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Review Article

Gadumba (*Citrullus colocynthis* (L.) Schrad.): Exploring its potential as a therapeutic solution for diverse ailments

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ABSTRACT

Gadumba (*Citrullus colocynthis*), has traditionally been utilized as a remedy for various ailments such as mastitis, cancer, jaundice, bronchitis, joint pain, asthma, constipation, leprosy and diabetes. Different parts of the plant, including leaves, stem, fruit, seeds and root have been used in various forms such as aqueous or oil extracts, dried, or fresh, and are believed to possess numerous medicinal properties such as antidiabetic, laxative, anti-inflammatory, analgesic, vermifuge, antihyperlipidemic, hair growth promoting, antibacterial, antifungal, and antioxidant effects. Although *C. colocynthis* shows promise for diseases like cancer and diabetes, certain parts, particularly the immature fruit, have toxic properties, necessitating precise dosage control and proper administration to mitigate adverse effects. Comprehensive research on the medicinal properties of *C. colocynthis* seeds is lacking, emphasizing the need for more studies to identify and understand the bioactive compounds responsible for its therapeutic effects. Concerns regarding toxicity, dosage control, and the need for further research to understand its pharmacological properties persist. Standardization of extracts and quality control present challenges in ensuring consistent efficacy and safety across different batches and preparations, underscoring the importance of rigorous scientific investigation and quality assurance measures. Establishing seed and field standards for quality seed production and facilitating international trade are necessary. Continued research efforts are required to explore the plant's full therapeutic potential, identify new bioactive compounds, and optimize extraction methods. By overcoming these challenges and capitalizing on its medicinal properties, it can emerge as a valuable resource for human welfare and healthcare.

1. Introduction

Medicinal plants hold immense promise in healthcare, offering natural remedies with fewer adverse effects compared to synthetic drugs. Their rich history in traditional medicine practices underscores their importance in disease control and health promotion. For centuries, medicinal plants and their isolated phytochemicals have served as fundamental elements in healthcare, offering a wellspring of potential for developing new drugs. Roughly a quarter of all drugs prescribed globally are sourced from plants. India boasts a diverse array of approximately 25,000 plant species, many of which possess medicinal properties, with around 150 species actively employed in the commercial production of medicinal formulations [1]. Furthermore, over 80% of the world's population relies solely on plants for their health and therapeutic needs [2]. As research continues to unveil their therapeutic potential, integrating medicinal plants into modern healthcare systems can enhance disease prevention and treatment strategies, paving the way for a healthier future. The significance of medicinal plants in healthcare and disease management is well-established and profound. Across diverse cultures worldwide, these plants have been utilized for millennia for their therapeutic properties. Their efficacy stems from bioactive compounds like alkaloids, phenols, tannins, glycosides, and terpenoids, which offer natural remedies with

minimal side effects compared to chemically prepared drugs. Traditional medicine practices in regions such as China, India, and Africa deeply incorporate the use of medicinal plants, which have been pivotal in healthcare for generations. Research underscores the crucial roles of medicinal plants in disease prevention and treatment, complementing existing prevention strategies. Recognizing their importance, the World Health Organization considers many plant-derived drugs as essential for healthcare. Globally, the therapeutic value of medicinal plants is widely acknowledged, contributing significantly to sustainable human health. Their versatility is evident in treating a wide array of conditions, from common ailments like fever and infections to chronic diseases [3]. Cucurbitaceae family includes familiar members such as bitter apples, cucumbers, gourds, pumpkins, and melons. As awareness of the health advantages associated with this plant family grows, their production has steadily increased over time. Gadumba (*Citrullus colocynthis*) also known as colocynth, bitter apple, bitter cucumber, desert gourd, egusi, vine of Sodom, wild gourd belongs to this family. This desert vine plant, reminiscent of a watermelon vine, produces small, tough fruits with a bitter pulp. This plant is widely distributed in the Arabian and Sahara deserts, Sudan, Egypt and southern parts of Asia, including India, Southern Islands, and Pakistan



[4, 5]. The fruit of *C. colocynthis* has traditionally been utilized as a remedy for various ailments, including mastitis, cancer, joint pain, jaundice, bronchitis, asthma, leprosy, constipation and diabetes. Different parts of the plant including seeds, fruit, root, stem, and leaves, used as either aqueous or oil extracts, dried or fresh, are believed to have antidiabetic [6-11], laxative [6, 8, 12], anti-inflammatory [12], antihyperlipidemic [13, 14], analgesic [12], vermifuge [10], hair-growth-promoting [15], antibacterial [16], antifungal [16] and antioxidant properties [17]. In spite of multiple medical benefits, some of the most

frequently reported complications such as colic, diarrhea, hematochezia, nephrosis, vomiting, and liver impairment [9, 18, 19] have placed *C. colocynthis* amongst the top 10 toxic plants [19]. To fully harness the commercial benefits and maximize the utilization of seed-propagated medicinal plants for human well-being, additional research is necessary to develop appropriate agro-technology packages and practices. It is imperative to establish standards for both seed development and field cultivation to ensure the quality production of seeds and facilitate their export for international trade [20].

