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Comprehensive Review on Garcinia Cambogia as Nutraceutical

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ABSTRACT: Medicinal plants are gifts of nature to cure limitless diseases among human beings. Garcinia is a plant under the family of Guttiferae; is commonly used as a flavoring agent. Various phytoconstituents including flavonoids and organic acid have been identified in the Garcinia. G. cambogia rind is considered a rich source of organic acids, amino acids, benzophenones, xanthones, and flavonoids Among all types of organic acids, hydroxycitric acid or more specifically (−)-hydroxycitric acid has been identified as a potential supplement for weight management and as antiobesity agent. Various in vivo studies have contributed to the understanding of the anti-obesity effects of Garcinia/hydroxycitric acid via regulation of serotonin level and glucose uptake. Besides, it also helps to enhance fat oxidation while reducing de novo lipogenesis. Clinical studies also showed both negative and positive antiobesity effects of Garcinia/hydroxycitric acid. G. cambogia is also pharmacologically studied for its antioxidative, chelating, free radical scavenging, anticancer, anti-inflammatory, and antiulcer activities. This review was prepared to highlight the update of chemical constituents, significance of in vivo/clinical anti-obesity effects, and the importance of the current market potential of Garcinia/hydroxycitric acid.

Keywords: Garcinia cambogia, Clusiaceae, hydroxycitric acid, antiobesity effects.

I. INTRODUCTION:

Biological sourceof Garcinia is Garcinia cambogia (gummi-gutta) fruit, Synonyms:Brindle berry and Malabar tamarind belonging to family : Guttiferae. Garcinia cambogia is a tropical fruit also known as Malabar tamarind, native to Indonesia and grown in Southeast Asia, India, and parts of Africa. It gained widespread attention in recent years due to its purported weight loss benefits. The active ingredient in Garcinia cambogia responsible for its weight loss properties is hydroxycitric acid (HCA), which is found in the fruit's rind (1-3). Garcinia cambogia, with its active component hydroxycitric acid (HCA), is widely used for weight loss due to its anorexigenic effect, increased fat oxidation, and regulation of endogenous lipid biosynthesis. Other beneficial effects of Garcinia in experimental studies include anti-inflammatory, antiulcerogenic, antioxidant, hepatoprotective, cytotoxic, erythropoietic, and miscellaneous other effects.Currently, a large number of G. cambogia/HCA-containing dietary supplements are being marketed.It is widely advertised as a weightloss supplement and is available in the market in various forms (4-9).

HISTORY:

The fruit of the Garcinia cambogia plant has been used for centuries in Southeast Asia, India, and some parts of Africa for both medical and gastronomic purposes.

Indigenous Use: For generations, the native regions of Garcinia cambogia, sometimes called Malabar tamarind, have employed it in traditional cookery. Due to its sour taste, it was often used as a component in chutneys, curries, and other recipes.

Ayurvedic Medicine: Garcinia cambogia has been used for its alleged therapeutic benefits in Ayurvedic medicine, an age-old Indian holistic healing method. It has been applied to relieve joint pain, treat constipation, and improve digestion.

Colonial Era: When European explorers and traders came across Garcinia cambogia in Southeast Asia and India at this time, they became interested in it. Early Western visitors were drawn to it because of its distinctive flavor and possible health benefits.

Scientific Research: In the latter half of the 20th century, Garcinia cambogia was first studied scientifically. Because of the hydroxycitric acid (HCA) in its rind, researchers started to get interested in its possible ability to aid in weight loss.

Garcinia cambogia has a long history of usage in traditional medicine. It is currently being researched for weight loss, and there are ongoing

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discussions about whether or not it is safe and effective as a dietary supplement (10-12).

