



# Effect of Processing Techniques on Nutritional Parameters of Antioxidant Rich Pomegranate Flowers

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## ABSTRACT

**Background:** India is the largest producer of pomegranate in world. The cultivation is having a drawback of producing more of agricultural waste; all bloomed flowers do not get developed to a proper fruit and drops down earlier only. Dropped flowers may be the male flowers which drop naturally after pollination and others are female flowers which dropped due to environmental conditions or agricultural factors. According to the literature, pomegranate flowers are chemically composed of various phenol compounds which shows medical properties like peroxisome proliferator-activated receptor property which helps in fats and glucose anabolism, antioxidative property, anti-inflammatory property and also hepatoprotective property.

**Methods:** The study was conducted reduce the agricultural waste by finding some nutritive composition of flowers. Nutritional analysis (energy, protein, fat and carbohydrates) and antioxidant analysis (Vitamin C and gallic acid) of fresh and shade dried pomegranate flowers of three different varieties *i.e.* Solapur Lal, Bhagwa and Ruby were done.

**Result:** Our findings shows that shade dried pomegranate flowers of ruby variety are having highest mean values for energy ( $334.7833 \pm 0.571$ ) and carbohydrates. ( $72.176 \pm 0.123$ ). protein and Fat content was found to be highest in shade dried pomegranate flowers of Solapur Lal variety with mean values as  $10.350 \pm 0.121$  and  $0.813 \pm 0.0152$  respectively. For antioxidant content, Shade dried pomegranate flowers of ruby variety contains highest amount of both the antioxidants *i.e.* Vitamin C and gallic acid with the mean values as  $35.330 \pm 0.249$  and  $1533.873 \pm 11.265$ , respectively.

**Key words:** Nutritional components, Pomegranate flowers, Shade drying.

## INTRODUCTION

Pomegranates were the first fruit trees domesticated in the Eastern Mediterranean region (Zohary *et al.*, 2012). Their native region is Iran to Northern India. Earlier, Pomegranate was only used as a fruit but now with civilization, Pomegranate is more demanded in industries for products like pomegranate juices, jams, *etc* (Morton, 1987). According to a report, Vision 2050 of ICAR- National Research Centre of Pomegranate, Solapur, Maharashtra, India being the largest producer of pomegranate in world cultivated around 107 hectare of land and produces 743 thousand tons of Pomegranate every year. But the cultivation having a drawback that all bloomed flowers do not get converted in whole fruit which may be because of environmental conditions or agricultural factors. As stated by Morton (1987) pomegranate flowers are very colorful but odorless and grow up to 3 cm in diameter. They are chemically composed of various phenol compounds which show medical properties like Peroxisome proliferator-activated receptor property which helps in fats and glucose anabolism, antioxidative property Zhang *et al.* (2011), Anti-inflammatory property Xu, J. *et al.* (2017) and also a study of defines the hepatoprotective property. Taking these valuable properties and the agriculture waste of these flowers in consideration the present study was conducted to analyze the nutritional values of fresh pomegranate flowers and shade dried pomegranate flowers. The process of drying is mainly done for preserving the perishable raw commodity against

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deterioration and also to reduce the cost of packing, handling, storing and transportation. It is also important to increase the shelf life of the product for its long time usage. Drying technique was done by various different methods with their own pros and cons. Shade drying is the technique of indirect sun drying which involves the spread out of the product in a thin layer on trays which needs to be covered with any breathable cloth to let the hot air passed from it. During the day, the product has to be turned over to accelerate drying permitting trapped moisture to escape. Study of Belessiotis and Delyannis (2011) says that shade

drying helps to retain maximum amount of nutrients, it is a cost effective method and also do not cause any chemical or mechanical harm to the sample.

## MATERIALS AND METHODS

Pomegranate flowers of three different varieties *i.e.* Solapur Lal, Bhagwa and Ruby were procured from National Research Centre of Pomegranate, Solapur, Maharashtra. Solapur Lal is a hybrid variety which is developed by National Research Centre of Pomegranate, Solapur in 2017. fruit yield is around 23-27kg per plant. Bhagwa is a clonal selection variety from Ganesh × Guleshah red which is developed by MPKV, Rahuri in 2003. Ruby variety is also a multiple hybrid variety made from Ganesh × Kabul × Yercaud and Guleshah rose pink by IIHR, Bengaluru in 1997. Collected samples were divided into 2 different groups as fresh flowers and other as Dried Flowers. Fresh pomegranate flowers were directly tested for its nutritional components *i.e.* energy, protein, fat, carbohydrates, vitamin C and gallic acid. Dried flowers were shade dried for 7 days temperature between 23°-27°C and then was tested for their nutritional components analysis was done by SIGMA test and research centre, an ISO accredited laboratory in New Delhi India. All the experiments were done in October 2022. Results for both the groups were statistically analyzed by SPSS software version 21.

