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GARCINIA CAMBOGIA (GARCINIA GUMMI-GUTTA): PHYTOCHEMISTRY, PHARMACOLOGICAL ACTIVITIES AND THERAPEUTIC POTENTIAL – A COMPREHENSIVE REVIEW

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ABSTRACT

Garcinia cambogia (syn. *Garcinia gummi-gutta* (L.) Roxb.), commonly known as Malabar tamarind, is an economically and medicinally important tropical plant belonging to the family Clusiaceae. The fruit rind of this plant has long been utilized in traditional medicine and culinary practices due to its characteristic sour taste and diverse therapeutic properties across South and Southeast Asia, particularly along the Western Ghats of India. The primary bioactive constituent of *G. cambogia* is Hydroxycitric acid (HCA), which is considered the principal active compound responsible for anti-obesity activity through inhibition of ATP-citrate lyase, thereby reducing fatty acid synthesis and promoting satiety and metabolic regulation.[1-3] In addition to HCA, the plant contains several secondary metabolites including flavonoids, anthocyanins, xanthones, benzophenones, organic acids, and polyphenolic compounds. These constituents contribute to diverse biological activities such as anti-obesity, antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, and hepatoprotective and gastroprotective effects.[4,5] Recent advancements in extraction technologies and nanotechnology-based delivery systems have further enhanced the pharmacological potential of *G. cambogia* bioactives. Despite promising therapeutic applications, concerns regarding safety, hepatotoxicity, and inconsistent clinical

outcomes highlight the need for rigorous clinical evaluation. This review critically summarizes the taxonomy, botanical characteristics, phytochemical composition, pharmacological properties, therapeutic applications, and safety considerations of *Garcinia cambogia*, with emphasis on its emerging role as a nutraceutical and functional food ingredient.

KEYWORDS: *Garcinia cambogia*; Hydroxycitric acid; Nutraceuticals; Phytochemistry; Anti‑obesity; Natural products.

1. INTRODUCTION

The genus *Garcinia* comprises more than 300 species widely distributed throughout tropical regions of Asia and Africa.[4,5] Members of this genus are commonly known as kokum, mangosteens, sap trees, or monkey fruits and are valued for their ornamental, culinary, and medicinal importance. Many species within this genus possess nutritional and medicinal significance due to their rich phytochemical profile. Among these, *Garcinia cambogia* (Gaertn.) Desr., also referred to as *Garcinia gummi-gutta*, has gained global attention because of its bioactive constituents, traditional therapeutic applications, as a nutraceutical with significant pharmacological properties. The plant is indigenous to the Western Ghats of India and other parts of South Asia. Traditionally, the dried fruit rind has been used as a souring agent in culinary preparations, particularly in fish-based dishes. In Ayurvedic medicine, the fruit rind has been employed to treat gastrointestinal disorders such as constipation, dysentery, intestinal parasites, indigestion and piles. It has also been used in the management of rheumatism, edema, and menstrual irregularities and cardiovascular conditions.[6-7] It has also been traditionally used in the treatment of rickets and splenomegaly, as aid to heal bone fracture .Owing to its ability to enhance satiety, the rind has also been traditionally used as an appetite suppressant, making meals more filling and satisfying. Scientific interest in *G. cambogia* has increased significantly due to the presence of Hydroxycitric acid (HCA), garcinol, and various polyphenolic constituents. In view of its extensive traditional use, complex phytochemistry, and growing global consumption, a critical evaluation of the botanical, phytochemical, pharmacological, and toxicological aspects of *Garcinia cambogia* is essential to establish evidence-based conclusions regarding its role in weight management and metabolic regulation.[1,2,7]

2. TAXONOMIC CLASSIFICATION

The taxonomic classification of *Garcinia cambogia* is as follows:

Rank	Classification
Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Malpighiales
Family	Clusiaceae
Genus	Garcinia
Species	*Garcinia cambogia*

The plant is also known by the synonym Garcinia gummi-gutta (L.) Roxb.[8]

3. VERNACULAR NAMES

Language	Name
Kannada	Manda Huli, Mantulli, Punara Huli Seeme Hunnise, Upagi Mara
Tamil	Gorakkapuli, Heela, Kottukkappuli Panampuli, Kodukkaippuli
English and Regional Names	Gambooge, Brindleberry/Brindall Berry, Fish Tamarind, Malabar Tamarind, Kerala Tamarind Goraka (Sri Lanka), Kodumpulli (Kerala)
Malayalam	Gorakkapuli, Kodampuli / Kudampuli. Marapuli, Meenpuli, Perumpuli Pinampuli, Pinar

4. BOTANICAL DESCRIPTION[8,9]

Garcinia cambogia is a small to medium-sized evergreen tree that typically grows between 5 and 20 meters in height. The tree exhibits a rounded crown with drooping branches and produces a yellow latex when injured.

