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Evaluating Garcinia Cambogia: A Comprehensive Analysis of its Effectiveness

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A R T I C L E I N F O

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A B S T R A C T

The Southeast Asian fruit *Garcinia cambogia* has become well-known as a weight-loss pill because of its supposed ability to inhibit appetite and obstruct fat. The goal of this review is to thoroughly assess the scientific data on the efficacy and safety of *Garcinia cambogia* for a range of medical ailments.

Methodology: To find research on how *Garcinia cambogia* affects blood sugar regulation, cholesterol levels, weight reduction, and other health outcomes, a thorough search of pertinent scientific databases will be carried out. To make sure the studies are of the highest calibre and are pertinent, inclusion and exclusion criteria will be developed.

Results: The key findings from the literature search will be presented, focusing on the effects of *Garcinia cambogia* on different health parameters. Data on weight reduction, alterations in body composition, impacts on cholesterol and blood sugar levels, and any other health markers that may have been noticed will all be included.

Discussion: Based on the research that have been analysed, the efficacy of *Garcinia cambogia* for a range of health advantages will be critically evaluated. Possible methods of action, as well as the shortcomings of the present study and directions for further research, will be covered. The safety profile of *Garcinia cambogia*, including any possible adverse effects and drug interactions, will also be covered in the conversation.

Summary: This study aims to present a fair and factual evaluation of the possible health and weight loss benefits of *Garcinia cambogia*.

Conclusion: The review will close with a summary of the most important discoveries and recommendations for further study and therapeutic applications.

1. INTRODUCTION

Formerly identified as *Garcinia cambogia* (Gaertn.) Desr. (Clusiaceae), *Garcinia gummi-gutta* (L.) Roxb., commonly referred to as the Malabar tamarind, originates from Southeast Asia. The utilization of fruit rinds for medicinal purposes is deeply rooted in numerous Asian regions, where they are employed in the treatment of various health conditions such as piles, rheumatism, oedema, irregular menstruation, and intestinal parasites. Furthermore, this botanical species is extensively utilized for its properties as a food-bulking agent, food-preserving agent, and flavour enhancer. Previous analyses on the phytochemical composition of this plant have identified a range of organic acids, benzophenones, and xanthones as its primary constituents. Moreover, a multitude of scientific investigations have highlighted its diverse biological activities, suggesting potential advantages such as hypolipidemia, anticancer effects, and anti-obesity properties. The surge in popularity of commercial products containing Garcinia cambogia has been accompanied by significant media attention, both favorable and unfavorable. The widespread recognition and

appeal of this botanical specimen is evident from the substantial number of search results, exceeding 11 million, retrieved by conducting a Google search for *"Garcinia cambogia"*. In the realm of garcinia supplements, the percentage of hydroxycitric acid (HCA) can vary between 20 to 60%, with numerous products containing substances besides *Garcinia Cambogia* as their primary element[4]. An important factor to consider during the evaluation of these products is the presence of other ingredients. Furthermore, it has come to light that several products exhibit lower concentrations of HCA than what is indicated on their labels[4].

2. METHODOLOGY

2.1. Literature Search Strategy

- **Databases:** PubMed, ScienceDirect, Cochrane Library, Scopus, Web of Science
- **Keywords:** Garcinia cambogia, Garcinia gummi-gutta, hydroxycitric acid (HCA), weight loss, appetite suppression, diabetes, cholesterol, inflammation, etc.
- **Boolean Operators:** Combine keywords with AND, OR, and NOT for targeted searches.
- **Filters:** Limit search results by publication date, language (English preferred), study type (clinical trials, randomized controlled trials (RCTs)), etc.

2.2. Selection Criteria

- **Inclusion Criteria:**
  - Research conducted on human subjects utilizing *Garcinia cambogia* or Hydroxycitric acid (HCA) supplements. Investigations examining the desired health effect (e.g., weight management, regulation of blood sugar levels).
  - Research incorporating a control group (placebo or alternate intervention).
  - Randomized controlled trials (RCTs) are favored due to their superior quality.
  - Research studies released within the past decade (to guarantee current and relevant data).
- **Exclusion Criteria:**
  - Research conducted on animals or through in vitro experimentation, with a specific emphasis on clinical trials involving human subjects.
  - Literature analyses, individual case studies, or expert commentaries, with a particular focus on original research findings.
  - Investigations that exhibit methodological limitations such as a limited number of participants or unclear procedures for random assignment.
  - Research endeavors that are influenced by conflicting interests, notably financial support from corporate entities.

3. INCLUSION OF KEY STUDIES

- After applying the selection criteria, screen titles, abstracts, and full texts of retrieved articles.
- Select relevant studies that address the research question and meet the inclusion criteria.
- Document the reasons for excluding studies.

