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Original Article

Pharmacognostical and Phytochemical Evaluation of *Benincasa Hispida*

F. Pincy Mol*, Madhankumar R., Harish S., Reshma R. Nath, Sowmiya J. S., Asha A. S.

Sun College of Pharmacy and Research Center

ABSTRACT

It is a fastgrowing annual vine that produces large, oblong fruits covered in a waxy, ashlike coating, which contributes to its common name. The fruit is rich in moisture, low in calories, and packed with essential nutrients, making it an important component of traditional diets and health remedies. Ash gourd has been recognized for its diverse pharmacological properties, including antioxidant, anti-inflammatory, diuretic, antimicrobial, and neuroprotective effects. It is a prominent Ingredient in Ayurveda and other traditional medicine systems, where it is used to treat ailments such as gastric ulcers, respiratory disorders, and metabolic imbalances. Its seeds, pulp, and rind have all demonstrated therapeutic potential. In agriculture, Benincasa hispida is valued for its adaptability, long shelf life, and resistance to pests, making it a viable crop in both subsistence and commercial farming systems. Ongoing research continues to explore its bioactive compounds and potential applications in functional foods and pharmaceuticals.This study/project aims to explore the botanical characteristics, nutritional composition, medicinal properties, and economic significance of Benincasa hispida, contributing to a deeper understanding of its role in sustainable agriculture and natural healthcare.

Keywords: *Benincasa Hispida*, Pharmacognostical, Phytochemical Evaluation

INTRODUCTION

Benincasa hispida (Thunb.) Cogn., commonly referred to as winter melon, ash gourd, white gourd, or wax gourd, is a valuable plant both economically and nutritionally, belonging to the Cucurbitaceae family. It is an annual climbing vine extensively grown in tropical and subtropical regions of Asia, particularly in countries such as India, China, Indonesia, and the Philippines. The plant features coarse, hairy stems, broad palmately lobed leaves, and yellow unisexual flowers that emerge from the leaf axils. Its fruits are generally large, fleshy, and cylindrical, usually measuring 40–60 cm in length, though they may reach up to 80 cm in some cases. Young fruits are covered with fine hairs that disappear upon maturity, leaving a thick whitish waxy layer, which significantly prolongs their storage life [1]. The fruit has a subtle, cucumber-like flavor and contains around 96% water, making it a hydrating and low-calorie food choice. It is valued not only for its culinary versatility but also for its nutritional composition, providing carbohydrates, proteins, dietary fiber, vitamins (notably vitamin C and certain B-complex vitamins), as well as minerals like calcium, iron, and phosphorus. Due to its mild taste, B. hispida readily absorbs spices and seasonings, making it suitable for a variety of dishes. In Indian cuisine, it is used in curries, sweets (such as petha), pickles, and stews, while in Chinese and Southeast Asian cooking, it is a common ingredient in soups, stir-fries, and sweet beverages like winter melon tea. Its thick waxy coating extends its shelf life, enhancing its importance in trade and long-term storage. Beyond its nutritional benefits, Benincasa hispida has long been an important component of traditional medicine for managing various health conditions. In traditional Chinese medicine, it is commonly recommended for alleviating heat, reducing inflammation, and addressing ailments related to edema and phlegm [2]. Different parts of the plant, including the seeds, rind, and leaves, are also employed in ethnomedicine for their wide range of therapeutic properties, such as anthelmintic, anti-inflammatory, and antiseptic activities. Recent pharmacological research has validated many of the traditional medicinal

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applications of B. hispida. Experimental studies have shown that its extracts possess antioxidant, anti-ulcer, anti-inflammatory, antimicrobial, neuroprotective, and anticancer activities. Several bioactive compounds have been identified, including flavonoids, triterpenes, glycosides, phenolic acids, sterols, and essential oils, which are largely responsible for its therapeutic potential. Additionally, because of its highwater content and low caloric value, the fruit is recognized in modern nutrition as a functional food that supports weight management and promotes metabolic health [3].

Benincasa hispida is a vigorous annual vine, either trailing or climbing, with a sturdy, hairy stem and branched tendrils that aid in its widespread growth. The leaves are large, coarse, and heart-shaped, typically divided into five to seven shallow lobes, giving them a rough texture. Its flowers are bright yellow, solitary, and unisexual, with the male flowers generally larger than the female ones. The fruit is a sizeable, fleshy berry that can be cylindrical or round, initially covered with fine white hairs, which are later replaced by a thick waxy coating, resulting in a grayish-green appearance. Fully matured fruits often grow to a substantial size, featuring white, spongy, water- rich flesh filled with numerous flat, pale seeds.

1.1 Leaves of Benincasa hispida:

The leaves of Benincasa hispida (winter melon/ash gourd) are a defining morphological trait of the plant, contributing significantly to photosynthesis, growth, and medicinal uses. This species is a fast-growing annual climber with rough, hairy stems that support large, simple, alternate, and palmately lobed leaves. Each leaf is broadly ovate to nearly circular, typically measuring 10–20 cm in both length and width. They are usually divided into five to seven shallow lobes, giving the foliage a rounded or heart-like form [4]. The leaves are densely covered with fine, bristly hairs, particularly on the upper surface and along the veins, which help protect them from herbivores and reduce excessive water loss. Their edges are unevenly serrated, while the long, sturdy, and hairy petioles support the wide leaf blade. Young leaves appear bright green, gradually darkening as they mature, indicating enhanced photosynthetic activity.