## RESULTS AND DISCUSSION

Table 1 depicted the comparison between nutritional analysis of three different varieties of fresh pomegranate flowers. In context with proximal analysis among all the three different varieties of Fresh Pomegranate flowers, Bhagwa variety was

found to be highly nutritious with highest content of energy, protein and CHO. The differences were statistically significant ( $p < 0.05$ ). For vitamin C content in all the three different varieties, Bhagwa variety was found to be at highest and result was statistically significant *i.e.* ( $p < 0.05$ ).

Regarding gallic acid content, the highest content was in Solapur Lal variety and the result was statistically significant *i.e.* ( $p < 0.05$ ). Table 2 depicted the comparison between nutritional analysis of three different varieties of shade dried pomegranate flower. For proximal analysis among all the three different varieties of shade dried pomegranate flowers, energy content was found highest in Ruby. Protein content was highest in Solapur Lal variety. Carbohydrate content among all three varieties was highest in Ruby variety. Fat content was seen highest in Solapur Lal. The results were statistically significant *i.e.* ( $p < 0.05$ ).

For antioxidant levels, Ruby variety contains highest amount of vitamin C with and gallic acid. The results were statistically significant *i.e.* ( $p < 0.05$ ). Table 3 depicted the comparison between proximal analysis of three different varieties of fresh pomegranate flowers and shade dried pomegranate flowers. Results revealed that mean values for proximal analysis of shade dried Pomegranate flowers are higher in all varieties as compared to fresh pomegranate flowers. Ruby variety of pomegranate flowers (shade dried) had highest content of energy and carbohydrates. Protein and fat content was found to be highest in Solapur Lal variety (shade dried). All the results were statistically significant at  $p < 0.05$ . Table 4 depicted the comparison between Antioxidant content of three different varieties of fresh pomegranate flowers and shade dried pomegranate flowers. Antioxidant content was found to be highest in shade dried

**Table 1:** Comparison between nutritional analysis of three different varieties of fresh pomegranate flowers.

Nutrients	Solapur Lal (Mean±SD)	Bhagwa (Mean±SD)	Ruby (Mean±SD)	ANOVA (F-value)	P- value
Energy	98.370±0.211 <sup>b</sup>	106.283±0.362 <sup>ac</sup>	97.426±1.012 <sup>b</sup>	177.046	0.000
Protein	2.340±0.017 <sup>bc</sup>	2.590±0.020 <sup>a</sup>	2.553±0.035 <sup>a</sup>	84.845	0.000
Carbohydrate	22.140±0.050 <sup>b</sup>	23.823±0.070 <sup>ac</sup>	21.623±0.270 <sup>b</sup>	147.838	0.000
Fat	0.0507±0.012 <sup>c</sup>	0.074±0.002	0.127±0.044 <sup>a</sup>	6.437	0.032
Vitamin C	11.533±0.023 <sup>b</sup>	23.633±0.220 <sup>ac</sup>	11.633±0.104 <sup>b</sup>	7272.621	0.000
Gallic acid	544.426±2.045 <sup>bc</sup>	389.016±3.965 <sup>a</sup>	381.520±1.440 <sup>a</sup>	3463.353	0.000

ANOVA ( $p < 0.05$ ) mean value with same superscripts are significantly significant as tested by ANOVA post hoc test.

**Table 2:** Comparison between nutritional analysis of three different varieties of shade dried pomegranate flower.

Nutrients	Solapur Lal (Mean±SD)	Bhagwa (Mean±SD)	Ruby (Mean±SD)	ANOVA (F-Value)	P- Value
Energy	331.146±0.058 <sup>c</sup>	332.240±0.291 <sup>c</sup>	334.783±0.571 <sup>ab</sup>	75.582	0.000
Protein	10.350±0.121 <sup>b</sup>	9.566±0.231 <sup>a</sup>	9.876±0.066	19.275	0.002
Carbohydrate	70.606±0.144 <sup>bc</sup>	72.076±0.330 <sup>a</sup>	72.176±0.123 <sup>a</sup>	47.890	0.000
Fat	0.813±0.015 <sup>bc</sup>	0.600±0.010 <sup>ac</sup>	0.730±0.010 <sup>ab</sup>	240.077	0.000
Vitamin C	33.500±0.478 <sup>bc</sup>	34.823±0.263 <sup>a</sup>	35.363±0.240 <sup>a</sup>	23.245	0.001
Gallic Acid	1099.916±6.298 <sup>bc</sup>	1162.770±11.873 <sup>ac</sup>	1533.873±11.265 <sup>ab</sup>	1609.306	0.000

ANOVA ( $p < 0.05$ ) mean value with same superscripts are significantly significant as tested by ANOVA post hoc test.

pomegranate flowers of all three different varieties as compared to fresh Pomegranate flowers. Ruby variety (shade dried) contains highest amount of both the antioxidants *i.e.* Vitamin C and gallic acid and all the results were statistically significant.