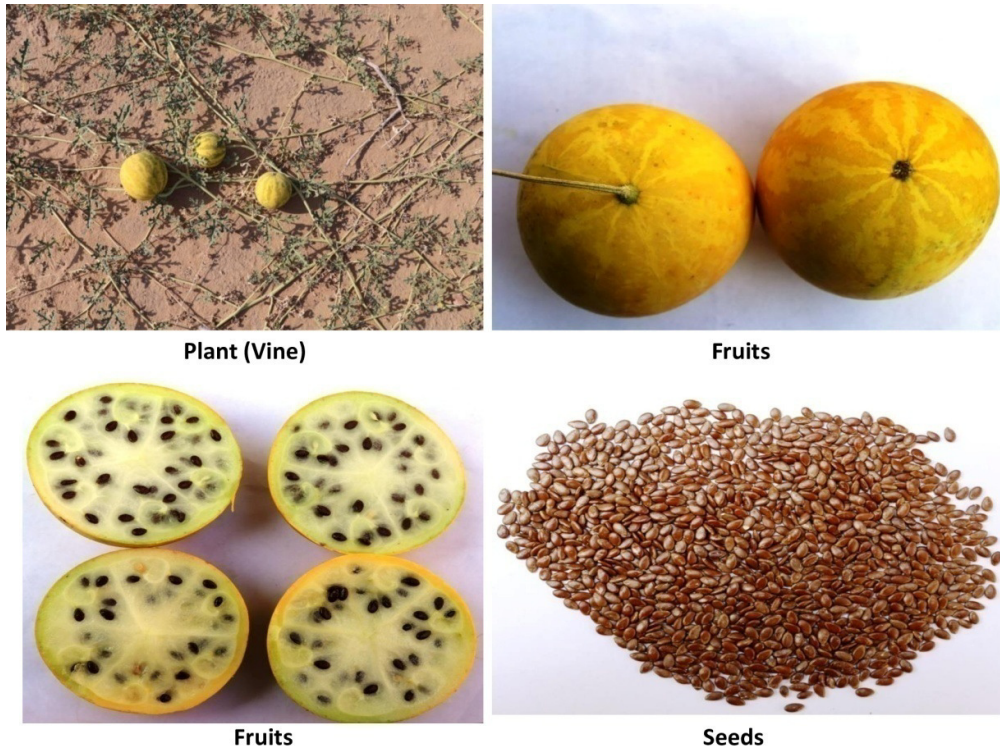


Figure 1: Gadumba (*Citrullus colocynthis*) vine with its fruits and seeds.

Plant: *Citrullus colocynthis* exhibits alternately arranged angular leaves supported by long petioles. Typically, these leaves measure 5 to 10 cm in length, featuring 3 to 7 lobes, with a central lobe displaying an ovate structure. They also possess a triangular shape with several clefts, characterized by a rough and hairy texture along with open sinuses. The leaves display a dual-color scheme; the upper surface appears green while the lower surface tends to be pale yellow. There is considerable variation in leaf size, with cultivated leaves being larger compared to their wild counterparts, which typically range from 3.8 to 6.3 cm in length and 2.5 cm in width. *Citrullus colocynthis* yields 15 to 30 globular-shaped fruits with diameters ranging from 7 to 10 cm. Encased in a green skin adorned with yellow stripes, the inner fruit also exhibits a yellow hue. Upon ripening, the fruit develops a hard and thin rind [21]. The pulp of the fruit is bitter, white, spongy, and soft, containing compressed ovate seeds. Yellow flowers are singularly present at the leaf axils, with monoecious characteristics bearing pistils and stamens on the same plant. These flowers are affixed to long peduncles, boasting five lobes of corolla and calyx. Female flowers are easily discernible by their villous and hairy ovary [22]. Pollination in *C. colocynthis* typically occurs through insects, and the fruits of this plant are indehiscent smooth barriers, ripe for harvesting within just three to four months after planting.

