

Development of cultivated and wild pomegranate mixed fruit jelly and its quality evaluation during storage

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Abstract: The present study was undertaken for the development of jelly from cultivated and wild pomegranate fruit juice mix and its quality evaluation during storage of six months. A product with 55 % mixed fruit juice content (cultivated and wild pomegranate juice in 80:20 ratio) with 45 % sugar was found to be the best on the basis of sensory analysis of prepared jelly. Jelly could safely be stored for a period of half year under both the ambient and refrigerated conditions without much change in its various chemical attributes viz., total soluble solids (TSS), titratable acidity, ascorbic acid, anthocyanins, pectin, total phenolics and sensory quality characteristics viz., colour, texture, flavour and overall acceptability. However, the changes in the quality characteristics of the jelly were slower in refrigerated storage conditions as compared to ambient conditions. Under refrigerated conditions, changes in TSS from 67.00 to 67.36 °B, titratable acidity from 0.75 to 0.71%, ascorbic acid from 9.18 to 7.35 mg/100 g, anthocyanins from 11.34 to 10.17 mg/100 g and total phenols from 63.10 to 60.06 mg/100 g were observed after 6 months of storage. Both the packaging material viz., polyethylene terephthalate (PET) and glass jars were found suitable with comparatively slower changes occurring in glass jars under refrigerated conditions.

Keywords: Jelly, Packaging material, Storage, Wild pomegranate juice

INTRODUCTION

Pomegranate (*Punica granatum* L.) is a drought-tolerant and long-lived plant. Arid and semiarid zones are popular for cultivation of pomegranate trees. They are widely cultivated in Iran, India and the Mediterranean countries such as Egypt, Turkey, Spain, Tunisia and Morocco (Ercisli *et al.*, 2011). Its wild form is mainly distributed in Transcaucasia and Central Asia (Chandra *et al.*, 2014). In India, pomegranate grows wild in certain regions of Western Himalaya which includes states like Himachal Pradesh, Jammu and Kashmir and Uttarakhand (Pandey *et al.*, 2008; Narzary *et al.*, 2009). Apart from enormous health benefits, this fruit also has potential to cure various diseases such as vomiting, sore eye, spinal cord troubles, bronchitis, liver, kidney and brain disorders (Jalilop *et al.*, 2002). It was also observed that pomegranate could be used in the treatment of prostate cancer due to its ability to inhibit apoptosis (Rettig *et al.*, 2008). Main reasons behind medicinal properties of *Punica granatum* L. are certain bioactive components such as polyphenols, anthocyanins and organic acids viz., citric, malic, tartaric and succinic acid present in its juice content (Thakur *et al.*, 2011; Chandra *et al.*, 2014; Sharma and Thakur, 2016). It is believed that the antioxidant potential of pomegranate juice is more than that of red wine and green tea, which is induced

through ellagitannins and hydrostable tannins (Zarfeshany *et al.*, 2014). Traditionally, arils of wild pomegranates are utilized for preparation of dried condiment (*anardana*) because fresh arils of this fruit are quite tart in taste and mostly not liked by consumers due to its extremely acidic nature (Sharma and Thakur, 2016). The cultivated pomegranate fruits have been processed into various products like juice, juice concentrates, beverage, squash, frozen seeds, molasses, jam, wine, seeds in syrup, grenadine, pomegranate spirits, pomegranate powder, pomegranate rind powder, pomegranate seed oil and confectionery etc. (Dhinesh and Ramasamy, 2016). But only few scientific efforts have been put in direction of value addition of wild species of pomegranate fruits. Thus, looking upon the nutritional, medicinal characteristics of pomegranate fruit and increasing demand of value added products in urban market, the present study has been done to standardize the recipe for preparation of jelly from mixed fruit juice of cultivated and wild pomegranate along with storage study of the prepared product.

MATERIALS AND METHODS

Preparation of jelly: Fully mature cultivated and wild pomegranates i.e. yellowish green fruits harvested at 140-165 days after full bloom (DAFB) were procured

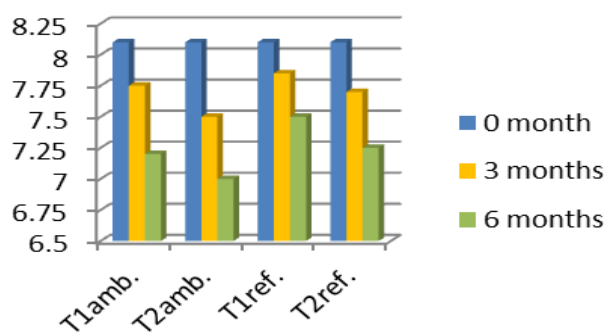


Fig. 1. Effect of different packaging treatments, storage conditions and intervals on colour scores of jelly.

