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Effect of convective drying on quality of *anardana*

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ABSTRACT

The conventional utilization of wild pomegranate fruit lies in the drying seeds alongwith pulp (arils) which constitute the product *'anardana'*. The dehydrated arils are acidic and help in improving mouth feel and digestion. Drying temperature is optimized in this study for getting better end product with quality retention during storage. The arils were dehydrated at 50, 55, 60^0 C and packed in polyethylene bags. The change in quality parameters such as acidity, colour, microbial load and enzymatic browning were studied. Pomegranate arils dried at 55^0 C drying air temperature (drying time, 7 h) retained desirable and acceptable quality parameters (titrable acidity 7.8%, Vitamin C as ascorbic acid, 15.16 mg/100 g) up to 180 days of storage. The appealing red colour of the product changed with storage period. The product obtained by drying at 55^0 C had permissible NE browning and microbial load within acceptable limits.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit of tropical and sub-tropical regions. The versatile adaptability, therapeutical values and better keeping quality are the features responsible for its cultivation on a wide scale (Dhandhar and Singh, 2). The fruit is native of Iran and extensively cultivated in Spain, Egypt, Russia, France, Argentina, China, Japan, USA and India (Patil and Karade, 9). Pomegranate is one of the favourite fruit of tropical and sub-tropical regions where it has enjoyed the consumer's patronage for its healthy dieteric and medicinal properties. The fruit is consumed fresh, can be also preserved into juice, syrup, jam, jelly or wine. In addition to dessert and sweet type, pomegranate is also found in its wild form in Syria, Afghanistan, Central Asia and in India (Saxana *et al.,* 12). In India, wild pomegranate also known as *Daru* has been growing wild in Himachal Pradesh, Uttaranchal and J & K. Dried arils of wild pomegranate are used as an acidulent for culinary purposes and improves mouth feel and digestion (Kingsly *et al.,* 7). Dried pomegranate arils are also good source of vitamins and minerals. In ayurveda, the *anardana* is being used for number of formulations to use in treatment of dysentery, diaorrhea, stomach ache, hymenoletidosis, dyspepsia, bronchitis and cardiac problems. Drying of arils in pomegranate for *anardana* is the most important process since it has a great effect on the quality of the end product. In India, traditionally pomegranate is dried in the open sunlight. But the sun drying has the disadvantage of time consumption, contamination with dust and insects and is also weather dependent (Doymaz and Pala, 3; Teaotia and Pruthi, 14). During open drying, due to exposure to open atmosphere for a long time causes microbial contamination and spoilage of product (Vagenas and Morinos-Kouris, 16). Industrial drying ensures uniform, hygenic and quality maintenance of dried product by more rapid drying (Doymaz, 4). The drying system models decide the drying kinetics and enzymatic browning. Systematic dehydration ensures longer shelf- life and can be used in off-season of the particular fruit crop. There are several studies describing the drying behaviour of various fruits and vegetables such as onion (Singh and Sodhi, 11), red pepper (Doymaz and Pala, 3), garlic cloves (Sharma *et al.,* 10), whereas the information on drying of pomegranate arils for quality *anardana* is very scanty. Therefore, present investigation was conducted on dehydration of wild pomegranate arils on drying behaviour of *anardana* and quality maintenance of the product.

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MATERIALS AND METHODS

Wild pomegranate fruits were procured from Solan for drying and storage studies. The arils were separated manually from the fruits. The initial physico-chemical characteristics of the fruits are given in Table 1. The drying experiments were conducted in a cabinet dryer. Before drying, *anardana* arils were washed for immersion in a sodium hypochlorite solution (100 ppm) for 5 minutes. The loading rate of samples was kept at 3 kg /m^2 of tray. The samples were dried at 50, 55 and 60°C. Moisture loss was estimated at 60 minutes interval with the help of an electronic balance. The drying was continued till there was no large variation in the moisture loss. The experiments were conducted in triplicate and average values are reported. Dehydrated arils (*anardana*) were packed in 200 gauge LDPE bags, sealed and stored in dry cool places. Rehydration study was conducted by

Table 1. Physico-chemical composition of fresh wild pomegranate fruit.

