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Wild pomegranate (*Punica granatum* L.): A review on physical and chemical attributes of himalayan wild pomegranate fruit

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Abstract
Pomegranate fruit is rich source of anthocyanins, phenolics, ascorbic acid and can be categorized as a functional food on the basis of these bio-active components. The wild form of pomegranate fruits are similar to cultivated pomegranates for various traits but exceptionally have higher acidity in comparison of cultivated one. This fruit has a characteristic flavour and colour due to the presence of the organic acids and anthocyanins. The anthocyanins as a pigment results in the formation of attractive pink-reddish tinge to its arils. Its pigments, phenolics, acids and vitamins have widespread medicinal attributes towards human health. Wild pomegranates are consumed either raw in fruit salads with additional flavour enhancers or can be preserved and processed into value added products viz. dried wild pomegranate arils, juice, beverages, wine and intermediate moisture products. This review paper revealed the physical, chemical, and nutritional aspect of the fresh wild pomegranate fruit in comparison to cultivated one.

Keywords: anthocyanins, nutritional, organic acids, value added products, wild pomegranate

Introduction
Wild pomegranate (*Punica granatum* L.) is an emerging wild fruit of Central Asia that belongs to the family Punicacea and genus *Prunus.* The pomegranate is native in the region from northern India to Iran (Morton, 1987) [37] with its wild shrubs found in the forests of these areas. In India, wild forms of pomegranate is widely distributed in drier and sub marginal land of outer Himalaya at an elevation of 900 to 1800 m above mean sea level covering the mid hill belts of Himachal Pradesh, Jammu and Kashmir and Uttarakhand states (Thakur *et al.* 2011) [63]. Wild pomegranate fruits have been noted with much smaller arils, thicker rinds and higher acidity as compared to cultivated ones (Kerimov, 1934; Bist *et al*. 1994; Kher, 1999) [26, 7, 28]. In recent years, the demand of its value added products got increased due to its recognition as a great source of natural antioxidants and health promoting constituents like organic acids, anthocyanins, phenolics, vitamins and minerals (Thakur *et al.* 2010; Thakur *et al.* 2011) [62, 63]. Wild pomegranate is the only commercial fruit crop of mid hills of Himalaya with different types of phyto-nutrients in the form of anthocyanins, phenolics and flavonoids that impart antioxidant properties in addition to color (Sharma and Thakur, 2016) [50]. The bio-active components are mainly concentrated in the juicy arils of the fruit and the presence of sufficient amount of the organic acids, vitamins and minerals have led (Sharma and Thakur, 2016) [50] to categorize it as a functional food with nutraceutical properties. Considering the nutritional and nutraceutical properties of the wild pomegranate, its industrialization in the form of different commercial processed products is very important in fulfilling the nutrient requirements of the people in developing countries particularly as a cheaper source of bio-active components as compared to cultivated one. The purpose of this review paper is to show the literature related to physico-chemical constituents of wild pomegranate and identifies future prospects for the utilization of this underutilized pomegranate on the basis of its nutritional value.

Bioactive components and medicinal value of wild pomegranate fruit
Bioactive components in plants are phyto-chemicals produced by plants having nutraceutical effects in man and animals when indigested in desirable quantity. Although nutrients give health promoting effects but can impart toxicological effects when consumed at high dosages. The bioactive compounds in plants are produced as secondary metabolites. Thus, plant components as secondary metabolites having health promoting properties are called bioactive compounds. The importance of antioxidant constituents in the maintenance of health and protection from coronary heart disease and cancer is raising considerable interest among scientists, food manufacturers and consumers as the trend of the future is moving toward