4. DATA EXTRACTION

Design a data extraction instrument to acquire essential data from every study that is encompassed. Acquire information including the study's design (e.g., RCT, double-blind), the sample size, and characteristics of the participants, the dosage and duration of the intervention involving *Garcinia cambogia*/HCA, the type of intervention in the control group, the primary and secondary measures of outcomes (e.g., weight loss, blood sugar levels), and any adverse events that have been documented.

4.1. Integration of Findings

- Summarization of the results of each encompassed study is presented in a tabular format.
- Perform a meta-analysis (if deemed statistically relevant) to amalgamate data from analogous studies and determine the collective impact of *Garcinia cambogia*.
- Evaluate the comprehensive robustness of the proof for each health consequence.
- Recognize any incongruities or contradictory findings across the studies.
- Examine the constraints of the present investigation and propose avenues for prospective research.

4.2. Cultivation

In South and Southeast Asia, the cultivation of the *Garcinia gummi-gutta* plant is undertaken for its edible fruit. Numerous species closely affiliated

with Garcinia, such *as Garcinia gummi-gutta*, are categorized within the botanical family Clusiaceae. Displaying a slender rind and expansive vertical lobes, the fruit of *G. Gummi-gutta* and its akin species exhibit a range in size from that of an orange to a grapefruit. *G. Gummi-gutta* bears a resemblance to a diminutive, greenish, or occasionally reddish pumpkin, with the possibility of notable variations in coloration. Upon undergoing the process of drying and curing, the peels undergo a transformation to a dark brown or black hue, facilitating their extraction and subsequent preservation [6].

Table 1: Botanical description [7]

Kingdom	Plantae
Clade	Angioperms
Class	Polypetalae
Subclass	Thalamiflorae
Order	Malpighiales
Family	Clusiaceae
Genus	Garcinia
Synonyms:	*Gamboge tree, Garcinia gummi-gutta, Garcinia hanburyi*

Table 2: Vernacular names [8]

English	Brindal berry
Kannada	Uppage
Sanskrit	Vrikshmala
Marathi	Amosole
Tamil	Panampuli
Malayalam	Gorakkapuli

4.3. Habitat and distribution

Garcinia cambogia trees are commonly observed in regions such as India, Sri Lanka, and Nepal. Moreover, the native habitat of *Garcinia cambogia* encompasses subtropical Asian countries like China, the Philippines, and Malaysia. These trees predominantly thrive in the Western Ghats of Southwest India, spanning across Tamil Nadu, Maharashtra, Kerala, and Karnataka, presenting a variety of forest types ranging from semi-evergreen to evergreen, exhibiting adaptability to diverse terrains such as hilltops and plains. In addition to their presence in India, *Garcinia cambogia* can also be spotted in countries like Nigeria, Ghana, Cameroon, Ivory Coast, Liberia, and Sierra Leone. The growth of *Garcinia cambogia* is not limited to specific soil conditions, as it thrives in both desert landscapes and waterlogged areas such as rivers and valleys [9–10].

4.4. Description of the plant [9-12]:

"*Garcinia Cambogia*" is a perennial, diminutive or medium-sized sub-canopy tree, standing between 5 to 20 meters tall, with a trunk diameter of approximately 70 centimeters, boasting a spherical canopy and either horizontal or drooping boughs. The stem, being lignified, typically attains a vertical extent of about 10 to 15 meters.

Leaves exhibit an alternate arrangement, possessing petioles, dark green hue, glossy texture, measuring 13-18 by 4-8 cm, displaying an elliptic to obovate shape, devoid of trichomes. Petioles measure between 1.2 to 2.2 cm in length.

Flowers are aggregated in clusters of 4-20, predominantly crimson, with select trees bearing yellow variants. Typically, each petal equates to 1.2 cm in width and 1.1 cm in length, featuring anthers connecting to a pistil ridge housing a functionless stigma. Female flowers emerge solitarily or in groups of up to four. The stigmatic surface is customarily enlarged, devoid of a style. Female flowers exhibit vestigial and inactive staminodes. Both male and female flowers lack nectar secretion. The fruit is an unripe green, ellipsoidal drupe, showcasing 6-8 ridges, 5 cm in width, transitioning to a yellow or red hue upon ripening. Seeds number 6-8, sleek, sizeable, around 5 cm long and 2 cm wide, enclosed by a fleshy aril.