Physical characteristics	
Weight of fruit	63 g
Size of fruit (L x B)	5.6 cm x 4.8 cm
No. of arils/ fruit	163
Peel weight	29.3 g
Weight of seed/fruit	32.3 g
Size of aril (L x B)	0.9 cm x 0.6 cm
Weight of single aril	0.2 g
Chemical composition	
TSS (°Brix.)	16.4
Acidity (%)	6.68
Juice (%)	40.0
pH	2.47
Vitamin C (mg/100g)	17.24
Reducing sugar (%)	8.3
Non-reducing sugar (%)	0.8
Total sugars (%)	9.1
Sugar : acid ratio	1.4
Mineral (ppm)	
Ca	30.0
Fe	168.0
Cu	489.0
Mn	11.0
Proteins (%)	1.47
Total phenols (%)	9.3

boiling for 10, 20 and 30 minutes. Storage studies for quality and colour were taken at 30 days interval. Quantitative parameters of the *anardana* like vitamin C, acidity, total sugars and reducing sugars were estimated as described by Ranagana (13) and AOAC (1). The product was analysed for colour characteristics L, a and b values determined using Hunterlab miniScan XE plus colorimeter. 'L' value indicates lightness or darkness, 'a' red or green and 'b' yellow or blue. The statistical interpretation of the data was carried out by as analysis of variance (Panse and Sukhatme, 8).

RESULTS AND DISCUSSION

The final moisture content of the samples dried under different moisture modes ranged from 8.56 to 8.93 % (db). In all the drying temperatures selected, higher temperature had shorter drying time (Table 2). Drying air temperature had also an important effect on drying of arils for *anardana.* Minimum time was recorded in case of cabinet drying at 60° C followed by 55° C. Time required to dry pomegranate arils from initial moisture content (79.1%) to the final moisture content was 600, 420 and 360 minutes at 50, 55 and 60°C of the drying air temperature, respectively. At higher temperature, due to quick removal of moisture the drying was less. Decrease in drying time with increase in drying time with increase in drying temperature may be due to increase in water vapour pressure within the arils which increased the migration of moisture. Similar observations are reported for garlic (Sharma *et al.,* 10), apricot (Dorymaz, 4; Vagenas and *Marinos-Kouris,* 16) and grapes (Dorymaz and Pala, 3).

Table 2. Drying of wild pomegranate arils for *anardana.*

Drying system	Final moisture (%)	Time taken for drying (min.)
Cabinet drying (50 ºC)	8.93	600
Cabinet drying (55 ºC)	8.80	420
Cabinet drying (60 ºC)	8.56	360
CD at 5%	0.117	2.84

Drying temperature significantly affected the size of *anardana,* i.e. length and breadth. It ranges from 6.70 mm × 2.08 mm in case of 60°C to 6.78 mm × 2.82 mm in case of 50°C (Table 3). Similarly, average weight of 100 seeds (g) varies with increasing drying temperature. It was recorded maximum in 50°C and minimum (2.86 g) was recorded in 60°C. The shape of the dehydrated pomegranate seed is conic, i.e. tapering towards apex, size is increased with increase in moisture content of dehydrated arils. Rehydration study conducted by boiling for 10, 20 and 30 min. of *anardana* shows that in case of cabinet drying at 55° C maximum ratio, i.e. 1:160 was recorded at boiling for 20 min. whereas rehydration co-efficient for 20 min. was also recorded maximum at 55° C (Table 4).

