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RESEARCH PAPER

Studies on convective drying of pomegranate arils

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SUMMARY : The study of convective drying or pomegranate arils was carried out to observe the effect of temperature on drying characteristics and physicochemical properties of pomegranate arils. The drying is done at 45, 50, 55 and 60°C to reduce initial moisture content 377.09 - 442.68 per cent (d.b.) to final moisture content of 5.7 - 9.62 per cent (d.b.) in 26.5, 17.5, 14 and 7.5h, respectively. The entire drying of pomegranate arils takes place in falling rate period. For arils, the moisture diffusivity increased from 2.54 x $10^{-7}m^2/s$ at 45°C, to 4.18 x $10^{-7}m^2/s$ at 50°C, to 5.42 x $10^{-7}m^2/s$ at 55°C, to 7.95 x $10^{-7}m^2/s$ at 60°C. The mathematical models for convective dehydration based on the Fick's law of diffusion were found quite adequate to predict the mass transport data during convective dehydration process.

KEY WORDS : Convective drying, Diffusivity, Physico-chemical properties

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Punica granatum L., the pomegranate belongs to the Punicacea family, is an important fruit of arid and semi-arid regions. It is sometimes called Chinese apple, and is native of Iran and extensively cultivated in Spain, Russia, France, Argentina, china, Japan, USA and India (Patil and Karade, 1990). In India, it is commercially grown in Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Himachal Pradesh and Rajasthan, (Singhal, 1999). The fresh juice is best for leprosy, heart, kidney and tuberculosis patients. The juice is a blood tonic and good for fast and high blood pressure. It is even a good brain tonic. Extract of fruit has antiviral activity (polio-virus) (Konowalchuk and Speirs, 1976). The edible part of the fruit (seeds) contains a considerableamount of sugars, vitamins, polysaccharides, minerals and polyphenols (Espiard, 2002). Despite all these advantages, the consumption of pomegranate seeds is limited to the crop season due to problems of preservation (Defilippi *et al.*, 2006).

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Drying is the most widely employed method for preserving food materials, which is based on reduction of the water activity values through moisture removal to achieve physicochemical and microbiological stability (Gorjian *et al.*, 2011). Dried products have almost unlimited shelf-life in proper packages and substantially lower transportation, handling and storage costs compared to foodstuffs produced with other preservation methods (Ertekin and Yaldiz, 2010). Traditionally, fruit and vegetables are dried in open sunlight. However, sun drying is weather dependent, affecting the homogeneity and quality of the final product. Moreover, the products are prone to microbial and other contaminations. To overcome these problems, the use of industrial type dryers (solar or convective dryers) should be used (Kingsly and Singh, 2007; Falade and Solademi, 2010). During open sun drying, due to exposure to open atmosphere for a long time causes microbial contamination and spoilage of product (Vagenas and Morinos-Kouris, 1991). Industrial drying ensures uniform, hygienic and quality maintenance of dried product by more rapid drying (Doymaz, 2004). Hence, an attempt was, therefore, made by using convective drying to obtain good quality dried arils as well as dried rind. The study was undertaken with the objective to study the drying characteristics of arils of pomegranate during convective drying and to evaluate the quality of dried pomegranate arils.

EXPERIMENTAL METHODS

A widely grown Bhagwa variety of pomegranate fruits were obtained from local market of Udaipur, Rajasthan for all the experiments. A hand operated pomegranate arils extractor was used for arils extraction developed at Central Institute of Post Harvest Engineering and Technology, Ludhiana. The machine consisted of two similar parts fitted with sharp knives. The capacity of this hand operated aril extractor was 0.8kg/h for medium size fruits which gives aril recovery of 95.31per cent. The pomegranate fruits were washed with water and the arils and rind were separated manually as well as by aril extractor. Initial moisture content of pomegranate arils and rind was determined on wet basis by using standard oven method by using AOAC (1984). Each sample of 100g arils was weighed by using electronic balance. To determine the drying characteristics, TSS, acidity, water activity, rehydration characteristics and colour of dried pomegranate arils, three replicates of samples of 100g arils were taken in mesh wire container and placed in a tray drier at different temperature levels of 45°C, 50°C, 55°C and 60°C and weight was taken at regular intervals of 30min by using electronic balance. The initial moisture content of 377.09 - 442.68 per cent (d.b.) was reduced to 5.7 - 9.62 per cent (d.b.).