Therapeutically, conditions such as gastrointestinal disturbances, including diarrhea, dysentery, and constipation, have been effectively managed through the use of *"Garcinia cambogia*." The presence of hydroxycitric acid (HCA) within "*Garcinia cambogia*" demonstrates efficacy in curtailing fat storage and reducing appetite, positioning it as a prevalent constituent in weight loss adjuncts. Historically, the consumption of the fruit derived from the *"Garcinia cambogia*" plant has been associated with advancing cardiovascular health by diminishing cholesterol levels and augmenting blood circulation. Furthermore, investigations have unveiled the fruit of the "*Garcinia cambogia*" plant to harbor antibacterial attributes against diverse bacterial strains and fungi. The polyphenolic compounds xanthones and flavonoids present in "*Garcinia cambogia*" showcase anti-inflammatory and antioxidant traits, indicating promise in alleviating and

regulating various chronic maladies. Additionally, "*Garcinia cambogia*" is integrated into culinary traditions, including the seasoning of curries to impart a zesty taste"[13-17].

4.5. Ethnobotanical uses

A commercially valuable spice tree, *Garcinia cambogia* is highly esteemed for its sun-dried, smoked rind, commonly employed as a flavoring agent, notably in fish curries. The dried rind of the fruit, utilized in India and Sri Lanka, possesses bacteriostatic qualities and is employed in fish preservation along with salt. Moreover, it is frequently incorporated into dishes to enhance satiety and as a substitute for Kokum butter, derived from *Garcinia indica* (Thouars) Choisy. Medicinally, the fruit rind serves as a purgative, hydragogue, anthelmintic, and emetic, beneficial in treating rheumatism and gastrointestinal ailments [18-19].

Furthermore, a solution containing *Garcinia cambogia* is applied in veterinary medicine to address oral disorders in cattle. Despite their high acidity, the fruits are fit for consumption, albeit seldom eaten raw. Within India, a tonic derived from the fruit is utilized in managing various cardiac conditions due to its substantial vitamin C content. Beyond medicinal purposes, the rind of *Garcinia cambogia* finds application in polishing gold and silver decorations and as a substitute for acetic acid in coagulating rubber latex. The gum serves as a varnish, while the resin can be employed as a pigment in watercolors and miniature paintings[20].

Phytochemistry: The phytochemistry of *Garcinia Cambogia* has not undergone a thorough and comprehensive study and documentation. Initial analyses of phytochemical composition indicated the existence of alkaloids, flavonoids, phenolic compounds, saponins, tannins, carbohydrates, and proteins. To date, a limited number of xanthones, benzophenones, as well as organic and amino acids have been extracted from different components of the plant. [21].

Xanthones: One plant's root was used to isolate garbogiol (1), while the bark was used to isolate rheediaxanthone A (2). The fruits produced oxy-guttiferone I (3), oxy-guttiferone K (4), oxy-guttiferone K2 (5), and oxy-guttiferone M (6), which are tetracyclic polyisoprenylated xanthones[22]. Figure N0.4 shows the chemical structures of the xanthones that were extracted from *G. cambogia.*

Benzophenones: While guttiferone I (9), guttiferone N (10), guttiferone J (11), guttiferone K (12), and guttiferone M (13), the polyisoprenylated benzophenones, were recovered from the fruits, garcinol (also known as camboginol or guttiferone E) (7) and isogarcinol (also known as cambogin) (8) were reported from the bark. The benzophenone chemical structures that have been reported from *G. Cambogia* are shown here. Figure No.4.