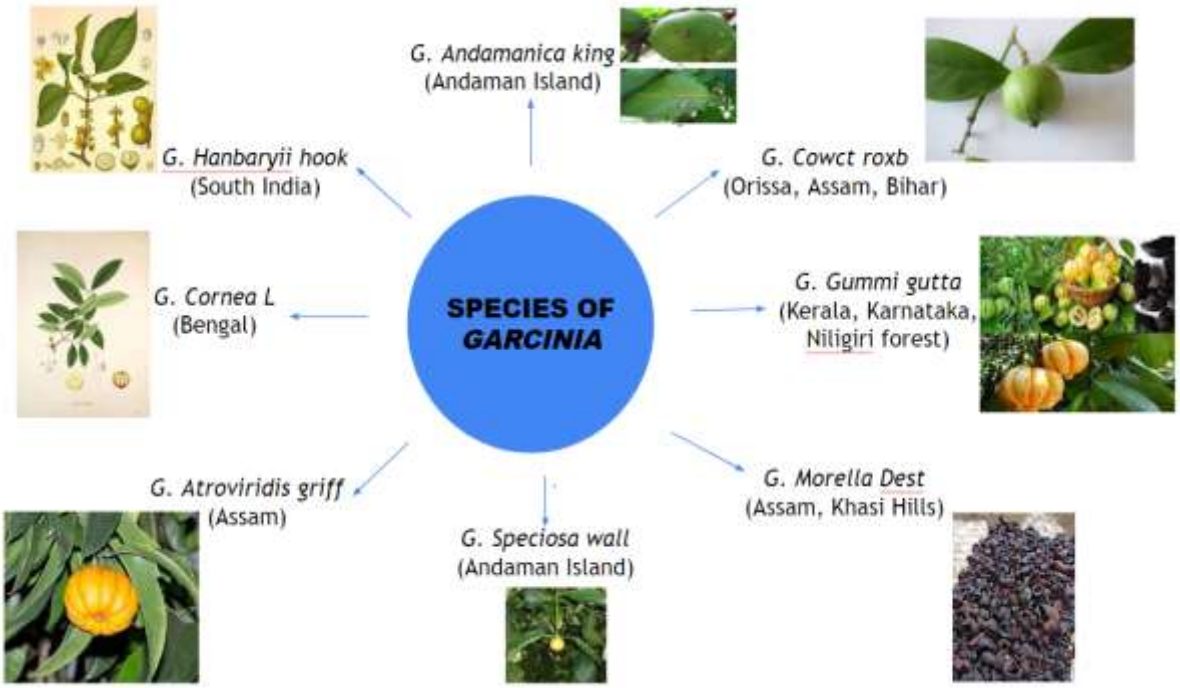
Morphology of Garcinia cambogia(Fig.1):

It is a small to medium-sized tree with rounded crown and drooping or horizontal branches that reaches a height of 20 meters. The tree's leaves are oval in shape, dark green, glossy, and vary in length from 5.5 to 9 cm and width from 2.5 to 4 cm. The tree produces ovoid-shaped, little green fruits with a diameter of 2-4 cm. When the fruits develop, they take on a yellow or red color and have 6-7 grooves. The fruit has a distinct purple hue, although it may resemble a tiny yellow or reddish pumpkin. A juicy portion of aril surrounds the fruit seeds. The fruit ripens during the rainy season, while the tree blossoms in the summer (13).

Fruits of G. cambogia G. cambogia plant G. cambogia leaves

Fig. 1 Morphology of Garcinia cambogia

Species of Garcinia available in India (14):



Garcinia cambogia& its chemical constituents

Garcinia cambogiais a fruit that is native to South Asian countries and marketed currently as a weight loss supplement. It has various chemical components that not only work for weight loss but also have other benefits suchas anti-inflammatory, antiulcerogenic, antioxidant, hepatoprotective, cytotoxic, erythropoietic, and miscellaneous other

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effects. Due to the various chemical compounds present in Garcinia cambogia.The different compounds like hydroxycitric acid, benzophenones, xanthones, organic acids. The main chemical constituent responsible for its potential health benefits is hydroxycitric acid (HCA). HCA is found primarily in the fruit's rind and is believed to be responsible for its weight loss effects (15-16).

In addition to HCA, Garcinia cambogiacontains other compounds such as:

Citric Acid: Present in various fruits, including Garcinia cambogia, citric acid is involved in the Krebs cycle (citric acid cycle) of cellular metabolism.

Polyphenols: These are compounds with antioxidant properties found in many fruits and vegetables, including Garcinia cambogia. They help protect cells from damage caused by free radicals

Xanthones: Garcinia cambogiacontains several xanthones, which are biologically active compounds with antioxidant and anti-inflammatory properties.

Flavonoids: Another group of antioxidant compounds found in plants, includingGarcinia cambogia. Flavonoids have various health benefits, including anti-inflammatory and anti-cancer properties.

Alkaloids: Some alkaloids have been identified in Garcinia cambogia, although their concentrations may vary. Alkaloids are nitrogen-containing compounds with diverse biological activities.

Terpenoids: These are compounds derived from the isoprene unit and are common in many plants, including Garcinia cambogia. Terpenoids have various biological activities, including anti-inflammatory, anti-cancer, and antimicrobial properties.