1.2 Reproduction of Benincasa hispida:

Benincasa hispida (winter melon/ash gourd) reproduces sexually through the production of flowers

and seeds. Being a monoecious plant, it bears both male and female flowers separately on the same vine. The flowers are solitary, large, and yellow, arising in the leaf axils. Male flowers, which are more abundant, develop on long peduncles, whereas female flowers are fewer, borne singly, and can be identified by the ovary located beneath the petals. In B. hispida, pollination mainly occurs through insects (entomophily), with bees and beetles serving as the primary pollinators that transfer pollen from male (staminate) to female (pistillate) flowers. While cross-pollination is the dominant mode, some selfpollination can take place depending on environmental factors and pollinator availability. Anthesis generally takes place in the early morning, during which pollen viability is at its peak, ensuring successful fertilization. Fertilization occurs when pollen grains germinate on the stigma of the female flower and pollen tubes grow toward the ovules. After successful fertilization, the ovary enlarges and matures into a large, fleshy fruit, botanically identified as a pepo. The ripe fruit contains many flat, white seeds embedded within the pulp. These seeds are oblong, compressed, and typically measure about 1–1.5 cm in length, serving as the main source of reproduction and propagation for the plant [5].

Distribution of *Benincasa hispida*:

Benincasa hispida (Thunb.) Cogn., commonly referred to as ash gourd or wax gourd, is widely grown across tropical and subtropical regions of Asia. It is thought to have originated in South and Southeast Asia particularly in India, China, and the IndoMalaysian region—where it has long been cultivated for both dietary and medicinal uses [6]. Today, the crop is extensively cultivated in India, China, Thailand, Indonesia, and the Philippines, and has also spread to countries such as Japan, Korea, and several Pacific islands. Beyond Asia, B. hispida is also grown in tropical Africa, the Caribbean, and parts of Central and South America, showcasing its adaptability to warm, humid climates. In India, it is especially prominent in states like Kerala, Tamil Nadu, Karnataka, and Uttar Pradesh, where it is grown both in household gardens and on a commercial scale [7].

LIERATURE RIVIEW ON *BENINCASA HISPIDA.*

1. Morton et al., (1987), Provides a comprehensive overview of wax gourd as a fruit of warm climates, highlighting its ethnobotanical significance, traditional uses, and agricultural aspects. The text emphasizes its culinary use and therapeutic applications across various cultures.

2. Wikipedia et al., (2025), Offers a general yet up-to-date summary of wax gourd's botanical features, cultivation, uses, and regional importance. While secondary in nature, it serves as a starting point for understanding the plant's global relevance.

3. Kirtikar and Basu et al., (1991), In Indian Medicinal Plants, detail the traditional Ayurvedic uses of Benincasa hispida, noting its application in treating conditions like peptic ulcers, respiratory issues, and urinary disorders. The text is a foundational reference in Indian herbal medicine.

4. Sharma et al., (2005), In Dravyaguna Vijnana, further explores the Ayurvedic perspective, classifying wax gourd as a cooling, diuretic, and rejuvenative herb. It is noted for balancing pitta and kapha doshas, with emphasis on its role in Rasayana (rejuvenation) therapy.

5. Esau et al., (1977) and Fahn et al., (1990), In their respective plant anatomy texts, provide essential frameworks for understanding the structural and functional characteristics of plant tissues. These works support anatomical studies of wax gourd, particularly in analyzing tissues such as parenchyma, collenchyma, and vascular bundles, which are vital for its storage and medicinal properties.

6. Islam et al. (2021), It exhibits diverse pharmacological activities including antioxidant, antiinflammatory, antimicrobial, and anticancer effects. The review also highlights its potential in managing metabolic, neurological, and gastrointestinal disorders. These findings suggest that B. hispida holds promise as both a nutraceutical and therapeutic agent, warranting further clinical research.

7. Kanase et al. (2025), Offer a comprehensive review of the plant's phytochemical and pharmacological profile. The study highlights its antioxidant, anti-inflammatory, diuretic, and

neuroprotective activities, ailments. Supported by both in vitro and in vivo experiments.

8. Zhang et al. (2023), Delve into the traditional uses of B. hispida in Chinese medicine, linking these practices to modern phytochemical findings. The authors report the presence of triterpenes and sterols, which may contribute to its anti-ulcer, anxiolytic, and hepatoprotective effects.

