

# *Unlocking the Potential of Pomegranates: The Health Benefits, Bioactive Compounds, and Cultivation Practices*

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## **ABSTRACT**

*Punica granatum*, popularly referred to as pomegranates, belongs to the Punicaceae monogeneric family and is primarily found in Iran. It is the most adaptable subtropical fruit crop, introduced to India in the fifteenth century from the Mediterranean region. Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, and Rajasthan are the states where it is grown for commercial use. It contains significant phytochemical elements such as ellagic acid, ellagitannins, Punic acid, flavonoids, anthocyanins, estrogenic flavonoids, and flavones, it has a wide range of therapeutic applications. Treatments for ulcers, snakebites, liver damage, dysentery, diarrhoea, helminthiasis, acidosis, bleeding, and respiratory issues have all been linked to these ingredients. Additionally, sustainable farming methods that emphasize agronomic breakthroughs that improve pomegranate crop quality, productivity, and environmental resilience. Pomegranate nutritional integrity and biodiversity are mentioned as being strongly correlated with the use of organic and environmentally friendly farming practices. Pomegranates are becoming recognized as an important resource for improving both

sustainable farming methods and human health. This review summarises all the cultivation practices, the bioactive components of pomegranates, and their nutritional qualities as functional foods, focusing on the fruit's peel, seed, and aril byproducts.

## INTRODUCTION

Pomegranate is a prominent fruit crop in arid and semiarid areas of the world. The pomegranate tree is a small shrub that grows to a height of five to eight meters. It is mostly found in Iran, China, the USA, the Himalayas in northern India, and the Mediterranean region (Facciola S. Cornucopia, 1990). It is derived from the Latin words *pomum*, which means apple, and *granatus*, which means full of seeds (Archana Kumari, 2012). Pomegranates usually have a chromosome number of  $2n=2x=16$ , resulting in diploids. However, some of them (like Double Flower, an ornamental variation that exclusively produces flowers) are believed to contain  $2n=2x=18$  chromosomes.

Pomegranates are renowned for several unique characteristics. they can survive in tough and unfavourable environments. It can tolerate heat, drought, and a lack of moisture. There are opportunities to increase the area under pomegranates in India due to their versatile adaptability, hardiness, low maintenance costs, steady but high yields, better-keeping quality, fine table, and therapeutic values. They also offer the option to put the plant into rest periods when irrigation potential is typically low. It is extremely valuable nutritionally and medicinally. One of the best sources of antioxidants is pomegranates.

Pomegranates have various anatomical compartments that can be separated, such as the seed, juice, peel, leaf, flower, bark, and root. Each of these compartments has unique pharmacological and toxicological properties. The fruit that can be eaten is a berry that has a diameter of approximately 5 to 12 cm, a rounded hexagonal form, thick reddish skin,

and 600 or more seeds. The seeds are surrounded by a water-filled pulp called an aril that can be white, deep red, or purple in colour. The aril is the portion of the fruit that can be eaten. There is a white pulp that is astringent and spongy around the seeds (Stover & Mercure, 2007).

The fruit has been extensively used as an ancient remedy for treating respiratory diseases, bleeding, helminth infection, acidosis, dysentery, and microbiological infections.

Seed oil has anti-inflammatory properties (Cáceres et al., 1987). The rind of *P. granatum* has antioxidant properties in both its alcoholic and aqueous extracts (Rajan et al., n.d.). Estrone and estradiol, both estrogenic substances, exist in seeds (Kim & Choi, 2009). For the treatment of colic, colitis, menorrhagia, oxyuriasis, headache, diuretic, acne, piles, allergic dermatitis, and oral illnesses, the fruit's juice and dried pericarp are believed to be therapeutic (Ricci et al., 2006).

