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Studies on drying of pomegranate arils for preparation of *Anardana*

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Abstract
A study was carried out for the preparation of *Anardana*. Fruit of cv. Ganesh, Bhagwa and Arakta were found the 67.22, 67 and 69 arils per cent respectively. Fruits were washed with thoroughly and dried under the fan. The fruits were cut into 4 pieces with the help of stainless steel knife and juicy arils were separated. The arils obtained from different cultivars subjected to different physical and chemical treatments like blanching for 3 min. and 1% pottasium metabisulphide (KMS) will be subjected to different modes of drying i.e. Solar drying temperature ranges 32 ± 3 ^{0}C for 17 hours, Cabinet tray drying temperature ranges 55 ± 3 ^{0}C for l0 hours and Freeze drying temperature was -45 ^{0}C for 24-48 hours. Among the different method of drying with pretreatment on different cultivars, freeze drying of cv. Ganesh with 1% KMS were found to be the best method with respect to quality, colour, flavour, taste, overall acceptability and nutritional parameters.

Keywords: Pomegranate anardana, pretreatment, drying, physicochemical composition, organoleptic evaluation

1. Introduction
Pomegranate (*Punica granatum* L.) fruit, native of Iran, is extensively cultivated in Spain, Egypt, Russia, France, Argentina, China, Japan USA and in India (Patil and Karade, 1996) [13]. In India, locally also known as anar has been grown since ancient period. The versatile adaptability, table and therapeutic values and better keeping quality are the features responsible for its cultivation on a wide scale (Dhandar and Singh, 2002) [4]. It belongs to family *Punicaceae*. Pomegranate is included among a novel category of exotic plant source called super fruits.

In India it is commercially grown in Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Rajasthan. The cultivation of pomegranate area in India is more than 1094 (000 ha.) with production 1835.3 MT. The area under pomegranate is increasing because of its versatile adaptability, hardy nature, low maintenance cost, tolerant to water stress, steady and high yields, fine fruit quality and its appetite values, better keeping quality and very good export potential. Cultivar Ganesh and Bhagwa is the best and commercial variety of pomegranate. It is highly suitable for domestic as well as export commercial exploitation (processing).

Pomegranate is mostly used for its healthy dietetic and medicinal properties on the basis of its medicinal and therapeutic value. The pomegranate juice is considered better for patient suffering from leprosy, high cholesterol levels and heart disorders; however *Anardana* goli is used for better digestion. Fruit juice has been significantly recognized as the most effective natural antioxidant which guards our body against free radical, the harmful molecules that cause premature aging and even cancer. It is found that diets rich in flavonoids have been associated with reduced risk for cardiovascular disease. Hence, pomegranates as good source of flavonoids help in reducing risk. Analysis of the edible portion of pomegranate fruit indicates that it contains nearly all the essential nutrients including minerals and vitamins (Sanghavi, 1997) [17]. The seeds have estrogenic activity due to the presence of steroidal estrogens (Singh and Sethi, 2003) [18]. The *Anardana* is user as an acidulant in the culinary (Kingsly A *et al*., 2006) and chutneys etc, in place of tamarind,'Amchur' (dried raw mango) in North India. It is used in Ayurvedic Medicines. The *Anardana* is also exported to some Eastern Asian Countries. There is little published material on the manufacture, composition, packaging, storage and quality standards for *Anardana* (Pruthi and Saxena, 1984) [14].

The storage and quality of *Anardana* is significantly influenced by the processing conditions such as type of drying method, T.S.S., acidity, moisture, hardness of seeds, reducing sugars, species and cultivar of pomegranate etc. however, very little information is available on the influence of these factors on *Anardana*. Efforts have been made in this investigation to study the drying of pomegranate aril with different drying method.