The statistical analysis was carried out in three replicates for all determinations. The mean and standard deviation of means were calculated. The data were analyzed by one-way analysis of variance (ANOVA).

EXPERIMENTAL FINDINGS AND ANALYSIS

The experimental findings obtained from the present study have been discussed in the following heads:

Effect of temperature on drying time :

The initial moisture content of arils was in the range of 377.09 to 442.68 per cent (d.b.) which reduced to 5.69 to 9.62 per cent (d.b.) after 26.5, 17.5, 14 and 7.5h for drying air temperature of 45, 50, 55 and 60°C, respectively (Fig. 1). The drying time was reduced to 17.5h when the drying air temperature was increased to 50°C, showing 33.96 per cent reduction in time. When the drying temperature further increased to 55°C, the drying time for same moisture reduction was decreased to 14h showing 47.16 per cent for the reduction in time. Finally for 60°C, the drying time was found to be 7.5h which was 71.69, 57.14 and 46 per cent less than 45, 50 and 55°C drying air temperature, respectively.

Drying rate of pomegranate arils :

The drying rate of the pomegranate arils and rind was estimated by determining the amount of moisture removal per unit time. It can be seen that initially the drying rate was large and subsequently it reduced with drying time. In Fig. 2 it can also be seen that they follow typical drying rate curves. The maximum rate of drying for arils was observed at initial stage of drying 43.41, 79.86, 83.21and 141.09g/100g/h for 45, 50, 55 and 60°C, respectively. These drying rates continuously decreased and finally at the end of drying, they reduced to 5.64, 4.00, 4.44 and 0.98g/100g/h for 45, 50, 55 and 60°C, respectively (Fig. 3 and 4).