Plant part	Chemical constituents
Juice	Anthocyanins, quercetin, rutin, gallic acid, catechin, glucose, ascorbic acid, caffeic acid, numerous minerals, amino acids
Seed oil	Punicic acid, ellagic acid, 10 different fatty acids, 14 types of sterols
Pericarp	Phenolic punicalagins, gallic acid, catechin, quercetin, rutin, anthocyanins, flavones, flavonones
Leaves	Tannins and flavone glycosides
Flowers	Gallic acid, ursolic acid, triterpenols, asiatic acid
Roots & Bark	Ellagitannins, numerous piperidine alkaloids

Source: (Mohd. Vaseem Fateh1, 2013)

Pomegranates have been shown in the literature to have significant medicinal benefits, including the ability to operate as an antioxidant and as an antitumor, with various extracts derived from different portions of the plant (Zhang et al., 2011) The presence of bioactive substances known as "tannins" is what causes these biological actions. Tannins are substances that are found naturally in the kingdom of plants. Because tannins are astringent and can form compounds with proteins and polysaccharides, their primary role in plants is protection against microbes and animal attacks (Aguilera-Carbo et al., 2008).

### Taxonomy

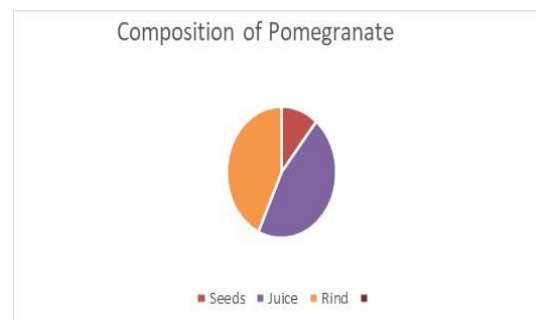
Scientific classification of *Punica granatum* L.

<b>Kingdom</b>	<b>PLANTAE</b>
<b>Division</b>	MAGNOLIOPHYTA
<b>Class</b>	MAGNOLIOPSIDA
<b>Subclass</b>	ROSIDAE
<b>Order</b>	MYRTALES
<b>Family</b>	PUNICACEAE
<b>Genus &amp; Species</b>	<i>Punica granatum</i> L.

There are two different species of pomegranate named *Punica granatum* and *Punica protopunica*. The most common species, *P. granatum*, is grown around the world whereas *P. protopunica* is limited to the Island of Socotra (Mohd. Vaseem Fateh1, 2013).

### 1. Nutritional composition

Pomegranate seeds have a high level of carbohydrates and protein and a low amount of fat. It has a significant amount of vitamin C, which is good for the immune system and blood coagulation. This fruit contains potassium, an essential mineral for the body that is needed for healthy blood pressure regulation, muscle synthesis, and nerve transmission (Abbas Syed, 2018).



Pomegranate seeds have the following approximate composition: percentage moisture (8.6%), total lipids (27.2%), crude fiber (35.3%), crude protein (13.2%), total sugars (4.2%), pectin (6%), and ash (2%); trace minerals include sodium (6 ppm), iron (1.3 ppm), potassium (45.2 ppm), magnesium (12.4 ppm), copper (1.2 ppm), and zinc (1 ppm) (Shahrajabian & Sun, 2023).

Components	Amount per gram	% Daily values
<b>Calories</b>	105	5
<b>Carbohydrates</b>	26.44 g	9
<b>Fats</b>	0.46 g	1
<b>Proteins</b>	1.46 g	5
<b>Cholesterol</b>	0 mg	0
<b>Dietary Fiber</b>	0.9 g	4
<b>Vitamin A</b>	Per serving	3
<b>Vitamin C</b>	-	16
<b>Iron</b>	-	3

Source: (Abbas Syed, 2018)

### 2. Production of Pomegranate

Pomegranate production and area have grown steadily throughout the nation over the years. It is grown on 2.78 lakh hectares in 2020–21, yielding 31.87 lakh MT of output. Pomegranates are grown on 1.62 lakh hectares in Maharashtra, where they yield 17.48 lakh MT of fruit.

