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Pummelo: A future fruit for human health and wellness

Pummelo (*Citrus grandis*/*Citrus maxima*), the largest citrus fruit, is emerging as a promising crop for human health and climate resilience. Increasing climate variability and rising demand for nutraceutical-rich foods highlight its significance. The fruit is rich in vitamin C, dietary fibre, potassium, and bioactive compounds such as flavonoids, limonoids, and carotenoids, which impart antioxidant, anti-inflammatory, and antimicrobial properties. Pummelo demonstrates tolerance to heat, drought, and certain pests and diseases, making it suitable for diverse agro-climatic conditions. Its thick rind, longer shelf life, and suitability for processing and transport enhance its commercial and export potential. Thus, pummelo holds great promise for nutritional security, sustainable horticulture, and future health-oriented food systems.

Keywords: Antioxidant properties, Climate resilience, Nutraceutical value, Nutritional security, Phytochemicals

PUMMELO (*Citrus grandis* Osbeck/*Citrus maxima* (Burm.) Merr.), belonging to the family Rutaceae, is the largest fruit among citrus species. Native to Southeast Asia, it is commonly known as pomelo, shaddock, Chinese grapefruit, and locally as *chakotha* or *chakotara*. The fruit is round to pear-shaped, weighs 500–2,000 g, and has a thick, aromatic rind with 11–18 easily separable segments. The flesh is sweeter and milder than grapefruit, with low acidity and minimal bitterness, and varies in colour from light yellow to deep red. It is also grown as an ornamental fruit due to its large size and attractive peel.

Pummelo is a tropical fruit crop well adapted to subtropical conditions and is widely cultivated in countries such as Indonesia, India, Bangladesh, Thailand, and China. In India, it is mainly grown in homestead gardens, with rich diversity in the North-East region, eastern Uttar Pradesh, Bihar, West Bengal, Karnataka, and Kerala. It holds cultural importance in Bihar during *Chhat* Puja and symbolizes prosperity during Chinese New Year.

Despite being the largest citrus fruit, pummelo remains underutilized in India. However, its high nutritional value, antioxidant properties, vitamins, minerals, and beneficial phytochemicals enhance its medicinal and commercial potential. The thick rind ensures good shelf life and ease of transport, making it suitable for distant markets and export-oriented cultivation.

Nutritional and food value

The nutritional quality of pummelo fruit is remarkable, with several important constituents. It is a rich source of carbohydrates, proteins, vitamins, minerals, and dietary fibre, with negligible fat. It is also enriched with various bioactive compounds beneficial for human health, such as carotenoids, flavonoids, acridones, alkaloids, coumarins, monoterpenes, triterpenes, benzenoids, steroids, limonoids, essential oils, citric acid, and B-complex vitamins.

In addition to being consumed as a table fruit, pummelo is widely processed into products such as soft drinks, blended juices, squash, nectar, jam, wine, fortified bread, candies, and salads. The rind is used for preparing preserves, sweets, sugar pickles, salt pickles, essential oils, pectin, polyphenols, and coumarins. Braised pummelo pith is used in recipes that are low in fat and high in fibre. The highly fragrant flowers, particularly collected in North Vietnam, are used in perfumery. The wood is heavy, durable, and fine-grained, making it suitable for tool handles.

Medicinal and therapeutic values

Pummelo has gained widespread recognition for its phytochemical, ethnobotanical, pharmacological, and medicinal properties. It has been scientifically proven to possess therapeutic potential and is considered safe for human consumption, including cholesterol-lowering effects and support in weight management. Traditionally, pummelo is used as a functional food, and various parts of the plant, including leaves, pulp, peel, seeds, and gum, are utilized for medicinal purposes.

The leaves are known to exhibit antimicrobial, antioxidant, and anticancer properties. The pulp has traditionally been used to treat mental disorders, asthma, leprosy, hiccups, cough, and epilepsy, and is reported to possess antioxidant, antihyperlipidemic, appetizing, antitoxic, stomachic, and cardiotonic properties. The