functional food with specific health effects. *In vitro* studies indicated phyto-nutrients such as antioxidants and phenolics may play a significant role, in addition to vitamin in protecting biological systems from the effects of oxidative stress (Nimse and Pal, 2015) [49]. Wild pomegranate is a significant source of bioactive components including phenolics, organic acids and anthocyanins (Sharma and Thakur, 2016) [50]. Due to appreciable level of variety of different components present, wild pomegranate is considered as a functional food with significant health promoting properties (Sharma and Thakur, 2016) [50]. The organic acids, anthocyanins and polyphenpols are found in abundance in wild pomegranate fruit. Wild pomegranate fruit is a rich source of organic acids. Citric acid is found as a major acid in this fruit, whereas, malic, oxalic, succinic and tartaric acids are found in lower concentrations (Kalyankar *et al.* 1952) [25]. The traditional use of the wild fruit is found in the form of a dried condiment which is known as *anardana* in Indian market (Kingsley *et al*. 2006, Kingsley and Singh) [30, 31]. *Anardana* is used as an acidulant in many Asian cusines, curries and also as an important medicinal ingredient in many Ayurvedic and Unani formulations for the treatment of infections such as mouth and stomach inflammations, dysentery, dyspepsia, vomiting, hymenoletidosis and cardiac troubles (Jalikop, 2002) [22]. Anthocyanins are water-soluble pigments which are derivatives of anthocyanidins. These pigments may appear red, purple or blue in the tissues of plants such as leaves, roots, fruits and flowers. They belong to a group of phyto-chemicals called flavonoids synthesized via the phenylpropanoid pathway. The color of these pigments is induenced by pH and metal ion complexes. The importance of anthocyanins in food goes beyond as natural pigments and biological functions and actions have increasingly been attributed to these pigments. The anthocyanins present in wild and cultivated pomegranates has a powerful singlet oxygen scavenging activity and its high levels in the blood plasma have an impact on lowering down the risk of various cancers (Chrong *et al.* 2007) [14]. Plant polyphenols are secondary metabolites that are widely distributed in higher plants. Polyphenols were considered as anti-nutrients, because some of these viz., tannins, have side effects in human body as they disturbe the functionality of digestive enzymes, decrease amino acids, proteins and mineral availabilities (Salunkhe *et al.* 1982) [47]. After recognition of the anti-oxidative functions of many phenolics have catched attention of nutritionists and nutraceutical companies (Bravo, 1998) [11]. Both phenolics and anthocyanins have been found with potential anti-oxidative and anti-carcinogenic properties (Pool *et al.* 1999) [45].

Maturity and harvesting of wild pomegranate

Maturity and harvesting are the factors which affect the quality of fruits. Wild pomegranate is a non-climactric fruit which is harvested at ripe stage (Ben Arie *et al.* 1984; Elyatem *et al.* 1984) [4, 17]. At maturity, the surface of green immature wild pomegranate fruit turned to yellowish green (Bhat, 2007; Dhaygude, 2010) [6, 16], whereas, the green purple rind colour of immature fruit of cultivated pomegranate turned to deep pink with reddish and yellowish patches at maturity. The milky white colour of arils at early stage turns to creamy pearl white when fruit matures and with the advancement of fruit maturity, the percentage of arils increases, while that of seed, rind and the thickness of rind decreases gradually in pomegranate (Khodade *et al*. 1990) [29].

In case of pomegranate varieties like Wonderful and Rosh-Hapered, the level of total phenols, antioxidant activity and hydrolysable tannins reduces in the peels during maturation while the anthocyanins level increases (Shwartz *et al.* 2009) [56]. This knowledge could help to establish the optimum harvest date ensuring the maximum nutritional properties of cultivated as well as wild pomegranate.

Physical attributes of fruit

Size

Parmar and Kaushal (1982) [41] have reported diameter of wild pomegranate fruit in the range of 4.2 to 6.6 cm, whereas, Pant (1995) [40] reported a wide variation in this fruit length (5.31 cm to 7.53 cm) and diameter (4.35 cm to 6.50 cm). However, Kher (1999) [28] has observed the average length and diameter in this fruit as 4.95 cm and 5.65 cm, respectively. Anon (2006) [2] has reported wide variation in diameter of same fruit which ranged from 3.3 cm to 7.7 cm. Size of this fruit with length and breadth as 5.6 cm and 4.8 cm, respectively has been observed by Singh and Kingsley (2008) [58]. In other studies, Thakur *et al.* (2010) [62] have observed average length and diameter of this fruit as 5.89 cm and 4.64 cm, respectively from Narag area of Sirmour district of H P. Whereas, wide variation in the length and breadth in this fruit ranging from 46.90 to 62.80 mm and 44.60 to 54.20 mm, respectively has been reported by Thakur *et al.* (2011) [63]. Sharma and Thakur (2016) [50] also recorded average length and diameter of wild pomegranate fruits as 55.99 mm and 43.26 mm, respectively from Karsog area of Mandi district of HP.