4.1 Literature review of *Garcinia cambogia*

Figure 1: Botanical morphology of *Garcinia cambogia.*

Morphological characteristics of *Garcinia cambogia* showing tree, leaves, flowers, bark, seeds, fruit & rind. Fruit morphology of *Garcinia cambogia* illustrating the grooved pericarp and seed arrangement.

4.11 Habit: Small to medium-sized evergreen dioecious or polygamous tree. Height ranges from 5–20 m (commonly up to 12 m). Crown is rounded, with horizontal or drooping branches. Growth is slow, and sex differentiation is evident only at flowering, typically after 7–9 years.

4.12 Leaves: The leaves are simple, opposite, leathery and coriaceous with an elliptic to obovate shape. The lamina typically measures 5–13 cm in length and displays a glossy green surface.

4.13 Flowers: The plant produces polygamous flowers that appear in clusters within axillary or terminal inflorescences. The flowers are generally cream to pink in color and bloom during the summer months.

4.14 Fruit: The fruit of *Garcinia cambogia* is a berry that is typically ovoid to globose in shape. It generally measures approximately 5 cm in diameter and weighs between 50 and 180 g. The surface of the fruit is characterized by 6–8 prominent longitudinal grooves that form blunt lobes and a thick fleshy rind containing hydroxycitric acid. In the unripe stage, the fruit is green in colour, whereas the ripe fruit turns yellow, orange, red, and occasionally purplish and contain 6–8 seeds surrounded by a fleshy succulent aril. The fruiting season usually occurs during the rainy months from June to September. The pericarp is thick and fleshy and possesses a characteristic sour taste due to the presence of organic acids.

4.15 Seed: The fruit of *Garcinia cambogia* typically contains 6–8 seeds. The seeds are kidney-shaped to ovoid in form with a smooth surface. They measure approximately 2-3cm in length and 1-1.5cm in width. Each seed is enclosed by a succulent aril that ranges in colour from white to yellowish.

4.16 Trunk & Bark: Outer bark reddish brown, lenticellate; blaze reddish**.**

4.17 Branches and Branchlets: Branches drooping; young branchlets subterete, glabrous.

4.18 Exudates: Latex yellow, profuse.

4.19 Inflorescence/Flower: Flowers polygamous, in axillary or terminal clusters; calyx cream; petals pink. Petals usually four, with male and female flowers occurring on separate or same trees.

4.20 Flowering season: Summer (March–May). Flowers are non-nectariferous. Male flowers are tetramerous 3to8 flower on axillary fasicles1-1.7cm×1-1.2cm, pedicle 7to12mm long. female flowers are tetramerous solitory or 1to3 fascicle on terminal or axillary,1.5-2cm×1.5cm.

5. GEOGRAPHIC DISTRIBUTION

Garcinia cambogia is primarily native to the Western Ghats region of India, particularly in states such as Karnataka, Kerala, Maharashtra, and Tamil Nadu. The plant is also distributed in Sri Lanka and Nepal. In addition, it has been introduced to several tropical and subtropical regions including Malaysia, China, and the Philippines. The species thrives in humid tropical climates and grows well in both hill slopes and valley regions. It demonstrates adaptability to various soil conditions including moderately waterlogged environments.[8,10]