Nutritional value of pummelo fruit per 100 g edible portion Source: USDA, 2018

Approx. composition/ (100 g edible portion)		Mineral composition/ (100 g edible portion)		Vitamin content/ (100 g edible portion)	
Composition	Value/100 g	Minerals	Value / 100 g	Vitamin	Value / 100g
Moisture	89.1 g	Sodium	1 mg	Vitamin A	20 I.U.
Energy	38 kcal	Phosphorus	17 mg	Thiamine (B1)	0.034 mg
Protein	0.76 g	Iron	0.11 mg	Riboflavin (B2)	0.02 mg
Fat	0.04 g	Magnesium	6 mg	Niacin (B3)	0.22-0.3 mg
Carbohydrates	9.62 g	Manganese	0.017 mg	Ascorbic acid	61 mg
Dietary Fibre	1.0 g	Potassium	216 mg	Vitamin B6	0.036 mg
Ash	0.48 g	Zinc	0.08 mg		
		Calcium	4 mg		

fruit peel exhibits analgesic, anti-inflammatory, antitumor, anticoagulant, antimicrobial, and antioxidant activities. Seeds are used to treat lumbago, dyspepsia, and cough, while the flowers are used for managing sleep disorders and anxiety.

In Brazil, gum obtained from declining trees is used as a remedy for cough. Leaf oil is applied topically to treat skin diseases, headaches, and stomach pain. Decoctions of leaves, flowers, and rind are widely used in Asian countries for their sedative properties in conditions such as epilepsy, chorea, oedema, and convulsive cough, as well as for cosmetic purposes.

Climate and soil

Pummelo grows best in hot, humid climates with an optimum temperature of 25–30°C and annual rainfall of 1,000–1,500 mm. It can be cultivated up to an elevation of 1,500 m and is adaptable to a wide range of climatic conditions. The crop prefers deep, well-drained, fertile soils with a *p*H of 5.5–7.5 and is sensitive to hot winds, extreme temperatures, and waterlogging.

Improved varieties

In India, pummelo varieties are broadly classified into white and pink/red aril types. Several improved varieties have been developed by ICAR institutes such as IARI, New Delhi; IIHR, Bengaluru; and CCRI, Nagpur.

Pusa Arun: A natural mutant, this seedless and highly juicy variety was released by ICAR-IARI in 2020. It is high yielding (34.30 kg/tree) with an average fruit weight of 500–600 g and 40–45% juice content. The variety matures about 20 days earlier than other sweet citrus types. Fruits have low acidity (0.4% citric acid), high TSS (12°Brix), and vitamin C content of 50–55 mg/100 ml juice. Trees are semi-vigorous and suitable for high-density planting at 4 × 4 m spacing.

Arka Chandra: Developed through clonal selection at ICAR-IIHR, Bengaluru, this variety has medium-sized trees and is a prolific bearer. Fruits weigh 0.8–1.0 kg, are spheroid in shape, with white pulp and a balanced sweet-acidic taste. TSS ranges from 11–12°Brix with moderate acidity (0.89%).

Arka Anantha: This high-yielding, pink-fleshed variety was developed through superior clonal selection at ICAR-IIHR, Bengaluru. The tree is medium-sized with a drooping growth habit. Fruits are spheroid, weighing 0.8–1.0 kg, with TSS of 11–12°Brix and acidity of 0.90%, having a sweet-acidic blend with low bitterness.

NRCC Pummelo-5: A promising high-yielding variety released by ICAR-CCRI, Nagpur. Fruits are yellow with attractive red segments, suitable for fresh consumption, and possess a good TSS–acid balance.

Pummelo US145: A high-yielding cultivar with medium-sized fruits, white flesh, high juice content (31.56%), and soft, tender segments suitable for both table use and juice extraction.

Propagation

Pummelo can be propagated asexually through air-layering, budding, and grafting. However, shield budding is the most standardized and preferred method for commercial propagation. Rangpur lime is commonly used as a rootstock. Micro-budding techniques have also been standardized for certain cultivars at ICAR-CCRI, Nagpur.

Planting

The ideal planting time is at the onset of the monsoon (July–August), avoiding heavy rains. Planting can also be done in spring with assured irrigation. A spacing of 8–10 m × 6–8 m is recommended depending on cultivar vigour and soil fertility, while high-density planting (4 × 4 m) is feasible with proper training and pruning.

Pits of 3 × 3 × 3 ft should be dug at least one month before planting and left open for a few days. These are filled with a mixture of well-decomposed FYM and topsoil (1:1), along with 350 g SSP and 400 g neem cake, raised about 15 cm above ground level. Saplings are planted at the centre of the pit, followed by light irrigation.

Manures and fertilizers

The recommended dose of manures and fertilizers for pummelo cultivation is given in the table below. Organic manure should preferably be applied during December–January. Inorganic fertilizers should be applied in two split doses: the first before flowering and the second 4–6 months later.