Flowers: The flowers of *Citrullus colocynthis* are solitary and yellow, emerging from yellow-greenish peduncles within the leaf axes. Each flower exhibits a subcampanulate five-lobed corolla and a five-parted calyx. Being monoecious, the plant bears male (stamens) and female (pistils and ovary) reproductive parts in separate flowers on the same plant. Male flowers feature a calyx shorter than the corolla, with 5 stamens, 4 of which are fused while 1 remains solitary, bearing a monadelphous anther. Female flowers, on the other hand, possess 3 staminoids and a 3-carpel ovary. Distinguishing between the two sexes is feasible by observing the globular and hairy inferior ovary present in the female flowers [23].

Roots and stems: With its large, fleshy, and perennial roots, Gadumba's (*Citrullus colocynthis*) survival rate is notably high, attributed to its extensive taproot. Its vine-like stems spread in various directions for several meters, seeking support to climb over. Shrubs and herbs are particularly favored and climbed using axillary branching tendrils when available [23].

Seeds: The fruit of *Citrullus colocynthis* is very bitter. Its seeds are smooth, ovoid-shaped, compressed and approximately 5 mm long and 3 mm wide. Seed colour varies from dark brown to orange yellow attached on parietal placenta. Despite their edible nature, they possess a distinct bitterness alongside nutty flavors, while being notably rich in fat and protein. These seeds are commonly consumed whole or utilized as an oilseed. With an oil content ranging from 17% to 19% (w/w), they comprise primarily of 67% to 73% linoleic acid, 10% to 16% oleic acid, 5% to 8% stearic acid, and 9% to 12% palmitic acid. The seed's oil yield is approximately 400 liters per hectare. The seeds are abundant in arginine, tryptophan, and sulfur-containing amino acids. Due to its abundance in micronutrients such as vitamins and minerals, particularly calcium and niacin, the seed flour of *C. colocynthis* holds promise for incorporation into food formulations, particularly in areas like West Africa where milk consumption is low [24].

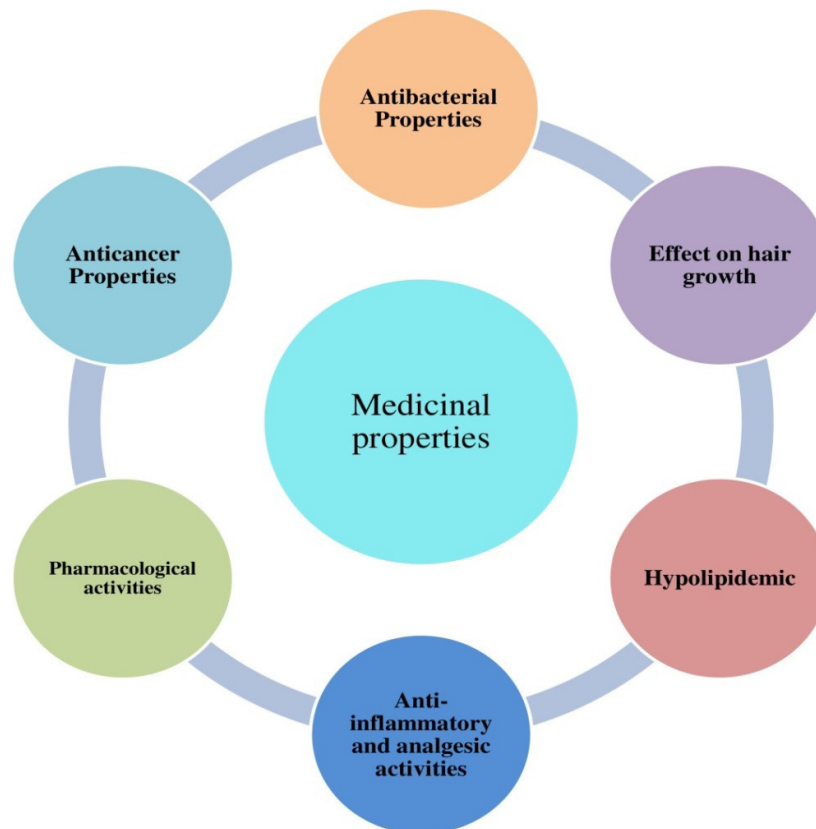


Figure 2: Medicinal properties of Gadumba (*Citrullus colocynthis*).

2. Medical properties

Antibacterial Properties: Antimicrobial and anticancer properties of *C. colocynthis* seeds extracted using methanol, hexane and chloroform solvents have been reported [25]. Their findings suggest that extracts from *C. colocynthis* seeds could potentially provide a range of phytopharmaceuticals, food products, and other commercial entities, containing biologically active pure phytochemicals like α -pinene and thymol. The antifungal potential of hydroalcoholic extracts was assessed against *Aspergillus* strains using disc diffusion and broth macrodilution methods, revealing sensitivity to the extract. Particularly notable was the significant antifungal activity observed against *A. niger* and *A. fumigatus* in comparison to *C. krusei* and *C. guilliermondii* [26]. The acetone, ethanol, methanol, and water extracts displayed significant antimicrobial activity against bacterial strains such as *E. coli*, *Salmonella typhi*, *Staphylococcus aureus*, *Shigella shigella*, as well as the fungus *Candida albicans*. In contrast, petroleum ether extracts exhibited minimal activity against all the aforementioned strains [27].