Whereas, the dimensions of cultivated pomegranate cultivars are higher as compared to this fruit. The length and diameter of different cultivated pomegranate cultivars ranged from 7.03 to 7.90 cm and 7.22 to 8.33 cm, respectively have been reported by various workers (Khodade *et al*. 1990; Patil *et al.* 2003; Singh and Sethi, 2003 and Jashkaran *et al.* 2005) [29, 42, 59, 23].

Weight

The various characteristics including weight of wild pomegranate fruit show wide variations depending upon geographical locations. Parmar and Kaushal (1982) [41] and Kher (1999) [28] have reported a narrow range of weight as 80.50 g to 85.17g in this fruit. Pant (1995) [40] have reported average weight of this fruit in the range of 59.77 to 101.0 g from different geographical locations of HP. According to Anon (2006) [2] the weight of this fruit ranged from 37 to 250g. Singh and Kingsley (2008) [58] have reported an average fruit weight as 63g in this fruit. Similarly, average weight of this fruit from Narag area of Sirmour district of HP was observed to be 64g (Thakur *et al*. 2010) [62] and Karsog area of Mandi district of HP as 61g (Sharma and Thakur, 2016) [50]. Thakur *et al.* (2011) [63] have reported the range of 55.10 to 83.50g for the same characteristic of this fruit.

The, average weight of cultivated cultivars was found to be higher (134.3-385.0 g) than the wild pomegranate fruits as reported by various workers (Bose 1986; Khodade *et al.* 1990; Patil *et al.* 2003; Singh and Sethi, 2003; Patil *et al.* 2005) [9, 29, 23, 59, 43]. Whereas, Malhotra *et al.* (1983) [34] have reported lower fruit weight in twenty one pomegranate cultivars ranging from 56.8 to 124.7 g.

Colour

Colour is a very important indicator of quality of fresh fruit. It also helps in estimating the stage of maturity of fruit. Chief pigments of fruits which impart the colour are chlorophylls,

carotenoids, anthocyanins etc. Parmar and Kaushal (1982) [41] and Kher (1999) [28] have, 42procured from different districts of HP has also been reported as greenish yellow by Thakur *et al.* (2011) [63] and Sharma and Thakur (2016) [50].

Various shades of red colour of different cultivars of pomegranates were observed by Cheema *et al.* (1949) [13] and Nath and Randhawa (1959) [39]. Malhotra *et al.* (1983) [34] have also reported that colour of twenty one cultivars of pomegranate fruits were either pink or rose with various intensities. The colour of cultivated pomegranate fruit was recorded reddish to the extent of 70 to 90 per cent by Shulman *et al.* (1984) [55]. Whereas, Singh and Sethi (2003) [59] have reported yellow and red coloured fruits while screening seven pomegranate cultivars for making *anardana*.

Weight of arils

Kher (1999) [28] has recorded average weight of 100 arils of wild pomegranate fruit as 12.65g, whereas, an average weight of 100 arils of this fruit as 15.34 g was reported by Thakur *et al.* (2010) [62]. Thakur *et al.* (2011) [63] have reported a range of weight of arils per fruit as 33.00 to 48.70g from different districts of HP.

Malhotra *et al.* (1983) [34] recorded highest and lowest aril weight as 25.2 and 14.7g, respectively, among twenty one cultivars of pomegranate. Singh and Sethi (2003) [59] after screening seven pomegranate cultivars have reported that weight of 100 arils ranged between 21.73 to 29.41g, whereas, weight of same number of arils was observed as 32.2 g in Ganesh cultivar (Patil *et al*. 2003) [43].

Colour of arils

Various colour shades of arils of wild pomegranate fruit were observed to be pink to blood red (Parmar and Kaushal, 1982) [41]. Bhat (2007) [6] and Sharma and Thakur (2016) [50] have reported pink colour of arils of this fruit in his studies. Whereas, Thakur *et al.* (2011) [63] have recorded red purple colour of arils of mature wild pomegranate fruit procured from different geographical locations of HP.

