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Pomegranate Varietal wines: Current status and process standardization

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Abstract

Pomegranate is a paramount important profit-making fruit crop across the world and is treated valuable because of the health-promoting features in edible and nonedible parts of the fruit that can be used for a wide range of human diseases. Pomegranate is one of the popular fruits which has 12.71% productivity in India whereas, Maharashtra itself produces 64.65% for the year 2017-18. Research institutes across India have developed several varieties like Mridula, Phule Arakta, Bhagwa, and Phule Bhagwa Super, etc.. Pomegranate has many nutritional properties that help the vinification of pomegranate varietal wines as an alternative product. This review summarizes current knowledge about pomegranate wine fermentation, various varieties of pomegranate used for winemaking and characteristic properties of pomegranate wine. Pomegranate wines can be made from Indian pomegranate varieties. Indian pomegranate varietal wines can be studied for the characteristic properties of pomegranate wine that will lead to the commercialization.

Keywords: Pomegranate, Wine, Pomegranate varietal wines, Productivity

1. Introduction

India is amongst the largest producers of fruits in the world as they are the most demanding foods of mankind. Fruits are not only nutritive but also indispensable for the maintenance of health. Fruits can be consumed fresh as well as in processed form which improves the quality of our diet by providing essential ingredients like vitamins, minerals, carbohydrates, etc... Postharvest loss of fresh fruit is one of the serious problems of tropical countries like India. Due to improper postharvest handling and inadequate processing facilities, nearly 35 to 40 percent of fruit production goes waste. India suffers postharvest fruits and vegetable losses each year mainly because of the absence of food processing units, modern cold storage facilities, and a callous attitude towards tackling the grave issue of post-harvest losses[1].

Pomegranate (Punica granatum L.) is an important fruit crop grown in India. The name ‘‘pomegranate’’ evolved from the Latin word Malum granatum, which literally means ‘‘grainy apple.’’ [2] It is originated in Iran and extensively pomegranate farming is done in Mediterranean countries like Spain, Morocco, Egypt, Iran, Afghanistan, and Baluchistan. It is cultivated to some extort in Myanmar, China, USA, and India. India stood first in pomegranate cultivation within the world. In India major pomegranate producing states are Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, and Rajasthan. Maharashtra is leading with a 90 thousand ha area with an annual production of 9.45 Lakh MT tones and productivity of 10.5 Mt/ha. Maharashtra state accounts for 78 percent of the total area in India and 84 percent of the total production in the country for the year 2018-2019. Enlisted are some of the commercial varieties Bhagwa, Mridula, Ganesh, Jyothi, Jalore Seedless, Kandhari, Phule Arakta, Phule Bhagwa Super, and Bhagwa Sindoor grown in India. Out of these, Bhagwa is the most cultivated variety due to its high demand for domestic as well as export purposes[3].

2. Health benefits:

Different parts of the pomegranate tree such as flower, fruit, bark, and leaves manifest various medicinal properties that are to be studied for health benefits. Research has shown pomegranate derivatives can increase plasma antioxidant capacity and decrease oxidative stress as lipid peroxidation in both humans as well as animals [4]–[6]. Antioxidant capacity measurement is vital as a bioactivity indicator in both pomegranate fruit as well as other products rich in polyphenols; synchronously it is interesting to compare it with other fruits and vegetables[7]. Phenolics present in both pomegranate fruit extract as well as juice can protect the blood vessels from inflammation[8]. Pomegranate derived products have shown antioncogenic properties against various cancers like skin cancer, lung cancer, colon cancer, prostate cancers in men. Recent scientific findings have led to a higher awareness of the public to benefits of the pomegranate fruit, particularly in the western world, and consequently to a prominent increase in the consumption of fruit and juice [2].

3. Pomegranate productivity:

In India, Maharashtra has a major share (>65%) for pomegranate cultivation (shown in Figure 3), followed by Karnataka, Gujarat. It is picking up fast in Andhra Pradesh, Telangana, Himachal Pradesh Madhya Pradesh, and Rajasthan (Table 2). Small areas are under cultivation in Tamil Nadu, Odisha, Nagaland, Mizoram, Kerala, Jammu & Kashmir, Andaman, Nicobar, and Lakshadweep. Pomegranate cultivation has also been introduced in Bihar, Uttar Pradesh, Uttarakhand, and West Bengal. Over the years, from 2008 to 2017 area under cultivation increased which resulted in production growth together with productivity as shown in Table 1[9]. Pomegranate holds a 2.81 % share in terms of production as compared to overall fruits for the year 2017-2018[10]. In Maharashtra, districts like Nashik, Solapur, Ahmadnagar, and Pune are major pomegranate producers (mentioned in Table 3). The majority of pomegranate production in Maharashtra takes place in Nashik (Figure 4). Most of the farmers prefer pomegranate in this area due to the availability of perfect soil for the nourishment of the pomegranate tree. Ganesh, Jyoti, Mridula, Bhagwa, Phule Bhagwa Super, Phule Arakta are the varieties of pomegranate developed by the institutes in Maharashtra and are widely grown here.