Materials and methods

Pomegranate (*Punica granatum* L.) fruit of three cultivars, 'Ganesh', 'Bhagwa' and 'Arakta' of proper maturity were obtained from local market. The fruits were free from blemishes and spoilage, fruits brought carefully to the laboratory, at the Food Technology Division, Department of Chemical Technology, Dr. Babasaheb Amebedkar Marathwada University and Fruit Research Station, Himayatbagh, Aurangabad. Fruits were washed with thoroughly and dried under the fan. The fruits were cut into 4 pieces with the help of stainless steel knife and juicy arils were separated. The arils obtained will be analyzed for various physico – chemical parameters. The arils obtained from different cultivars subjected to different physical and chemical treatments like blanching and pottasium metabisulphide (KMS) will be subjected to different modes of drying. The arils of Cv. Ganesh, Bhagwa, Arakta of pomegranate were subjected to the following treatments. GT_1 - Ganesh control, GT_2 - Ganesh with blanching, GT_3 - Ganesh with 1% KMS, BT_1 - Bhagwa control, BT_2 - Bhagwa with blanching, BT_3 - Bhagwa with 1% KMS, AT_1- Arakta control, AT_2 - Arakta with blanching, AT_3 - Arakta with 1% KMS drying of pomegranate arils with three drying methods i.e. Solar drying temperature ranges 32 ± 3 ^{0}C for 17 hours, Cabinet tray drying temperature ranges 55 ± 3 ^{0}C for l0 hours and Freeze drying temperature was -45 ^{0}C for 24-48 hours requires to prepare the *Anardana*. The physicochemical parameter was determined by methods given by Ranganna (2000). The prepared *Anardana* was packed in polyethylene bags 200 gauge and stored at room temperature ranges from 9.5 to 36 ^{0}C and relative humidity was 22.0 to 93.00%.

Chemical parameters

Total soluble solids (TSS): content of sweet orange juice was determined by using with digital hand Refractometer (Model Pal-3, Atago make, Tokyo, Japan) and expressed as degree brix.

Titratable acidity was determined by volumetric method as per standard procedure. The juice was titrated against 0.1N sodium hydroxide (NaOH) using phenolphthalein as an indicator to faint pink end point. The percent titratable acidity was calculated by the following formula and result was recorded in percent acidity as citric acid.

$$\text{Acidity} = \frac{\text{Titre x Normality of alkali x Eq. wt. of acid x volume made up}}{\text{Wt/volume of sample x vol. of aliquot taken for estimation}} \times 100$$

Ascorbic acid was determined by the method as per standard procedure. The juice was diluted with 3 metaphosphoric acid and titrated against 2,6dichlorophenol indophenols dye to a faint pink end point the ascorbic acid content of juice was calculated by the following formula and result was recorded as milligram of ascorbic acid per 100 ml juice.

$$\text{Ascorbic acid (mg /100g)} = \frac{\text{Titre value X dye factor X vol. made up X 100}}{\text{Weight of sample X aliquot of sample}}$$

Dye factor = 0.5 (Titre with standard ascorbic acid solution)

Total Protein Content

0.5 g of sample was digested by wing catalyst mixture and conc. sulphuric acid. The digested sample transfer to 50ml. conical flask and volume was made up. Out of which 5ml of digested material used for distillation by 50 per cent NaOH soluction. The NH_3 gas was collected in 4 per cent Boric acid with 4-5 drops of methyl red and 10-15 drops of bromary sol green. The distillation collected about 50ml. Then collected ammonia was titrated against 0.1 N HCl till pink colour was developed.

$$\text{Per cent of N} = \frac{\text{Titre x N of HCl x 14.007 x Vol made of digestion}}{\text{Wt of sample x Aliquot of digest taken x 1000}}$$

$$\text{Per cent Protein} = 1\ N_2 \times 6.25$$

Moisture content

Moisture content of the fruits of different cultivar was determined by using rapid moisture analyzer (shimod Zu) which expressed in per cent.

Rehydration Ratio

The Rehydration coefficient was defined as the ratio of amount of water taken up over the total amount of water removed by drying

$$\text{Equation of rehydration ratio } R = \frac{\text{M rehydrated}}{\text{M dried}}$$

Organoleptic evaluation

The organoleptic evaluation for assessing the colour, flavour taste and overall acceptability was done by semi-trained panel of judges with the help of 9 - point hedonic scale (Kapse, 1976) [7].

Statistical analysis

The experiment was conducted in "Factorial Completely Randomized Design" (FCRD) with ten treatments. The treatments were replicated thrice. The statistical analysis of data recorded in respect of all above parameters was done for

interpretation of results following standard methods. (Gomez and Gomez, 1984) [14], data were statistically analyzed by the method of Panse and Sukhatme (1985) [11] and the significance was drawn at 5% level of probability.

