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in

Melgarejo P. (ed.), Valero D. (ed.).
II International Symposium on the Pomegranate

Zaragoza : CIHEAM / Universidad Miguel Hernández
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 103

2012
pages 255-259

Convective and microwave drying influence on the chemical composition, functional properties and sensory quality of pomegranate arils and rind

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Abstract. The objective of this study was to evaluate the application of: (i) convective drying (50, 60 or 70ºC), (ii) vacuum-microwave drying (240, 360 or 480 W) and (iii) a combined method of convective pre-drying and vacuum-microwave finishing drying in the processing of dehydrated pomegranate arils and rind. The parameters under study included sugars and organic acids contents, total antioxidant activity and total polyphenols content. All parameters were calculated on a dry matter basis and analysis of data showed drying let to a reduction in all the parameters under study; however, the behavior of arils and rind were different. Vacuum-microwave drying at 240 W was the best drying treatment of arils, while rind required softer conditions of convective drying (50ºC) and vacuum-microwave drying (240 W). Convective pre-drying and vacuum-microwave finishing drying was not a proper treatment for pomegranate drying.

Keywords. Drying – Arils – Rind – Quality – DPPH.

I – Introduction

Pomegranate (*Punica granatum* L.) is mainly cultivated in Iran, Afghanistan, India, USA and Mediterranean countries. Spain is the greatest European producer. There is a huge amount of pomegranate fruits (PG) which quality is not good enough to be consumed as a fresh fruit due to small damages or defects that mainly affect fruit appearance but not jeopardize their global sensory quality. Due to the different market requirements and the huge popularity of the health benefits of pomegranate, there are many scientific manuscripts where researchers have developed or characterized PG based products and co-products, such as juices (Calín-Sánchez *et al.*, 2010; Mena *et al.*, 2011), jams (Melgarejo *et al.*, 2010), wines (Zhuang *et al.*, 2011) and dried arils (Singh *et al.*, 2007).

Pomegranate rind is a richer source of antioxidants compared with arils (Li *et al.*, 2006) and could be use as a nutraceutical supplement (Espín *et al.*, 2007), as well as condiment for food and drinks (Navarro *et al.*, 2011). Dried arils and rind seemed to be a proper PG based product and co-product, respectively; however, up to this time there is no research literature on the influence of different drying methods on the quality of PG arils and rind. Therefore, the main objective of this study was to determine the influence of different drying methods: (i) convective drying (CD), (ii) vacuum microwave drying (VMD) and (iii) combined drying (CPD-WMFD) on the chemical composition, functional properties and sensory quality of dried PG arils and rind.

II – Material and methods

1. Plant material and processing of samples

Fresh pomegranate fruits (*Punica granatum* L. cv. *Mollar de Elche*) were picked on October 30, 2010 in a commercial orchard in Elche (Alicante, Spain). Fifty fruits were randomly harvested at commercial ripening and 20 homogenous fruits were finally selected. In all the samples under study, arils were manually separated and rinds, including peel and carpelar membranes, were separately submitted to the treatments. The initial moisture contents of the arils and rind were 80.4% and 76.3%, respectively. PG samples of 60 g were subjected to three different drying protocols: (i) CD was operated at three different temperatures: 50, 60 or 70°C with an air velocity of 0.8 m s^{-1}; (ii) VMD was operated at three different power levels: 240, 360 or 480 W and a pressure ranging from 4 to 6 kPa; and (iii) CPD-VMFD consisted of convective pre-drying (CPD) at temperature 60 °C for 90 or 150 min, followed by VM finish-drying (VMFD) with a microwave wattage of 360 W.

2. Extraction and determination of sugars and organic acids of fresh and dried arils

Fresh and dried samples were extracted with ultra pure water and phosphoric acid 0.1%, homogenized and then centrifuged. One milliliter of the centrifuged supernatant was filtered and injected into a HPLC. Organic acids and sugars were quantified using a diode-array detector and a refractive index detector, respectively.