Anticancer Properties: *Citrullus colocynthis* is rich in cucurbitacins, which are crucial compounds in drug development, particularly in the creation of chemotherapeutic agents, owing to their potent anti-cancer properties. Cancerous cell lines MDA-MB-231 displayed greater sensitivity to *C. colocynthis* seed extract compared to HT-29 cell lines were observed [28]. The extract demonstrated significant antioxidant activity, with an IC₅₀ value of 1.37 mg/mL. These findings suggest that *C. colocynthis* seed extract holds promise as a potential tool in combating cancer and protecting against damage caused by free radicals.

Effect on hair growth: Ethanol and petroleum ether extracts from *C. colocynthis* plant were applied to the denuded skin of albino mice to assess hair growth and the time required for hair growth initiation. The growth cycle was monitored using a 2% Minoxidil solution as a standard comparator. The extracts demonstrated a superior quantity of hair follicles compared to the standard solution, indicating their potential effectiveness in promoting hair growth [29].

Hypolipidemic: The investigation extended to explore the hypolipidemic effects of *C. colocynthis* beyond its hypoglycemic effects in humans [14]. It was noted that the consumption of powdered seeds (at a dosage of 300 mg per day) by non-diabetic hyperlipidemia patients yielded significant benefits in lowering triglyceride and cholesterol levels.

Pharmacological activities: *C. colocynthis* is characterized by its abundance of phytochemicals such as polyphenols and flavonoids, contributing to its notable antioxidant properties. Therefore, it is relevant to ascertain the primary chemical constituents of *C. colocynthis* extracts and to document their capacity for scavenging free radicals as well as other therapeutic effects [30]. The ethanolic extract (80%) derived from *C. colocynthis* fruits lacks alkaloids, anthraquinones, coumarins, and tannins, yet it does contain flavonoids and terpenoids [31]. Presence of alkaloids, flavonoids, glycosides, and saponins was reported in both ethanolic (80%) and aqueous extracts from *C. colocynthis* leaves and fruits [32]. Similarly, the presence of 1.39 mg flavonoids, 0.52 mg saponins, 1.64 mg alkaloids, 1.64 mg phenolic compounds, and 30.12 mg ascorbic acid per 100 g of whole *C. colocynthis* plants was discovered [33].

Anti-inflammatory and analgesic activities: Analgesic and anti-inflammatory activities were observed in aqueous extracts of fruits, roots, stems and seeds at various stages of growth. Pharmacological assays including the Carrageenan-induced paw edema test in mice and the Acetic acid writhing test in rats were employed to evaluate these activities. Notably, the fruit and seed extracts exhibited significant analgesic and anti-inflammatory effects, while the stem and root extracts displayed comparatively lower inhibitory activity [12, 34].

3. Conclusions

While *Citrullus colocynthis* has been utilized as a remedy for various ailments such as mastitis, joint pain, jaundice, cancer, bronchitis, leprosy, constipation, asthma and diabetes, concerns regarding toxicity, dosage control, and the need for further research to comprehend its pharmacological properties persist. Although the plant exhibits promising pharmaceutical potential for diseases like cancer and diabetes, certain parts, particularly the immature fruit, possess toxic properties, emphasizing the necessity for precise dosage control and proper administration to mitigate adverse effects. Additionally, there is a lack of comprehensive research on the medicinal properties of *Citrullus colocynthis* seeds, indicating the importance of conducting more studies to identify and understand the bioactive compounds responsible for its therapeutic effects. Moreover, as with many traditional herbal medicines, standardization of extracts and quality control pose challenges in ensuring consistent efficacy and safety across different batches and preparations. Addressing these challenges through rigorous scientific investigation and quality assurance measures is crucial for fully harnessing the medicinal potential of *C. colocynthis*. In addition to addressing existing challenges, future prospects for *Citrullus colocynthis* involve standardization of suitable agro-technology and practices for commercial cultivation. There is also a need to fix seed and field standards for quality seed production to facilitate international trade. Furthermore, continued research efforts are

required to explore the plant's full therapeutic potential, identify new bioactive compounds, and optimize extraction methods. By overcoming these hurdles and capitalizing on its medicinal properties, *Citrullus colocynthis* can emerge as a valuable resource for human welfare and healthcare.

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