It is a crop that is perfect for small holdings to be sustainable since it fits in well with the agro-climate and topography of dry and semi-arid locations. Additionally, because it has a great potential for using wastelands that are commonly available in the area and is a perfect

crop for diversification, it offers plenty of opportunities for livelihood stability (NHB).

State	Production (2021-22)
Maharashtra	1763.99
Gujarat	684.32
Karnataka	305.72
Andhra Pradesh	283.54
Madhya Pradesh	75.16
Rajasthan	70.31
Telangana	16.96
Chhattisgarh	6.14
Tamil Nadu	3.35
Himachal Pradesh	2.83
Total	3212.32

**Source:** National Horticulture Board (NHB)

### 3. Agronomic Practices

#### Soil requirement

It can flourish on a variety of soil types, pomegranates Favor deeply loamy or alluvial soil that is prolific, rich in humus, medium in thickness, and has excellent seepage. Although it can withstand soil alkalinity up to pH 7.5 and an active lime content of 12–15%, it thrives in neutral soil (pH 5.5–7.0).

Despite being a salt-tolerant plant, too much salt buildup in the soil (more than 0.5%) is detrimental (Wang HuanXing Wang HuanXing, 2003). Throughout the growing season, it is advised that the soil retain enough moisture, which helps to minimize splitting, growth, and production (KK Sharma, 2006).

#### Climatic Conditions

Pomegranates are naturally adapted to areas with moderate winters and hot summers, and they Favor a semi-arid mild-temperate to subtropical climate. Fruit formation is negatively impacted by a humid environment. Below-12°F temperatures might do serious harm to the tree.

#### Varieties Cultivated

Important pomegranate varieties cultivated in India are Alandi or Vadki, Dholka, Kandhari,

Kabul, Muskati Red, Paper Shelled, Spanish Ruby, Ganesh (GB I), G 137, P 23, P 26, Mridula, Aarakta, Jyoti, Ruby, IIHR Selection, Yercaud 1 and Co 1. **Source:** National Horticulture Board (NHB).

#### Irrigation

Regular irrigation weekly in the summertime and biweekly in the winter is advised to get a larger fruit yield while inconsistent watering leads to the creation of cracked fruits (Badizadegan, 1975). Once established, pomegranates can withstand extended periods of drought; nevertheless, irrigation is necessary to ensure optimal fruit output. During the dry season, young plants need to be watered every two to four weeks to establish. The plants may survive in soil and water that is somewhat salinized.

#### Nutritional Requirement

A tree should get 600–700 g of N, 200–250 g of P<sub>2</sub>O<sub>5</sub>, and 200–250 g of K<sub>2</sub>O per year in fertilizer. For a five-year-old tree, applying 10 kg of farmyard manure and 75 g of ammonium sulphate every year is sufficient; however, applying 50 kg of farmyard manure and 3.5 kg of oil cake or 1 kilogram of ammonia sulphate before blooming is optimal for fruiting and healthy growth (National Horticulture Board).

Age of plant (in years)	Dose of Fertilizer/Plant/Year			
	FYM (kg)	N (g)	P (g)	K (g)
2	5	250	125	125
3	10	500	125	250
4	20	500	125	250
5	20	500	125	250
Above 5	30-40	625	250	250

**Source:** National Horticulture Board (NHB)

Fruit weight, length, diameter, and ascorbic acid content increased due to foliar spraying with calcium chloride and urea. Proline and tryptophan therapy also resulted in increased

fruit quality, production, and growth (El Sayed et al., 2014).

(Wasaki et al., 2003) found that intercropping increases the rhizosphere's ability to mobilize nutrients, which boosts component crop growth and production. Vegetables, legumes, and green compost crops are advised as intercrops until the main crop is four to five years old.

