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EFFECT OF VARIOUS DRYING METHODS ON QUALITY OF POMEGRANATE (*PUNICA GRANATUM* L.) ARILS

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ABSTRACT
Pomegranate (*Punica granatum* L.) arils for anardana preparation were dried under different drying conditions *viz*., oven drying at 55ºC, oven drying at 60ºC, oven drying at 65ºC, sun drying, solar dryer, and solar tunnel dryer. The results showed that, drying was faster in solar tunnel dryer (2 days) but quality was not so high. Solar dryer was found to be most suitable on the basis of faster drying rate (3days) and physico-chemical characteristics. Sample dried under solar dryer took 3 days to dry with maximum recovery of 21.04%, low moisture content (8.77%), low pH (4.02), highest TSS (37.15ºBrix), acidity (5.29%), ascorbic acid (24.16mg/100g), total sugars (24.69%) and reducing sugars (22.32%). Although solar tunnel dryer took less drying time but from quality point of view solar dryer was superior over it.

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to the plant family Punicaceae. The fruit is consumed fresh or it can be processed into juice, syrup, jam (anar rub), wine (Singh and Kingsly, 2008) or anardana. The seeds are dried along with pulp *i.e.* aril, which constitutes the product "anardana" (Pruthi and Saxena, 2005). The anardana has good keeping qualities along with certain advantages such as flavour and stability at room temperature over a long storage period, protection from enzymatic and oxidative spoilage, light weight for transport beside elimination of costly refrigeration. Dried pomegranate (anardana) finds its utility as a condiment in the acidification of chutneys and adds a peculiar taste to some famous north Indian delicacies. The traditional healers used a number of formulations of anardana as ayurvedic medicines in the treatment of dysentery, diarrhoea, stomach ache, inflammations, hymenoletidosis, dyspepsia, bronchitis, and cardiac problem. It is also used in tanning and colouring industry (Jalikop *et al*., 2002). Every year, anardana worth crores of rupees is sold at various places throughout the country and abroad. The availability of fruit (seasonal commodities) can be extended by the process of dehydration which acts as a preservation technique. The basic principle of dehydration is the removal of moisture through simultaneous heat and mass transfer, that provide more shelf-life, reduces weight and volume (Bakshi *et al.,* 2013). The processing (drying) of pomegranate seeds has not been standardized which leads to production of anardana with poor colour and quality. Its seeds are often dyed with artificial colour and adulterated with seeds of mature fruits. Such anardana is very hard and sour and when used in dishes are not so good in quality, Bakshi *et al.* (2013). Different drying methods have been tried and it has different effect on quality and yield of the anardana. Various works has tried by different scientist. Singh and Kingsly (2008) studied the effect of convective drying on quality of anardana. The arils were dehydrated at 50, 55, 60ºC and packed in polyethylene bags. Pomegranate arils dried at 55º 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. Dadarao *et al.,* 2010, the maximum acceptability of anardana was found in case of 3% citric acid treatment dried at 60º C for intermittent drying cycle of 1.5 to 0.5h. Pretreated arils were dried in different drying modes like mechanical cabinet drier (62 + 2º C), solar cabinet drier (50-55º C) and open sun (18-24º C), among all mechanical cabinet drier was found to be most suitable on the basis of faster drying rate, physico-chemical and sensory characteristics (Bhat *et al.*, 2014). Bakshi *et al.* (2013) found that among the various drying methods used *viz.,* vacuum drying, oven drying, sun drying, poly-tent house drying and room drying, sun drying method for anardana preparation is the best one as it resulted in 73.62 % reduction in moisture content with a dehydration ratio of 3.81.

Keeping in view of the above mentioned points hence, a study was undertaken to standardize the drying method for pomegranate arils and to find out the effect of various drying

methods on the quality of anardana.

MATERIALS AND METHODS

The experiment was carried out in the laboratories of Department of Horticulture and Department of Processing and Food Engineering, CCS HAU, Hisar (Haryana) during 2015. The fruits of pomegranate were procured from Centre of Excellence for Fruits, The Indo-Israel Agriculture Project, Mangiana (Haryana). A detail of experiment is given below:-

The arils were extracted from the fruits of pomegranate manually by using a knife. The arils were dried under different conditions till they attained a constant weight.

(T1)• : Oven drying at 55ºC**,** (T2), : Oven drying at 60ºC**,** (T3)*f* : Oven drying at 65ºC**,** (T4)„ : Sun drying, (T5)… : Solar dryer, (T6)† : Solar tunnel dryer

The following observations were recorded.

$$\text{Recovery (\%)} = \frac{\text{Dry weight of aril (g)}}{\text{Fresh weight of aril (g)}} \times 100$$

$$\text{Moisture (\%)} = \frac{\text{Loss in weight (g)}}{\text{weight of sample (g)}} \times 100$$

The chemical characteristic of anardana was determined as described below. TSS (ºBrix) and pH were determined by using hand refractometer and pH metre respectively. Titrable acidity (%) and ascorbic acid content (mg/100g) were determined by AOAC (2000). Sugars (%) were estimated by using the method of Hulme and Narain (1993). All the statistical analysis (ANOVA) was carried out by using OPSTAT statistical software.