Table 1 Pomegranate productivity in India

Year	India		
	Area (x1000 ha)	roduction (x1000 MT)	Productivity (T/ha)
2017 -18	220	2795	12.71
2016 -17	216	2613	12.09
2015 -16	197	2306	11.71
2014 -15	181	1789	9.9
2013 -14	131	1346	10.3
2012 -13	113	745	6.6
2011 -12	112	772	6.9
2010 -11	107	743	6.94
2009 -10	127.16	820.97	6.46
2008 -09	109.21	807.17	7.39

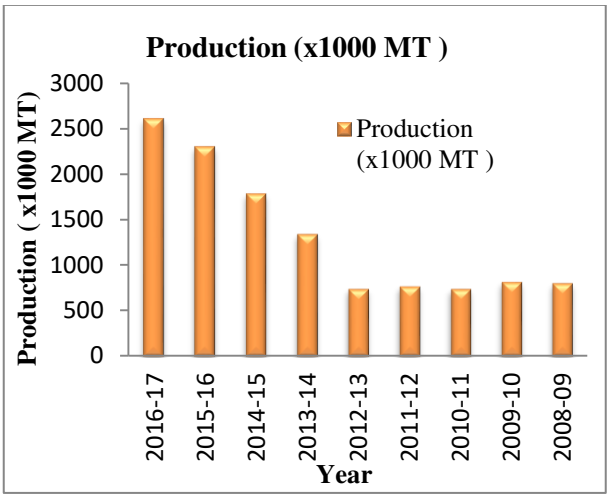

Figure 1 Production of pomegranate in India

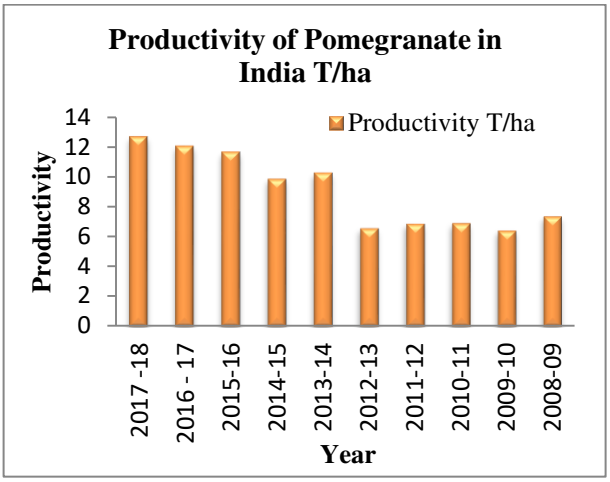

Figure 2 Productivity of Pomegranate in India

Table 2 Pomegranate producing states in India

State	Area (x 1000 ha)	Production (x 1000MT)	Productivity (T/ha)
Maharashtra	136.75	1578.04	11.54
Karnataka	28.09	328.92	11.71
Gujarat	18.54	278.1	15
Madhya Pradesh	9.23	88.86	9.63
Andhra Pradesh	7.71	105.2	13.64
Rajasthan	2.5	10	4
Himachal Pradesh	2.48	2.55	1.2
Telangana	2.08	30.84	14.82
Tamil Nadu	0.51	13.96	27.43
Chhattisgarh	0.48	4.33	9.06