Table 3. Physical characteristics of *anardana.*

Drying system	Size of anardana		Av. wt. of 100-seeds (g)
	Length (mm)	Breadth (mm)	
Cabinet drying (50 ºC)	6.78	2.82	3.12
Cabinet drying (55 ºC)	6.70	2.80	2.96
Cabinet drying (60 ºC)	6.30	2.08	2.86
CD at 5%	0.013	NS	0.13

Table 4. Rehydration behaviour of *anardana.*

Drying technique	Rehydration ratio (20 min.)	Rehydration co-efficient (20 min.)
Cabinet (50°C)	1:1.45	0.304
Cabinet (55°C)	1:1.60	0.336
Cabinet (60°C)	1:1.54	0.321
CD at 5%		0.010

Drying temperature significantly affected the quality parameters (Figs. 1-4). Storage studies done at 30, 60, 90, 120, 150 and 180 days after drying at drying temperatures of 55, 60 and 65°C packed in 200 g LDPE reveals that up to 90 days of storage, there was no adverse and significant change in TSS, acidity, vitamin C and total sugars by drying temperature applied.

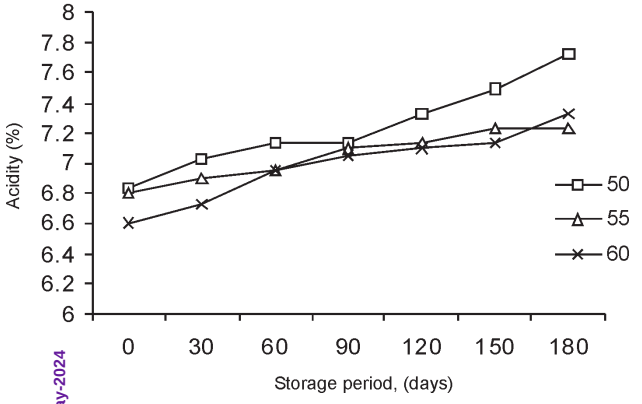

Fig. 1. Acidity of *anardana* during storage.

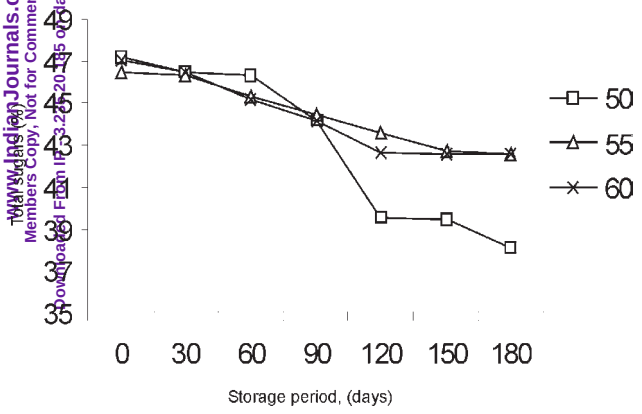

Fig. 3. Total sugars of *anardana* during storage.

the drying techniques and found in between 44.2 to 45.5 % but after this period the decrease in this level was significant for different drying modes/temperatures and 55-60°C was found to have maximum total sugars. Similar trend was observed in case of reducing sugars. Maximum value was recorded in case of drying at 55°C followed by 60°C.

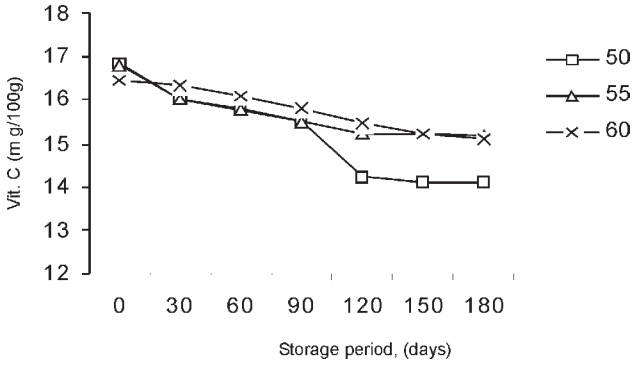

Fig. 2. Vitamin C of *anardana* during storage.