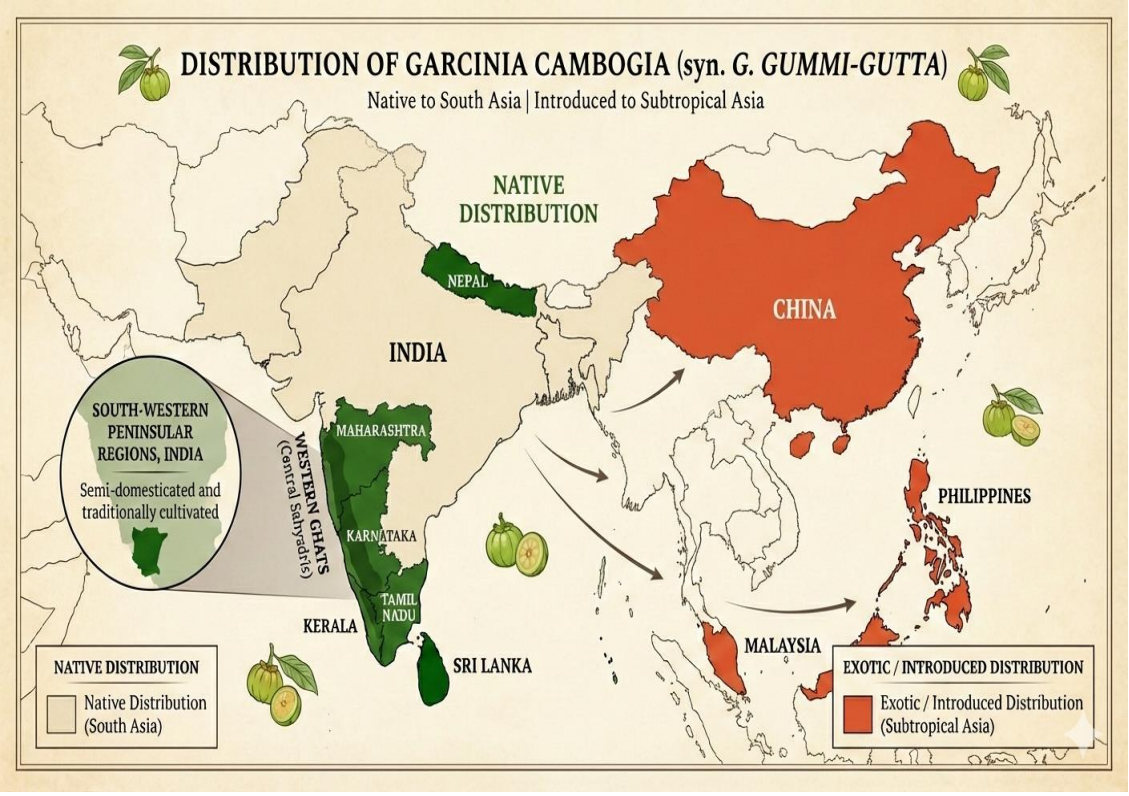


Figure 2: Geographic distribution of *Garcinia cambogia* (Garcinia Gummi-gutta) across South and Southeast Asia.

6. ETHNOBOTANICAL USES

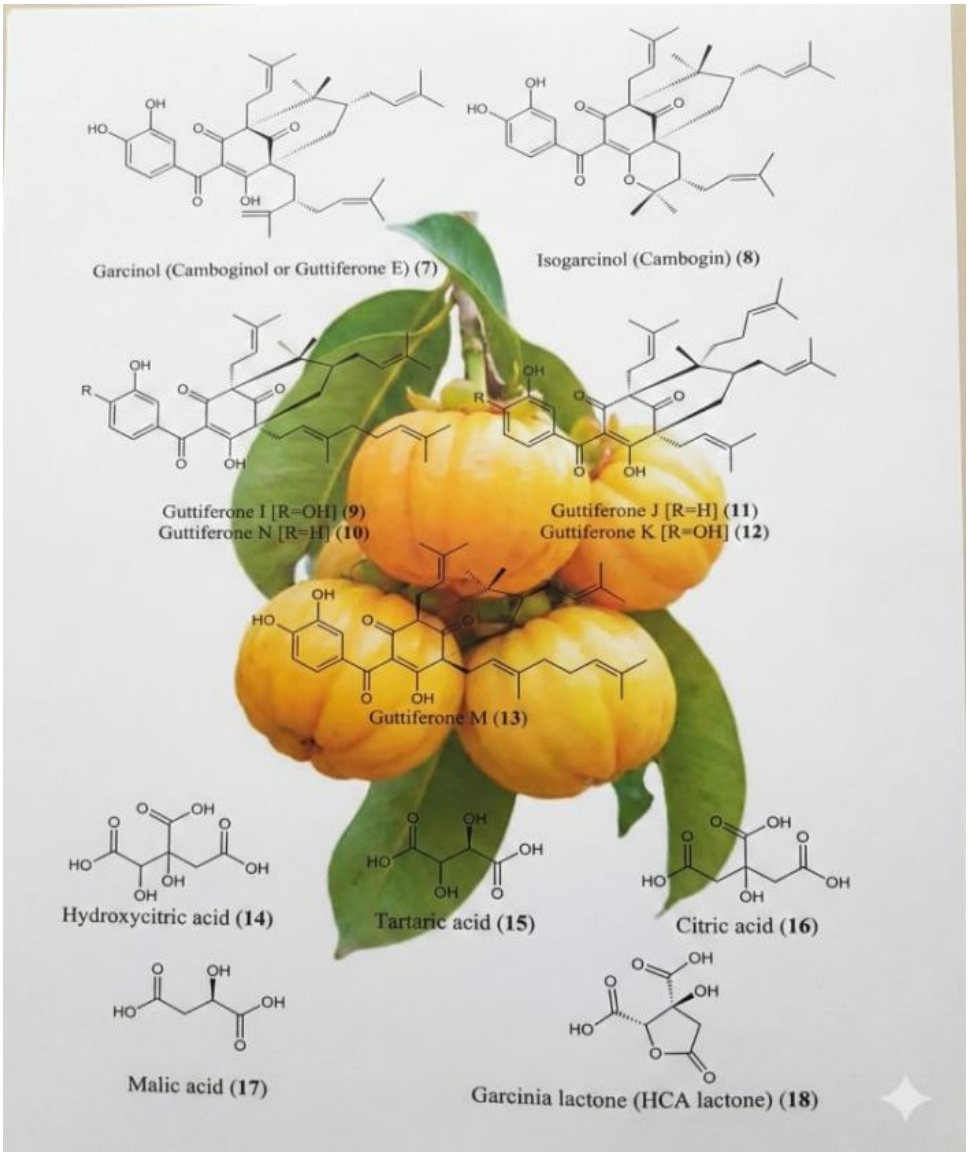
Figure 3: Ethnobotanical and traditional uses of *Garcinia cambogia* in food, medicine and industry.