Hiller, (1994) states that fresh flowers are very attractive, but quite expensive as well as short lived and also available during their particular seasons only. Dried flowers, on other side are long lived and retained their aesthetic value irrespective of the season. Quality of dried flowers depends on the method of drying being used and also their moisture content, which must ranges from 8-11.5%, it ensures their good quality, firmness and also helps to maintain their lives for more than 180 days. Excessive drying may result into petal shedding during handling, this have been documented by (Singh, 2004). Rahimmalek and Goli, (2013) explain in their study that drying process also stops the microorganism growth and prevents certain biochemical reactions that might alter the organoleptic changes. A study of by Kumar *et al.*

(2021) describes the importance of dried flowers as they stated that demand of dry flowers for ornamental purpose is continuously increasing and India is among the most leading countries in this industry. This sector of agriculture is getting popularity due to the significant properties of dried flowers like eco- friendly, sustainability, year around availability. Also, researches like Katalinie *et al.* (2012) show that there is growing interest of humans to find the naturally occurring antioxidants in food items or medicinal materials to replace synthetic antioxidants, which are already almost restricted due to their carcinogenicity.

Hence keeping these properties in consideration this study is done to find out the nutritional properties of the "Pomegranate" flowers and to observe the nutritional difference among the fresh and dried pomegranate flowers. There is variety of methods used for dehydration of different flowers such as air drying, water drying, sun drying, press drying, hot air oven drying, freeze drying *etc.* In this study, Pomegranate flowers were dehydrated by shade drying and

**Table 3:** Comparison between proximal analysis of three different varieties of fresh pomegranate flowers and shade dried pomegranate flowers.

Variety	Mean±SD		T- Test	P- Value
	Fresh flowers	Shade dried flowers		
<b>Energy</b>				
Solapur lal	98.370±0.211	331.146±0.058	-1835.805	0.000
Bhagwa	106.283±0.362	332.240±0.291	- 840.859	0.000
Ruby	97.426±1.0129	334.7833±0.571	-353.521	0.000
<b>Protein</b>				
Solapur lal	2.340±0.017	10.350±0.121	-112.903	0.000
Bhagwa	2.590±0.020	9.566±0.231	- 52.081	0.000
Ruby	2.553±0.035	9.876±0.066	- 168.502	0.000
<b>Fat</b>				
Solapur lal	0.050±0.012	0.813±0.0152	-86.554	0.000
Bhagwa	0.070±0.002	0.600±0.010	- 91.799	0.000
Ruby	0.080±0.013	0.730±0.010	- 112.583	0.000
<b>Carbohydrates</b>				
Solapur lal	22.140±0.050	70.606±0.144	-548.386	0.000
Bhagwa	23.823±0.070	72.143±0.234	- 341.484	0.000
Ruby	21.623±0.270	72.176±0.123	- 294.722	0.000

\*2- tailed "T- test (p<0.05)" mean value are significantly significant.

**Table 4:** Comparison between antioxidant content of three different varieties of fresh pomegranate flowers and shade dried pomegranate flowers.

Variety	Mean±SD		*T- Test	P-value
	Fresh Flowers	Shade Dried Flowers		
<b>Vitamin C</b>				
Solapur lal	11.533±0.023	33.500±0.478	-79.432	0.000
Bhagwa	23.633±0.220	34.823±0.263	- 56.478	0.000
Ruby	11.633±0.104	35.330±0.249	- 151.668	0.000
<b>Gallic acid</b>				
Solapur lal	544.426±2.045	1099.916±6.298	-145.284	0.000
Bhagwa	389.0167±3.965	1162.770±11.873	- 107.056	0.000
Ruby	381.520±1.440	1533.873±11.265	- 175.744	0.000

\*2- tailed "T- test (p<0.05)" mean value are significantly significant.

oven drying method and the study concluded that the shade dried Pomegranate flowers were found to be holding much more nutritive value as compared to fresh pomegranate flowers.

## LIMITATIONS

Storage life / Shelf life of Shade dried “Pomegranate” flowers powder of Ruby variety can be analyzed to ensure the stability of its “nutritional properties”.

## CONCLUSION

Shade dried Pomegranate flowers of Ruby variety were found to have more nutritional value and also rich in antioxidant content *i.e.* gallic acid and vitamin C followed by Solapur Lal variety and Bhagwa variety. According to recommended dietary allowances for Indians by “National Institute of Nutrition, Indian Council of Medical Research (ICMR)”, the antioxidants are recommended a minimum of 500 grams per day from fruits and vegetables. Hence we can recommend Shade dried Pomegranate flowers powder of Ruby variety to a living soul to enhance antioxidant amount in the body.

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**Conflict of interest:** None.

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