EPH–International Journal of Biological & Pharmaceutical Science
Published by: **Southern Cross Academic Press**
ISSN (Online): **2208-2166**
Volume 12 Issue03 June 2026
DOI:https://doi.org/10.69980/hcp24270

Antidiabetic Potential of Bimbi (*Coccinia indica*): A Review

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Article History:
Received : 2026-05-13
Revised : 2026-06-14
Accepted : 2026-06-21
Published : 2026-06-29

Abstract

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycaemia resulting from abnormalities in insulin secretion, insulin action, or both. Medicinal plants have received considerable attention as potential sources of bioactive compounds capable of influencing glucose metabolism. Bimbi, commonly identified in the scientific literature as Coccinia indica and Coccinia grandis (L.) Voigt, is a medicinal and edible plant traditionally used in Ayurveda, particularly in the context of Prameha. The plant contains several classes of phytoconstituents, including flavonoids, glycosides, phenolic compounds, tannins, sterols, terpenoids and other secondary metabolites. Experimental investigations have demonstrated several activities relevant to diabetes, particularly inhibition of α-amylase and α-glucosidase, antioxidant effects and modulation of glucose metabolism. Chromatographic and advanced analytical investigations have further demonstrated the chemical diversity of the plant and identified potentially bioactive constituents. Animal and limited human studies have also reported favourable effects on glycaemic parameters. This review summarizes the Ayurvedic perspective, phytochemical characteristics, experimentally demonstrated antidiabetic activities, possible mechanisms of action and available clinical evidence regarding Bimbi. Current evidence supports its potential as a source of natural antidiabetic agents; however, standardization of extracts, identification of active principles and well-designed clinical studies remain necessary.

Keywords: Bimbi, *Coccinia indica, Coccinia grandis*, diabetes mellitus, Prameha, α-amylase, α-glucosidase, phytochemicals, antidiabetic activity.

1. Introduction

Diabetes mellitus is one of the major metabolic disorders affecting populations worldwide. Persistent elevation of blood glucose is associated with progressive damage to multiple organs and increases the risk of cardiovascular, renal, neurological and ophthalmological complications. Although several effective pharmacological treatments are available, interest continues in medicinal plants because they represent chemically diverse sources of compounds that may act through multiple metabolic pathways.[1]

Ayurveda describes Prameha as a group of disorders characterized by abnormalities of Mutra, Meda, Kleda and other metabolic components. Several medicinal plants have traditionally been employed in its management. Among these, Bimbi is an important medicinal as well as dietary plant.[2]

Bimbi belongs to the family Cucurbitaceae and is widely distributed in tropical regions. The plant is commonly referred to as ivy gourd. Considerable nomenclatural variation exists in the scientific literature, with *Coccinia indica, Coccinia grandi*s and *Coccinia cordifolia* appearing in different publications. Consequently, evidence under these synonyms is relevant when reviewing the pharmacological properties of Bimbi.[3]

Modern investigations have demonstrated the presence of numerous secondary metabolites in the plant and reported antihyperglycaemic, antioxidant, enzyme-inhibitory and other pharmacological activities. Of particular interest is its ability to inhibit α-amylase and α-glucosidase, enzymes directly involved in carbohydrate digestion.

This review summarizes the traditional Ayurvedic basis, phytochemistry and experimental and clinical evidence supporting the potential antidiabetic activity of Bimbi.

Ayurvedic Perspective of Bimbi

Bimbi has been described in Ayurvedic literature as a medicinal plant with applications in several disorders, including Prameha. Its therapeutic interpretation is based upon its Rasa Panchaka and pharmacological actions described in classical and later Ayurvedic literature.

The drug is generally described as having Tikta and Kashaya predominance, with properties that can be interpreted as useful in metabolic conditions involving excessive Kapha, Meda and Kleda. Its traditional association with Prameha is particularly relevant to the modern investigation of its effects on glucose metabolism.

From an Ayurvedic perspective, Prameha involves derangement of multiple Dushyas, particularly Meda, Mamsa, Kleda, Shukra, Shonita, Vasa, Majja, Lasika, Rasa and Ojas. The involvement of Kapha and Meda in the pathogenesis of many forms of Prameha provides a conceptual basis for the use of drugs possessing Kapha-Medohara, Kleda-hara and metabolically corrective actions[4]

Nevertheless, the Ayurvedic concept of Prameha should not be considered completely synonymous with modern diabetes mellitus. The traditional indications of Bimbi and modern antidiabetic experiments should therefore be regarded as complementary but distinct bodies of evidence.

Botanical Profile[3]

Bimbi is a perennial climbing plant belonging to the Cucurbitaceae family. It bears simple leaves, tendrils, white flowers and characteristic elongated fruits that become red on ripening. Different parts of the plant, including the leaves, fruits, stems and roots, have been investigated pharmacologically.

The leaves are particularly important in antidiabetic research. Variations in the plant part selected for investigation are important because the qualitative and quantitative phytochemical composition may differ considerably between leaves, fruits, stems and roots.

Proper botanical authentication is therefore essential before pharmacognostical or pharmacological investigation.

2. RESULT & DISCUSSION

Phytochemical Profile

Phytochemical investigations of *Coccinia indica/Coccinia grandis* demonstrate that the plant contains a broad spectrum of primary and secondary metabolites. Reported phytochemical groups include:[5]

- Flavonoids and other phenolic compounds
- Glycosides

- Alkaloids
- Tannins
- Sterols and phytosterols
- Terpenoids and triterpenoids
- Saponins
- Carbohydrates and reducing sugars
- Other plant secondary metabolites

The occurrence of multiple phytochemical groups is pharmacologically important because the antidiabetic effect of a crude botanical extract is unlikely to arise from a single compound.