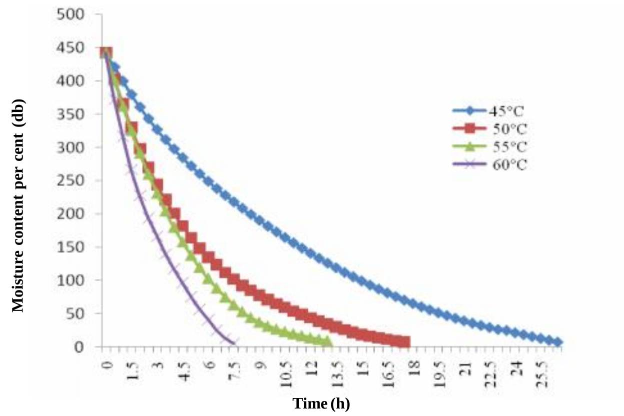

Fig. 1: Variation in moisture content of arils with drying time

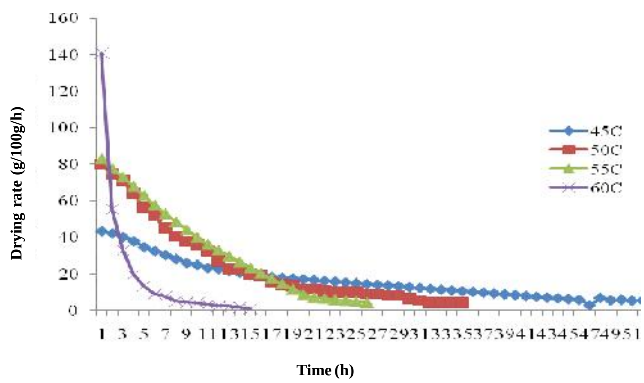

Fig. 2: Variation of drying rate of arils with drying time

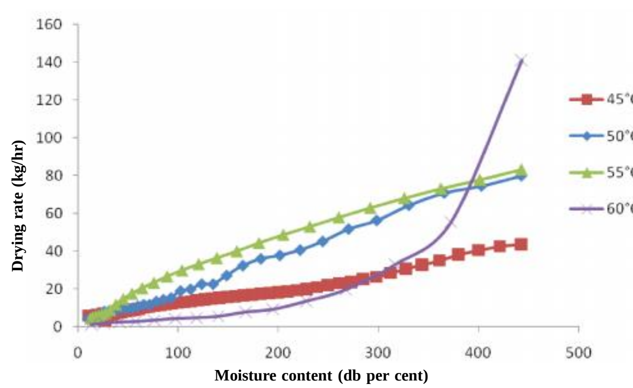

Fig. 3: Variation of drying rate with moisture content of arils

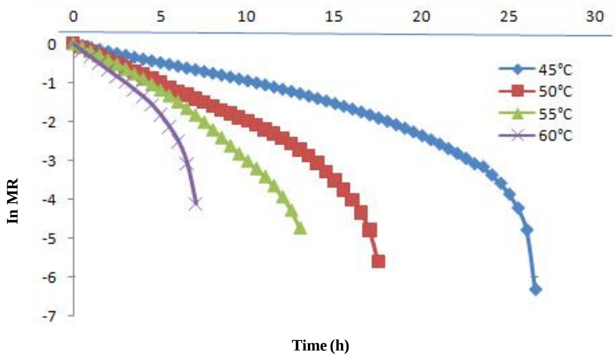

Fig. 4: Variation of in (MR) of arils with drying time

Moisture diffusivity :

The moisture diffusivity of dried arils varies from 2.547 x 10^7 m^2/s at 45°C, 4.186 x 10^7 m^2/s at 50°C, 5.420 x 10^7 m^2/s at 55°C and 7.950 x 10^7 m^2/s (Table 1).

Effect of tray drying on physico-chemical properties of pomegranate arils :

The maximum value of T.S.S. of dried arils was found to be 38.73 per cent at 50°C, followed by 37.63 per cent at 45°C, 30.56 per cent at 60°C and 30.2 per cent at 55°C (Table 2). An analysis of variance was carried out to study the effect of drying temperatures on T.S.S. and which showed that temperature had non-significant effect at 5 per cent level of significance. The maximum acid value of dried arils was found 0.605 per cent at 45°C, followed by 0.5 per cent at 50°C, 0.409 per cent at 60°C, and 0.395 per cent at 55°C. An analysis of variance was carried out to study the effect of drying temperature on the acidity of dried arils and it had significant effect at 1 per cent level of significance. The maximum water activity value of dried arils was found 0.283 at 45°C, followed by 0.274 at 55°C, 0.273 at 50°C and 0.268 at 60°C. An analysis of variance was carried out to study the effect of temperature on the water activity of dried pomegranate arils and it showed that temperature had significant effect on arils at 5 per cent level of significance.

In this study the maximum and minimum RR (Rehydration ratio) and COR (Coefficient of rehydration) was found at 45°C and 60°C, respectively. The RR and COR ranged from 3.03 to 3.34 and 5.91 to 6.51, respectively. An analysis of variance was carried out to study the effect of temperature on the rehydration characteristics of dried pomegranate arils and it showed that temperature had significant effect on rehydration ratio and coefficient of rehydration on arils at 5 per cent level of significance. An analysis of variance was carried out to study the effect of temperature on the colour of dried pomegranate arils and it showed that temperature had non significant effect on arils at 1 per cent level of significance. The maximum chroma value (C*) of dried arils was found 26.74 at 55°C, 24.78 at 45°C, 24.18 at 50°C and 23.79 at 60°C. From the organoleptic evaluation it can be concluded that, arils dried at 45°C was liked moderately by 60 per cent people, arils dried at 50°C was liked very much by 70 per cent people, arils dried at 55°C was liked very much by 90 per cent people and arils dried at 60°C was liked extremely

Table 1 : Moisture difusivity equation of dried pomegranate arils

Sample	Temperature	Equation of straight line (y = mx+c)	Slope (m)	Diffusivity (m^2/s)	R^2
Dried arils	45°C	y = -0.157x+0.441	0.157	2.547 x 10^{-7}	0.866
	50°C	y = -0.258x+0.295	0.258	4.186 x 10^{-7}	0941
	55°C	y = -0.344x+0.354	0.344	5.420 x 10^{-7}	0.976
	60°C	y = -0.490x+0.297	0.490	7.950 x 10^{-7}	0.911