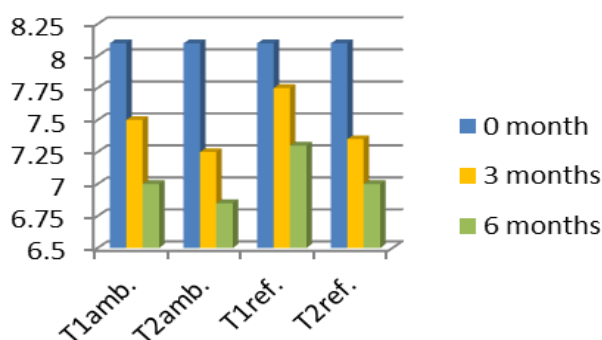


Fig. 2. Effect of different packaging treatments, storage conditions and intervals on texture scores of jelly.

from farmers of district Solan and brought to the FPR laboratory of the Department of Food Science and Technology, Dr. Yashwant Singh Parmar, University of Horticulture and Forestry, Nauni, Solan (HP). After washing of fruits, arils were extracted manually. A manual driven screw type juice extractor of Gardeners Corp, New Delhi make was used to extract juice from the freshly extracted arils of cultivated and wild pomegranate fruits, separately. Further, clarified juice was collected in a jar after filtration for jelly preparation.

Different combinations of wild pomegranate and commercial cultivated pomegranate juice were tried to develop a mixed fruit jelly at two levels

of sugars as per details mentioned in Table 1. However, TSS of the product was kept constant at 67 °B. A known proportion of the mixture of juice of wild pomegranate and commercial pomegranate was cooked along with sugar to the desirable consistency when TSS of the product reached near to 67 °B. Pectin (1 %) was also added in all the treatment combinations during cooking. At the end of product preparation sodium benzoate (200 ppm) was mixed in the mixture as preservative. Jelly was filled hot into previously sterilized jars and allowed to cool at room temperature for proper setting.

Sensory and chemical analysis: After preparation

Table 1. Detail of recipes prepared from blend of commercial and wild pomegranate fruit juice for preparation of jelly.

Recipe symbol		R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈
Juice (%)	WP (%)	20	15	10	5	20	15	10	5
	CV (%)	80	85	90	95	80	85	90	95
Juice % (WP + CV)		50	50	50	50	55	55	55	55
Sugar (%)		50	50	50	50	45	45	45	45

WP: Wild pomegranate, CV: Commercial cultivar

Table 2. Sensory characteristics (scores on 9 point hedonic scale) of different recipes of jelly.

Treatment	Colour	Texture	Flavour	Overall acceptability
R ₁	8.00	7.10	8.50	7.50
R ₂	8.10	6.50	7.80	6.25
R ₃	8.10	5.40	6.80	5.30
R ₄	8.20	4.00	6.00	4.25
R ₅	8.10	8.10	8.50	8.35
R ₆	8.20	6.75	8.00	7.10
R ₇	8.20	5.60	7.05	5.50
R ₈	8.40	4.20	6.25	4.60
CD _{0.05}	NS	1.17	1.12	1.16

Table 3. Effect of different packaging treatments, storage conditions and intervals on TSS (°B) of jelly.

V	Ambient storage (Months)				Refrigerated storage (Months)			
	0	3	6	Mean	0	3	6	Mean
T ₁	67.00	67.46	68.12	67.53	67.00	67.26	67.74	67.33
T ₂	67.00	67.58	68.46	67.68	67.00	67.36	67.80	67.39
Mean	67.00	67.52	68.29	67.60	67.00	67.31	67.77	67.36
CD _{0.05}	T= NS, S= 0.31, V= NS, T×S= NS, T×V= NS, S×V= NS							

T=Packaging material, S= Storage period, V= Storage conditions, T₁=Glass jar, T₂=PET jar

Table 4. Effect of different packaging treatments, storage conditions and intervals on titratable acidity (%) of jelly.