Morphological Characteristics of Ash Gourd

Plant Parts	Morphological Features
Root	Strong tap root system with several spreading lateral roots; roots are shallow to moderately deep and adapt well to moist soils.
Stem	Long, climbing or creeping vine; green, ridged, and covered with fine hairs; hollow internodes make it light but not sturdy, so it often requires support.
Leaves	Broad, simple, and alternately arranged; surface is rough with short hairs; typically, 3–5 lobes with serrated edges; veins spread out from a single point (palmate venation).
Tendrils	Slender, spirally coiling outgrowths from the nodes, helping the plant to climb and attach to supports.
Flowers	General Large, bright yellow blossoms; plant bears separate male and female flowers (monoecious).
• Male Flowers	Produced in clusters; tubular corolla with stamens; no ovary present.
• Female Flowers	Generally solitary; positioned on short stalks; contain a distinct ovary with style and stigma [8].
Fruits	A large fleshy berry (pepo); round, oblong, or oval in shape; immature fruits are green turning pale grey-white with a waxy layer at maturity; inner flesh is white, soft, and watery.
Seeds	Numerous, flat, oval seeds with a smooth coat; fresh seeds are embedded in a sticky mucilage, and mature seeds are pale yellow to brown

4. Microscopical Characters of *Benincasa Hispida*

The transverse section of the Benincasa hispida fruit shows a well- differentiated structure comprising the epidermis, mesocarp, and endocarp.

Epidermis: The outermost layer consists of a single row of compactly arranged, rectangular to barrel-shaped parenchymatous cells. These cells are covered with a thin cuticle. Trichomes are generally absent in the mature fruit epidermis.

Mesocarp: This middle region is composed of several layers of large, thin-walled parenchymatous cells, many of which contain scattered vascular bundles. The cells are mostly rounded or oval in shape, with intercellular spaces. Some parenchyma cells maycontain starch grains and occasional calcium oxalate crystals in the form of clusters or rosettes.

Vascular Bundles: Collateral vascular bundles are embedded within the mesocarp. Xylem lies towards the inner side and phloem towards the outer. The xylem elements are composed of vessels and tracheids, whereas the phloem consists of sieve tubes and companion cells.

Endocarp: The innermost layer is made up of a few rows of compact, elongated parenchymatous cells. It is relatively thinner and may degenerate in overripe fruits.

Seeds: The seed coat is multi-layered, with an outer testa and inner tegmen. The outermost cells of the testa are polygonal and lignified. The cotyledons are rich in oil globules and proteinaceous matter, and they exhibit dense cytoplasm with distinct nuclei and nucleoli [9].

5. Phytochemistry Of Ash Gourd (*Benincasa Hispida)*

5.1 Primary Phytochemicals:

The fruit pulp of B. hispida predominantly contains carbohydrates, serving as a key source of energy. Proteins are present in moderate amounts, with higher concentrations in the seeds. Fats and oils, including essential fatty acids, are primarily localized in the

seeds. The pulp is also a source of vitamins such as vitamin A, vitamin C, and B-complex vitamin. Furthermore, the plant provides essential minerals including calcium, potassium, magnesium, iron, and zinc, which contribute to its nutritional value [10].

5.2 Secondary Metabolites / Bioactive Constituents:

Several secondary metabolites have been identified in B. hispida. Flavonoids act as potent antioxidants that protect against oxidative damage. Saponins exhibit anti-inflammatory and antidiabetic effects. Alkaloids contribute to diverse therapeutic activities, while phenolic compounds serve as free radical scavengers. Tannins display antimicrobial and anti-inflammatory properties, and glycosides are associated with digestive and cardiovascular health [11].

5.3 Distribution of Phytochemicals by Plant Part:

Phytochemical composition varies across different plant parts. The fruit pulp contains vitamins, flavonoids, and phenolic compounds that provide antioxidant, antidiabetic, and nutritional benefits. The seeds are rich in proteins, fats, and saponins, supporting nutritional value and anti-inflammatory activity [12]. The leaves contain alkaloids, tannins, and flavonoids, which contribute to antimicrobial and anti-inflammatory functions. The peel is mainly composed of phenolic compounds and saponins, imparting antioxidant and protective roles [13].

5.4 Significance of Phytochemicals:

The diverse phytoconstituents of B. hispida are associated with multiple health benefits, including reduction of oxidative stress, regulation of blood glucose levels, and promotion of cardiovascular and liver health. Additionally, the phytochemicals have significant industrial applications, being widely utilized in nutraceuticals, herbal medicines, and cosmetic formulations.

MATERIALS AND METHODS

6.1 Collection of Plant Materials:

Fresh fruits, leaves, and seeds of Benincasa hispida were procured from local agricultural fields and botanical gardens. Only healthy, mature, and disease-free samples were selected and appropriately labeled for further study [14].

6.2 Preparation of Samples:

The collected plant materials were thoroughly rinsed with clean water to eliminate dust and surface contaminants. The fruits, leaves, and seeds were cut into smaller portions and shadedried to preserve phytoconstituents. Once dried, the samples were finely powdered using a laboratory- grade grinder and stored in airtight containers until further use [15].

6.3 Extraction Procedures:

The powdered materials were extracted separately using solvents such as distilled water, ethanol, and methanol. Each extraction was performed by soaking the powder in the respective solvent with intermittent shaking for 24–48 hours [16]. The extracts were filtered through Whatman No. 1 filter paper to remove particulate matter, and the filtrates were concentrated using a rotary evaporator under reduced pressure to obtain crude extracts [17].

6.4 Preliminary Phytochemical Analysis:

The crude extracts were subjected to standard qualitative phytochemical screening to detect the presence of flavonoids, alkaloids, saponins, phenolics, and vitamins. These tests were performed following established phytochemical protocols [18].