Pummelo fruit salad

Cultivation of pummelo fruit at ICAR-Indian Institute of Horticultural Research, Bengaluru

Fruiting in pummelo

Pummelo variety: *Arka Chandra*

Pummelo variety: *Arka Anantha*

Annual requirement of manure and fertilizers in pummelo

Year	FYM (Kg)	N (g)	P (g)	K(g)
1st	10-15	80-100	60-80	80-100
2nd	20-25	160-200	160-180	160-200
3rd	30-35	300-350	260-280	300-350
4th	40-45	450-500	360-380	450-500
5th onwards	50-55	600-650	460-480	600-650

Irrigation and weed management

Irrigation should be provided to young trees twice a week during summer. Bearing trees require watering at 7–10 day intervals in summer and 30–40 day intervals in winter, with regular irrigation from flowering to harvest. Tree basins should be kept weed-free to avoid competition for moisture and nutrients.

Training and pruning

Generally, the open-centre system of training is followed in pummelo. Although heavy pruning is not required, light pruning should be carried out after planting to develop a proper framework. Regular removal of dead, dry, crisscross branches and water sprouts is essential. Bordeaux paste should be applied immediately after pruning to prevent secondary infection.

Flowering and fruiting

Pummelo plants generally start flowering after 4–5 years of planting. Flowering occurs during March–April, and fruits mature from October to November in North India. The fruit takes about 5–6 months to mature.

Harvesting and yield

Pummelo is a potentially heavy-bearing fruit crop. Mature trees generally produce about 70–100 fruits per year, with a total yield of 50–100 kg per tree. It is a non-climacteric fruit and should be harvested at full eating maturity. During ripening, oil glands become larger and glossier, and the rind colour changes from dull to bright yellow. Fruits can be stored for up to 12 weeks at 7–9°C and 85–90% relative humidity.

Diseases, pests, and physiological disorders management

The major diseases of pummelo include foot rot, root rot, crown rot, gummosis, powdery mildew, scab, and citrus greening. Major pests include soft green scale, citrus leaf miner, aphids, and citrus psylla.

Future prospect

There is a need to create awareness among the common men about the importance and benefits of pummelo. Its commercialization as a climate-resilient fruit crop can be strengthened through the large-scale availability of quality planting material, standardization of

Disease/pest/ disorders	Symptoms	Management
Phytophthora rot	Damping off of seedlings, crown rot till foot rot and brown rot of fruits	Use of resistant rootstocks Drenching of Ridomil MZ 72@ 2.75 g/l or Aliette (2.5 g/l) Biocontrol agent: *Trichoderma harzianum* 100-150 g/ pit
Powdery mildew	White powdery growth on plants specially leaves	Spraying: Wettable sulphur (2 g/l).
Citrus greening	Yellowing of new leaves, shoots, infected fruits remain green, small size, distortion, low juice and insipid taste.	Use of disease-free planting material. Removal of infected trees. Control psylla population.
Soft green scale	Suck the plant sap and secrete honeydew, which attracts the sooty mould.	Application of methyl parathion (0.075%) or methomyl (0.05%).
Citrus psylla	Vector for the citrus greening disease	Application of dimethoate (0.025%) or imidacloprid (0.003%)
Fruit fly	Makes small punctures on fruits and lay eggs in the fruits larvae eat the fruits and fruit become yellow and fall down.	Application of bait containing malathion 2 ml/l + carbendazim (0.1%) with 10 g of jaggery or sugar. The pheromone traps (4 to 6 No./acre) using methyl eugenol.
Fruit Splitting	Longitudinal cracks near stylar end and exposure of juice vesicles	Uniform irrigation Foliar spray of $CaCl_2$ (0.5–1%) Boron spray (0.1% boric acid) Mulching
Granulation	Hard, dry juice vesicles, reduced juice content, whitish, stiff segments	Balanced fertilization Timely harvesting

production technologies, adoption of safe plant protection measures, and the development of high-yielding dwarf cultivars suitable for high-density planting with deep pink/ red-coloured arils and enhanced processing potential.

SUMMARY

Pummelo is a promising fruit crop known for its valuable nutritional and therapeutic properties and numerous health benefits. It has the ability to adapt to adverse soil and agro-climatic conditions and shows tolerance to both biotic and abiotic stresses. Therefore, in the context of climate change, pummelo holds great potential for future cultivation in the country, owing to its large fruit size and high yield. Its consumption as a fresh fruit and in salads is increasing rapidly in oriental countries, as well as in India, where tourist footfall is also rising.

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