V	Ambient storage (Months)				Refrigerated storage (Months)				
	S	0	3	6	Mean	0	3	6	Mean
T									
T ₁		0.75	0.69	0.64	0.69	0.75	0.71	0.69	0.72
T ₂		0.75	0.67	0.65	0.69	0.75	0.70	0.67	0.71
Mean		0.75	0.68	0.65	0.69	0.75	0.71	0.68	0.71

T= NS, S= 0.03, V= NS, T×S= NS, T×V= NS, S×V= NS

T =Packaging material, S =Storage period, V= Storage conditions, T₁ =Glass jar, T₂ =PET jar

Table 5. Effect of different packaging treatments, storage conditions and intervals on ascorbic acid (mg/100 g) of jelly.

V	Ambient storage (Months)				Refrigerated storage (Months)				
	S	0	3	6	Mean	0	3	6	Mean
T									
T ₁		9.18	6.60	4.95	6.91	9.18	7.34	5.95	7.49
T ₂		9.18	6.02	4.25	6.49	9.18	7.00	5.40	7.20
Mean		9.18	6.31	4.60	6.70	9.18	7.17	5.68	7.35

T= 0.12, S= 0.14, V= 0.12, T×S= 0.20, T×V= NS, S×V= 0.20

T =Packaging material, S =Storage period, V= Storage conditions, T₁ =Glass jar, T₂ =PET jar

Table 6. Effect of different packaging treatments, storage conditions and intervals on anthocyanins (mg/100 g) of jelly.

V	Ambient storage (Months)				Refrigerated storage (Months)				
	S	0	3	6	Mean	0	3	6	Mean
T									
T ₁		11.34	9.35	8.30	9.66	11.34	10.05	9.62	10.34
T ₂		11.34	8.95	7.75	9.35	11.34	9.55	9.12	10.00
Mean		11.34	9.15	8.03	9.51	11.34	9.80	9.37	10.17

T= 0.10, S= 0.12, V= 0.10, T×S= 0.18, T×V= NS, S×V= 0.18

T =Packaging material, S =Storage period, V= Storage conditions, T₁ =Glass jar, T₂ =PET jar

of different recipes of jelly, the best combination was selected on the basis of organoleptic analysis on 9 point hedonic scale for colour, texture, flavour and overall acceptability by a panel of 10 judges (Amerine *et al.*, 1965). Further, selected samples of jelly were filled into glass and PET jars, sealed, tilted and stored at ambient and refrigerated temperature conditions for storage studies. The sensory analysis of stored samples of jelly at 0 day as well as at storage intervals of 3 and 6 months was also done at 9 point hedonic rating scale. Chemical characteristics of jelly were analyzed by standardized methods.

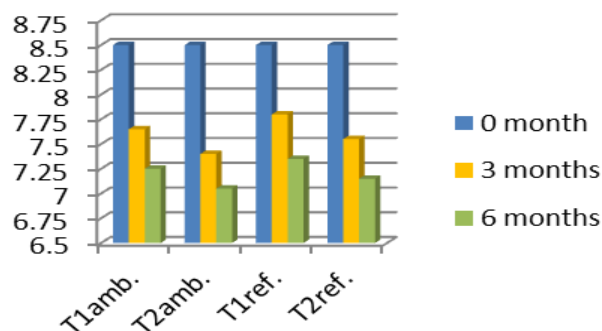


Fig. 3. Effect of different packaging treatments, storage conditions and intervals on flavour scores of jelly.

Hand refractometer was used to measure TSS of jelly and the results were expressed as degree Brix (°B) or percentage (Ranganna, 2009). Titratable acidity and ascorbic acid (vitamin C) were determined as per AOAC (2004) methods and expressed conveniently in per cent (%) citric acid and mg/100 g of the sample, respectively. The total anthocyanins in mg/100 g of sample were determined by the method given by Ranganna (2009). The total phenols were estimated by the Folin-Ciocalteu procedure given by Singleton and Fosssi (1965) and expressed in

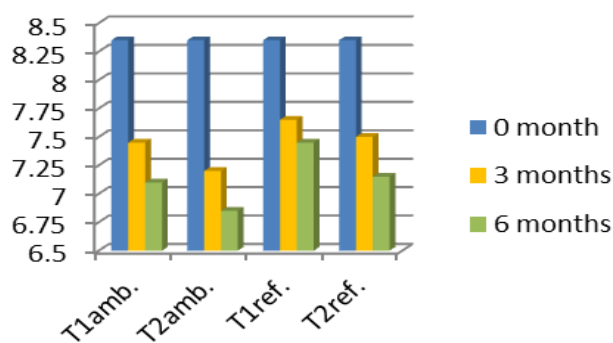


Fig. 4. Effect of different packaging treatments, storage conditions and intervals on overall acceptability scores of jelly.