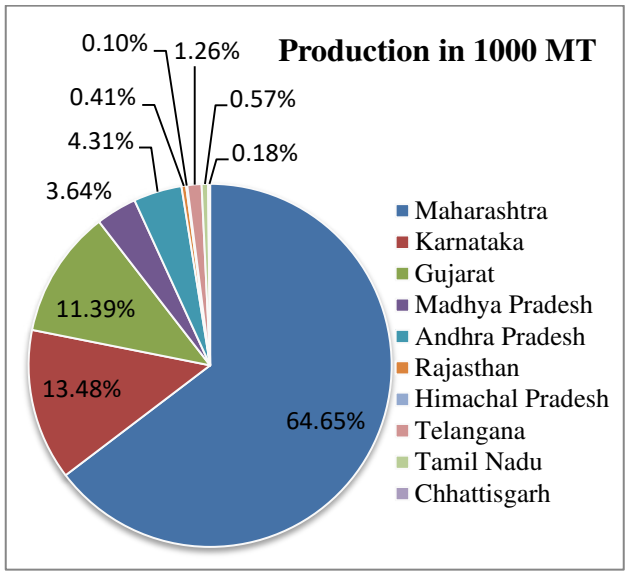

Figure 3 Pomegranate production in India

Table 3 Major Pomegranate Producing Districts in Maharashtra (2016-2017)

Districts	Area (in 1000 ha)	Production (in 1000 MT)
Nashik	38.80	628.11
Solapur	25.50	229.50
Ahmadnagar	21.50	215.00
Pune	13.50	136.00

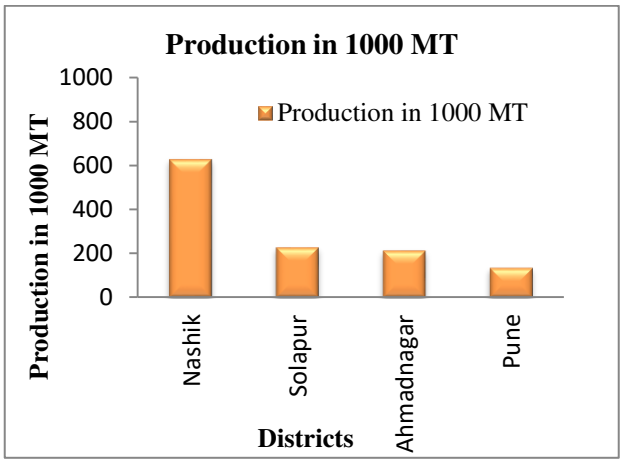

Figure 4 Pomegranate production in Maharashtra

4. Promising varieties/ hybrids developed in India:

Some promising pomegranate varieties/ hybrids were developed through crop improvement program in India

[11]. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri developed various varieties of pomegranate such as Ganesh, G-137, Mridula, Phule Arakta, Bhagwa, and Phule Bhagwa Super. Every variety has its own characteristic traits. Fruits of the "Ganesh" variety are medium-sized, with a yellow, smooth surface and red tinge. The seeds are soft with pinkish aril. The juice tastes sweet. Fruits of the "G-137" variety are large sized with deep pink aril, sweet taste, soft seeds, and prolific bearer; quality better than Ganesh. The tree has a spreading habit, the fruit surface smooth, yellow with a red tinge. Plants of variety "Mridula" are dwarf; its fruits are medium-sized, rind smooth, dark red in color. It has blood-red arils with very soft seeds, juicy and sweet in taste. "Phule Arakta" variety of pomegranate fruits has dark red rind; dark red arils; sweet in taste. However, "Bhagwa" fruits have an attractive red rind and red bold sized arils, sweet in taste; Bhagwa is the predominant ruling variety in the Maharashtra region. "Phule Bhagwa Super" pomegranate fruits are very attractive, dark saffron rind color with glossiness on the rind surface, good quality fruits. These fruits mature earlier than Bhagwa and hence beneficial for farmers.

Tamil Nadu Agricultural University (TNAU), Coimbatore researched 2 varieties like Yercaud-1 and CO-1. "CO-1" variety is high yielding. Its fruits are medium-sized with attractive rind, soft seeds, higher pulp content, and sweet taste on the other hand "Yercaud-1" has medium-sized fruits with easily peelable rind. The seeds are soft with attractive, deep purple aril. University of Agricultural Sciences (UAS), Dharwad flourished "Jyoti" variety fruit are medium to large-sized, having attractive, yellowish-red color, more fleshy and pink aril. Fruits are very sweet, soft seeded and taste good.

Indian Institute of Horticultural Research (IIHR), Bengaluru evolved two varieties namely Ruby and Amlidana. "Ruby" variety is a hybrid from a 3-way cross between Ganesh x Kabul x Yercaud and Gulesha Rose Pink. It has soft and red arils with good flavor. The plants are dwarf, prolific bearer, providing uniformly red fruits. Amlidana variety is suitable for anardana. It has medium-sized fruits; arils are highly acidic and short stature.