Resin: Garcinia cambogiamay contain resin, a complex mixture of organic compounds secreted by plants. Resins can have various biological activities and are sometimes used in traditional medicine.

Tannins: Tannins are polyphenolic compounds found in many plants, including Garcinia cambogia. They have antioxidant properties and may contribute to the fruit's astringent taste.

Essential Oils: Garcinia cambogia may contain small amounts of essential oils, which contribute to its aroma and flavor. These oils can consist of various volatile organic compounds with potential health benefits. Like many fruits, Garcinia cambogia contains vitamin C (ascorbic acid), which is an essential nutrient with antioxidant properties. Vitamin C plays a crucial role in collagen synthesis, immune function, and wound healing.

Sugars: Garcinia cambogiacontains natural sugars, including glucose, fructose, and sucrose, which provide energy and contribute to its sweet taste.

Apart from these components there are other**micronutrients**:

Calcium: Garcinia cambogiacontains calcium, an essential mineral that plays a vital role in bone health, muscle function, nerve transmission, and various enzymatic reactions in the body.

Potassium: Potassium is another mineral present in Garcinia cambogia. It is important for maintaining fluid balance, nerve function, muscle contractions, and blood pressure regulation.

Iron: While present in smaller amounts, Garcinia cambogiaalso contains iron, an essential mineral involved in oxygen transport, energy metabolism, and DNA synthesis.

Phosphorus: Phosphorus is found in Garcinia cambogiaand is essential for bone health, energy metabolism, and cell membrane structure.

Beta-Carotene: Some studies suggest that Garcinia cambogiacontains beta-carotene, a precursor to vitamin A. Beta-carotene is a powerful antioxidant that helps maintain healthy skin, vision, and immune function (17-19).

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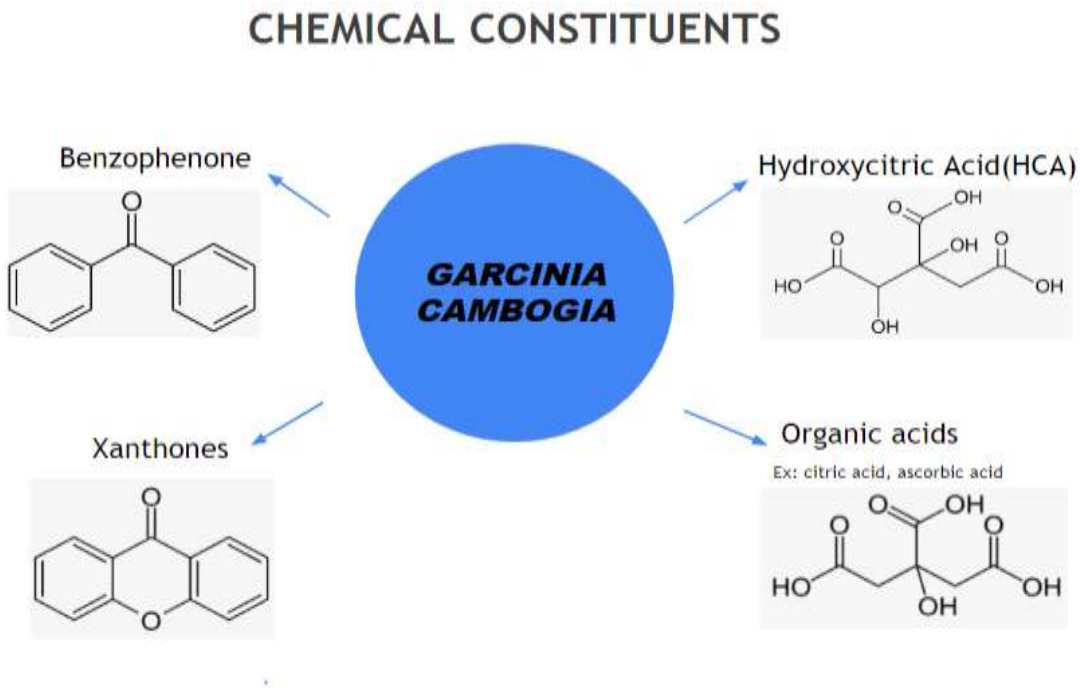

Fig. 1. Chemical constituents of Garcinia cambogia

Traditional uses of Garcinia cambogia: Traditionally Garcinia was used to reduce appetite, block fat production and reduce belly fat, anti-diabetes effects, increased energy and athletic performance (20-21).