6.5 Review of Pharmacological Properties:

A comprehensive literature review was conducted to document the pharmacological activities of B. hispida. Reported biological effects include antioxidant, antidiabetic, antiinflammatory, hepatoprotective, hypolipidemic, neuroprotective, and cardioprotective activities. Relevant details regarding experimental models, dosage forms, and observed outcomes were summarized [19].

6.6 Data Compilation and Critical Analysis:

Extracted data from published sources were systematically arranged into tables and figures for clarity. Comparative evaluation was performed to correlate identified phytochemicals with their pharmacological relevance. A critical discussion was

also included to highlight current research trends, limitations of existing findings, and possible future directions [20].

7. Preparation of Plant Crude Extract from Ash Gourd

7.1 Collection of Plant Material:

Fresh and healthy ash gourd fruits are collected from a reliable source. The fruits are thoroughly washed with clean water to remove dust, dirt, and surface contaminants [21].

7.2 Drying Process:

The cleaned fruits are cut into small pieces and air-dried under shade at room temperature. Shade drying helps in retaining the bioactive compounds without causing thermal degradation. The drying process continues until a constant weight is obtained [22].

7.3 Powdering of Plant Material:

The dried fruit pieces are finely ground using a clean mechanical grinder to obtain a uniform powder. The powder is then stored in an airtight container to prevent moisture absorption [23].

7.4 Extraction Procedure:

A measured amount of ash gourd powder is soaked in a suitable solvent (such as ethanol, methanol, or distilled water) at a specific ratio [24]. The mixture is kept on a shaker or stirred intermittently for 24–48 hours at room temperature to allow maximum extraction of phytochemicals [25]. After extraction, the mixture is filtered using muslin cloth or Whatman filter paper to separate the liquid extract from the plant residue [26].

7.5 Concentration of Extract:

The filtrate is concentrated using a rotary evaporator or by gentle evaporation at low temperature to remove excess solvent. The concentrated crude extract is then collected [27].

7.6 Storage:

The final crude extract is stored in sterile, airtight vials or bottles at 4 °C until further use in phytochemical or biological studies [28].

8. Traditional Uses of Ash Gourd

8.1 Digestive Health & Cooling Properties:

Ash gourd is highly valued for its cooling nature. In Ayurveda, it's used to pacify excess Pitta (heat), alleviate acidity, and soothe digestive discomfort like gastritis and peptic ulcers [29]. In Traditional Chinese Medicine (TCM), it's considered a yin (cooling) food, often used to relieve stomach upset and promote hydration [29].

8.2 Laxative and Diuretic Effects:

Its high water and fiber content contribute to natural laxative and diuretic properties helping with constipation and supporting urinary health [30].

8.3 Respiratory and Nervous System Support:

In Ayurveda, ash gourd is used to manage respiratory issues such as asthma, coughs, and bronchitis as well as certain nervous system disorders including epilepsy and urinary retention [31].

8.4 Anti-Ulcer & Anti-Inflammatory Actions:

Animal and in vitro studies show that extracts of ash gourd may help prevent ulcers and reduce inflammation, supporting its traditional use for digestive and inflammatory conditions [32].

8.5 Metabolic Benefits:

Traditionally, ash gourd is used to manage ailments such as diabetes, urinary tract issues, and internal bleeding; scientific reviews also cite its beneficial role in diabetes and urinary infection management as per Ayurvedic knowledge [33].

8.6 Mental and Emotional Well-Being:

Ayurveda regards ash gourd as a calming agent for the mind—a nervine tonic that may reduce stress, anxiety, and support cognitive clarity [34].

8.7 Spiritual and Cultural Significance:

Beyond its medicinal uses, ash gourd holds symbolic importance in certain Indian traditions. For example, it is used as a sacrificial substitute in rituals, where the fruit is marked and split instead of animal sacrifice [35].

8.8 Cooling Effect:

Ash gourd is considered a natural coolant. In hot climates, its juice is consumed to reduce body heat and prevent dehydration [36].

8.9 Wound Healing:

In some folk traditions, ash gourd pulp is applied externally on burns, boils, and wounds to promote faster healing and reduce inflammation [37].

8.10 Nutritional Support:

It has been traditionally included in diets for recovering patients due to its lightness, easy digestibility, and highwater content [38].