Malhotra *et al.* (1983) [34] have observed various shades of pink and red rose colour in arils of different cultivars of pomegranate. Various colour shades from pinkish white to bright maroon red in seven pomegranate genotypes have been reported by Singh and Sethi (2003) [59]. Patil *et al.* (2005) [42] and Jashkaran *et al.* (2005) [23] have reported pink to red colour shades of arils from cultivated pomegranates.

Edible portion

Parmar and Kaushal (1982) [41] have reported 64 per cent edible portion in wild pomegranate fruits from HP. Bhat (2007) [6] has recorded aril pomace ratio of this fruit as 1.04. Whereas, aril pomace ratio of 1.50 of this fruit from different districts of HP has been reported by Thakur *et al.* (2011) [63].

Edible portion in cultivated pomegranate cultivars was recorded to be in the range of 61 to 68 percent by various workers (Sood *et al*. 1982; Khodade *et al.* 1990; Singh and Sethi, 2003; Jashkaran *et al.* 2005) [61, 29, 59, 23].

Chemical and nutritional attributes of fruit

Chemical composition of wild pomegranate fruit varies with strain, location and area where it is grown. The genetic differences in the plants also cause variation in chemical composition of wild pomegranate fruits of different plants (Sharma and Sharma, 1990) [52]. Pundir and Pathak (1980) [46] have also observed variation in chemical composition of different pomegranate cultivars.

Moisture

Parmar and Kaushal (1982) [41] have reported 69.5 per cent moisture content in wild pomegranate fruits. Chauhan *et al.* (1994) [12] reported slightly higher content of moisture content as 76.8 per cent in this fruit. Moisture content of this fruit has been reported to be 73.31 and 71.10 per cent by Thakur *et al.* (2010) [62] and Sharma and Thakur (2016) [50], respectively. Thakur *et al.* (2011) [63] have also reported moisture content of this fruit from different geographical locations of HP in the range of 73.20 to 74.60 per cent.

Studies conducted on the moisture content of cultivated pomegranate fruits showed higher values ranging from 76.00 to 82.85 per cent (Sood *et al*. 1982; Bomble, 2000; Sandhan, 2003; Singh and Sethi, 2003; Jashkaran *et al.* 2005) [61, 8, 48, 59, 23].

Total soluble solids (TSS)

Parmar and Kaushal (1982) [41] have reported 15.5^0B TSS of wild pomegranate fruits, whereas, Sharma and Sharma (1990) [52] reported the range of TSS as 12 to 17^0B in the same fruit obtained from Nauni area of district Solan of HP. TSS of this fruit as 10.6 to 14.0^0B from different geographical locations of HP has been reported by Pant (1995) [40]. Singh and Kingsley (2008) [58] have reported 16.4^0B TSS in the same fruit from Solan district of HP, whereas, TSS as 20.08^0B in this fruit from Sirmour district and 18.00^0B from Mandi district has been reported by Thakur *et al.* (2010) [62] and Sharma and Thakur (2016) [50], respectively. A narrow range of TSS (15.40 to 16.50 ^{0}B) in this fruit from different districts of HP has been reported by Thakur *et al.* (2011) [63].

TSS in the cultivated pomegranates has been reported in the range of 8.6 to 18.0 ^{o}B by various workers (Malhotra *et al*. 1983; Khodade *et al.* 1990; Jagtap *et al.* 1992; Bomble, 2000; Singh and Sethi, 2003; Patil *et al.* 2003; Patil *et al.* 2005; Jashkaran *et al.* 2005) [34, 29, 21, 8, 59, 43, 42, 23].

Titratable acidity

Wild pomegranate fruit is a potential source of organic acids because of which it is used as an acidulant in various culinary preparations. Citric acid is found as a dominating acid in this fruit (Kalyankar *et al.* 1952) [25]. As high as 9 per cent citric acid from this fruit has been obtained by Damirov and Shukybrov (1958) [15]. Parmar and Kaushal (1982) [41] have reported 5.53 per cent titratable acidity in this fruit. Its range from 4.6 to 8.7 per cent has also been reported in the fruits of Nauni area of district Solan (Sharma and Sharma, 1990) [52]. Singh and Kingsley (2008) [58] found titratable acidity of wild pomegranate fruits as 6.68 per cent which is higher as compared to the observations of Thakur *et al.* (2010) [62] and Sharma and Thakur (2016) [50] who recorded 3.96 and 3.87 percent titratable acidity in this fruit from Sirmour and Mandi district of HP, respectively. Thakur *et al.* (2011) [63] have also reported titratable acidity ranging from 3.20 to 3.65 per cent in the same fruit from different geographical locations of HP.