Garcinia cambogia is an economically and culturally important spice tree widely used throughout South and Southeast Asia. The sun-dried or smoked fruit rind is extensively utilized as a flavouring agent, particularly in traditional fish curries. Due to its pronounced acidity and bacteriostatic properties, the dried rind—often combined with salt—has long been employed in India and Sri Lanka for fish curing and preservation. In culinary applications, the rind is also used as a bulking agent that enhances satiety and is occasionally employed as a substitute for kokum butter obtained from *Garcinia indica*. Although the fruits are edible, their high acidity generally limits their consumption in raw form. Ethnomedicinally, the fruit rind is valued for its therapeutic use in managing rheumatism and various gastrointestinal disorders like purgative, anthelmintic, and digestive aid., including bowel complaints. Traditional medical systems describe its use as a purgative, hydragogue, anthelmintic, and emetic. In veterinary medicine, aqueous extracts of the rind are used as a mouth rinse for treating oral infections in cattle. The plant also has industrial applications, including its use in the preparation of traditional fermented beverages such as wine. Furthermore, it has been traditionally used for thermogenic, cardiotonic, antiscorbutic, and respiratory conditions such as phthisis pulmonalis.[9] Additionally, a vitamin C–rich tonic prepared from the fruit is

traditionally consumed in India for the management of cardiac ailments. Beyond medicinal applications, *G. cambogia* has several non-food ethnobotanical uses. The acidic fruit rind is used for polishing gold and silver ornaments, while its extract serves as a natural coagulant for rubber latex, functioning as a substitute for acetic acid. Moreover, the gum obtained from the plant is utilized as a varnish, and the resin has traditionally been employed as a pigment in miniature paintings and watercolour art.[11-13]

7. PHYTOCHEMICAL COMPOSITION[15-19]

Phytochemical investigations have revealed that *Garcinia cambogia* contains a diverse array of bioactive constituents rind. The most important compound present in the fruit rind is (−)-hydroxycitric acid (HCA), garcinol and flavonoids which may constitute up to 10–60% of the dried rind.[1,6,14]



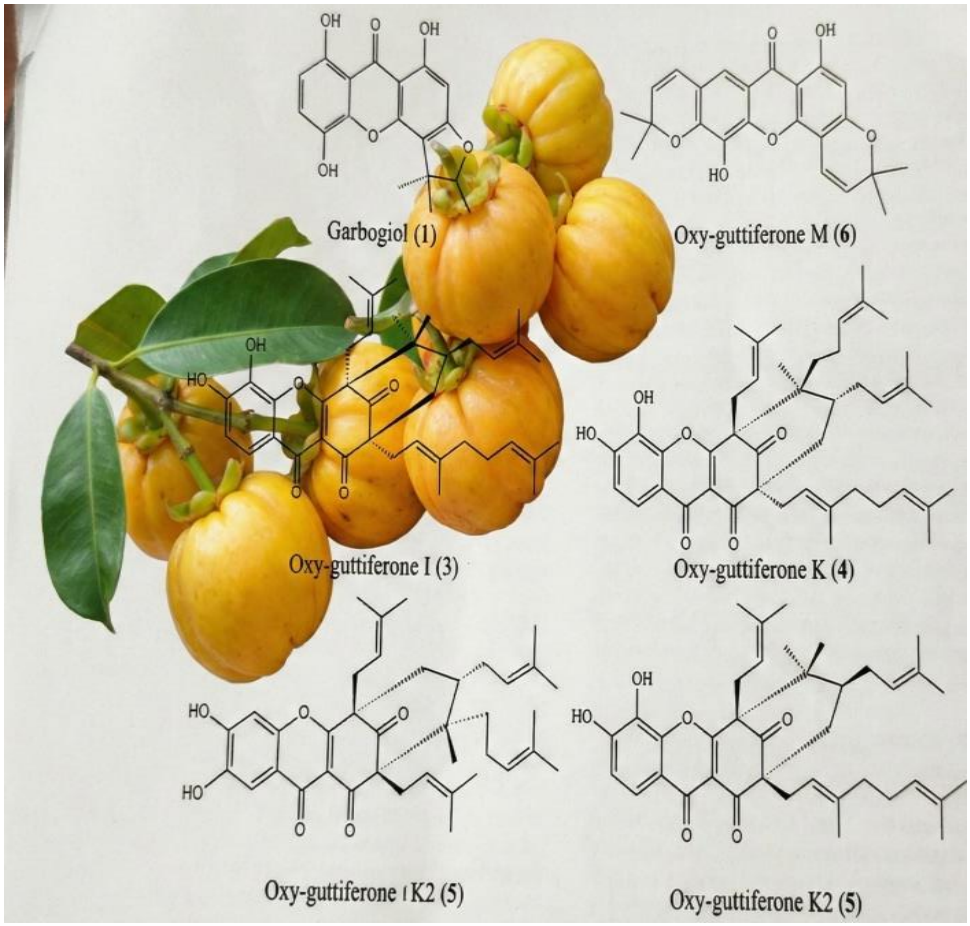


Figure 4: Phytochemical classification of *Garcinia cambogia* (Garcinia Gummi-gutta).