RESULTS AND DISCUSSION

Analysis of data obtained from different treatments *viz*., oven drying at 55ºC, oven drying at 60ºC, oven drying at 65ºC, sun drying, solar dryer and solar tunnel dryer produced significant results and the results were discussed below.

Drying time was significantly affected by the drying methods. Drying time was less in solar tunnel dryer (2 days) followed by solar dryer and oven drying at 65ºC (3 days), oven drying at 60ºC (3.66 days), oven drying at 55ºC (4.25 days) and maximum in sun drying (4.83 days). In all the drying methods selected, higher temperature had shorter drying time. At higher temperature, due to quick removal of moisture the drying time was less. Similar results were observed by Singh and Kingsly, 2008, Mahajan *et al.*, 2011, Basunia *et al.*, 2013, Meher *et al.*, 2015 and Yilmaz *et al.*, 2015. Dry aril recovery percent was found significantly maximum in solar dryer (21.04%) which was at par with solar tunnel dryer (19.97%). Minimum dry aril recovery percent was reported in sun drying (14.01%). Dry aril moisture content was significantly maximum in sun drying method (9.54%) and minimum in solar dryer method (8.77%). The moisture content of produce depends on

Table 1: Effect of drying methods on drying time, recovery (%) and moisture content (%)

Treatments	Drying time (Days)	Recovery (%)	Moisture content (%)
Oven drying at 55ºC	4.25	19.32	9.07
Oven drying at 60ºC	3.66	18.59	9.11
Oven drying at 65ºC	3.00	18.52	9.09
Sun drying	4.83	14.01	9.54
Solar dryer	3.00	21.04	8.77
Solar tunnel dryer	2.00	19.97	8.94
C.D. (P≤ 0.05)	0.27	1.11	0.11

Table 2: Effect of drying methods on TSS (º Brix), pH and acidity (%)

Treatments	TSS (p Brix)	pH	Acidity (%)
Oven drying at 55ºC	35.50	5.13	3.76
Oven drying at 60ºC	37.50	4.32	4.63
Oven drying at 65ºC	36.47	4.29	4.18
Sun drying	31.75	4.41	4.88
Solar dryer	37.15	4.02	5.29
Solar tunnel dryer	36.92	4.33	3.10
C.D. (P≤ 0.05)	1.69	0.27	0.41

Table 3: Effect of drying methods on Ascorbic acid (mg/100g), Total sugars (%) and Reducing sugars (%)

Treatments	Ascorbic acid (mg/100g)	Total sugars (%)	Reducing sugars (%)
Oven drying at 55ºC	11.50	25.59	22.41
Oven drying at 60ºC	21.37	23.20	19.91
Oven drying at 65ºC	24.00	22.26	19.69
Sun drying	19.73	21.53	18.73
Solar dryer	24.16	24.69	22.32
Solar tunnel dryer	20.55	22.16	18.51
C.D. (Pd″ 0.05)	3.20	1.53	1.60