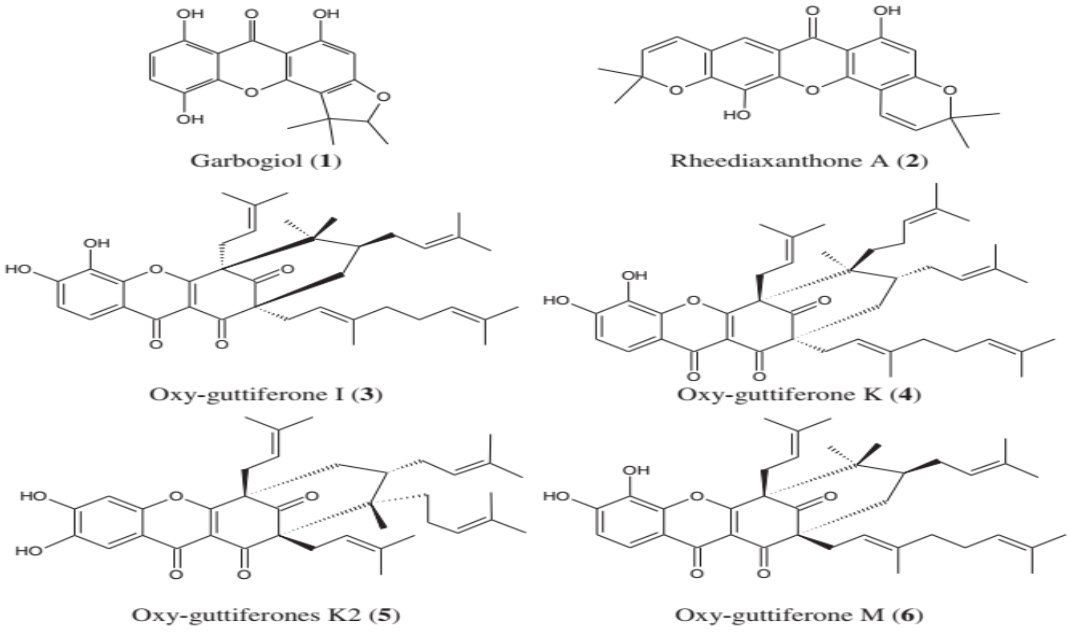

Figure 4: Garbogiol (1) ,rheediaxanthone A (2) ,xanthones namely oxy-guttiferone I (3), oxy-guttiferone K (4), oxy-guttiferone K2 (5) and oxy-guttiferone M (6).

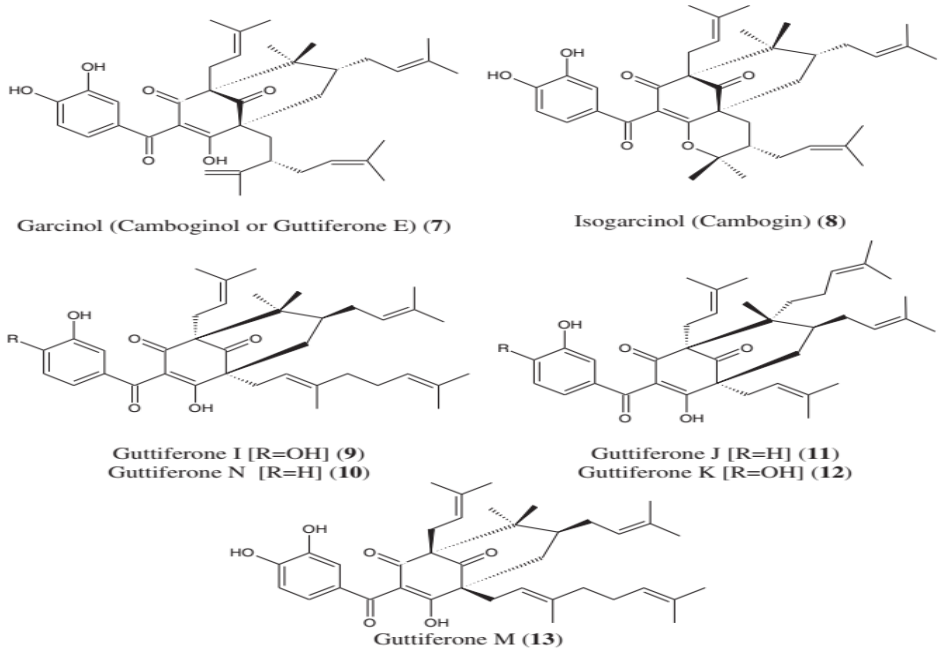

Fig. 4. Benzophenones isolated from various parts of *Garcinia cambogia*.

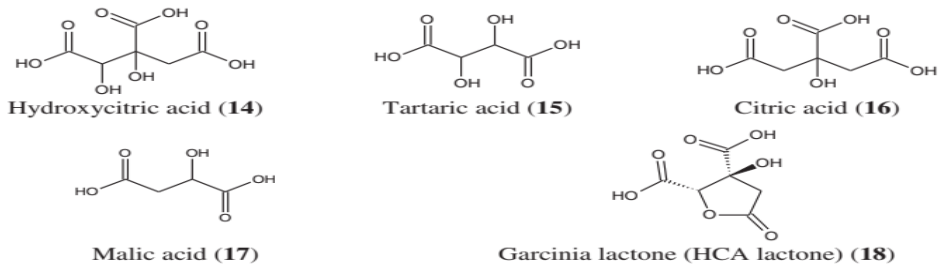

Figure.5: Garcinol (camboginol or guttiferone E) (7) and isogarcinol (cambogin) (8) ,guttiferone I (9), guttiferone N (10), guttiferone J (11), guttiferone K (12) and guttiferone M (13), Organic acids HCA (14) ,Other organic acids such as tartaric acid (15), citric acid (16) and malic acid (17) , HCA lactone or Garcinia lactone (18)

- **Amino acids**

The total quantity of free amino acids was ascertained to be below 60 mg per 100 g of *Garcinia Cambogia* fruit. Identified amino acids encompass arginine, asparagine, glutamine, threonine, glycine, proline, γ-aminobutyric acid, leucine, isoleucine, ornithine, and lysine. [23] .