In cultivated pomegranate the titratable acidity has been found lower (0.28-3.86%) as compared to the wild pomegranate fruit (Sood *et al.* 1982; Malhotra *et al.* 1983; Khodade *et al.* 1990; Jagtap *et al.* 1992; Singh and Sethi, 2003; Patil *et al.* 2003; Grande *et al.* 2004; Jashkaran *et al.* 2005; Patil *et al.* 2005) [61, 34, 29, 21, 59, 42, 20, 23, 42].

pH

pH is an important quality attribute for wild pomegranate fruit's processing and it is affected by fruit maturity and over maturity. Sharma and Sharma (1990) [52] and Chauhan *et al.*

(1994) [12] have reported pH in the range of 2.72 to 3.02 in wild pomegranate fruits. Singh and Kingsley (2008) [58] have observed pH as 2.47 in this fruit from Solan district of HP, Thakur *et al.* (2010) [62] recorded pH of this fruit from Narag area of Sirmour district as 2.55 and Sharma and Thakur (2016) [50] have reported 2.62 pH for wild pomegranate fruit of Karsog area of Mandi district of HP. Thakur *et al.* (2011) [63] have recorded pH in the range of 2.80 to 3.15 of same fruit from different geographical locations of HP.

Patil *et al.* (2003) [43] have recorded a pH value of 3.44 in the pomegranate cultivar Ganesh. However, lower pH values of 3.02, 2.93 and 2.95 have been recorded by Patil *et al.* (2005) [42], in the pomegranate cultivars like Ganesh, Kesar and Arakta, respectively.

Sugars

Sugars with reducing property (having aldehyde and keto groups) are called as reducing sugars, whereas, total sugars are comprised of both reducing and non-reducing sugars. Glucose and fructose are found as principal sugars in pomegranates, whereas, sucrose is usually absent (Shrivastva, 1953; Siddappa and Bhatia, 1954; Anon, 1969; Lee *et al.*, 1974) [54, 57, 3, 33].

Parmar and Kaushal (1982) [41] have reported reducing and total sugars content as 8.87 and 10.01 per cent, respectively in wild pomegranate fruits. The reducing sugars of 6.7 per cent and total sugars as 7.8 per cent in this fruit have been reported by Sharma and Sharma (1990) [52]. Slightly lower contents (4.47% and 6.82%) of reducing and total sugars in the same fruit have been reported by Pant (1995) [40]. Singh and Kingsley (2008) [58] observed 8.3 and 9.1 per cent reducing and total sugars, respectively in this fruit from Solan district of HP, whereas, Thakur *et al.* (2010) [62] recorded reducing and total sugars content of 7.07 and 7.28 per cent, respectively in this fruit from Narag area of Sirmour district of HP. The reducing and total sugars contents in range of 6.85 to 7.75 per cent and 7.85 to 8.55 per cent, respectively in this fruit, were reported by Thakur *et al.* (2011) [63], while, the reducing and total sugars in the arils of wild pomegrantate fruits of Mandi district of HP were found to be 7.67 and 8.48 per cent, respectively by Sharma and Thakur (2016) [50].

In cultivated pomegranate fruits, reducing and total sugars have been observed, varying between 5.70 to 14.99 per cent and 6.20 to 15.74 per cent, respectively (Abdurazakova and Gabbasova, 1968; Sood *et al*. 1982; Malhotra *et al.* 1983; Khodade *et al.* 1990; Jagtap *et al.* 1992; Nakadi, 1998; Ghule, 1998; Kumbhar, 1998; Shelar, 2001; Sandhan, 2003; Patil *et al.* 2003; Singh and Sethi, 2003, Jashkaran *et al.* 2005, Patil *et al.* 2005) [1, 61, 34, 29, 21, 38, 18, 32, 53, 48, 43, 59, 23, 42].