Results and Discussion

Table 1: Physico chemical characteristics of pomegranate fruit

Parameters	Varietal observations		
	Ganesh	**Bhagwa**	**Arakta**
Colour of fruit	Yellowish with pink patches	Slight red	Deep red
Arils (%)	67.22	67.00	69.00
Peel (%)	32.78	33.00	31.00
Weight of 100 seeds			
a. Flesh (%)	32.30	32.60	30.00
b.Without flesh	9.73	10.01	08.23
TSS (^{0}B)	16.3	15.9	16.00
Acidity (%)	0.47	0.45	0.41
Ascorbic Acid (mg/100 g of aril)	14.71	14.11	14.20
Moisture (%)	79.9	80.5	78.9

* Each value is average of 3 determinations

The cultivar of pomegranate i.e. Ganesh, Bhagwa, Arakta showed yellowish colour with pink patches, slight red and deep red respectively. The arils per cent of Cv. Ganesh, Bhagwa and Arakta is 67.22 per cent 67 per cent, 69 per cent and peels per cent is 32.78 per cent, 33 per cent, 31 per cent respectively (Table 1). The weight of 100 seeds of Ganesh fruit was also determined as 32.30 per cent flesh and 9.73 per cent without flesh. The weight of 100 seeds of Bhagwa fruit was also determined as 32.60 per cent flesh and 10.01 per cent without flesh. The weight of 100 seeds of Arakta fruit was also determined as 30 per cent flesh and 8.23 per cent without flesh, were studied by several workers like Sahotre (1998) [16]. There were variation in each parameter is due to number of factors such as variety, region and climate. The TSS percent was observed for Cv. Ganesh, Bhagwa and Arakta is 16.3 per cent, 15.9 per cent, 16.00 per cent. The acidity per cent recorded for Cv. Ganesh, Bhagwa, Arakta is 0.47 per cent, 0.45 per cent, 0.41 per cent respectively. The vitamin content observed in Cv. Ganesh, Bhagwa, Arakta is 14.71 mg/100 g, 14.11 mg/100 g, 14.20 mg/100 g respectively. The moisture percent for Cv. Ganesh, Bhagwa, Arakta is 79.9 per cent, 80.5 per cent, 78.9 per cent respectively. The protein percent recorded for Cv. Ganesh, Bhagwa, Arakta is 2.6 per cent, 2.8 per cent, 2.5 per cent respectively. The chemical characteristics of Cv. Ganesh, Bhagwa, Arakta fruit mentioned above were also studied by Mohammad (1994) [9]. Pruthi and Saxena (1984) [14], Sanghavi (1997) [17] reported composition of fruit based *Anardana* having moisture content ranged from 5.4 to 14.7 percent, the acidity ranged from 7.8 to 15.4 percent, the reducing sugars ranged from 6.26 to 16.8 per cent, crude protein ranged from 4.74 to 6.25 per cent, 2.04 to 4.4 percent mineral, Ascorbic acid as vitamin C ranged from 5 to 6 mg/100gm.

Effect of pretreatment with different drying method on physicochemical composition of *Anardana*

The Total soluble solids (TSS) content increased during drying of pomegranate arils (Table 2). The maximum TSS GT_3 (30.01) was recorded in freeze drying to the cv. Ganesh with application of 1% KMS. This may be due to concentration of sugars on drying. Significant effects of drying in freeze drying followed by cabinet drying and solar drying. Similar finding also reported by Tripathi *et al*. (1998) [20]. The titratable acidity increased from 0.47 to 8.10 during drying of pomegranate arils by different dryer. Maximum acidity GT_3 (8.20) was recorded in cv. Ganesh with 1% KMS samples dried in freeze drying where as minimum acidity BT_1 (7.86) was recorded in solar drying to the cv. Bhagwa control (without-treatment). Anrdana samples had 7 to 8 per cent more acidity in freeze dried product than solar dried and cabinet dried product irrespective of pretreatments used, with respect to pretreatments, blanched and sulphured samples had more acidity as compared to without blanch samples. The increase in acidity in the sulphured sample may be due to formation of sulphurous acid (Dabhade and Khedkar 1980) [3]. The similar study also reported by Gujar (1994) [6], Navale and Kulkarni (1999) [10]. Maximum ascorbic acid AT_3 (6.81) was recorded in cv. Arkta with 1% KMS treatment, samples dried in freeze drying, whereas minimum ascorbic acid BT_1 (5.10) was recorded in solar drying to the cv. Bhagwa control (without treatment). The ascorbic acid might have been lost due to enzymatic oxidation of ascorbic acid into dehydro-ascorbic acid. The finding also similar to the Pruthi and Saxena (1994) [14] and Singh and Kinglay (2008) [19]. The protein of dried anardana was observed maximum in treatment GT_3 (5.96%) cv. Ganesh with 1% KMS samples dried in freeze drying, whereas minimum protein contain AT2 (3.70%) was recorded in solar drying to the cv. Arkta with blanching. Pruthi and Saxena (1984) [14] reported the crude protein content is in the 4.74% to 6.25% range which is nearly to the finding. The similar results were also reported by Antal and Kerekes (2007) [1] in tomato vaccum freeze drying.