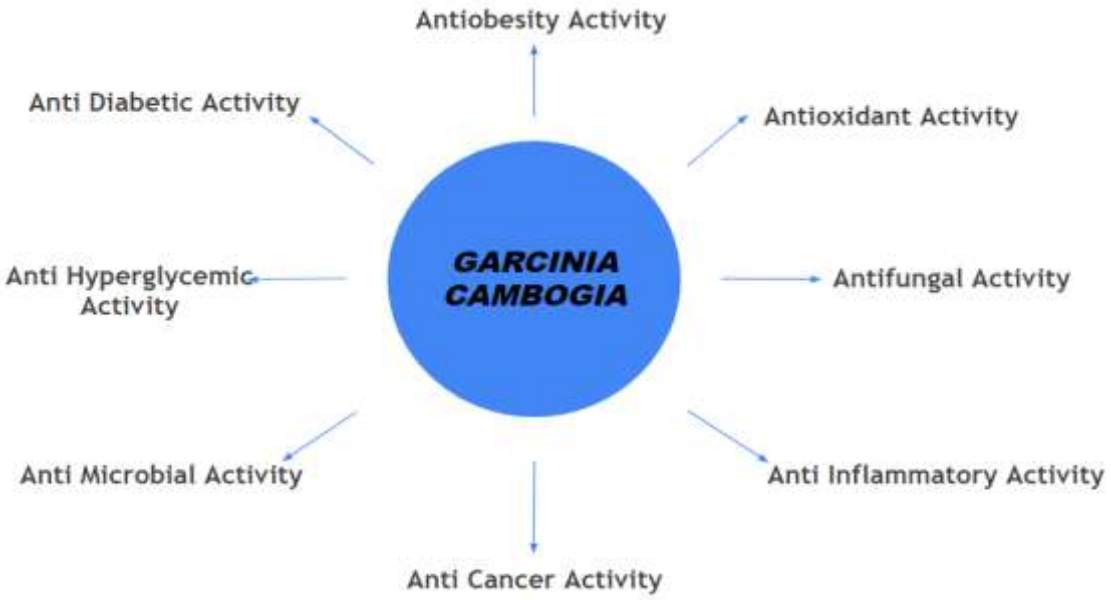

Fig. 2. Biological activities of Garcinia cambogia

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Mechanisms of action on anti-obesity

ATP citrate lyase inhibition: An enzyme involved in the production of fatty acids is called ATP citrate lyase (ACL). One important way that hydroxycitric acid (HCA), the active component of Garcinia cambogia, helps people manage their weight is by inhibiting this enzyme.

Upon ingestion, carbohydrates are converted to glucose, which is then released into your bloodstream. Next, extra glucose is transformed into the crucial metabolic chemical acetyl-CoA. The production of fatty acids is one of the metabolic processes in which acetyl-CoA can be employed.

Citrate is converted into oxaloacetate and acetyl-CoA by ATP citrate lyase. Fatty acid production uses acetyl-CoA, while other metabolic processes such as gluconeogenesis—the process of making glucose from non-carbohydrate sources—benefit from oxaloacetate. Acetyl-CoA for fatty acid synthesis is less available when HCA inhibits ATP citrate lyase. Fatty acid synthesis is reduced as a result, and the resulting triglycerides are then stored in adipose tissue. As a result, the body can start using fat reserves as an alternate energy source, which would cause weight loss.

Additionally, other metabolic pathways, such as the synthesis of cholesterol, may be impacted by the decrease in acetyl-CoA availability. Reducing the production of cholesterol may also improve cardiovascular health (22-23).

Blood sugar regulation:Garcinia cambogiais thought to alter blood sugar homeostasis by inhibiting ATP citrate lyase, which could reduce glucose synthesis, as well as potentially affecting glucose uptake and insulin sensitivity. Furthermore, Garcinia cambogiamay influence appetite and food consumption, so indirectly affecting blood sugar levels.

Increased fat oxidation:Increased fat oxidation is the process by which the body breaks down stored fat molecules to release fatty acids, which are then used as a source of energy. This mechanism is essential for weight management since it reduces fat storage and promotes fat removal. Several factors can influence fat oxidation, and some chemicals, such as hydroxycitric acid (HCA) present in Garcinia cambogia, have been suggested to improve the process.

Here's a more extensive description of how greater fat oxidation happens and how Garcinia cambogiacould play a role.