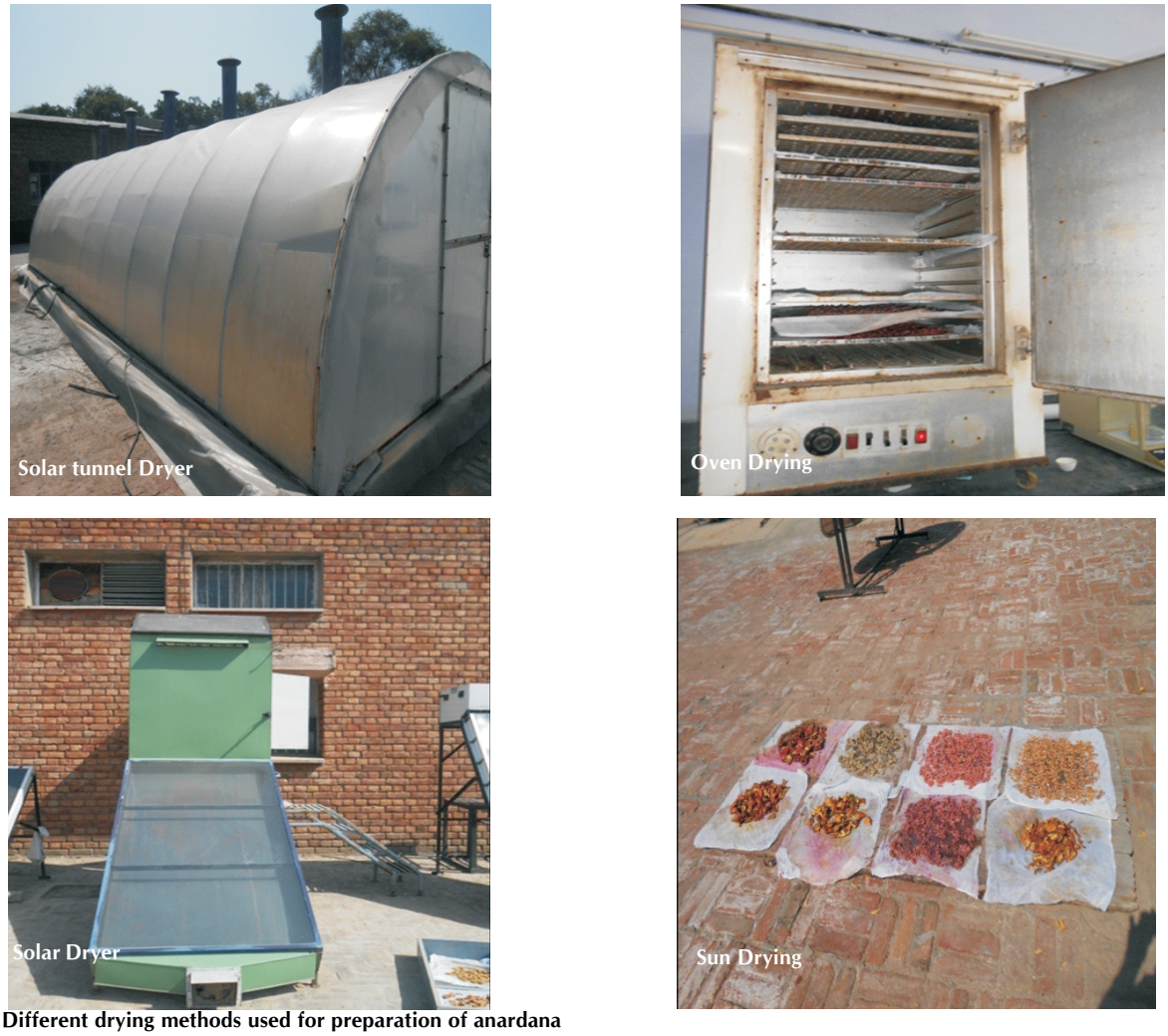

Plate 1: Different drying methods used for preparation of anardana

moisture removal. The removal of moisture depend on temperature, higher temperature resulted in more moisture removal and low moisture content of the produce. These findings are in line with the findings of Bhat *et al.*, 2014 and Singh and Dayal, 2015.

Significantly maximum TSS was found in oven drying at 60ºC (37.50ºBrix) which was at par with solar dryer (37.15ºBrix), solar tunnel dryer (36.92ºBrix) and oven drying at 65ºC (36.47ºBrix) and minimum in sun drying (31.75ºBrix). Due to low removal of moisture and high moisture content of produce in sun drying, minimum TSS were found in sun dried produce. Significantly maximum pH was observed in oven drying at 55ºC (5.13) and minimum in case of solar dryer (4.02) which was at par with oven drying at 65ºC (4.29). Hande *et al.*, 2014 found low pH in kokum rind dried in solar dryer. Maximum acidity was found in case of solar dryer (5.29%) and minimum in solar tunnel dryer (3.10%).

Drying methods affect the ascorbic acid content significantly. Ascorbic acid content of anardana was maximum under solar dryer (24.16mg/100g) being at par with oven drying at 65ºC (24.00mg/100g) and oven drying at 60ºC (21.37mg/100g). Reduced losses of ascorbic acid might be due to because of fast drying rate reducing the exposure time of arils for oxidation. Aggarwal *et al.*, 2010 reported similar findings for arils dried under indirect solar dryer. Verma and Gupta, 2004, Singh *et al.*, 2006 and Prajapati *et al.*, 2011 all of them reported that solar dryer proved better for retention of ascorbic acid in dried aonla fruit. Minimum ascorbic acid content was reported in oven drying at 55ºC (11.50mg/100g).

The data revealed that total sugars were maximum in oven drying at 55ºC (25.59%) which was at par with solar dryer (24.69%). Minimum total sugars were recorded in sun drying method (21.53%) which was at par with solar tunnel dryer (22.16%) and oven drying at 65ºC (22.26%). The results are in accordance with the findings of Aggarwal *et al.*, 2010. Maximum reducing sugars were found in oven drying at 55ºC (22.41%) which was at par with solar dryer (22.32%) and minimum in case of solar tunnel dryer (18.51%) and at par with sun drying (18.73%), oven drying at 65ºC (19.69%) and oven drying at 60ºC (19.91%). Aril sugars were more stable with softer drying conditions (low temperature and long time. An increase in the product temperature caused important degradation of fructose and glucose (45%), mainly because of Maillard and browning reactions (Mota *et al.*, 2010). Calin–Sanchez *et al.*, 2013 reported similar findings. Low sugars

content in sun drying is due to development of fungal infection during drying.

The above results concluded that there is significant variation in quality of produce dried under different drying methods. Among all, drying was faster in solar tunnel dryer (2 days) but quality was not so high. Solar dryer was found to be most suitable on the basis of faster drying rate (3days) and physico-chemical characteristics. Sample dried under solar dryer took 3 days to dry with maximum recovery of 21.04%, low moisture content (8.77%), low pH (4.02), highest TSS (37.15ºBrix), acidity (5.29%), ascorbic acid (24.16mg/100g), total sugars (24.69%) and reducing sugars (22.32%).

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