Major phytochemical classes identified in *Garcinia cambogia.*

Phytochemical Class	Major Compounds	Plant Part	Pharmacological Activities
Organic acids	Hydroxycitric acid, citric acid, malic acid	Fruit rind	Anti-obesity, appetite suppression, lipid metabolism regulation
Benzophenones	Garcinol, isogarcinol, guttiferone J	Fruit rind, whole plant	Anticancer, antioxidant, anti-inflammatory
Flavonoids	Quercetin, rutin, catechin, naringin	Fruit rind	Antioxidant, antidiabetic, anti-inflammatory
Anthocyanins	Cyanidin-3-O-glucoside, cyanidin-3-O-sambubioside	Fruit rind	Free radical scavenging, cardioprotective activity
Xanthones	Garbogiol, rheediaxanthone	Root, bark	Antioxidant, antimicrobial.
Amino acids	Arginine, leucine, glycine, glutamine	Fruit pulp	Metabolic and nutritional functions
Fatty acid and	Palmitic acid, oleic acid, linoleic acid	Seeds and	Nutritional value and lipid metabolism.
volatile oils	β-Caryophyllene (53.82%), (E)-β-farnesene (22.62%), δ-cadinene (32.4%), α-copaene (30.2%).	leaves	Aromatic

7.1. Organic Acids: The most prominent phytochemical group in *Garcinia cambogia* is organic acids, particularly (−)-hydroxycitric acid (HCA), which constitutes approximately 10–60% of the dried fruit rind. HCA acts as a competitive inhibitor of ATP-citrate lyase, an enzyme responsible for converting citrate into acetyl-CoA during fatty acid biosynthesis. This inhibition reduces lipid accumulation and promotes glycogen synthesis in the liver, which contributes to appetite suppression and body weight regulation. Other organic acids such as citric acid and malic acid contribute to the fruit's sour taste and also exhibit antioxidant properties.

7.2. Benzophenones: Benzophenones are another important class of phytochemicals present in *Garcinia cambogia*. Key compounds include garcinol, isogarcinol, and guttiferones. Garcinol has been extensively studied due to its potent anticancer properties. It inhibits cancer cell proliferation through modulation of signaling pathways such as NF-κB and STAT3, and promotes apoptosis in tumor cells.

Additionally, benzophenones demonstrate significant anti-inflammatory and antioxidant activities, contributing to the plant's therapeutic potential.

7.3. Flavonoids and Polyphenols: Flavonoids such as quercetin, rutin, catechin, and naringin are widely distributed in the fruit rind. These compounds act as strong free radical scavengers and protect cells from oxidative stress. They also contribute to antidiabetic, cardioprotective, and anti-inflammatory activities. Polyphenolic compounds further enhance the antioxidant capacity of the plant, which may reduce the risk of chronic diseases.

7.4. Anthocyanins: Anthocyanins such as cyanidin-3-O-glucoside and cyanidin-3-O-sambubioside are pigments responsible for the coloration of the fruit. These compounds possess strong antioxidant activity and contribute to cardiovascular protection by reducing oxidative damage.

7.5. Xanthones: Xanthones are secondary metabolites identified mainly in the roots and bark of *Garcinia* species. Compounds such as garbogiol and rheediaxanthone exhibit antimicrobial, antioxidant, and anti-inflammatory activities. Xanthones are also known for their cytotoxic effects against certain cancer cell lines.

7.6. Fatty Acids: Seeds of *Garcinia cambogia* contain several fatty acids including palmitic acid, oleic acid, linoleic acid, and arachidic acid. These compounds contribute to the

nutritional value of the plant and may influence lipid metabolism.

8. NANOTECHNOLOGY AND DRUG DELIVERY: Recent studies have focused on nanoformulation strategies to improve the bioavailability of Garcinia bioactive compounds. Nanocarriers such as liposomes, nanoemulsions, and solid lipid nanoparticles enhance gastrointestinal stability and facilitate targeted delivery of hydroxycitric acid. Recent studies have demonstrated the development of nanoemulsion and lipid-based nanocarriers for improved delivery of hydroxycitric acid.[14]

9. NUTRITIONAL COMPOSITION: The fruit contains carbohydrates, dietary fiber, and essential minerals such as potassium and sodium. The seeds also contain proteins and fats that contribute to its nutritional value of the plant.[9,14]

10. PHARMACOLOGICAL ACTIVITIES

10.1 Anti-Obesity Activity: The anti-obesity effect of *Garcinia cambogia* is primarily attributed to its major bioactive constituent, hydroxycitric acid (HCA). HCA acts as a competitive inhibitor of ATP-citrate lyase, a key enzyme involved in the conversion of citrate into acetyl-CoA during fatty acid biosynthesis. Inhibition of this enzyme reduces the conversion of carbohydrates into fatty acids, thereby limiting lipid accumulation and adipose tissue formation. Additionally, HCA has been reported to enhance hepatic glycogen synthesis, which contributes to increased satiety signals and reduced caloric intake. These combined metabolic effects play a significant role in body weight regulation.[1,3]