- Fat Mobilisation: The initial stage in fat oxidation is the release of stored fat from adipose tissue. Hormones including adrenaline (epinephrine) and noradrenaline (norepinephrine) signal the breakdown of triglycerides into fatty acids and glycerol, which are then released into the bloodstream.
- Fatty Acid Transport: Once released into the bloodstream, fatty acids go to numerous tissues, including muscle cells, where they are used to produce energy. Fatty acids require transport proteins to enter cells and be oxidized.
- Mitochondrial Oxidation: Within cells, fatty acids undergo a sequence of metabolic events known as beta-oxidation. During beta-oxidation, fatty acids are converted into acetyl-CoA molecules, which enter the citric acid cycle (Krebs cycle) and produce ATP, the primary energy currency.
- Energy production: The oxidation of fatty acids in the mitochondria produces ATP via oxidative phosphorylation. ATP provides energy for a variety of cellular operations, including muscular contraction, metabolism, and general body functioning.
- Fat Oxidation regulating: Hormonal modulation, activity, dietary composition, and specific chemicals present in foods or supplements all have an impact on fat oxidation rates.Compounds like HCA present in Garcinia cambogia have been proposed to influence fat oxidation via a variety of ways.

Appetite Suppression: HCA has been shown to raise serotonin levels in the brain. Serotonin is a neurotransmitter that influences both mood and appetite. Garcinia cambogiamay increase serotonin levels, promoting feelings of fullness and satisfaction while decreasing food intake and calorie consumption (23-24).

Effects of Garcinia cambogiaon Cancer Prevention and Treatment: Some research have suggested that Garcinia cambogiaextracts, especially those high in hydroxycitric acid (HCA), may have anticancer properties. These effects are hypothesized to be caused by numerous mechanisms, including (25).

Inhibiting cell proliferation: According to some research, HCA may suppress cancer cell growth and proliferation by interfering with cellular signalling pathways that control cell division and survival.

Induction of apoptosis: Apoptosis, or programmed cell death, is a natural process that regulates cell growth and prevents cancer from

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spreading. According to studies, HCA can cause apoptosis in cancer cells, resulting in their death.Apoptosis is a natural process that regulates cell proliferation and prevents cancer from spreading. HCA has been demonstrated in studies to cause apoptosis in cancer cells, which results in their elimination (26).

Anti-inflammatory effects: Chronic inflammation increases the risk of cancer formation and progression. Garcinia cambogiaextracts have been demonstrated to have anti-inflammatory characteristics, which may lessen the chance of developing cancer (27-28).

Antioxidant activity: Free radicals can create oxidative stress in cells, which can lead to cancer growth. Garcinia cambogiaextracts include antioxidants, which help to neutralise free radicals and protect cells from oxidative stress (29).

Camellia sinensis combination with Garcinia cambogia

Green tea and Garcinia cambogiaare commonly used in weight loss products. Green tea and Garcinia cambogiaare both known to offer potential weight-management benefits, and combining them is anticipated to improve their effects synergistically. Here's a summary of how each item may help with weight loss:

Green Tea: Green tea contains catechins, including epigallocatechin gallate (EGCG), which are antioxidants with numerous health benefits, including weight management. EGCG has been shown to boost thermogenesis and fat oxidation, resulting in increased calorie expenditure and fat burning. Green tea may decrease appetite and improve satiety, potentially lowering calorie consumption.

Garcinia cambogia**:** HCA inhibits the enzyme ATP citrate lyase, which converts carbohydrates into fat. HCA may suppress appetite by increasing serotonin levels in the brain, leading to feelings of fullness and reduced food intake. Some research suggests that Garcinia cambogia can help manage blood sugar levels and enhance lipid metabolism.When coupled, green tea and Garcinia cambogia may have complementing effects for weight loss. Green tea's thermogenic qualities, along with Garcinia cambogia's ability to prevent fat synthesis and stimulate fat burning, may boost fat oxidation.Green tea and Garcinia cambogia can suppress appetite and improve satiety, leading to reduced calorie intake.

The combination may help with weight management by improving insulin sensitivity and lipid profile regulation.It's worth noting that, while some studies suggest that mixing green tea and Garcinia cambogia can help with weight loss, research results are mixed, and individual responses may differ.Furthermore, the quality and purity of supplements containing these components may vary, influencing their efficacy. Before using a product containing green tea and Garcinia cambogia, contact with a healthcare expert, as you should with any dietary supplement, especially if you have underlying health concerns or are taking drugs. They can offer personalized advice and help you decide whether such a supplement is right for you.

