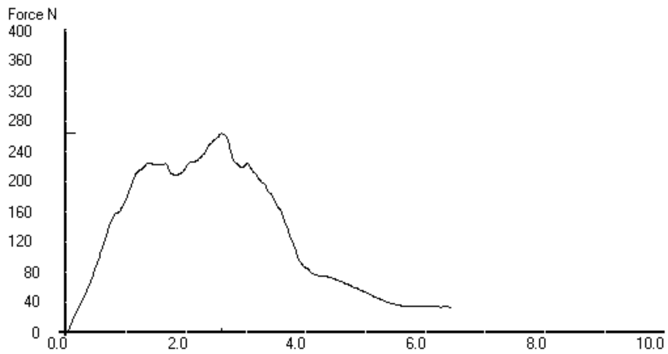

Fig.6. Stress-strain curve of samples dried by solar dyer

As it is appear in table 1, the effect of all treatments, except dipping time, on the moisture content of the samples was significant and ascorbic acid was more effective than citric acid in retaining moisture.

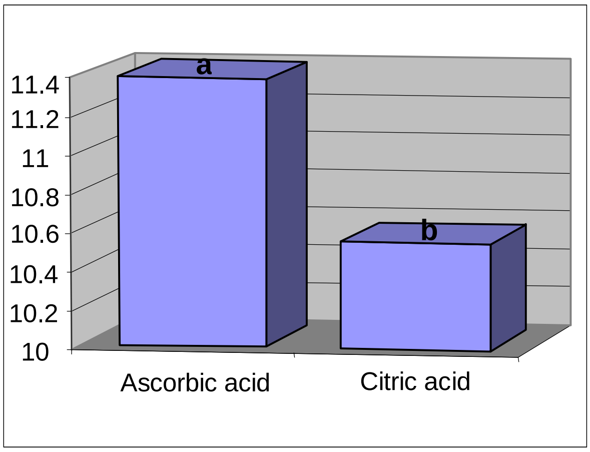

Fig.7. The effect of acid type on the moisture content of dry apricots

Drying method and acid concentration significantly affected the soluble solids (Brix value), in a way that the Brix of the samples produced by conventional sun drying was less than the Brix of the samples dried by solar dryer. In the latter method samples lost more water than in the former method due to higher temperature. This can explain the higher Brix value of the samples dried by solar dryer. Also the amount of soluble solids (Brix) in the samples dipped in 0.5% acids was more than the Brix of the samples dipped in 0.3% acids.

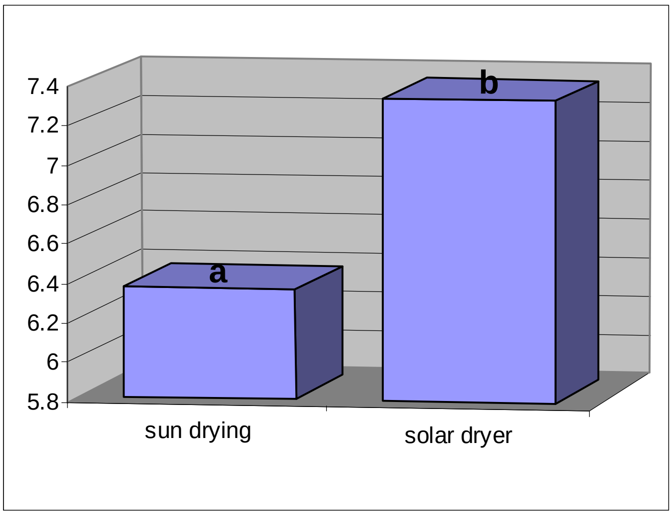

Fig.8.The effect of drying method on soluble solids of the dry apricots

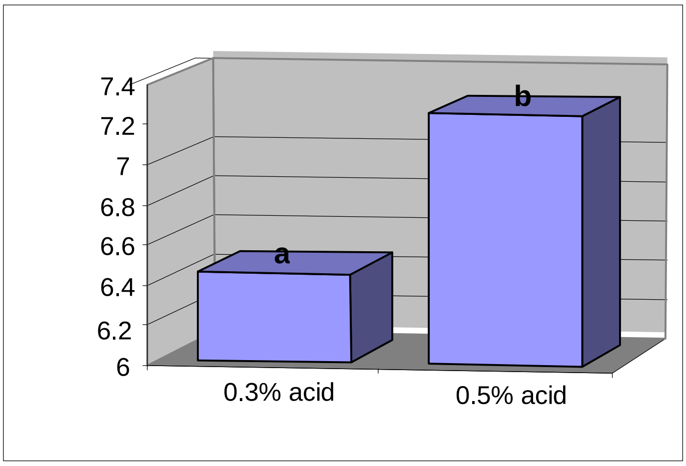

Fig.9.The effect of acid concentration on soluble solids of dry apricots

CONCLUSION

As the results showed, the amount of vitamin C in the samples dried by conventional sun drying was more than in solar dryer. Also, as the samples absorb ascorbic acid, the amount of vitamin C in ascorbic acid treatment was higher than its amount in the citric acid treatment. Consequently we can recommend that it is better to use solar dryer for drying apricots, and dipping apricot halves in ascorbic acid at concentration of 0.3% for at least 3 minutes could be a good alternative for SO_2 in preventing discoloration of apricots.

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