9. Pharmacological Activities and Other Uses

9.1 Antioxidant Properties:

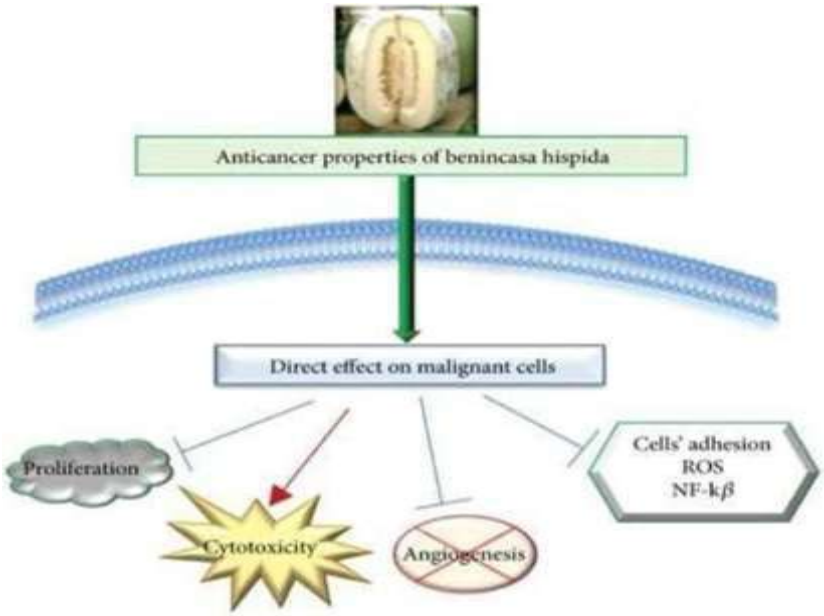
Oxidative stress occurs when there is an imbalance between free radicals (oxidants) and antioxidants in the body, leading to potential cellular damage. Studies have shown that methanolic seed extracts of Benincasa hispida exhibit concentration-dependent activity (25–200 μg/mL) against hydrogen peroxide and DPPH radicals. Similarly, ethanolic seed extracts were reported to have stronger phenolic content and higher radical scavenging activity compared to ethyl acetate and n-hexane extracts [39]. In experimental studies with rats, the seed oil demonstrated significant DPPH and ABTS scavenging activity at 0.1 mg/mL, although its effectiveness was lower than standard antioxidants like catechin and BHT. The oil was also found to contain total phenolic compounds (TPC). Additionally, aqueous extracts reduced reactive oxygen species (ROS) in HUVEC cells, while fruit polysaccharides displayed notable free radical scavenging capacity with an EC50 value of 0.98 mg/mL. Methanolic and petroleum ether fruit extracts improved catalase (CAT) levels in rats with gastric ulcers. Another compound, hispidalin, was shown to neutralize DPPH radicals and inhibit lipid peroxidation. Furthermore, aqueous fruit extracts significantly increased vitamin C concentration and enhanced antioxidant status in rat gastric juice. Several other studies also confirmed the antioxidant potential of various plant components in different experimental models [40].

9.2 Anti-inflammatory Properties:

In carrageenan-induced paw edema rat models (n=6), methanolic seed extracts (100– 300 mg/kg, orally) demonstrated a dose-dependent anti-inflammatory effect. Similarly, fruit peel methanolic extracts showed protective effects in egg albumin-induced inflammation. Moreover, in rats with histamine-induced paw edema, both petroleum ether and methanolic fruit extracts (300 mg/kg, orally) displayed significant dose-dependent anti-inflammatory activity [41].

9.3 Cytotoxic and Anticancer Effects:

Cancers are diseases characterized by uncontrolled and continuous growth of abnormal cells, which can eventually spread to and damage nearby healthy tissues. These abnormal cells can originate in any part of the body. The anticancer activity of medicinal plants is mainly attributed to bioactive compounds such as flavonoids, carotenoids, terpenes, and antioxidant vitamins. Flavonoids inhibit the spread (metastasis) of cancer cells and reduce the activity of carcinogens. Carotenoids help protect against colon cancer, while terpen. Schematic representation of the anticancer mechanisms of natural compounds present in Benincasa hispida. The red arrows indicate stimulation or increase in reactive oxygen species and activation of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB). The other arrows represent inhibition and reduction processes.



9.4 Anti-Obesity and Lipid-Lowering Effects:

Lipids, or fatty compounds, are primarily used by the body to produce energy. While a small portion circulates in the blood in liquid form, most lipids are stored as solid deposits in various organs and beneath the skin. Disturbances in lipid metabolism can trigger several chronic health conditions such as diabetes, fatty liver disease, endocrine disorders, and cardiovascular complications. Experimental studies on mice revealed that methanolic fruit extracts (0.2–1 g/kg, intraperitoneally) reduced food consumption, suggesting a possible appetite-suppressing effect [99]. Furthermore, the hexane fraction of the aqueous fruit extract was shown to inhibit the expression of leptin, peroxisome proliferator-activated receptor gamma (PPARγ), and CCAAT/enhancer-binding protein alpha (C/EBPα). This suppression prevented the formation of fat cells (adipocyte differentiation), reduced lipid accumulation, and increased the release of glycerol and intracellular triglycerides in 3T3-L1 cells [41].

9.5 Neuroprotective Properties:

9.5.1 Anticonvulsant Effects:

In seizure models induced by maximum electroshock, pentylenetetrazole, strychnine, and picrotoxin, methanolic fruit extracts (0.2–1 g/kg, orally) exhibited dose-dependent anticonvulsant activity. Similarly, in mice with pentylenetetrazole-induced seizures, methanolic extracts of the fruit peel (0.25–1.5 g/kg) also demonstrated significant anticonvulsant potential. Additionally, Swiss albino mice treated with ethanolic seed extracts (250–500 mg/kg, orally) showed a dose- dependent reduction in seizure activity.