3. Antioxidant capacity (AOC) and total polyphenols (TP)

AOC using the radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) was evaluated in both arils and rind. Samples were homogenized and then centrifuged. 10 µl of the supernatant and 40 µl of MeOH were added to 950 µl of a 0.094 mM DPPH solution. The absorbance at 515 nm was measured after 50 min of the reaction. The TP content was quantified in both arils and rind using Folin-Ciocalteu reagent. Samples were homogenized, centrifuged and then the absorbance was measured at 760 nm.

4. Sensory evaluation with a trained panel

Sensory evaluation with a trained panel was used to describe fresh and dried PG arils. Seven panelists were trained in descriptive evaluation of pomegranate and pomegranate based products. Panelists were asked to evaluate the intensity of the following attributes: color, fresh PG odor and aroma, burnt odor and aroma, caramel odor and aroma, sourness, sweetness, bitterness, adhesiveness and solubility. The individual products were scored for the intensity of the different attributes on a scale of 0 to 10, where; 0 = non perceptible intensity and; 10 = extremely high intensity.

III – Results and discussion

1. Effect of drying treatments on sugars and organic acids

Fructose and glucose were the main sugars found in the dried pomegranate arils. In the current study, fructose values were higher than glucose contents (Table 1), as previous reported by different researchers (Tezcan *et al.*, 2009; Melgarejo *et al.*, 2000). According to the data, soft conditions of CD provided the best result regarding fructose and glucose contents, followed by 150 min CPD-VMFD, while medium and high VMD conditions seemed to be the best VMD options. It can be observed that as the temperature increased during the CD, the sugars contents decreased; however, intensive treatments (short times and high VMD powers) led to high sugar contents.

Table 1. Sugars and organic acids contents (g/100 g of DW) in pomegranate arils as affected by drying treatments

	Sugars		Organic acids	
Samples	**Glucose**	**Fructose**	**Citric**	**Malic**
Fresh	27.1 ± 0.1 a	46.3 ± 0.2 a	0.52 ± 0.09 a	2.49 ± 0.02 a
CD 50 ºC	15.7 ± 1.4 b	27.8 ± 2.6 b	0.03 ± 0.01 cd	0.18 ± 0.01 b
CD 60 ºC	14.2 ± 0.2 c	24.2 ± 0.3 c	0.03 ± 0.01 bcd	0.20 ± 0.01 b
CD 70 ºC	14.1 ± 0.4 c	24.2 ± 0.6 c	0.03 ± 0.01bc	0.20 ± 0.01 b
VM 240 W	14.4 ± 0.2 bc	24.8 ± 0.3 c	0.03 ± 0.01 cd	0.30 ± 0.01 d
VM 360 W	14.8 ± 0.1 bc	25.7 ± 0.1 bc	0.02 ± 0.01 d	0.42 ± 0.02 c
VM 480 W	14.6 ± 0.1 bc	25.3 ± 0.6 bc	0.02 ± 0.01 d	0.40 ± 0.01 c
90 min CPD-VMFD	14.7 ± 0.2 bc	25.2 ± 0.4 bc	0.03 ± 0.01 cd	0.36 ± 0.01 c
150 min CPD-VMFD	15.0 ± 0.1 bc	25.7 ± 0.2 bc	0.03 ± 0.01 bcd	0.32 ± 0.01 d
ANOVA	***	***	***	***

Malic and citric acids were the main organic acids found in the dried pomegranate arils. Malic acid content was higher than that of citric acid (Table 1), as previously showed in sweet pomegranates by Mirdehghan *et al.* (2007). Results showed that high temperatures of CD and high VMD power seemed to be the best drying option for malic acid content; however the softest conditions of both CD and WM show the highest values of citric acid. Regarding the contents of organic acids, VMD and CPD-VMFD were better treatments than CD. Too high temperatures and too long drying times often cause poor color, flavor and nutritional value (Hu *et al.*, 2006). Figiel (2009) reported that during drying of garlic, the highest temperature was obtained for the highest VMD power. Finally, it can be concluded that pomegranate sugars were more stable with softer drying conditions (application of low temperatures during long times). A different situation was observed in the case of organic acids, where the data showed that shorter times but higher temperatures led to higher contents.