10.2 Appetite Suppression: Hydroxycitric acid has been reported to influence appetite regulation by increasing serotonin levels in the brain. Serotonin is an important neurotransmitter that regulates mood, appetite, and satiety. Elevated serotonin levels promote a feeling of fullness and reduce food intake, thereby contributing to weight management. This appetite-suppressing effect further supports the potential role of *Garcinia cambogia* in obesity management.[1,3]

10.3 Anticancer Activity: Bioactive compounds present in *Garcinia cambogia*, particularly garcinol and related benzophenones, exhibit significant anticancer properties. These compounds inhibit the proliferation of cancer cells through multiple mechanisms, including induction of apoptosis, inhibition of tumor cell growth, and modulation of key signaling pathways such as NF-κB and STAT3. Furthermore, these compounds may inhibit lipid

biosynthesis pathways that are essential for rapid tumor cell proliferation, thereby contributing to their anticancer activity.[16,20]

10.4 Antioxidant Activity: Phenolic compounds and flavonoids present in *Garcinia cambogia* exhibit strong antioxidant properties. These compounds effectively scavenge reactive oxygen species (ROS) and other free radicals, thereby protecting cellular components such as lipids, proteins, and DNA from oxidative damage. The antioxidant activity of the plant may contribute to the prevention of various oxidative stress-related disorders, including cardiovascular diseases, metabolic syndrome, and neurodegenerative conditions.[5,21]

10.5 Anti-Inflammatory Activity: Extracts of *Garcinia cambogia* have demonstrated notable anti-inflammatory effects in several experimental studies. These extracts reduce the production of inflammatory mediators such as tumor necrosis factor-alpha (TNF-α), interleukins, and prostaglandins. In addition, garcinol has been shown to inhibit inflammatory enzymes such as cyclooxygenase-2 (COX-2) and suppress nuclear factor-kappa B (NF-κB) signaling pathways, which play a central role in the inflammatory response.[17]

10.6 Antidiabetic Activity: Hydroxycitric acid has been reported to improve glucose metabolism and insulin sensitivity. It may reduce intestinal glucose absorption and enhance peripheral glucose utilization, thereby contributing to improved glycemic control. Experimental studies suggest that supplementation with *Garcinia cambogia* extracts may help regulate blood glucose levels and reduce metabolic disturbances associated with diabetes.[22,23]

10.7 Hepatoprotective Activity: Several experimental studies have demonstrated the hepatoprotective potential of *Garcinia cambogia*. Extracts of the plant have been shown to protect liver tissues against drug-induced and alcohol-induced toxicity. The protective effect is primarily attributed to the antioxidant properties of its bioactive constituents, which enhance the activity of endogenous antioxidant enzymes and reduce lipid peroxidation in hepatic tissues.[24]

10.8 Antimicrobial Activity: *Garcinia cambogia* extracts exhibit significant antimicrobial activity against a variety of pathogenic microorganisms. Studies have reported inhibitory effects against bacterial species such as *Escherichia coli*, *Klebsiella pneumoniae*, and

Pseudomonas aeruginosa. These antimicrobial properties are mainly attributed to the presence of polyphenols, flavonoids, and benzophenone derivatives present in the fruit rind.[25,26]

10.9 Effects on Fertility: Ethanolic extracts of *Garcinia cambogia* seeds have been reported to influence reproductive parameters in experimental animal models. Studies conducted in male rats demonstrated an increase in sperm count and enlargement of interstitial spaces following administration of the seed extract. However, higher doses were associated with degeneration of spermatogenic cells. In addition, administration of hydroxycitric acid (HCA) was found to reduce the levels of testicular meiosis-activating sterols. In contrast, female reproductive hormones and ovarian parameters were not significantly affected. These findings suggest that *G. cambogia* may exert dose-dependent reproductive effects without causing significant hormonal imbalance.[27,28]

10.10 Anticholinesterase Activity: Extracts of *Garcinia cambogia* fruit rind have demonstrated significant acetylcholinesterase inhibitory activity. *In vitro* studies reported inhibition levels of up to 67% at higher extract concentrations. The observed inhibitory effect was found to be comparable to that of the standard cholinesterase inhibitor neostigmine. This activity suggests that *G. cambogia* may possess therapeutic potential in the management of neurodegenerative disorders such as Alzheimer's disease, where acetylcholinesterase inhibition plays a crucial role in improving cognitive function.