Table 7. Effect of different packaging treatments, storage conditions and intervals on pectin (%) of jelly.

V T	Ambient storage (Months)				Refrigerated storage (Months)				
	S	0	3	6	Mean	0	3	6	Mean
T ₁		1.18	0.98	0.94	1.03	1.18	1.02	0.98	1.06
T ₂		1.18	0.94	0.90	1.00	1.18	0.98	0.95	1.04
Mean		1.18	0.96	0.92	1.02	1.18	1.00	0.97	1.05

T= NS, S= 0.04, V= NS, T×S= NS, T×V= NS, S×V= NS

T =Packaging material, S =Storage period, V= Storage conditions, T₁ =Glass jar, T₂ =PET jar**Table 8.** Effect of different packaging treatments, storage conditions and intervals on total phenols (mg/100g) of jelly.

V T	Ambient storage (Months)				Refrigerated storage (Months)				
	S	0	3	6	Mean	0	3	6	Mean
T ₁		63.10	58.85	56.81	59.59	63.10	60.34	58.07	60.50
T ₂		63.10	57.51	55.99	58.87	63.10	58.73	57.04	59.62
Mean		63.10	58.18	56.40	59.23	63.10	59.53	57.55	60.06

T= 0.43, S= 0.53, V= 0.43, T×S= 0.75, T×V= NS, S×V= 0.75

T =Packaging material, S =Storage period, V= Storage conditions, T₁ =Glass jar, T₂ =PET jar

mg/100 g of jelly. For estimation of pectin per cent (%) in jelly, modified Carre and Haynes (1922) method as described by Ranganna (2009) was followed.

Statistical data analysis: The data pertaining to the sensory evaluation and chemical analysis of samples was analyzed by randomized block design (RBD) and completely randomized design (CRD), respectively. The experiments conducted in these studies were replicated thrice.

RESULTS AND DISCUSSION

From sensory scores mentioned in Table 2, it was concluded that recipe (R₅) with 55 % mixed juice content containing 80 % commercial variety juice and 20 % wild pomegranate juice with 45 % sugar was found to be best on the basis of sensory characteristics of jelly and was selected for further studies.

While studying the changes in jelly during storage (Table 3), a slight increase in TSS of wild pomegranate jelly was observed. The effect of storage period (S) on TSS of jelly reveals that it increased from 67.00 to 67.60 and 67.36 °B under ambient and refrigerated conditions, respectively. However, less increase of TSS in refrigerated storage might be due to the slower rate of bio-chemical reactions at low temperature as compared to ambient storage conditions. The TSS of jelly increased non-significantly and this increase in TSS during storage might be due to conversion of polysaccharides into monosaccharide and soluble disaccharides (Gould, 1983). Our trend of results are in conformity with the findings of Kumar *et al.* (2007) in guava leather, Ahmed *et al.* (2011) in spota jam, Kuchi *et al.* (2014) in guava jelly bar and Sindumathi and Amutha (2014) in coconut based jam.

Gel firmness of jelly is dependent on per cent pectin along acidity of jelly. It is evident from the data given

in Table 4 that there was a negligible decrease in acid content of jelly during entire storage period. The overall effect of storage period on the titratable acidity indicates that it decreased from 0.75 to 0.69 and 0.71 % citric acid in jelly under ambient and refrigerated conditions, respectively. A decrease in titratable acidity of jelly might be due to co-polymerization of organic acids with sugars and amino acids. Similar trend of results were recorded by Paul *et al.* (2007) in guava jelly, Assis *et al.* (2007) in cashew apple jelly and Sundaram *et al.* (2007) in seabuckthorn mixed fruit jelly.

While going through data presented in Table 5 it was found that there was a decrease in ascorbic acid content of wild pomegranate jelly during storage. The effect of storage period (S), storage conditions (V) and packaging materials (T) on ascorbic acid content of jelly shows that it decreased with storage but retained more (7.35 mg/100 g) in refrigerated storage as compared to ambient conditions (6.70 mg/100 g) and further glass jar retained higher ascorbic acid and PET jar the lower during storage. Decrease in ascorbic acid content might be due to its degradation into dehydro-ascorbic acid or furfural during storage. Less decrease of ascorbic acid in refrigerated storage might be due to the slower rate of its degradation in low temperature as compared to ambient storage conditions because of its susceptibility to high temperature. Retention of higher ascorbic acid in glass jar may be due to the slower rate of reactions in glass jar as glass absorbs heat at slower rate as compared to PET jar during storage. The findings of the present studies are in agreement with the results reported by Assis *et al.* (2007) in cashew apple jelly, Sundaram *et al.* (2007) in seabuckthorn mixed fruit jelly, Sindumathi and Amutha (2014) in coconut based jam and Abolila *et al.* (2015) in orange based formulated low-calorie jam.