2. Changes in AOC and TP after processing of pomegranate arils and rind

To quantify the AOC and TP of fresh and dried pomegranate arils and rind, the DPPH and Folin-Ciocalteu method and reagent were respectively used. Among the eight treatments, the highest AOC and TP values were observed for VMD. Lower AOC and TP were obtained for dehydrated samples compared with the fresh ones (Table 2). Pomegranate rind showed higher values of both AOC and TP than pomegranate arils; this statement agrees with previous studies, such as that of Li *et al.* (2006). Pomegranate rind showed higher values of AOC and TP for soft conditions of both CD and VMD. This behavior could be the result of high temperatures decreasing the antioxidant activities of the products being dried, independently of the time required for the process. The CPD-VMFD did not improve the AOC and TP compared with CD and VMD. Pomegranate arils showed better results with low temperatures and long times in CD; however, when VMD was applied, higher power leading to high temperatures and low times was recommended. The first trend (CD) was similar to that already described for the rind, while the second one (VMD) could be explained due to Maillard reactions producing compounds with high antioxidant capacity (Yilmaz *et al.*, 2005; Manzocco *et al.*, 2001).

Table 2. Effect of drying method on AOC and TP of pomegranate arils and rind

Samples	Rind		Arils	
	TP (mg eq gallic acid/g DW)	**TAA (mg eq Trolox/100 g DW)**	**TP (mg eq gallic acid/g DW)**	**TAA (mg eq Trolox/100 g DW)**
Fresh	125 ± 1a	4511 ± 14e	7.57 ±0.07a	120 ± 2a
CD 50 ºC	108 ± 1d	2575 ± 13bc	2.05 ±0.05d	70.0 ± 1bc
CD 60 ºC	105 ± 1e	2447 ± 24d	1.99 ±0.07de	65.6 ± 0.3cde
CD 70 ºC	72.8 ± 0.1f	1255 ± 1e	2.01 ±0.04d	68.1 ± 2.3bed
VM 240 W	111 ± 1c	2535 ± 39c	1.57 ±0.01f	56.5 ± 1.5f
VM 360 W	69.2 ± 0.1g	1295 ± 7e	2.38 ±0.02c	59.6 ± 0.7ef
VM 480 W	57.3 ± 0.4i	1295 ± 7e	2.51 ±0.03b	73.9 ± 5b
90 min CPD-VMFD	63.4 ± 0.6h	1294 ± 14e	2.00 ±0.04de	69.9 ± 4.6bc
150 min CPD-VMFD	69.9 ± 0.1g	1256 ± 14e	1.87 ±0.03e	72.2 ± 1.7bc
ANOVA	***	***	***	***

3. Sensory analysis of fresh and dried pomegranate arils

In general, the drying type significantly affected the intensities of the dried aril attributes. Attributes such as color, fresh PG odor and aroma, sourness and solubility significantly decreased after the drying process compared with the fresh sample, while the rest of attributes, burnt odor and aroma, caramel odor and aroma, sweetness, bitterness and adhesiveness increased during the dehydration of the fresh fruits. The color changes were linked with the Maillard reactions, which modify the color becoming darker and with a higher intensity of the brown color. VMD at 240 W was scored with the maximum values for fresh PG odor and aroma (3.1 and 5.6, respectively) after the fresh sample; besides these attributes took lower values as the temperature increased. Sourness decreased too during the drying process and the increase in the sweetness may hide sour notes. Solubility obtained lower scores in dried products compared to fresh samples and this fact could be linked with lower cohesiveness of particles in the dried items. Caramel notes were clearly influenced by the temperature. Burnt odor and aroma were evaluated and the following treatments led to unacceptable (too high) values: VMD at 480 W and both CPD-VMFD treatments. Bitterness scores were positively correlated with burnt notes. The sweetness/organic acids ratio was always over 100, explaining the high sweetness scores obtained for all dried products.