Marketed formulation

A product that has been manufactured, produced, and made available for purchase in the market is referred to as a "marketed formulation". A "marketed formulation" in the context of medications or supplements usually refers to a particular concoction of components, doses, and delivery systems meant to accomplish a certain nutritional or therapeutic goal.

For instance, a marketed formulation for Garcinia cambogia supplements would contain the precise combination of ingredients used in the supplement, such as standardized Garcinia cambogia extract with a specific percentage of hydroxycitric acid (HCA), along with any additional ingredients added to improve stability, efficacy, or absorption.

Some of the marketed products of Garcinia cambogia(30)

S.no	Marketed products	Dosage forms	Uses
1.	NatureWise Garcinia cambogiaExtract	Capsule	Weight reduction
2.	NOW Garcinia	Tablets	Metabolism booster
3.	BioSchwartz Garcinia cambogia	Powder	Dietary supplement
4.	Nature's Bounty Garcinia cambogia	Soft gel	Dietary supplement
5.	Purely Inspired Garcinia Cambogia	Tablets	Weight loss supplement

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6.	Garcinia cambogia Plus by VitaBalance	Capsule	Dietary supplement
7.	Garcinia cambogiaExtra by Evolution Slimming	Capsule	Dietary supplement
8.	NutriRise Garcinia cambogia	Capsule	Appetite reduction& Metabolism
9.	Belly fat tea	Powder	Weight reduction
10.	Kapiva 6(aloe+garcinia)	Liquid	Metabolism booster

Fig. 3. Marketed formulations of Garcinia cambogia

NANOTECHNOLOGY

Nanotechnology is a branch of science and engineering that studies the manipulation of matter on an atomic or molecular scale, often at dimensions of less than 100 nanometers. Materials can have distinct qualities and behaviors at this scale that set them apart from their macroscale equivalents. A wide range of academic fields, including physics, chemistry, biology, engineering, and materials science, are included in nanotechnology.

Some important elements and uses of nanotechnology are:

- **Nanomaterials**: These materials have nanoscalely organized constituents. When compared to traditional materials, they can have improved mechanical, electrical, thermal, and optical properties. Nanoparticles, quantum dots, and carbon nanotubes are a few examples.
- **Medicine & Healthcare**: Drug delivery, imaging, and diagnostics are just a few of the medical applications where nanotechnology shows promise. Treatment efficacy can be increased while reducing adverse effects by targeting particular cells or tissues with nanoparticles. Additionally, biosensors that identify illness biomarkers employ nanotechnology.
- **Food and agricultural:** Food packaging, food preservation, and agricultural are areas where nanotechnology may find use. Nanomaterials can increase food items' shelf lives, optimize nutrient delivery, and allow for the targeted application of fertilizers and pesticides.

Nanotechnology application on Garcinia cambogia species

The topic of health and nutrition is among the many industries that nanotechnology has the

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potential to alter. While there may be potential uses for nanotechnology to improve the characteristics or modes of delivery of compounds found in plants like Garcinia cambogia, as of the time of my last update, there were no well-established or widely acknowledged uses of nanotechnology in relation to Garcinia cambogia (31-32).

In this regard, a few possible uses for nanotechnology could be:

- **Increased Bioavailability:** Garcinia cambogia extract's solubility and bioavailability could be increased by encasing it in nanoparticles, which would increase its effectiveness when ingested.
- **Targeted Delivery:** Garcinia cambogia extract may be more effective while having fewer negative effects if nanoparticles are designed to carry it to particular bodily regions or cells.
- **Sustained Release:** Garcinia cambogia extract compositions with controlled releases could be created using nanotechnology to distribute the active ingredients more steadily and sustainably over time.
- **Enhanced Stability**: Garcinia cambogia extract may be more stable and have a longer shelf life if nanoparticles shield it from oxidation or breakdown.

Though these applications are theoretically feasible, it's crucial to remember that they could still be in the experimental or early development phases, and further study would be required to confirm their efficacy and safety.

Prior to being released into the market, dietary supplements and health products utilizing nanotechnology would need to pass stringent regulatory clearance and testing procedures to guarantee their efficacy and safety.

II. CONCLUSION

Garcinia cambogiacontains many active constituents that couldprovide promising source of treatment of various diseases.Even though the plants originated from genus of Garciniabecome target of HCA for weight management agent, thepotential of other constituents should not to be overlooked.Further exploration and investigation is anticipated toconfirm the traditional medicinal value claimed of this plantand maximize the use of Garcinia cambogiain betterment of healthstatus.

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