9.5.2 Effects on Alzheimer's Disease:

Neurodegenerative disorders, such as Alzheimer's disease, are marked by central nervous system dysfunction, protein aggregation, inflammation, and oxidative stress. These conditions often arise due to multiple factors, including unhealthy lifestyle choices, which gradually impair nervous system function and significantly lower a patient's quality of life. Although there are currently no treatments that can fully restore nerve function, increasing evidence highlights the role of natural remedies in alleviating symptoms and improving overall well-being in patients with neurodegenerative diseases. In experimental studies, oral administration of fruit extract at 400 mg/kg in rats with colchicine-induced Alzheimer's disease produced neuroprotective effects. These benefits were likely linked to the presence of vitamin E and β-carotene, which safeguard neurons against oxidative stress. Similarly, in another colchicine-induced Alzheimer's rat model, aqueous fruit pulp extract (100–450 mg/kg, orally) reduced lipid peroxidation (LPO) levels and significantly enhanced antioxidant enzyme activity, including superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH), in a dose-dependent manner [42].

9.5.3 Effects on Memory and Cognitive Behavior:

Cognitive disorders are characterized by structural and functional changes in the brain that impair learning, memory, judgment, orientation, and overall intellectual performance. In animal studies, methanolic fruit extracts (200, 400, and 600 mg/kg, orally) showed significant dose-dependent anticompulsive effects in marble-burying and moto coordination tests in mice. Similarly, in mouse models assessing cognitive behavior, aqueous, methanolic, and petroleum ether fruit extracts (100, 200, and 400 mg/kg, orally) exhibited notable dose dependent nootropic (memory-enhancing) effects. Additional studies by Kumar and Nirmala further confirmed the potential of the fruit to enhance nootropic activity in experimental animals [43].

9.5.4 Antidepressant and Anxiolytic Effects:

Anxiety is described as a persistent sense of fear or worry about everyday situations without an obvious cause. Methanolic fruit extracts (50, 100, and 200 mg/kg, orally) produced dose-dependent antidepressant-like effects in tail suspension test (TST) and forced swim test (FST) models, which may be linked to GABAergic mechanisms in Swiss mice. Furthermore, extracts prepared with petroleum ether, methanol, and water (100–400 mg/kg, orally) demonstrated significant dose-dependent anxiolytic (anti-anxiety) effects in rat models.

9.6 Potential Biological Activities:

9.6.1 Bronchodilator Effects:

Methanolic extracts of Benincasa hispida fruits were found to suppress histamine release. Two bioactive compounds, multiflorenol and alnusenol (classified as triterpenes and sterols), exhibited particularly strong inhibitory activity in this study. In guinea pigs, oral administration of B. hispida extract at doses of 50, 200, and 400 mg/kg provided significant protection against bronchospasms triggered by acetylcholine and histamine Moreover, the fruit extract showed strong antihistaminic effects in experimental animals, including mice and rats, when administered at doses ranging from 200 to 3000 mg/kg orally.

9.6.2 Antihypertensive Effects:

In traditional Chinese medicine, Benincasa hispida has long been used for managing high blood pressure, an effect now understood to be linked to its angiotensin-converting enzyme (ACE) inhibitory activity. Experimental studies revealed that intravenous administration of the fruit juice (0.4–1.6 mL/kg) lowered blood pressure in a dose-dependent manner, promoted concentration- dependent relaxation of isolated rat aortic rings, and stimulated nitric oxide (NO) release in cultured swine aortic endothelial cells [44].

9.6.3 Nephroprotective effect:

In female Wistar albino rats with renal ischemia/reperfusion injury, administration of methanolic fruit extract (500 mg/kg/day, p.o.) for five consecutive days significantly reduced MDA content, while enhancing the levels of SOD, CAT, and GSH. In another study, chronic hyperoxaluria induced by ethylene glycol in Wistar albino rats led to decreased urinary oxalate, kidney retention of protein, oxalate, and calcium, as well as reduced serum sodium, calcium, phosphorus, and creatinine levels. Treatment with ethanolic seed extract of Benincasa hispida (250–500 mg/kg, p.o.) for 35 days reduced urinary oxalate levels, suggesting a regulatory effect on the endogenous synthesis of oxalate.

9.6.4 Anti-ageing effects on skin:

A cream formulated with dried fruit pulp extract (petroleum etherchloroform, ethyl acetate, and methanol fractions) demonstrated significant anti-ageing activity when tested on the stratum corneum of human skin and dansyl chloride fluorescence models.

9.7 Anti-angiogenic activity:

This study investigated the anti-angiogenic potential of Benincasa hispida seed extract. Basic fibroblast growth factor (bFGF), a potent angiogenic mediator commonly associated with tumors, was used to induce angiogenesis. The results showed that the seed extract inhibited bFGF-induced endothelial cell proliferation and tube formation in a dose-dependent manner. Importantly, the extract exhibited no cytotoxic effects on human umbilical vein endothelial cells (HUVECs) or normal fibroblast cells. Additionally, in vivo studies confirmed a strong inhibitory effect of the seed

extract on bFGF-induced angiogenesis. These findings suggest that Benincasa hispida seed extract suppresses endothelial cell proliferation induced by bFGF, thereby contributing to its anti-angiogenic properties.

9.8 Antiulcer activity:

This study evaluated the ulcer-healing potential of the fruit extract of Benincasa hispida (ash gourd) against indomethacin-induced gastric ulcers in rats, with particular focus on its antioxidant role. Induction of gastric ulcers resulted in a significant increase in SOD levels in red blood cells and tissue homogenates, as well as elevated plasma vitaminC. Treatment with the fruit extract led to a marked reduction in ulcer index. Moreover, a significant decrease in MDA levels was observed, accompanied by a reduction in SOD and vitamin C compared to untreated ulcer-induced rats. Phytochemical analysis of Benincasa hispida has identified active constituents such as terpenes, flavonoid Cglycosides, and sterols, which possess antioxidant properties.