- **Biological activity**

Several extracts and pure chemicals, primarily sourced from the fruit of *Garcinia cambogia*, have been shown to exhibit biological activity in both in vitro and in vivo environments. The focus of numerous clinical trial reports revolves around the potential of *Garcinia Cambogia*/HCA supplements to combat obesity. Although Garcinia and its derived pills are predominantly utilized for weight management, various other research studies have indicated encouraging properties such as hepatoprotective, anti-inflammatory, antidiabetic, antioxidant, and antibacterial effects. [24].

- **Hypolipidemic activity**

Several extracts, like flavonoids and garcinia cambogia, have exhibited potential in research concerning lipid metabolism and associated health markers [25]. Over a period of 45 days, rats administered an oral dosage of 10 mg/kg body weight of a fruit rind extract rich in flavonoids displayed a notable decrease in cholesterol. Interestingly, higher doses of the flavonoid extract diminished its efficacy in reducing cholesterol

levels[15]. This indicates that the hypolipidemic impact of the extract may be attributed to a reduction in lipogenesis, which is the synthesis of fat, and an elevation in breakdown rates. The ingestion of *Garcinia cambogia* fruit extract substantially lessened the cholesterol levels in rats treated with dexamethasone when provided orally for eight days at a dosage of 1000 mg/kg body weight. It effectively thwarted the production of free acids in the liver and plasma triggered by dexamethasone and restored elevated levels of triglycerides and cholesterol to normal levels. In a separate investigation, the preventative advantages of *Garcinia cambogia* fruit extract (4.5% w/w with meal) against lipid metabolism and liver enzyme function were evaluated in rats fed a high-fat diet[26]. The extract's modest preventive efficacy and moderate decline in the activity of γ-glutamyl transferase, aspartate aminotransferase, and alanine aminotransferase implied potential advantages for liver well-being [27]. In a clinical analysis, obese women who consumed 800 mg of *Garcinia cambogia* extract (50% HCA) orally three times daily for 60 days observed a reduction in their triglyceride levels. Nevertheless, there were no alterations in insulin and leptin levels or other components of the lipid profile[28]. The hypotriglyceridemic effect of *G. cambogia* was not found to be associated with changes in leptin levels [19]. Hydroxycitric acid, the primary constituent of *Garcinia cambogia*, has been proven to enhance glucose utilization during physical activity and stimulate lipid oxidation in mice. It raised blood free fatty acid levels following an oral intake of 100 minutes; sixteen hours later, it notably increased the glycogen concentration in the gastrocnemius muscle. Lastly, a polyherbal blend named Antichol, comprising various herbal extracts including *G. cambogia*, exhibited preventative impacts against cholesterol-induced alterations in glucose, lipid profile, and alkaline phosphatase levels in rats. Nevertheless, the specific role of *G. cambogia* in these effects could not be ascertained [29].

- **Antidiabetic activity**

As per the findings of Hayamizu et al., mice administered with 3.3% Garcinia extract and 10% sucrose daily for a duration of 28 days did not manifest any alterations in body weight, fat pad weight, or serum glucose concentrations. Conversely, it amplified glucose metabolism while diminishing serum insulin, leptin, and the leptin/WAT ratio. Rats afflicted with type-2 diabetes-related inflammation and oxidative stress displayed diminished quantities of malondialdehyde, protein carbonyl, and protein tyrosine nitration in their liver and kidney subsequent to the intake of Super Citrimax (HCA-SX) at a concentration of 500 mg/kg for the initial fourteen days followed by 1500 mg/kg BW per day for a maximum of seven weeks.

The levels of Interleukin-6 and C-reactive protein in plasma were observed to decline subsequent to supplementation without concurrent elevation in insulin resistance. In rats, the assimilation of enterally administered glucose in the small intestine mucosa was delayed post oral administration of HCA at a dosage of 310 mg/kg BW. Furthermore, it led to a reduction in postprandial plasma glucose levels subsequent to intragastric and intraduodenal glucose delivery. The administration of a polyherbal blend of Gymnema sylvestre, *Garcinia cambogia*, and Lagerstroemia speciosa Pers. to human skeletal muscle for seven days, with 500 mg/day of HCA, upregulated the expression of fatty acid translocase/CD36 mrna, enhanced glycogen synthesis, and augmented muscle sensitivity to insulin post meals.