Table 4 Promising varieties/ hybrids developed in India

Variety	Year of release	Institute
Ganesh	1936	MPKV, Rahuri
CO-1	1983	TNAU, Coimbatore
G-137	1984	MPKV, Rahuri
Yercaud-1	1985	TNAU, Coimbatore
Jyoti	1985	UAS. Dharwad
Mridula	1994	MPKV, Rahuri
Ruby	1997	IIHR, Bengaluru
Amlidana	1999	IIHR, Bengaluru
Phule Arakta	2003	MPKV, Rahuri
Bhagwa	2003	MPKV, Rahuri
Phule Bhagwa Super	2013	MPKV, Rahuri

5. Contents of pomegranate:

Pomegranate is a natural source of iron, vitamin C and sugar; also it contains amino acid such as glutamic acid, tryptophan, aspartic acid, and methionine. Pomegranate has a higher content of phenolic compounds. Due to which, Pomegranate has a higher antioxidant capacity than any other fruit juices and beverages [12]. Pomegranate juice contains flavanols namely epicatechin, catechin, and epigallocatechin. Flavanols class is similar to flavonoids. Flavonoids such as catechin, quercetin, and phloridzin are present in pomegranate juice along with some potent antioxidants. Anthocyanins are another class of compounds that give color to the fruit juice mainly due to two different glucosidic forms [13]. The edible parts of fruits that are arils, consumed fresh or used for the preparation of fresh juice, canned beverages, jam, syrups, jelly, and sauces, or coloring beverage products[12].

6. Pomegranate alternate products:

Pomegranate is one of the popular choices amongst fruits. Apart from the consumption of pomegranates as fresh fruit, they are also used for other purposes, like isolated arils, juice, syrup, squash, jelly, anar rub, juice

concentrates, carbonated cold-drinks, health-promoting agents and wine. One of the newest developments in pomegranate culture is an efficient commercial method to extract intact arils [14]. The juice is preferably produced in industries from isolated arils as the juice is less bitter and tastes better to many people. Byproducts of the aril and juice industry are fruit skin, membranes, and seeds. In which fruit skins and membranes are rich in ellagitannins, which have extensive usage in health-promoting bioactivities and their extracts have a commercial value for humans and animal feed. The seeds are a source of oil that has an uncommon combination of unsaturated fatty acids and sterols. Seed powder is a common component of some Indian food recipes [15]. Pomegranate juice contains anthocyanins, ellagic acid derivatives, and hydrolyzable tannins specifically tannin named punicalagin, account for the higher antioxidant capacity[16]. Pomegranate wine is prepared by pressing cut fruits without crushing or extraction of juice from arils.

7. Fermentation Process for pomegranate wine :

Production of wine with fermentation is mentioned in the flow chart (Figure 5). Zhuang et al.,(2011) added 5 g pectinase per 100 kg for must preparation[17]. Mena et al.,(2012) has added Actimax Plus 200 mg/L along with sodium metabisulphite[18]. Researchers have used yeast immobilized in sodium alginate to produce wine, so as to reuse the yeast again[19]. For new winemakers, it would be difficult to decide when to stop the fermentation. Soibam et al.,(2014) suggested for new winemakers, when the fermenting substrate shows the same ºBrix consecutively for 2-3 days fermentation can be stopped[20]. Different researchers had tried different fermentation temperatures (20ºc to 30 ± 1 ºc) as well as ºBrix (15 to 22± 1 ºBrix). [21][18][22]