### Propagation

It is mostly propagated by clonal, or vegetative methods. Sexual propagation is not, however, a business endeavour. With the exception of India, where air-layering is more common, most of the globe uses stem cutting as the primary propagation technique. (Chandra & Dhinesh Babu, 2010) Cuttings root easily and plants from them bear fruit after about 3 years. Twelve to 20 inches long cuttings should be taken in winter from mature, one-year old wood. The leaves should be removed and the cuttings treated with rooting hormone and inserted about two-thirds their length into the soil or into some other warm rooting medium. Plants can also be air-layered but grafting is seldom successful (Archana Kumari, 2012).

### Planting Method

The most common planting method is the square system. Climate and soil type are taken into consideration while choosing planting distance. On marginal and extremely light soils, a spacing of 4-5 meters is advised. About a month before planting, 60 X 60 X 60 cm pits are excavated (spaced 5 cm apart in a square pattern) and left exposed to the sun for a period of two weeks. To protect against termites, 50 g. of 5% BHC or carbaryl dust is applied to the sides and bottom of the pits. Top soil combined with 20 kg of farmyard manure and 1 kilogram of super phosphate is used to fill the pits. Watering the pit after filling it helps the dirt settle (NHB).

### Training and Pruning

Plants are trained in systems involving multiple stems or on a single stem. A different strategy is more common in country as crops trained on a single stem training system are more vulnerable to pests like stem borer and shoot hole borer. Except from removing dead and diseased twigs, water shoots, cross branches, and ground suckers, pruning is not really necessary. Pruning also helps the tree take on shape. To promote the formation of new spurs, some thinning and trimming of older ones is done (NHB).

### Flowering and Fruiting

Bahar	Flowering Period	Harvesting Period	Advantages	Disadvantages
Ambe Bahar	February to March	June to August	Fruit matures during dry periods having attractive color and good quality suitable for export. Low pest and disease incidences.	Require assured irrigation facilities. Poor growth and yield.
Mrig Bahar	June to July	December to January	Flowering and fruiting coincide with the maximum moisture availability period and, hence do not require much irrigation. Suitable for hot and arid regions.	Flowering and fruiting coincide with the rainy season. Not favored in the bacterial blight endemic area.
Hasta Bahar	September to October	March to April	Fruits are attractive with dark-colored arils. Fetch high value due to less availability.	Stress cannot be given during the rainy season. Poor flowering and yield.

Source: (Saroj & Kumar, 2019).

## 4. Plant Protection Measures

### Diseases

Pomegranate fruit can become infected through a variety of routes. These include infections on the fruit through stigmata, pedicels, wounds from thorn punctures, bird pecks, insect exit holes, or natural cracking, or infections directly through the cuticle (Munhuweyi et al., 2016a). The most dangerous pomegranate anthracnose, caused by *Colletotrichum gloeosporioides*, occurs from July to October. In Karnataka and Maharashtra, pomegranate wilt (*Ceratocystis*



*fimbriata*) has been the most serious disease. The symptoms include abrupt wilting, epinasty, and yellowing of the foliage. The pathogen spreads by infected seedlings; to stop the illness, practice good sanitation by removing and destroying any afflicted trees and sterilizing the soil with formalin (20 ml/L) (M.M. Jamadar et al., 2011).

Name of disease	Causal organism	Symptoms	Affected plant part	References
Alternaria fruit spot	<i>A. alternata</i>	Tiny, round spots, red to brown on the surface of fruits and leaves	Fruits and leaves	(Ezra et al., 2010)
Heart rot	<i>Aspergillus niger</i>	Black sporulating fungus inside the fruits causes decay of fruit skin.	fruits	(Hany M. Yehia, 2013)
Anthrachnose	<i>Colletotrichum gloeosporioides</i>	Round to sporadic, dark brown spots with depressed centers, resulting in fruit decay	Complete plant	(Munhuweyi et al., 2016b)
wilt	<i>Ceratocystis fimbriata, Fusarium oxysporum, Rhizoctonia</i>	Yellowing and withering of leaves causes death of plant in a few weeks	Leaves	(Munhuweyi et al., 2016b)

### Insect Pests

Fruit borer, mealy bugs, aphids, white flies, and fruit sucking moths are the most common insect pests that are seen. Depending on the kind of insect infestation, spraying with dimethoate, deltamethrin, malathion, etc. has been proven to be beneficial in most situations.