Mean values for moisture differed significantly in solar drying, cabinet drying and freeze drying (Fig 1) samples. Among various pretreatments, the control sample had highest mean value for moisture content AT_1 (10.20) cv. Arkta control as compared to cabinet drying samples and freeze drying sample BT_3 (9.79) cv. Bhagwa with 1% KMS samples, showing significant differences between them. Blanched samples moisture content reduced may be due to disorganization of fruit tissue by steam, there by releasing turgour pressure, which was responsible for holding fruit moisture. Similar results are also reported by Patil *et al*., (2003) [13], Pruthi and Saxena (1984) [14]. The effect of different pretreatment and dri\ying method on the rehydration ratio of anardana shown in (Fig 2). As for drying method concerned freeze drying recorded highest significant rehydration ratio (1.96) followed by cabinet drying (1.81) and solar drying (1.66). As far as pretreatment of pomegranate arils treatment GT_3 (2.2) cv. Ganesh with 1% KMS was recorded highest rehydration ratio of anardana. The interaction effects were non-significant in solar drying and

cabinet drying while it is significant in freeze drying. The similar results are reported by Antal and Kerkes (2007) [1].

Organoleptic evaluation

The organoleptic evaluation score of pomegranate anardana samples with the pretreatment and different drying method presented in (Table 3). The maximum colour score by visualized recorded in AT2 and AT3 (9.0) freeze drying of cv. Arkta with blanching and 1% KMS treatment of anardana samples. The maximum flavour score of anardana was recorded in GT2 (8.6) freeze drying of cv. Ganesh with the blanching treatment of sample. The maximum taste score and overall acceptability was recorded in GT_3 (8.8 and 8.4) in freeze drying of cv. Ganesh with 1% KMS treatment. The similar results are reported by Chauhan *et al.* (1994) [2] and Garande *et al*. (2004).

Conclusion

Pomegranate fruit highly suitable for domestic as well as export commercial exploitation (Processing). It is well known for its nutritional and medicinal value. *Anardana* goli used for better digestion. Results suggested that, the cv. Ganesh treated with 1% per cent KMS was found superior with quality, colour, flavour, taste and overall acceptability over the rest of treatment.

Table 2: Effect of pretreatments and drying methods on physicochemical characteristics of anardana.

Treatment	TSS (^{0}Brix)			Titratable Acidity (%)			Ascorbic acid (mg/100g)			Total protein (%)		
	SD	CD	FD	SD	CD	FD	SD	CD	FD	SD	CD	FD
GT1	27.25	27.50	27.76	7.89	7.96	7.98	5.60	5.75	5.77	4.60	5.52	5.30
GT2	28.50	28.78	28.98	7.90	7.99	8.10	5.70	5.80	5.65	4.10	5.10	5.60
GT3	29.50	29.73	30.01	7.93	8.00	8.20	5.76	5.88	6.01	4.41	5.30	5.96
BT1	26.15	26.42	26.70	7.86	7.90	7.92	5.10	5.21	5.50	4.10	4.90	5.00
BT2	26.50	26.73	27.99	7.88	7.93	7.96	5.20	5.30	5.43	3.80	4.70	5.20
BT3	27.40	27.74	24.31	7.90	7.98	8.10	5.31	5.40	5.94	4.00	4.76	5.10
AT1	26.24	26.50	26.80	7.88	7.94	7.97	5.30	5.65	5.72	4.20	4.83	4.90
AT2	27.00	27.28	27.57	7.90	7.96	8.00	5.50	5.76	5.60	3.70	4.60	5.13
AT3	28.00	28.23	28.56	7.95	7.99	8.10	5.60	5.80	6.81	3.90	4.80	5.10
SE ±	0.26	0.006	0.17	0.03	0.01	0.04	0.05	0.04	0.07	0.07	0.08	0.04
CD at 5%	0.72	0.018	0.50	NS	0.04	0.11	NS	0.10	0.21	0.20	NS	0.12

SD= Solar drying, CD= Cabinet drying, FD= Freeze drying

Table 3: Effect of pretreatments and drying methods on Organoleptic evaluation of anardana.