9.9 Antidiarrheal activity:

Findings from this study suggest that Benincasa hispida fruit extract (BHFE), administered in graded doses, effectively reduced diarrhea by inhibiting intestinal peristalsis, gastrointestinal motility, and prostaglandin E2 (PGE2)-induced enter pooling. These inhibitory effects support the traditional use of Benincasa hispida in folk medicine as a non-specific antidiarrheal agent. The mechanism underlying this effect appears to be related to its spasmolytic and anti-enter pooling properties, through which the fruit extract alleviates diarrheal symptoms [45].

9.10 Anticompulsive activity:

The present study demonstrated that the methanolic extract of Benincasa hispida (MEBH) fruit exhibited significant anti-compulsive activity in mice, as evidenced by the inhibition of marble-burying behavior. Its effect was found to be comparable to fluoxetine. Furthermore, co-administration of a sub-effective dose of MEBH with a sub-effective dose of fluoxetine potentiated the inhibitory effect on marble-burying behavior. Preliminary phytochemical screening of MEBH revealed the presence of tryptophan, a key precursor of serotonin in serotonergic neurons, which may enhance serotonin biosynthesis and contribute to the observed anti-compulsive activity [46].

Toxicological Profile: Safety and Adverse Effects

Studies on the safety of Benincasa hispida have shown that administration of its fresh juice (5% v/v) for three months did not alter hematological parameters such as total white blood cell (WBC) count, red blood cell count, hemoglobin (Hb), mean corpuscular hemoglobin, hematocrit (HCT), mean corpuscular volume, as well as biochemical markers including blood sugar and urea levels in rats and mice. No behavioral changes were observed in the treated animals [47]. The methanolic fruit extract was found to be safe at doses up to 3.0 g/kg, without causing mortality in mice, rats, or guinea pigs. Similarly, oral administration of standardized hydroalcoholic (70% ethanol) extract of B. hispida fruit pulp was reported to be safe in both male and female rats. A 90-day subchronic toxicity study established the no-observed-adverse-effect level (NOAEL) at oral doses up to 1000 mg/kg body weight/day. Moreover, ethanolic seed extract was well tolerated at doses up to 5000 mg/kg (p.o.) without harmful effects in rats [48]. However, phytochemical investigations identified the presence of Di-2-ethylhexyl phthalate (DEHP) in the fruit, at concentrations ranging from 18.3–75.5 mg/kg. DEHP is a commonly used plasticizer known to exert detrimental effects on human health [49].

11. Other Uses of Ash Gourd

11.1 Accelerates weight loss:

Ash gourd is low in calories yet rich in essential nutrients, making it a suitable dietary component for individuals following strict weight-loss regimens, including those with diabetes. Its high dietary fiber content promotes satiety, reduces cravings, and supports fat metabolism, thereby accelerating weight loss [50].

11.2 Augments heart function:

With negligible cholesterol content, ash gourd can be safely incorporated into the daily diet to promote

cardiovascular health. Consuming it in simple preparations, such as boiled ash gourd added to homemade dishes, enhances blood circulation and supports optimal cardiac muscle function.

11.3 Detoxifies the kidneys:

Ash gourd facilitates the elimination of metabolic waste products through the excretory system by stimulating fluid secretion in the kidneys. This not only aids in the removal of accumulated toxins but also ensures proper hydration of internal organs. Regular consumption of ash gourd juice has been shown to support the normal functions of the kidneys and bladder [51].

11.4 Complements ketogenic diet:

As a naturally low-carbohydrate and low-sugar vegetable, ash gourd serves as an excellent addition to ketogenic diets, which emphasize carbohydrate restriction. A simple preparation of boiled ash gourd seasoned with salt and pepper can be incorporated regularly as part of ketofriendly meals [51].

12. Additional Therapeutic and Cosmetic Uses of Ash Gourd

12. 1 Naturally moisturizes skin:

Ash gourd is a natural source of vitamin E, which functions as an emollient and antioxidant. The gel extract, when applied to sunburns or rashes, soothes irritated skin, alleviates dryness, and restores softness by providing deep moisturization [52].

12.2 Combats skin infections:

Residue derived from ash gourd leaves exhibits astringent properties, helping to calm inflamed skin regions. It has been reported to reduce abscesses, boils, pus formation, and carbuncles arising from allergies, fungal infections, environmental pollutants, or excessive sun exposure.

12.3 Promotes hair growth:

Rich in vitamins and minerals, ash gourd provides essential nourishment to hair strands. Topical application of ash gourd gel penetrates the scalp, strengthens hair follicles, and help maintain thickness and resilience of hair, making it beneficial for those seeking long and strong hair [53].

12.4 Tackles excessive dandruff:

Ash gourd contains bioactive compounds that help reduce scalp flakiness and dandruff. By protecting follicles from dirt and fungal particles that trigger dandruff, routine application of ash gourd gel improves scalp health and restores shine to dull hair [54].

