Benincasa hispida: A comprehensive Botanical review

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Abstract

Benincasa hispida (Thunb.) Cogn., commonly known as ash gourd or wax gourd, is an important cucurbitaceous vegetable with significant nutritional, medicinal, phytochemical, agronomic, and industrial relevance. The plant is widely cultivated throughout Asia and is recognized for its exceptional shelf-life, diverse secondary metabolites, and extensive ethnobotanical applications. This review comprehensively analyzes its taxonomy, morphology, anatomy, phytochemistry, pharmacological properties, agronomic practices, post-harvest biology, food applications, and future prospects. The discussion synthesizes multidisciplinary findings to highlight B. hispida as a promising plant species for nutraceutical, biopharmaceutical, and sustainable agricultural research.

Keywords: *Benincasa hispida*, Wax gourd, Pharmacological properties, Agronomic practices, Biopharmaceutical, Agricultural research.

1. Introduction

Benincasa hispida (wax gourd or ash gourd) is one of the most economically and medicinally important cucurbit crops grown in tropical and subtropical regions (Kumar & Singh, 2018). The species belongs to the family Cucurbitaceae, a diverse group of climbing and trailing plants with specialized tendrils and unisexual flowers (Jeffrey, 2005). Ash gourd is valued for its large berries, wax-coated rind, soft pulp, and seeds enriched with oil and proteins (Nagarani et al., 2014).

Traditionally, *B. hispida* has been extensively utilized in Ayurveda, Siddha, Unani, and Chinese medicine for treating peptic ulcers, epilepsy, diabetes, urinary infections, and inflammation (Kirtikar & Basu, 2012; Meena et al., 2018). Modern studies confirm its antioxidant, anti-inflammatory, anxiolytic, antimicrobial, and gastroprotective properties (Saha et al., 2019; Ullah et al., 2020).

Its long shelf life (up to 6 months) and resistance to microbial spoilage contribute to its relevance in sustainable food storage systems (Upadhyay & Singh, 2016). Furthermore, the species contains a wide range of phytochemicals including flavonoids, terpenoids, sterols, vitamins, minerals, and polysaccharides (Zhong et al., 2021).

Because of its diverse pharmacological and agricultural potential, Benincasa hispida is considered a significant crop for horticultural, nutraceutical, and biotechnological research (Renner et al., 2017).

2. Taxonomy

According to recent classification, Benincasa hispida is the only cultivated species of the genus Benincasa (Schaefer & Renner, 2011).

Table 1: Taxonomic Position of Benincasa hispida

Rank	Classification
Kingdom:	Plantae
Phylum:	Angiosperms
Class:	Magnoliopsida
Order:	Cucurbitales
Family:	Cucurbitaceae
Genus:	Benincasa
Species:	*Benincasa hispida* (Thunb.) Cogn.

The genus is closely related to Lagenaria, Cucurbita, Trichosanthes, and Momordica based on molecular phylogeny (Kocyan et al., 2007).

3. Botanical Description

3.1 Habit

B. hispida is an annual climbing or creeping herb characterized by soft hairy vines extending 5–10 meters in length (Singh et al., 2015).

3.2 Vegetative Morphology

Stem: Soft, angular, and covered with fine trichomes. Green, cylindrical, and branched, facilitating rapid spread across fields (Bose et al., 2003).

Leaves: Simple, alternate, orbicular, deeply lobed (5–7 lobes). Palmate venation; diameter 10–25 cm (Pant & Kidwai, 1962). Surface covered with pubescence.

Tendrils: Axillary, branched; help climbing and anchorage (Jeffrey, 2005).

3.3 Reproductive Morphology

Flowers: Unisexual, bright yellow, solitary.

Male flowers: larger; three stamens.

Female flowers: inferior ovary, short peduncle (Kirtikar & Basu, 2012).

Fruit: A large berry, variable shape (round, oblong).

Young fruit: hairy; mature fruit: smooth with thick waxy bloom.

Weight: 1–10 kg depending on cultivar (Yadav et al., 2013).

Seeds: Many, flat, oblong, white to cream; rich in proteins and lipids (Meena et al., 2018).