The beneficial effects were demonstrated in rats with obesity-induced diabetes when provided with dosages of 412, 825, and 1625 mg/kg BW/day for a duration of 21 days. The formulation resulted in reductions in blood sugar, triglycerides, total cholesterol, as well as increments in very-low-density and low-density lipoprotein levels. The formulation exhibited comparable efficacy to the positive controls, which encompassed sibutramine (5 mg/kg) for obesity and glibenclamide (4 mg/kg) for diabetes [19].

- **Anti-inflammatory activity [30]**

An excerpt derived from the pericarp of the *Garcinia cambogia* fruit, containing 51.2% (-)-HCA, exhibited notable anti-inflammatory properties in rats with TNBS-induced colitis. Administration of the extract at doses of 500 and 1000 mg/kg body weight led to a significant decrease in the expression of three inflammatory biomarkers: MPO, COX-2, and inos, alongside an exacerbation of macroscopic damage. Additionally, the extract lowered colonic levels of PGE2 and IL-1β without eliciting any adverse reactions. These results

indicate a potential therapeutic efficacy of the extract in managing inflammatory bowel disease, characterized by an abnormal immune response of the mucosa.

Numerous compounds derived from *Garcinia cambogia*, such as garcinol, guttiferone K, and guttiferone M, have displayed anti-inflammatory effects. Garcinol hindered the activation of JAK/STAT-1 and/or NF-κB in LPS-stimulated macrophages at a concentration of 5 μm. Furthermore, it suppressed the synthesis of inos and COX-2 while reducing intracellular ROS levels. Guttiferone M, K, and G were shown to impede STAT-1 nuclear translocation and DNA binding, thereby modulating cytokine signaling. Particularly noteworthy was the efficacy of garcinol in halting cytokine-induced STAT-1 activation. Additionally, garcinol inhibited NF-κB activation induced by TNF-α. Rats treated with 28 and 84 mg/day of oral potassium-magnesium hydroxycitrate (kmghca) exhibited marginal enhancements in systolic blood pressure and reductions in paw edema. Moreover, it decreased inflammatory markers like TNF-α and CRP.

- **Anti-oxidant activity[31]**

Ferric thiocyanate, DPPH, and hydroxyl radical scavenging assays were employed to evaluate the antioxidant potential of aqueous fruit rind extract against lipid peroxidation, total peroxy radical entrapment, DPPH, and hydroxyl radical. The extract exhibited notable efficacy in combatting the DPPH radical, hydroxyl radical, peroxy radical, and lipid peroxidation, with IC50 values of 36, 50, 44, and 62 μg/ml, respectively. Positive controls such as ascorbic acid (with IC50 values of 10 and 24 μg/ml against DPPH radicals and lipid peroxidation) were utilized, along with quercetin (IC50 of 36 μg/ml against hydroxyl radical) and TROLOX (IC50 of 18 μg/ml against peroxy radical). The findings of the study propose that the observed effects may be attributed to the phenolic constituents present in the extract, as further investigated by Shivakumar and collaborators.

The investigation involved the utilization of ferric thiocyanate, DPPH, and hydroxyl radical scavenging assays to evaluate the antioxidant properties of hydro-alcoholic and ethanolic extracts obtained from fruit rind. The extracts, at a concentration of 300 μg/ml, demonstrated a substantial reduction in DPPH radicals by 79% (ethanol) and 87% (hydro-alcoholic), while ascorbic acid exhibited 94% activity at the same concentration. In comparison to ascorbic acid, which displayed a 97% inhibition of hydroxyl radicals at 1.4 mg/ml, the hydro-alcoholic and ethanol extracts showed inhibitions of 82% and 62%, respectively. Furthermore, both extracts effectively decreased lipid peroxidation in the ferric thiocyanate assay when compared to α-tocopherol used as a positive control.

Derived from the fruit source, glutathione K and garcinol have demonstrated protective effects against lipid and protein oxidation in experimental settings. Remarkably, at a concentration of 125 mg/ml, these compounds markedly reduced the levels of thiobarbituric acid reactive species induced by peroxynitrite, as well as the formation of carbonyl groups in plasma and platelet proteins. However, it is worth noting that these substances did not prevent the nitration of platelet proteins and plasma induced by peroxynitrite.