### Disorders

Cracking fruit is a serious condition. This physiological disease is primarily caused by moisture imbalances in fully developed fruits, while boron insufficiency is the cause seen in young fruits. In other situations, it has been found to be helpful to spray with calcium hydroxide shortly after fruit set. Tolerant

cultivars, such as Bedana Bose and Khog, may be produced.

### 5. Harvesting

When the fruits begin to take up a characteristic shade and produce a metallic sound when tapped, they are considered ripe. When the fruits get too mature and begin to split, especially after rain, they must be harvested. Similar to apples, pomegranates have an extended shelf life. It keeps best between 32 to 41 degrees Fahrenheit, and it may be stored there for up to seven months at 80 to 85% relative humidity without going bad or shrinking. Fruits get better with storage, becoming more delicious and juicier (Archana Kumar, 2012).

### 6. Post Harvest Management

#### Grading

Fruits are ranked according to their size, color, and weight. There are super, king, queen, and prince-sized grades among others. Pomegranates are likewise rated into two categories: 12A and 12 B. Fruits rated 12-A are typically favored in the north and south.

#### Storage

Fruits can be kept in cold storage for two months or ten weeks at 50 degrees Celsius. To prevent weight loss and chilling harm, longer storage should be at 100 C and 95% RH.

#### Packing

The quality of the fruits determines the size of the packets. The majority of boxes are made of corrugated fiberboard. A single box may contain 4–5 queen-sized fruits, 12 prince-sized fruits, and some fruits from grades 12A and 12B. Red-colored boxes with three plies are utilized for local markets, while white-colored boxes with five plies are typically used for export. Compared to white-colored boxes, red-colored ones are less expensive. Usually, the

waste paper's chopped bits are used as padding.

### Transportation

Due to the ease of access from orchards to the market, road transport by trucks or lorries is the most practical method of transportation.

### Marketing

The bulk of growers either use commission agents at the market or trade agents at the village level to sell their produce.

## 7. The Health Benefits of Pomegranates

- Immune System Support.
- Skin Health.
- Anti-Diabetic Effects.
- Anti-Inflammatory Properties.
- Cancer Prevention.

### CONCLUSION

One of the world's most versatile fruit crops, pomegranates are grown in subtropical regions. Over the past ten years, India has emerged as the world's largest pomegranate grower and exporter. The Deccan Plateau, encompassing the Indian states of Maharashtra, Karnataka, and Andhra Pradesh, is known for its distinct geographical features and climatic circumstances that enable the year-round production of pomegranates. Understanding the physiological issues and illnesses affecting pomegranates is necessary to increase their shelf life and provide a steady supply of fruit all year round. Pomegranates are highly vulnerable to a wide range of illnesses and insect infestations. At the moment, anthracnose poses a serious risk to pomegranates in India, resulting in significant losses and frightening producers. Developing superior cultivars that are resistant to diseases and insect pests requires intense study. Pomegranates have a wealth of bioactive

components, which make them an excellent source of health benefits and functional food. Pomegranate antioxidants, polyphenols, and anti-inflammatory qualities have been the subject of much research, which has demonstrated their effectiveness in boosting immune system function, lowering the risk of diabetes and cancer, and improving cardiovascular health. Punicalagins and ellagic acid, two of the fruit's special chemicals that support cellular defence and general well-being, are responsible for these health advantages. Furthermore, adjustments to current farming methods would help manage the illness more effectively and increase the amount and quality of the crop, which would boost the country's economy.

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