Treatment	Colour			Flavour			Taste			Overall acceptability		
	SD	CD	FD	SD	CD	FD	SD	CD	FD	SD	CD	FD
GT1	6.5	7.2	7.5	7.6	8.0	8.2	7.8	8.0	8.1	6.1	7.4	8.0
GT2	6.6	7.1	7.6	8.0	8.4	8.6	8.3	8.6	8.7	7.4	7.7	8.3
GT3	6.8	7.4	7.6	8.1	8.6	8.5	8.3	8.7	8.8	7.5	7.8	8.4
BT1	7.2	7.5	7.8	7.3	7.6	7.7	7.8	7.9	8.0	7.5	7.7	7.9
BT2	7.7	8.1	7.9	7.5	7.7	8.2	8.0	8.1	8.2	7.7	7.8	8.0
BT3	7.8	8.3	8.0	7.8	8.0	8.0	8.0	8.2	8.2	7.9	8.1	8.0
AT1	7.8	8.1	8.8	7.0	7.0	7.2	7.6	7.8	7.8	7.7	7.8	7.6
AT2	8.0	8.1	9.0	7.8	8.2	8.1	7.9	8.0	8.1	7.9	8.0	7.9
AT3	7.9	8.4	9.0	8.0	8.0	8.2	7.9	8.1	8.1	8.0	8.1	7.9
SE ±	0.50	0.10	0.04	0.06	0.07	0.04	0.07	0.07	0.05	0.10	0.09	0.04
CD at 5%	NS	NS	0.13	NS	0.21	0.12	0.21	0.21	NS	0.30	NS	0.11

SD= Solar Drying, CD= Cabinet Drying, FD= Freeze Drying

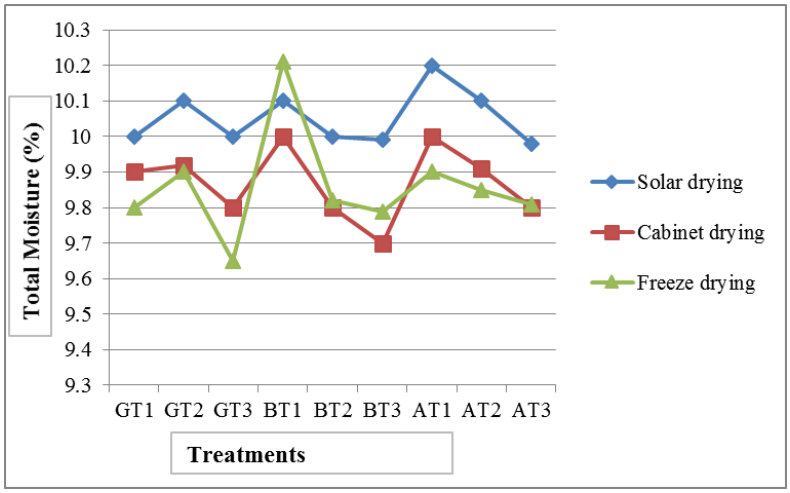

Fig 1: Total Moisture Content of Anardana (%)

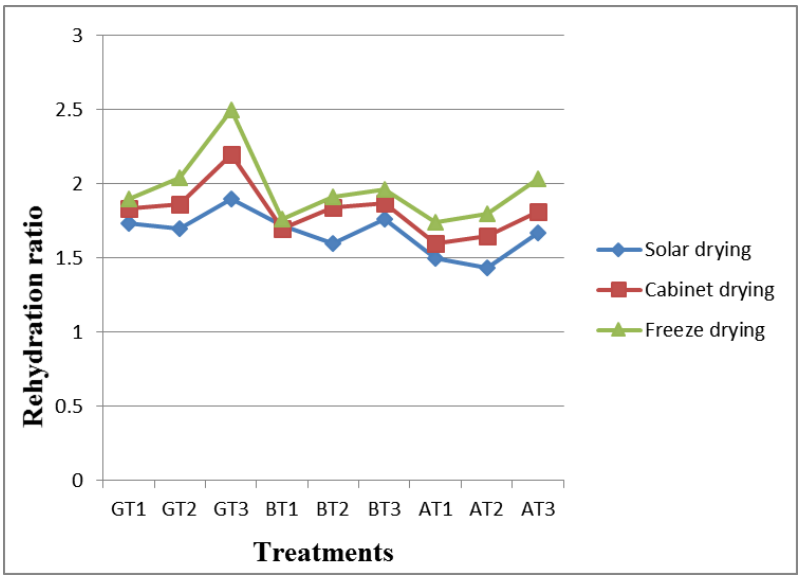

Fig 2: Rehydration ratio of Anardana

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