Table 2: Experimental values of T.S.S., acidity, rehydration characteristics, water activity and colour of dried pomegranate arils

Property → / Temp ↓	Mean ±S.D.					
	T.S.S	Acidity	Water acidity	Rehydration characteristics		Colour(C*)
				RR	COR	
45°C	37.633±5.2811	0.605±0.005	0.283±0.012	3.340±0.036	6.513±0.076	24.783±0.696
50°C	38.733±5.770	0.500±0.010	0.273±0.010	3.306±0.155	6.456±0.304	24.183±1.365
55°C	30.200±2.046	0.395±0.016	0.274±0.002	3.066±0.151	5.976±0.299	26.743±0.461
60°C	30.566±1.855	0.409±0.003	0.268±0.006	3.033±0.110	5.916±0.215	23.796±2.639
GM	34.283±5.487	0.4770.088	0.274±0.009	3.186±0.177	6.215±0.350	24.876±1.770
Se	2.471	0.005	0.004	0.070	0.139	0.891
C.D.5%	8.061	0.018	0.016	0.231	0.456	2.905
C.D.1%	12.409	0.029	0.024	0.356	0.702	4.473
C.V.	12.49	2.10	3.12	3.86	3.90	6.20

by 70 per cent people.

Summary and conclusion :

The study revealed that drying at 60°C required minimum time of 7.5h followed by 55°C of 13.5h, 50°C of 17.5h and 45°C of 26.5h. The drying rate was maximum at 60°C of 141.097g/100g/h. The entire drying of pomegranate arils taken place in falling rate period. For arils, the moisture diffusivity increased from 2.54 x $10^{-7}m^2/s$ at 45°C, to 4.18 x $10^{-7}m^2/s$ at 50°C, to 5.42 x $10^{-7}m^2/s$ at 55°C, to 7.95 x $10^{-7}m^2/s$ at 60°C. Physicochemical analysis of dried arils indicated highest value to T.S.S., acidity, water activity, rehydration characteristics at drying temperature of 45°C. The highest chroma value was obtained at 55°C for arils.

LITERATURE CITED

Defilippi, G., Whitaker, B., Hess-Pierce, B., and Kader, A. (2006). Development and control of scald on wonderful pomegranates during long-term storage. *Postharvest Biol. & Technol.,* **41**: 234–243.

Doymaz, I.(2004). Effect of pre-treatments using potassium metabisulphide and alkaline ethyl oleate on the drying kinetics of apricot. *Biosystems Engg.* **89**:281-287.

Ertekin, C. and Yaldiz, O. (2010). Thin layer drying of sliced quash by forced convection. XVIIth World Congress of the International Commission of Agricultural and Biosystems Engineering (CIGR). Qubec, CANADA.

Espiard, E. (2002). Introduction à la transformation industrielle des fruits. TEC and DOC-Lavoisier, pp. 181–182.

Falade, K.O. and Solademi, O.J. (2010). Modelling of air drying of fresh and blanched sweet potato slices. *Internat. J. Food Sci Technol.,* **45**:278–288.

Gorjian, Sh., Tavakkoli Hashjin, T., Khoshtaghaza, M.H. and Nikbakht, A.M. (2011). Drying kinetics and quality of barbarry in a thin layer dryer. *J. Agric. Part Sci. Technol*., **13**:303–314.

Kingsly, A.R.P. and Singh, D.B. (2007). Drying kinetics of pomegranate arils. *J. Food Eng.,* **79**:741–744.

Konowalchuk, J. and Speirs, T.J. (1976). Antiviral activity of fruit extractor, *J. Food Sci*., **41**(5):103-117.

Patil, A. V. and Karade, A. R. (1990). Pomegranate in T.K. Bose and S.K. Mitra (Ed.) *Fruits: Tropical and sub tropical.* Naya Prokash, Calcutta, pp. 614-631.

Singhal, V. (1999). Fresh fruits and vegetables. *Indian Agric.*Vikas Pub., New Delhi 173 pp.

Veganas, G.K. and Marinos–Kouris, D. (1991). Drying kinetics of apricot. *Drying Technol*., **9**: 735-752.

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