Ascorbic acid

Fruits are considered to be important sources of ascorbic acid which is also known as vitamin C. Vitamin C or l-ascorbic acid participate in oxidation reactions in fruits and vegetables. Parmar and Kaushal (1982) [41] have reported higher amount of vitamin C (36.62 mg/100g) in wild pomegranate fruits, however, comparatively lower amount of vitamin C (20.2 mg/100g) in the this fruit from Nauni area of district Solan has been reported by Chauhan *et al.* (1994) [12]. Singh and Kingsley (2008) [58] have reported a lower amount of vitamin C as 17.24 mg/100g in this fruit from Solan district of HP. However, Thakur *et al.* (2010) [62] has reported ascorbic acid as 21.08 mg/100g in the same fruit from Narag area of Sirmour district. Vitamin C content of wild pomegranate fruit in the range of 16.83 to 21.14 mg/100g has been reported by Thakur *et al.* (2011) [63] and an average of 23.06 mg/100g has been observed by Sharma and Thakur (2016) [50].

It has been reported that cultivated pomegranates are poor source of ascorbic acid (Besaric and Rikovski, 1946). Reports of these workers have also been endorsed by Petrosini (1947) [44] who reported that pomegranates are poor source of vitamin C. He reported a very low content of 6 mg/100g of ascorbic acid in pomegranate fruits of South Italy. Somewhat similar values for vitamin C content of pomegranate fruits have been reported by Malhotra *et al.* (1983)[34] from Indian cultivars. They reported 4.29 to 8.92 mg per 100 g ascorbic acid from twenty one cultivars of pomegranate. Singh and Sethi (2003) [59] have reported higher (21.73 to 29.41 mg per 100 g) contents of ascorbic acid from seven pomegranate cultivars.

Phenols

Phenols, the aromatic compounds with hydroxyl groups are widespread in plant kingdom. An array of compounds like tannins, flavanols, etc. come under phenolic compounds. Polyphenols confer on fruits and vegetables qualities and help in development of final colour, taste and aroma of many products.

Parmar and Kaushal (1982) [41] have reported an insignificant amount of tannin content in the edible part of wild pomegranates, whereas, tannin content of wild pomegranate fruit was reported to be in the range of 103.4 to 147.2 mg per 100 ml of juice (Sharma and Sharma, 1990) [52]. Thakur *et al.* (2010) [62] and Sharma and Thakur (2016) [50] have reported almost similar phenolic content of 89.78 and 89.67 mg/100g in this fruit from Narag area of Sirmour district and Karsog area of Mandi district of HP, whereas, Thakur *et al.* (2011) [63] recorded comparatively higher contents of phenolic compounds (108.5 to 116.3 mg/100g) in this fruit from different locations of HP.

Presence of sufficient polyphenolic compounds (catechins, flavonols etc.) in the juice of unripe pomegranate fruit have been reported by Joslyn and Smith (1954) [24]. Markh and Lysogor (1973) [35] also identified a number of polyphenols like chlorogenic acid, neo-chlorogenic acid and n-caumaric acid from the juice of 16 cultivated pomegranates from central Asia. The catechins and flavonols in the juice and peel of pomegranate cultivars of Syria and Azerbaijan have also been reported by Botrus *et al.* (1984) [10]. Khodade *et al.* (1990) [29] reported a very minute content of tannins (0.28 percent) in fresh pomegranate arils. However, Patil *et al.* (2005) [42] reported tannins varying between 76 to 91 mg per 100g of fruit in some pomegranate cultivars, whereas, Jashkaran *et al.* (2005) [23] observed higher amount (169.4-336.2 mg/100g) of tannins in the pulp of four pomegranate cultivars.

Anthocyanins

Anthocyanins are the plant pigments which come under flavonoids. They are water soluble and are invariably present in the juices of fruits and vegetables. These are red, blue and purple pigments which impart colour to many fruits and vegetables. In fruits, they affect aesthetic appeal and also act as antioxidants. Colour of wild and cultivated arils is attributed to anthocyanins. Leuco-anthocyanidins in wild unripe pomegranate fruit have been reported by Khanna (1964) [27]. Thakur *et al.* (2010) [62], during their studies observed 7.37 mg/100g of anthocyanins in wild pomegranate fruit arils, whereas, Sharma and Thakur (2016) [50] recorded 9.73 mg/100g. Thakur *et al.* (2011) [63] reported anthocyanin

content in range of 15.12 to 20.05 mg per 100g in the same fruit from different districts of HP.