4. Anatomy

4.1 Root Anatomy

The dicot root exhibits a multilayered cortex, narrow pericycle, and radially arranged vascular bundles (Esau, 1977).

4.2 Stem Anatomy

a. Epidermis with trichomes.

b. Collenchymatous hypodermis.

c. Bicollateral vascular bundles—a characteristic of Cucurbitaceae (Metcalfe & Chalk, 1988).

d. Extended extrafascicular phloem (Pant & Kidwai, 1962).

4.3 Leaf Anatomy

a. Dorsiventral leaf with thick palisade tissue.

b. Anomocytic stomata.

c. Well-developed vascular bundle sheath.

5. Cultivation and Agronomy

5.1 Climate

The crop thrives in warm tropical climates (25–30°C), with high sunlight requirement (Rai et al., 2014).

5.2 Soil

Loamy, well-drained soil rich in organic matter enhances productivity (Bose et al., 2003).

5.3 Propagation

Seed propagation is the only method; germination occurs in 8–12 days (Yadav et al., 2013).

5.4 Nutrient Management

Application of N:P:K (60:40:40 kg/ha) improves fruit yield significantly (Banerjee & Datta, 2018).

5.5 Pest & Disease Management

Major pests:

Red pumpkin beetle

Aphids

Fruit fly (Borah et al., 2016)

Diseases: Mosaic virus, Powdery & downy mildew, Anthracnose (Rana et al., 2014).

6. Phytochemistry

Extensive phytochemical profiling shows the presence of flavonoids, phenolics, terpenoids, sterols, vitamins, and polysaccharides (Nagarani et al., 2014; Ullah et al., 2020).

Major constituents: Flavonoids: quercetin, kaempferol

Phenolic acids: gallic acid, caffeic acid

Triterpenoids: cucurbitacins

Sterols: β-sitosterol

Amino acids, sugars, pectins

7. Nutritional Value

According to USDA (2019) and Gopalan et al. (2007):

Moisture: 95–96%

Carbohydrates: 3%

Protein: 0.4%

Fiber: 0.6%

Minerals: K, Ca, Mg

Vitamins: C, B-complex

The fruit is extremely low in calories and widely used in diet therapy (Ganesan, 2019).

8. Pharmacological Properties

8.1 Antioxidant Activity

Fruit and seed extracts show strong DPPH and ABTS radical scavenging (Rahman et al., 2018).

8.2 Anti-inflammatory Effects

Methanolic pulp extract reduces inflammatory cytokines (Ullah et al., 2020).

8.3 Antidiabetic Activity

Enhances insulin secretion and reduces blood glucose in animal models (Saha et al., 2019).

8.4 Antimicrobial Activity

Inhibits E. coli, S. aureus, Pseudomonas, Candida (Meena et al., 2018).

8.5 Neuroprotective & Anxiolytic Effects

Used in Ayurveda for anxiety; shows GABA-mediated calming effect (Parle & Singh, 2011).

8.6 Gastroprotective Activity

Demonstrates ulcer healing and mucosal protection (Karthikeyan et al., 2014).

9. Ethnobotanical Uses

a. Cooling agent in Ayurveda

b. Remedy for ulcers and gastritis

c. Used in epilepsy management

d. Seed oil in cosmetics

Pulp in traditional detoxification therapy (Nadkarni, 2009).

10. Post-Harvest Biology

The wax coating on the fruit minimizes respiration and water loss, allowing storage up to 6 months (Upadhyay & Singh, 2016).

11. Industrial Applications

a. Confectionery (petha)

b. Cosmetics

c. Bio-packaging films from polysaccharides (Zhong et al., 2021)

d. Functional foods and juices

12. Future Prospects

Molecular breeding for high-yield hybrids

Genomic exploration for disease resistance genes (Renner et al., 2017)

Clinical validation of medicinal properties

Eco-friendly packaging materials

Pharmacokinetic research on cucurbitacins

13. Conclusion

Benincasa hispida stands as a valuable plant species with significant agricultural, nutritional, medicinal, and industrial potential. Its wide spectrum of phytochemicals and pharmacological properties positions it as a prospective crop for nutraceutical innovation and sustainable agricultural systems. Further genomic and pharmacological research is essential to unlock its full potential.

14. Conflict of Interest: None.

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