10.11 Anthelmintic Activity: Leaf and fruit rind extracts of *Garcinia cambogia* have demonstrated significant anthelmintic activity in experimental studies. When tested against earthworms, the extracts caused rapid paralysis within 1–2.5 minutes, followed by death within 3–7 minutes. Among the tested extracts, ethanolic preparations exhibited the highest anthelmintic efficacy. The observed activity was comparable to that of the standard anthelmintic drug albendazole, supporting the traditional use of the plant as a natural antiparasitic agent.[29]

10.12 Erythropoietic Effect: *Garcinia cambogia* has been reported to exhibit erythropoietic activity in animal studies involving ethanolic seed extracts. Administration of the extract was shown to enhance red blood cell production and stimulate erythropoiesis. This effect is believed to be associated with the presence of essential trace elements such as iron, zinc, copper, cobalt, and phosphorus, which play vital roles in hemoglobin synthesis and

erythrocyte formation. Additionally, the bioflavonoids present in *G. cambogia* may increase peripheral testosterone levels, thereby further stimulating erythropoiesis. The antioxidant properties of the plant also contribute to reduced oxidative hemolysis, ultimately prolonging the lifespan of red blood cells.

10.13 Anti-Aging Activity

Skin aging is a complex biological process characterized by the progressive appearance of wrinkles, dryness, and loss of skin elasticity. One of the major biochemical mechanisms underlying skin aging is the increased activity of elastase, an enzyme responsible for the degradation of elastin fibers, resulting in decreased skin elasticity and structural integrity. Furthermore, aging is associated with a gradual decline in hyaluronic acid levels, leading to reduced skin hydration and enhanced wrinkle formation. Environmental factors such as prolonged exposure to ultraviolet radiation and harmful chemicals further accelerate the aging process through oxidative stress-mediated mechanisms. Recent *in vitro* studies conducted by Sahasrabudhe and Deodhar demonstrated that the methanolic extract of *Garcinia cambogia* rind, along with its ethyl acetate and aqueous fractions, exhibits significant anti-hyaluronidase and anti-elastase activities. Notably, the ethyl acetate fraction showed substantial inhibition of hyaluronidase at a concentration as low as 25 µg/mL, whereas the aqueous fraction effectively inhibited both elastase and hyaluronidase at 90 µg/mL. These findings indicate that phytoconstituents present in *G. cambogia* may help preserve skin elasticity and hydration. Moreover, pigments derived from *Garcinia* species possess ultraviolet-absorbing properties, further supporting their potential application in dermatological and anti-aging formulations.

10.14 Gastroprotective Effects: Peptic ulcer disease is a multifactorial gastrointestinal disorder resulting from an imbalance between aggressive factors such as gastric acid, non-steroidal anti-inflammatory drugs (NSAIDs), and stress, and protective mechanisms including mucus secretion and antioxidant defense systems. Experimental studies have demonstrated the gastroprotective potential of garcinol, a major bioactive compound isolated from *Garcinia cambogia*. Oral administration of garcinol at doses ranging from 40 to 200 mg/kg significantly reduced indomethacin-induced gastric ulceration in rat models, with the maximum protective effect observed at 200 mg/kg. Notably, the anti-ulcer activity at this dose was found to be superior to that of the standard reference drug cetraxate hydrochloride. Furthermore, garcinol effectively attenuated gastric lesions induced by cold-water immersion

stress, exhibiting gastroprotective activity comparable to cetraxate-HCl. These findings suggest that garcinol exerts strong cytoprotective effects on the gastric mucosa, possibly through antioxidant and anti-inflammatory mechanisms.[30,31,32]

10.15 Diuretic Activity: *Garcinia cambogia*, a member of the family Clusiaceae, has long been used in Ayurvedic medicine for the management of digestive and metabolic disorders. Phytochemical investigations have identified hydroxycitric acid as the principal organic acid present in the plant, along with several other secondary metabolites including xanthones, flavonoids, glycosides, and triterpenoids that contribute to its pharmacological properties.

Experimental studies using Soxhlet-extracted ethanolic and aqueous leaf extracts demonstrated significant diuretic activity in male albino rats. The extracts increased urinary excretion of sodium, potassium, and chloride ions, producing effects comparable to the standard diuretic drug furosemide. This electrolyte modulation suggests that *Garcinia cambogia* may influence renal regulation of fluid balance and blood pressure. The observed diuretic activity is likely attributed to the presence of bioactive secondary metabolites, particularly flavonoids and glycosides, thereby supporting the therapeutic relevance of the plant in the management of renal and metabolic disorders.[33]

11. MECHANISM OF ANTI‑OBESITY ACTION

Hydroxycitric acid inhibits ATP‑citrate lyase, a key enzyme involved in fatty acid biosynthesis. This inhibition prevents the conversion of citrate into acetyl‑CoA, thereby reducing lipid synthesis and fat accumulation. Additionally, hydroxycitric acid enhances hepatic glycogen synthesis and promotes serotonin‑mediated satiety, resulting in reduced food intake.[1,3]