Sharma and Sheshadri (1965) [51] observed Malvadin pentose glucoside anthocyanin in Indian pomegranates. Markh and Lysogor (1973) [35] identified Cyanidin-3, 5-diglucoside, Cyanidin-3-glucoside and Delphinidin-3-glucoside from the juice of 16 cultivars of cultivated pomegranates from Central Asia. Pomegranate juices of different cultivars were analyzed by Skorikova *et al.* (1986) [60] and they have concluded that by changing the pH value there is change in anthocyanin pigments. Singh and Sethi (2003) [59] have recorded a wide variation in anthocyanins of seven pomegranate cultivars ranging from 10.30 to 17.85 mg/100g of fruit. Whereas, Jashkaran *et al.* (2005) [23] found very less anthocyanins content varying from 0.44 to 1.62 mg per 100 g of fruit in four pomegranate cultivars viz., Arakta, Kandhari, Muskat and Ganesh. A wide range of total anthocyanins content in fresh pomegranate arils has been found to be 8.96 to 76.44 mg/100g (Anon, 2006) [2].

Pectin

Pectic substances abundantly exist in the middle lamella of the plant cells. The pectin of fruits vary in their methoxyl content and in jellying power. These are polymers of sugar acids of fruits that forms jell with sugars and acids. Parmar and Kaushal (1982) [41] have reported pectin content as 0.06 per cent in the juice extracted from wild pomegranate arils. Thakur *et al.* (2010) [62] have observed 0.70 percent pectin content in wild pomegranate fruits of HP, whereas, Sharma *et al.* (2016) [50] have observed 0.70 percent of pectin. Thakur *et al.* (2011) [63] reported lower amount of pectin (0.30-0.40 per cent) in the same fruit from different geographical locations of HP.

The edible portion of cultivated pomegranate fruit contained 1.4 per cent pectin (Gill *et al.* 2000) [19]. Jashkaran *et al.* (2005) [23] observed the pectin content of 1.5, 1.4, 1.3 and 1.2 per cent in pomegranate cultivars like Kandhari, Arakta, Muscat and Ganesh, respectively.

Ash

Ash content of fruit represents the total minerals present in it. It is obtained as an inorganic residue after destruction of organic matter. Parmar and Kaushal (1982) [41] have recorded 1.49 per cent ash content in wild pomegranate fruit, whereas, a lower amount (0.5%) in edible portion of the same fruit was reported by Chauhan *et al.* (1994) [12]. Thakur *et al.* (2010) [62] and Sharma and Thakur (2016) [50] have reported 0.90 and 0.87 percent of ash content, respectively in this fruit, however, in similar studies, slightly low percentage of ash content (0.70%) was observed by Thakur *et al.* (2011) [63].

Markh (1984) [36] has reported the presence of major minerals like potassium, sodium, calcium, magnesium and phosphorous with minor elements like copper, zinc, iron, magnesium, molybdenum, cobalt, chromium, vanadium, lead and zirconium in Syrian pomegranate fruit. Total mineral content ranging from 0.59 to 0.76 per cent has been reported in various cultivars of pomegranate by various workers (Sood *et al.* 1982; Patil *et al.* 2003; Jashkaran *et al.* 2005) [61, 43, 23].

Conclusion

The consumption of pomegranate has grown tremendously due to its reported health benefits. Pomegranate and derivates, such as juice, peel, and seeds, are rich sources of several high-value compounds with potential beneficial physiological activities. The rich bioactive profile of pomegranate makes it a highly nutritious and desirable fruit crop. The consumption of pomegranate has grown tremendously due to its reported health promoting effects. Wild form of pomegranate have been found as rich as pomegranate fruits because of the presence of various chemical components which have potential beneficial physiological activities. The presence of valuable bioactive components makes this fruit highly nutritious. The findings of various researchers revealed that wild pomegranate have higher amount of certain bioactive compounds such as organic acids in comparison to cultivated one. As a result, there have been increasing the interest of utilization of wild and underutilized fruits as food because of their health promoting benefits. Using low cost value added products of this fruit can ultimately offer society a way of utilizing the broad health benefits of this fruit as it has been reported to be a very rich source of nutritional components by various research workers in their previous studies.

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