- **Hepatoprotective activity [32]**

For a period of 45 days, rats were administered an oral fruit extract at a dosage of 1000 mg/kg BW, resulting in a reduction of peroxidative damage induced by ethanol. The extract's ability to mitigate lipid levels and ethanol-induced peroxidative damage is attributed to its antioxidant properties. Treatment led to normal serum levels of alkaline phosphatase (ALP), alanine transaminase (ALT), and aspartate aminotransferase (AST). Studies conducted on hepg2 cells in vitro demonstrated that a 1% concentration of Garcinia extract (60% HCA) decreased palmitate-induced lipotoxicity by minimizing cellular damage and reactive aldehydes, despite concerns regarding hepatotoxicity in humans associated with Garcinia Cambogia/HCA.

Furthermore, the *Garcinia Cambogia* (8% w/w) product, Antichol, altered the liver antioxidant enzymes glutathione, catalase, and superoxide dismutases, and shielded the rats' livers from fatty degeneration induced by cholesterol.

- **Anti-cancer activity [33-35]**

An early in vitro screening study conducted by Mazzio and Soliman unveiled that the fruit extract of *Garcinia cambogia* exhibited tumoricidal effects against the survival of the murine neuroblastoma cell line (Neuro-2A cells), which originated from a spontaneous malignant tumor. The LC50 value of the extract was measured at 0.235 mg/ml. The scientific community displays a keen interest in

garcinol, a component found in both *G. Indica* and *G. Cambogia*, despite the fact that the potential of *Garcinia Cambogia* in cancer prevention has not been thoroughly explored. The examination by Saadat and Gupta delves into the possible application of garcinol as an anti-cancer pharmaceutical agent.

Garcinol demonstrates antioxidative, anti-inflammatory, antiproliferative, anti-angiogenic, and proapoptotic properties, while also inhibiting histone acetyltransferases (HAT 300). Its capacity to potentially influence transcription mechanisms by altering miRNA profiles linked to carcinogenesis is noteworthy. Alongside investigations on hela cells, numerous in vitro studies have been conducted to assess its effects on hepatocellular carcinoma, medulloblastoma, multiple myeloma, Burkitt's lymphoma, oesophageal, lung, renal, pancreatic, and prostate cancers.

- **Anti-ulcer activity [36]**

Indomethacin protected the stomach mucosa from harm when rats received an oral dose of 1000 mg/kg BW/day of a *Garcinia cambogia* fruit extract for 5, 10, or 15 days. Moreover, the extract enhanced mucosal protection and decreased stomach acidity. The same group's follow-up investigation found that by lowering the amount and acidity of stomach fluid, the extract at 1000 mg/kg BW/day at intervals of 7 and 15 days had protective effects against hcl-ethanol-induced damage in rats' gastric mucosa.

Furthermore, the extract increased lipid peroxidation and antioxidant enzyme activity, and also altered the quantities of proteins and glycoproteins in the ulcerated mucosa.

A polyherbal formulation including 150 mg of Glycyrrhiza glabra L., 500 mg of Garcinia, 200 mg of deglycyrrhizinated licorice extract, and 150 mg of Azadirachta indica was administered to rats suffering from ulcers brought on by naproxen, histamine, cysteamine, and ethanol. These ulcers were treated with the mixture's anti-ulcer properties. The oral formulation dramatically reduced the ulcer index and ulcer area and showed stomach healing efficacy at doses of 300 and 600 mg/kg, with an 80% protection value.

- **Anticholinesterase activity[7]**

In cholinergic brain synapses and neuro-muscular joints, acetylcholinesterase enzymes hydrolyze the essential neurotransmitter acetylcholine. This enzyme is determined to be responsible for the loss of cognitive function that is characteristic of the early stages of Alzheimer's disease by blocking synaptic communication. The aqueous extract of Garcinia cambogia fruit rind demonstrated a significant anticholinesterase activity, inhibiting cholinesterase by 30% and 67% at 500 and 1000 µg/ml, respectively. Neostigmine, the positive control, inhibited cholinesterase by 78% and 92% at dosages of 5 and 10 µg/ml, respectively, and was used to compare the activity.

- **Antimicrobial activity [37-39]**

Fruit rind extracts containing ethanol, hydro-alcoholic extract, and ethyl acetate showed antimicrobial activity against Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Bacillus subtilis, and Staphylococcus aureus when tested at a concentration of 25 mg/ml, with inhibition zone diameters ranging from 15 to 34 mm. The results showed that the most effective extracts against all test pathogens were ethanol and ethyl acetate, while hexane extracts showed no impact against any of the infections. The two main HIV enzymes, HIV-1 integrase and HIV-1 protease, were repressed by water and ethanolic preparations made from *Garcinia cambogia* leaves. The water extract had IC50 values of 67 and 70 µg/ml against protease and integrase, respectively, whereas the ethanolic extract demonstrated relatively low activity with an IC50 value of 100 µg/ml against both enzymes.