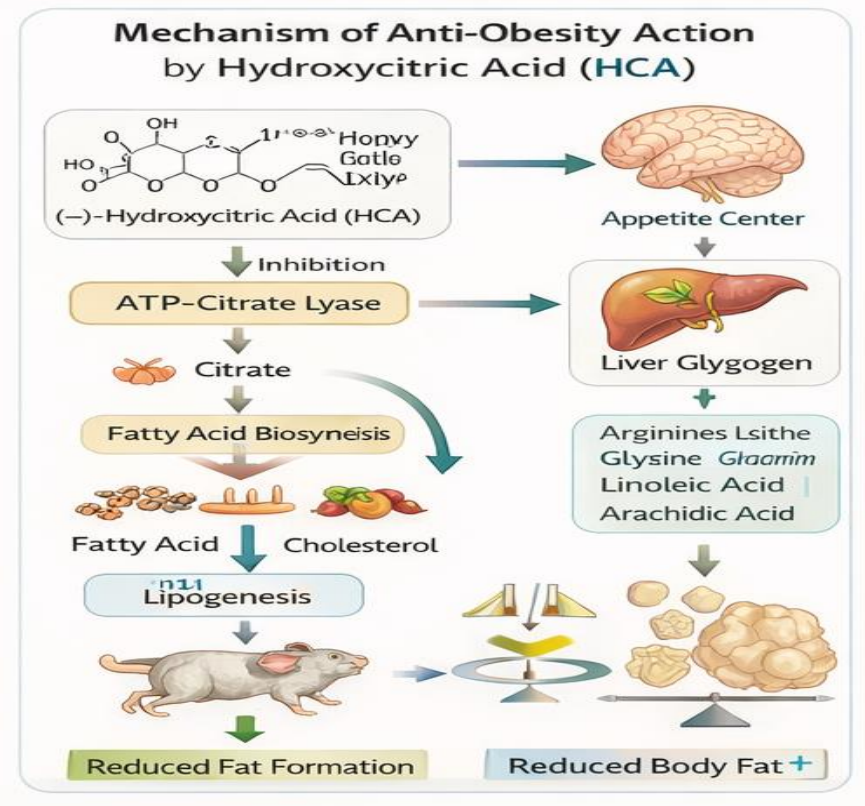


Figure 5: Mechanism of anti-obesity action Mechanism of anti-obesity action of hydroxycitric acid through inhibition of ATP-citrate lyase.

12. GENETICS AND CYTOGENETICS OF *GARCINIA CAMBOGIA*

Cytogenetic investigations of *Garcinia cambogia* have revealed variability in chromosome numbers, indicating the presence of considerable genetic diversity within the species. The diploid chromosome number (2n) of *G. cambogia* is most commonly reported as 2n = 54, corresponding to a haploid number (n) of 27, which suggests a polyploid cytotype. This chromosomal configuration indicates the presence of 27 homologous chromosome pairs within the somatic cells. Variations in chromosome numbers observed in *G. cambogia* reflect the cytogenetic complexity of the species and may arise from evolutionary mechanisms such as polyploidy and chromosomal rearrangements, which are common within the genus *Garcinia*. The presence of different chromosomal reports also highlights the potential for intraspecific genetic variability. Such genetic variation may influence phenotypic characteristics, secondary metabolite composition, and the adaptive capacity of the species in different ecological environments. Furthermore, the documented cytogenetic variability in *G. cambogia* provides an important foundation for genetic characterization, conservation planning, and future breeding programmes aimed at improving yield and enhancing the production of bioactive constituents. Chromosome numbers vary among different *Garcinia*

species, indicating cytogenetic diversity within the genus. Some species such as *Garcinia morella* and *Garcinia cowa* exhibit diploid chromosome numbers of 2n = 48, whereas others such as *Garcinia spicata* and *Garcinia parviflora* have been reported to possess triploid chromosome numbers of 2n = 72. This variation suggests that polyploidy and chromosomal rearrangements play an important role in the evolutionary diversification of the genus.[8]

13. SAFETY AND TOXICITY

Although *Garcinia cambogia* is generally considered safe within recommended doses, some adverse effects have been reported. Common side effects include gastrointestinal discomfort, nausea, headache, and dizziness. Rare cases of hepatotoxicity associated with multi-ingredient supplements have also been documented. Particularly in multi-ingredient formulations. Toxicological evaluations suggest that hydroxycitric acid is safe at doses up to approximately 2800 mg per day.[7,34]

14. CONCLUSION

Garcinia cambogia is an important traditional ethnomedicinal plant with significant nutraceutical potential. Its rich phytochemical profile contributes to diverse pharmacological activities including anti-obesity, antioxidant, antidiabetic, and anti-inflammatory effects. The presence of hydroxycitric acid and other bioactive compounds contributes to its therapeutic potential in obesity management, metabolic disorders, inflammation, and oxidative stress-related diseases. Advances in extraction technologies and nanotechnology-based delivery systems may further enhance its therapeutic applications of its active constituents. However, additional well-designed clinical trials are required to establish long-term safety and therapeutic effectiveness.

Future research should focus on clinical trials, standardization of extracts, and nanoformulation strategies to improve the therapeutic potential of *Garcinia cambogia.*[1,5,7]

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CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

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