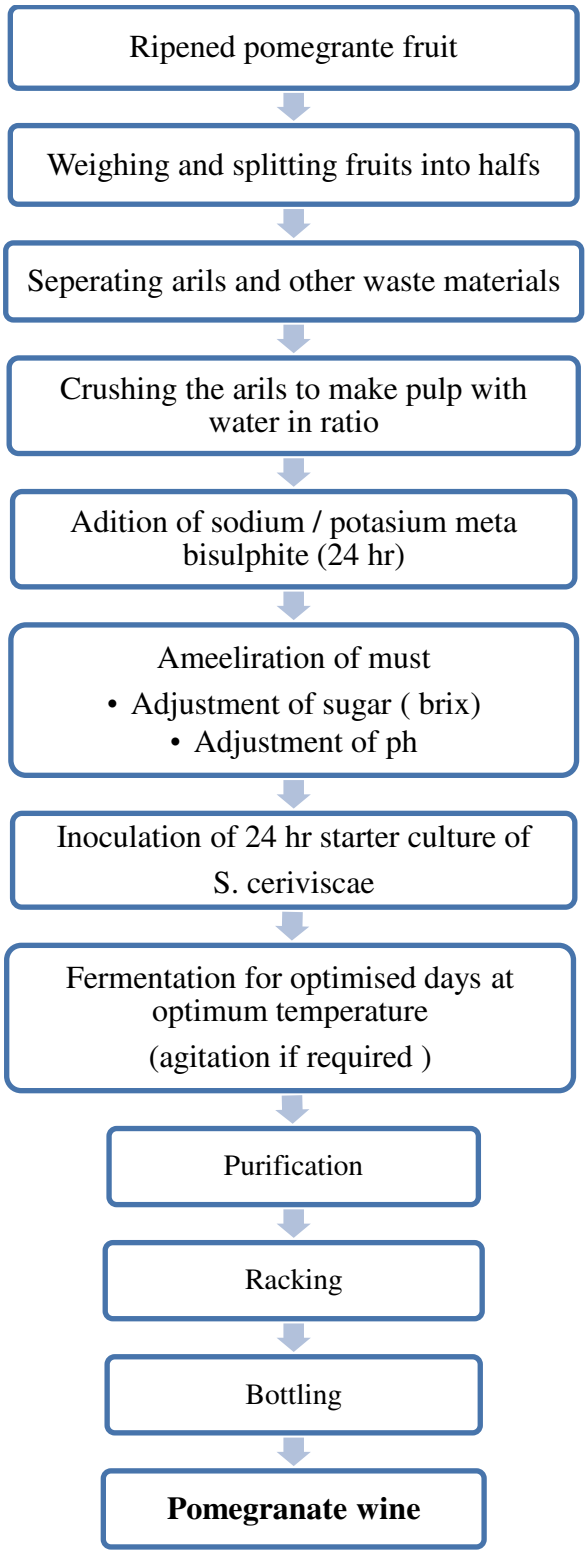

Figure 5 Fermentation process for pomegranate wine

8. Pomegranate varietal wines:

Researchers studied different varieties of Pomegranate like Bhgava, ruby, mridula, etc, and some varieties like Mollar de Elche to produce varietal wines. Berenguer *et al.* (2015) studied the physicochemical characteristics of wines by using different yeasts[21]. Andreu-Sevilla *et al* (2013) studied volatile compounds in pomegranate wine[23]. Mena *et al.* (2012) optimized the fermentation process for winemaking along with phytochemical characterization and other chemical studies[18]. Lan *et al.* (2017) studied flavor profile changes for wine along with antioxidant properties and its effects on the human body. They also optimized the use of pectinase enzyme and Sulfurous acid for fermentation of must to produce wine[22]. Sevda used immobilized *saccharomyces cerevisiae* to produce the wine so that yeast cells can be reused again [19]. Pomegranate wine blended with sugarcane juice to produce fruit crop wine varying the concentration of both substrates. It is observed that alcohol percentage strengthened with increasing pomegranate blending up to 50 % and found highest at 50% pomegranate concentration. The highest alcohol percentage was noticed at the highest TSS value[20].

9. Case studies for characteristics of pomegranate wine:

9.1 Oenological characteristics of wine

Analysis of wine predominantly includes five basic tests that are pH, ºBrix, Titrable Acidity (TA), Volatile Acidity (VA), and percentage alcohol by volume (% ABV). These parameters are cumulatively called as oenological characteristics of the wine. These are primary analyzing factors for the wine. Zhuang, du and wang, (2011) studied pomegranate juice along with alcoholic fermentation of pomegranate wine. Remarkable differences in characteristics were observed between pomegranate juice and wines. They concluded sour pomegranate juice showed the highest titratable acidity of 35.90 g/L and the lowest pH value of 2.56. Red pomegranate juice was found to have the highest TA (82.26 mg/L). The yeast *S. cerevisiae* D576 exhibited exceptional fermenting ability in the entire pomegranate juices at room temperature (20 ºC to 22 ºC) as residual sugar in all the samples was decreased to below 3.27 g/L after alcoholic fermentation. Especially in sour pomegranate juice, 13.76% (by volume) alcohol was produced although the juice pH value was extremely low at 2.56. When 50 mg/L SO_2 was added, only little SO_2 was remained in pomegranate wines after fermentation due to loss during fermentation[17].