Anthocyanins not only act as potent antioxidants but

also impart appealing red natural colour to pomegranate jelly. Infact, content of anthocyanin is proportional to the colour of jelly. Data in Table 6 reveals that there was a general decrease in anthocyanins of jelly during storage. However, its content retained more (10.17 mg/100 g) under refrigerated storage as compared to ambient conditions (9.51 mg/100 g). While, observing the overall effect of packaging on the anthocyanins of product, higher amount of anthocyanins were retained in glass jar and lower in PET jar. Loss of anthocyanins in jelly might be due to their high susceptibility to auto oxidative degradation during storage. More retention of this attribute in the product in refrigerated conditions as compared to ambient might be due to slower rate of auto oxidation of anthocyanins in refrigerated conditions. Retention of higher anthocyanins in glass jar may be due to the slower rate of reactions in glass as it absorbs heat at slower rate as compared to PET jar during storage. Similar findings were recorded by Sundaram *et al.* (2007) in seabuckthorn mixed fruit jelly.

Data presented in Table 7 indicate that there was a general decrease in pectin content of jelly during storage. The effect of storage period (S) on the pectin content of jelly shows that it decreased from 1.18 to 1.02 and 1.05 % under ambient and refrigerated conditions, respectively. Possible reason for slight decrease in pectin content of wild pomegranate jelly may be due to hydrolysis of pectin into simple compounds. Our results are in confirmity to the findings of Paul *et al.* (2007) in guava jelly and Assis *et al.* (2007) in cashew apple jelly.

An appraisal of data (Table 8) reveals that there was a general decreasing trend in total phenols of fruit jelly during entire storage period of 6 months. While comparing effect of storage conditions (V) on total phenol content, more (60.06 mg/100 g) phenols were retained under refrigerated conditions as compared to ambient conditions (59.23 mg/100 g). The overall effect of packaging materials (T) indicates that higher phenols were retained in jelly packed in glass and lower in PET jar during storage. The decrease in total phenols in jelly during storage might be due to their involvement in the formation of polymeric compounds by complexing with protein and their subsequent precipitation as observed by Abers and Wrolstad (1979). As far as packaging material is concerned more retention of phenols in jelly packed in glass jar than PET jar might be due to the difference in their thermal conductance properties which affected internal decomposition reactions. Similar trend of decrease in total phenols have been reported by Sundaram *et al.* (2007) in seabuckthorn mixed fruit jelly and Assis *et al.* (2007) in cashew apple jelly.

There was a decrease in sensory scores viz., colour, texture, flavour and overall acceptability scores of jelly with the advancement of storage period (Fig. 1-4).

However, this decrease was within the acceptable limit (5-9 on 9 point hedonic) during whole storage period of 6 months. Decrease in scores was found significantly lower under refrigerated storage conditions than ambient conditions. As far as packaging effect is concerned, higher sensory scores of jelly were retained in the jelly packed in glass jar than PET jar. The decrease in sensory scores of product during storage might be due to degradation of anthocyanins, loss of sugar-acid blend and volatile aromatic compounds. Higher sensory scores in refrigerated storage conditions might be due to less degradation of pectin, slow biochemical reactions and degradation of anthocyanins as compared to ambient storage conditions which led the judges to award higher scores to the product in this condition. Trend of results for sensory scores are in conformity with the findings of Paul *et al.* (2007) in guava jelly, Sundaram *et al.* (2007) in seabuckthorn mixed fruit jelly, Touati *et al.* (2014) in apricot jam and Kuchi *et al.* (2014) in guava jelly bar.

Conclusion

Among all recipes, recipe (R₅) with 55 % juice (80 % commercial variety juice + 20 % wild pomegranate juice) with 45 % sugar and a constant quantity of pectin was found to be the best on the basis of some sensory quality scores of jelly. Jelly packed in PET and glass jars could be stored for a period of six months under both the ambient and refrigerated conditions without much changes in various quality characteristics. However, the changes in the quality attributes of the jelly were slower under refrigerated storage as compared to ambient conditions.

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