- **Anthelmintic activity[40]**

It was discovered that different concentrations of petroleum ether, chloroform, and *Garcinia cambogia* leaf extracts (20, 40, and 60 mg/ml) shown effectiveness against earthworms. The paralysis period in earthworms ranged from 1.1 to 2.5 minutes, while the death period varied from 3.1 to 7.4 minutes. At 60 mg/ml, the positive control drug albendazole caused paralysis in 1.2 minutes and death in 3.2 minutes. The results indicated that the petroleum ether and chloroform extracts were the next strongest anthelmintics, after the ethanol extract.

- **Effects on fertility [41-42]**

For a duration of six weeks, male rats were given an ethanol extract made from *Garcinia cambogia* seeds six days a week in order to evaluate the impact on testicular histology and sperm counts. At dosages of 100 and 200 mg/kg BW/day, the extract dramatically increased the number of sperm and

interstitial spaces in all experimental rats. It also caused the degeneration of Leydig cells and altered the architecture of the spermatogenic series cells.
Testis meiosis-activating sterol levels decreased in male rats with an oral dosage of 102 mmol/kg BW. This sterol may be involved in the signal transmission for spermatogenesis and functions as an intermediate in the synthesis of cholesterol from acetyl-coa.
In a subsequent study, the same group discovered that administering (-)-HCA to female rats at a dose of 154 mmol kg-1 day-1 for four weeks did not change the levels of progesterone, oestradiol, luteinizing hormone, or follicle-stimulating hormone in the blood. Throughout the course of treatment, the amounts of the meiosis-activating sterol in the corpus luteum, testis, ovarian follicular fluid, and follicles were unchanged. It was observed that there was a reduction in both body weight and abdomen fat after treatment.

- **Diuretic activity [43-44]**

Mathew et al. investigated the diuretic effects of ethanolic and aqueous *Garcinia cambogia* leaf extracts. Rats were given oral dosages of 100 and 200 mg/kg BW/day; the positive control was intraperitoneal furosemide 20 mg/kg. This led to an increase in urine output from salt, potassium, and chloride excretion.

5. RESULTS AND DISCUSSION

This article provides a comprehensive overview of *Garcinia cambogia (Garcinia gummi-gutta)*, a plant native to Southeast Asia with a long history of medicinal use.

5.1. Traditional Uses and Phytochemistry

• Garcinia cambogia has been used for a very long time to treat a wide range of conditions, such as weight loss, rheumatism, diarrhoea, and constipation.

• The main portion of the fruit that is utilised medicinally is the rind, which has many bioactive substances as benzophenones, xanthones, organic acids, and hydroxycitric acid (HCA).

5.2. Weight Loss and Body Fat Regulation

• There's conflicting evidence to support the popular notion that garcinia cambogia helps people lose weight. Some studies indicate a little drop in body weight and fat mass, while others show no discernible impact.

• The main bioactive ingredient, HCA, may promote fat burning and prevent the synthesis of new fat. Larger, more thorough clinical trials are nevertheless required to support these conclusions.

5.3. Other Potential Health Benefits

- Studies conducted in vivo and in vitro have shown that garcinia cambogia extracts and isolated components display a variety of biological actions.
- Among these are the following:

o Hypolipidemic activity: Possibility of reducing triglycerides and blood cholesterol.
o Antidiabetic activity: May enhance insulin sensitivity and glucose metabolism.
o Anti-inflammatory activity: May lessen oxidative stress and inflammation.
o Antioxidant activity: May guard against free radical damage to cells.
o Hepatoprotective activity: May offer defence against harm to the liver.
o Anti-cancer activity: Research on the chemical garcinol, which is present in garcinia cambogia, has shown promise in combating cancer.

- o Anti-ulcer activity: May guard against ulcers on the lining of the stomach.
- o Anticholinesterase activity: May be advantageous to cognitive performance.
- o Antimicrobial activity: Extracts show activity against some bacteria and fungi.
- o Anthelmintic activity: May be effective against intestinal worms.
- o Diuretic activity: May increase urine output and excretion of electrolytes.

6. CONCLUSION

The active component in cambogia extracts, organic acid (HCA), is found in high amounts in the fruit Garcinia cambogia. Numerous biological characteristics of these extracts, such as their ability to reduce hunger and prevent obesity and hyperlipidemia, have been demonstrated. Research carried out in vivo has confirmed that Garcinia cambogia/HCA works to increase serotonin release, burn fat, and return lipid profiles to normal. The results of clinical studies indicate that Garcinia cambogia extracts may help those who are obese; nevertheless, toxicity and

interactions with SSRIs need to be considered. Regulatory agencies should require safety demonstrations and post-marketing surveillance systems.

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