12.5 Battles fevers:

The phytonutrients in ash gourd possess natural antipyretic activity. Rubbing the leaves on individuals with high fever provides symptomatic relief by reducing body temperature and fatigue. Additionally, the leaves aid in expelling excess water and salts, thereby maintaining electrolyte balance during fever episodes [55].

13. Further Medicinal Benefits of Ash Gourd

13.1 Treats alopecia:

Topical application of ash gourd gel has been reported to stimulate blood circulation and nerve activity in the scalp, thereby promoting rapid hair growth. In cases of alopecia, which is characterized by bald patches and excessive hair loss, the high carotene content of ash gourd gel helps counter hair fall, while improving hair strength, thickness, and smoothness [56].

13.2 Recovers joint illnesses:

Ash gourd juice exhibits potent anti-inflammatory activity, making it beneficial in alleviating bone and muscle pain, as well as joint disorders such as arthritis, osteoporosis, gout, and fractures. It is also rich in calcium, magnesium, and phosphorus—three essential minerals that strengthen bone mass and restore flexibility in muscles and joints.

13.3 Uplifts immunity:

Ash gourd is a rich source of vitamin C, flavonoids, and carotenes, which contribute to its strong immunomodulatory effects. During illness, when organ functions are compromised, consumption of ash gourd provides vitamin C to blood cells, which is

subsequently transported to organs to restore their optimal functioning. It also aids in reducing fatigue and accelerating recovery [57].

13.4 Regulates thyroid function:

Ash gourd is a natural source of iodine, which helps regulate elevated thyroid hormone levels, particularly in hyperthyroidism. In addition, its zinc content supports enzymatic activity necessary for maintaining balanced thyroid function.

13.4 Alleviates insomnia:

The juice of ash gourd is abundant in vitamin B6 (pyridoxine), which plays a crucial role in regulating brain function and ensuring efficient nerve impulse transmission. In individuals experiencing insomnia or sleep disturbances, regular consumption of ash gourd juice may help reduce excessive neurotransmitter activity, thereby promoting relaxation and improving sleep quality [58].

14. Adverse Effects of Ash Gourd

14.1 Gastrointestinal Distress:

Ash gourd contains high water and fiber content, which can cause bloating, gas, or diarrhea when consumed in large amounts. Unripe fruit or juice taken on an empty stomach may lead to stomach discomfort in some individuals [59].

14.2 Respiratory Issues:

Due to its cooling nature, ash gourd can increase mucus production. In individuals with asthma, sinusitis, or other respiratory problems, regular consumption might aggravate symptoms [60].

14.3 Hypoglycemic Risk:

Ash gourd has mild glucose-lowering properties. When combined with diabetic medications, it may cause hypoglycemia (low blood sugar), particularly in sensitive individuals [61].

14.4 Nutrient Absorption Interference:

Compounds such as oxalates and phytates found in ash gourd may interfere with the absorption of essential minerals like calcium and iron. Long-term overconsumption could lead to nutritional imbalance [62].

14.5 Allergic Reactions:

Although rare, allergic responses like skin rashes, itching, or swelling have been reported. Individuals with known food sensitivities should introduce ash gourd cautiously into their diet [63].

14.6 Toxicity from Fermented Juice:

Fresh juice is commonly consumed for detoxification, but if left unrefrigerated or consumed after fermentation, it may produce toxic compounds harmful to the digestive tract [64].

15. Toxicity of Ash Gourd

15.1 Acute and Sub-Chronic Toxicity:

Animal studies evaluating the toxicity of ash gourd extracts have shown that it is safe at low to moderate doses. However, at high concentrations, mild toxicological effects have been observed, Including behavioral changes and slight histopathological alterations in liver and kidney tissues [65].

15.2 Risk of Hypoglycemia:

Ash gourd has natural blood sugar-lowering properties. In diabetic patients taking insulin or hypoglycemic drugs, it may enhance the effect and lead to dangerously low blood glucose levels if not monitored properly [66].

15.3 Gastrointestinal Effects:

Large quantities of ash gourd juice can cause digestive issues such as diarrhea, bloating, and abdominal discomfort, particularly if consumed on an empty stomach [67].

15.4 Respiratory Concerns:

Due to its cooling nature, excessive intake may lead to increased mucus production. This can potentially worsen symptoms in individuals with asthma, bronchitis, or sinusitis [68].

15.5 Risk from Fermented Juice:

Fresh ash gourd juice is often recommended for detoxification, but when stored improperly or consumed after fermentation, it may produce harmful metabolites. These compounds can irritate the gastrointestinal tract and, in rare cases, cause toxicity [69].

15.6 Anti-Nutritional Compound:

Ash gourd contains oxalates and phytates that may interfere with mineral absorption, particularly calcium and iron, if consumed in large amounts over a long period [70].

CONCLUSION

In conclusion, ash gourd is a highly nutritious and versatile vegetable that offers numerous health benefits. Rich in vitamins, minerals, and antioxidants, it supports digestion, boosts immunity, and helps maintain hydration. Its low-calorie content makes it an ideal choice for weight management and overall wellness. Whether consumed as juice, in curries, or in traditional remedies, incorporating ash gourd into the diet can significantly enhance health and well-being.

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