IV – Conclusions

Dried pomegranate arils and rind could be good options to commercialize pomegranate fruits without generating huge amounts of wastes. Dried PG arils were a delicious and sweet product due to high but equilibrated sugars and organic acids contents; besides, this product had significant antioxidant capacity. VM at 240 W was the best drying treatment for PG arils. Dried PG rind is a suitable nutraceutical and food condiment, but in this case soft drying conditions were recommended (CD at 50ºC or VMD at 240 W). CPD-VMFD was not an appropriate treatment neither for PG arils nor rind.

References

Calín-Sánchez Á., Martínez J.J. *et al.*, 2011. Volatile composition and sensory quality of Spanish pomegranates (*Punica granatum* L.). In: *J. Sci. Food Agric.*, 91(3), p. 586-592.
Espín J.C., García-Conesa M.T. *et al.*, 2007. Nutraceuticals: Facts and fiction. In: *Phytochemistry*, 68(22-24), p. 2986-3008.

Figiel A. (2009). Drying kinetics and quality of vacuum-microwave dehydrated garlic cloves and slices. In: *J. Food Eng.*, 94(1) , p. 98-104.

Hu Q., Zhang M., Mujumdar A.S., Xiao G. and Sun J., 2006. Drying of edamames by hot air and vacuum microwave combination. In: *J. Food Eng.*, 77, p. 977-982.

Li Y., Guo C. *et al.*, 2006. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. In: *Food Chem.*, 96(2), p. 254-260.

Manzocco L., Calligaris S., Mastrocola D., Nicoli M.C. and Lerici C.R., 2000. Review of non-enzymatic browning and antioxidant capacity in processed foods. In: *Trends Food Sci. Tech,* 11, p. 340–346.

Melgarejo P., Martínez R. *et al.*, 2010. Anthocyanin content and colour development of pomegranate jam. In: *Food Bioprod Process*. (In press).

Melgarejo P., Salazar D.M. and Artés, F., 2000. Organic acids and sugars composition of harvested pomegranate fruits. In: *Euro. Food Research Tech.*, 211, p. 185-190.

Mena P., García-Viguera C. *et al.*, 2011. Phytochemical characterisation for industrial use of pomegranate (*Punica granatum* L.) cultivars grown in Spain. In: *J. Sci. Food Agric.*, 91(10), p. 1893-1906.

Mirdehghan S.H., Rahemi M., Serrano M., Guillén F., Martínez-Romero D. and Valero, D., 2007. The application of polyamines by pressure or immersion as tool to maintain functional properties in stored pomegranate arils. In: *J. Agr. Food Chem.*, 55, p. 755-760.

Navarro P., Nicolas T.S. *et al.*, 2011. Effects of Cyclodextrin Type on Vitamin C, Antioxidant Activity, and Sensory Attributes of a Mandarin Juice Enriched with Pomegranate and Goji Berries. In: *J. Food Sci.*, 76(5), p. S319-S324.

Singh D.B., Kingly A.R.P. *et al.*, 2007. Studies on separation techniques of pomegranate arils and their effect on quality of anardana. In: *J. Food Eng.*, 79(2), p. 671-674.

Yilmaz Y. and Toledo R., 2005. Antioxidant activity of water-soluble Maillard reaction products. In: *Food Chem.*, 93, p. 273-278.

Zhuang H., Du J. *et al.*, 2011. Antioxidant Capacity Changes of 3 Cultivar Chinese Pomegranate (*Punica granatum* L.) Juices and Corresponding Wines. In: *J. Food Sci.*, 76(4), p. C606-C611.