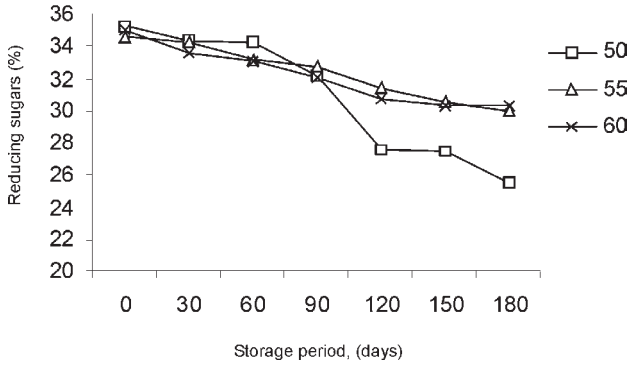

Fig. 4. Reducing sugar of *anardana* during storage.

The acidity of *anardana* at 90 days after storage was in range of 7.1 to 7.25%. After this during storage up to 180 days, the acidity level started increasing with different drying temperature modes and minimum rise was recorded in case of 55°C. Ascorbic acid in *anardana* was significantly affected by drying temperature. There was decrease in vitamin C content with storage period. However, it was slow in all the temperatures up to 90 days of storage. After 90 days, decline was rapid and significant. Comparatively, 55 and 60°C drying was found to retain maximum vitamin C. Similar results were also given by Gajanana *et al.* (5) for *aonla* slices. The change in total sugars of the *anardana* up to 90 days was in the same trend for all

With respect of non-enzymatic browning, there was significant effect on browning among drying, temperature (Table 5). Initially 60°C drying the value was less followed by 55°C. The OD value changed with storage period. However, it was low rate in case of 55 and 60°C. Similar trends were reported by Hymavathi and Khader (6) for *aonla* powder and Tripathi *et al.* (15) for dried *aonla*. Initial moisture content after drying in anardana ranged from 8.56 at 60°C to 8.93 in 50°C. Afterwards, it decreased with storage period. The decrease was recorded rapid in case of 60°C and slow at 50°C. At final stage of storage at 180 days, moisture was minimum at 60 and 55°C and maximum in case of 50°C.

Table 5. Non-enzymatic browning of *anardana* (OD at 440 nm).

Drying technique	Period (Days)						
	0	30	60	90	120	150	180
Cabinet (50°C)	1.93	1.96	1.99	2.06	2.08	2.10	2.20
Cabinet (55°C)	1.92	1.95	1.97	2.00	2.04	2.06	2.10
Cabinet (60°C)	1.90	1.94	1.98	2.01	2.05	2.20	2.13
CD at 5%	0.106	NS	0.08	0.014	0.014	0.085	0.010

There was significant and visible change in colour of *anardana* during storage period (Fig. 5). 'L' value indicating bright or lightness was maximum in case of cabinet drying at 50°C followed by 55°C at initial stage. However, it was of same value at 180 days of storage. 'L' value of *anardana* dried at 60°C was minimum at initial stage but loss of brightness was in moderate trend upto 180 days of storage. At initial stage 'a' value indicating redness of *anardana* was maximum in 50 and 55° C drying and after 180 days of storage, drying at 50 and 60 C were equally effective to retain redness. The results indicate that by drying arils at high temperature colour is lost while at 50 and 55° C colour was maintained to desired and acceptable level.

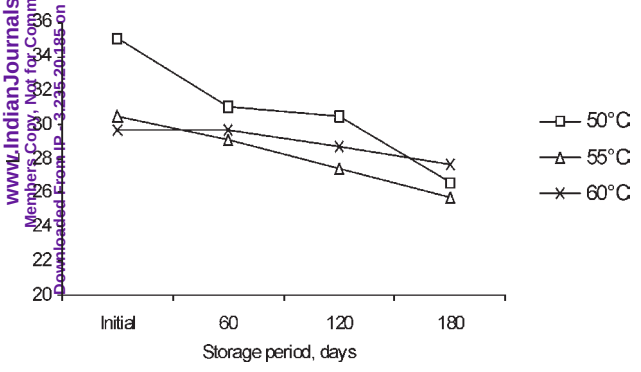

Fig. 5. L value (bright or lightness) of *anardana.*

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