The evolution of quality parameters for the phytochemical composition of fruit wines throughout the different wine manufacturing stages for both Wonderful and Mollar de Elche was monitored by Mena et al.,(2012) Perceptible changes took place during wine elaboration, especially over the fermentation period. On top, a substantial role of the cultivar used in the Phenolics profile was noted[18]. Mena *et al.*,(2012) as well as Andreu-Sevilla *et al.*, (2013) studied wine production from three varieties of pomegranate such that Wonderful, Coupage and Mollar de Elche. Total acidity as well as pH for Wonderful, Coupage and Mollar de Elche wines, showed an increase as compared to respective juices. Wonderful, Coupage and Mollar de Elche juices had TSS in the range 16 -18 Brix on fermentation, it decreased up to 8 Brix. Final wines produced from these varieties had alcohol content for Wonderful, Coupage and Mollar de Elche wines 8.3%, 8.7%, and 9.1% respectively[18], [23].

Berenguer *et al.* (2015) studied the physicochemical characteristics of wines by using different yeasts. *Saccharomyces cerevisiae Viniferm,* Revelación *Viniferm* SV, *Viniferm* PDM are the three yeast used during the study and later named as *Saccharomyces* Yeasts 1, 2 and 3, respectively for convenience. The pH values fluctuated from 3.40 to 3.58 for all three strains. TA was followed during the fermentation process because it is easy to analyze the extent of decrease or increase of the different acids (citric, malic, lactic, or acetic) that may be present. This parameter has a decisive influence on the aroma and flavor of fermented products and their levels can be used as an index of shelf-life. THE initial TA value for the pomegranate juice blend was found to be 2.81 ± 0.38 g citric acid/L and increased until day 9 of fermentation. Berenguer *et al* (2015) observed from day 9, the TA level remained almost constant until the end of the study. Ethanol contents of approximately 10.6%, 11.1% and 11.0% (v/v) were determined for pomegranate wines

fermented with the three *Saccharomyces* Yeasts 1, 2 and 3, respectively [21].

9.2 Total phenolics of wine

Wines contain several polyphenols like gallic acid, Chlorogenic acid, Catechin, Ferulic acid, caffeic acid, Vanillin, etc. Phenolic contents are responsible for both antioxidant activity as well as sensory attributes of wine. Phenolic contents may increase after the maturation of wine. Zhuang, du and wang, In sweet pomegranate juice, 1596.67 mg/L total phenolics was found which was much higher than that in sour pomegranate juice and red pomegranate juice. A high correlation between antioxidant capacities and Total Phenols indicated that phenolic compounds were major contributors to the high antioxidant activity of Juice as well as wine [17]. Y. Lan *et al.*, (2017) studied flavor profile changes for wine along with antioxidant properties and its effects on the human body. They also optimized the use of pectinase enzyme and Sulfurous acid for the fermentation of must to produce wine[22].

9.3 Antioxidant capacity of wine

The antioxidant capacity of pomegranate juice or pomegranate wines largely depended on the composition of samples and conditions of the test systems, which cannot be fully described with one single method due to many potential factors. OH- and O_2-- scavenging abilities were used to evaluate the antioxidant capacity, respectively. Sweet pomegranate juice and red pomegranate juice showed the highest (70.58%) and the lowest (41.20%) DPPH scavenging, respectively. There was an extremely significant difference in DPPH-scavenging ability between pomegranate juices[17]. The antioxidant activity of pomegranate wine during the fermentation and aging process was investigated by authors Lan *et al.* (2017). DPPH free radical scavenging capacity lowered firstly and then increased during fermentation. DPPH free radical scavenging capacity maintained a relatively stable level in the final aging period of pomegranate wine.

Conclusion:

"Pomegranate" is a highly produced fruit in India which contains numerous health benefits. Pomegranate alternative products are made to avoid the wastage of surplus production. Pomegranate wine is a value-added product that also ensures the nutritional benefits. Although during the last few years, remarkable progress has been made in the wine industry such as process standardization, culture improvement, and characterization for various properties of wines. The fruit wine industry has huge scope to evolve and for that matter, pomegranate can be the best option. Presently most studies have been concentrated on pomegranate wine production, however, several characteristics have not yet been thoroughly examined. Volatile analysis, chromatographic analysis, nutritional analysis, mineral analysis and evaluation of sensory profile should lead to the industrialization and commercialization of pomegranate wine. Pomegranate varietal wines made from Indian varieties can be studied, thus contributing more to the Indian economy of the wine industry.

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