Flavonoids and phenolic compounds are of particular interest because several members of these groups are capable of interacting with carbohydrate-digesting enzymes and oxidative pathways. Bioactivity-guided investigations of C. grandis have also identified flavonoid glycosides exhibiting α-glucosidase inhibitory activity.

Modern chromatographic and mass-spectrometric investigations further demonstrate that Bimbi contains a complex mixture of metabolites. These findings indicate that crude extracts may exert their biological activity through additive or synergistic interactions among multiple constituents rather than through a single isolated phytochemical.

Antidiabetic Activity

α-Amylase Inhibition[6]

α-Amylase is a major digestive enzyme responsible for hydrolysing complex dietary starch into smaller carbohydrates. Excessively rapid carbohydrate digestion contributes to postprandial elevation of blood glucose. Consequently, inhibition of α-amylase represents an established strategy for reducing the rate of carbohydrate digestion.

Experimental studies on Coccinia extracts have demonstrated α-amylase inhibitory activity. Increasing inhibition with increasing extract concentration has been observed in experimental systems, indicating a concentration-response relationship.

The activity may be associated with flavonoids, phenolic compounds, tannins and related constituents capable of interacting with the enzyme or its substrate-binding regions. Computational studies have additionally investigated interactions between individual Coccinia phytochemicals and α-amylase.

These observations provide one plausible biochemical explanation for the traditional and experimentally reported glucose-lowering activity of the plant.

α-Glucosidase Inhibition[7]

α-Glucosidase acts at a later stage of carbohydrate digestion and catalyses the conversion of oligosaccharides and disaccharides into absorbable monosaccharides. Inhibition of this enzyme delays intestinal carbohydrate digestion and can consequently reduce rapid postprandial glucose elevation.

Several experimental investigations have demonstrated α-glucosidase inhibitory activity of *Coccinia grandis.*

Importantly, bioactivity-guided phytochemical investigations have isolated α-glucosidase-inhibitory flavonoid glycosides from the leaves. This strengthens the mechanistic evidence because it connects identifiable constituents of the plant with a specific molecular target relevant to diabetes.

Thus, the combined inhibition of α-amylase and α-glucosidase suggests that Bimbi may potentially influence more than one stage of dietary carbohydrate digestion.

Antioxidant Activity and Diabetes[7]

Oxidative stress contributes to the development and progression of diabetes and its

complications. Chronic hyperglycaemia promotes the generation of reactive oxygen species and may impair endogenous antioxidant defence systems.
Experimental studies involving *Coccinia indica* have reported antioxidant effects in diabetic models. Leaf preparations have been investigated for their influence on antioxidant status in streptozotocin-induced diabetic animals.
Phenolic compounds and flavonoids present in Bimbi may contribute to this activity through free-radical scavenging and modulation of oxidative processes.
The antioxidant effect is therefore potentially complementary to the direct glucose-regulating mechanisms of the plant. Rather than merely reducing glucose concentrations, some constituents may theoretically protect tissues against metabolic oxidative stress associated with chronic hyperglycaemia.

Other Possible Antidiabetic Mechanisms[7]
The available evidence suggests that the antidiabetic potential of Bimbi cannot be explained exclusively through digestive-enzyme inhibition.
Experimental literature has investigated effects related to hepatic glucose metabolism, glucose utilization, antioxidant defence and enzymes associated with diabetic complications. Antiglycation and aldose-reductase inhibitory activities have also been investigated.
Taken together, the available findings suggest several possible mechanisms:
Bimbi phytoconstituents → inhibition of α-amylase and α-glucosidase → slower carbohydrate digestion → reduced postprandial glucose exposure.
At the same time:
Antioxidant and metabolically active phytochemicals → modulation of oxidative stress and glucose-related metabolic pathways → additional antidiabetic effects.
This multitarget activity is consistent with the chemically complex nature of medicinal plant extracts.

Evidence from Animal Studies
Animal investigations provide an important bridge between isolated enzyme assays and clinical studies.
Experimental studies using diabetic animal models have reported reductions in blood glucose and improvements in biochemical parameters following administration of *Coccinia indica* preparations. Some studies have additionally demonstrated favourable effects on antioxidant status.
These findings support the biological activity observed in in-vitro experiments because they indicate that components of the plant may retain activity within a living biological system.
However, animal studies have used different extraction solvents, doses, plant parts, treatment durations and models of diabetes. Direct comparison of their reported efficacy is therefore difficult.
Furthermore, efficacy in chemically induced diabetic rodents does not automatically establish therapeutic efficacy in human type 2 diabetes.

Clinical Evidence[8]
Clinical evidence for Bimbi is considerably more limited than the experimental literature, although some controlled investigations have reported encouraging results.
Early clinical investigations of *Coccinia indica* reported improvements in glucose tolerance among patients receiving the botanical preparation compared with controls.
Subsequently, randomized controlled investigations have examined Coccinia preparations in individuals with type 2 diabetes. Improvements in glycaemic parameters have been reported in some studies, providing preliminary clinical support for the antidiabetic observations obtained from experimental research.
Clinical evidence is particularly important because strong inhibition of an enzyme in

vitro does not necessarily mean that the responsible phytochemical will be absorbed, achieve an effective concentration in vivo or produce clinically meaningful glucose reduction.
The available clinical observations are therefore encouraging but not sufficient to establish Bimbi as a replacement for established antidiabetic treatment. Larger and methodologically rigorous trials using standardized preparations are required.

Critical Appraisal of Existing Evidence
Overall, the available evidence supports the antidiabetic potential of *Coccinia indica/Coccinia grandis*, but several limitations prevent definitive conclusions.
A major strength is that supportive findings occur across different levels of investigation. Phytochemical studies identify potentially relevant compounds; enzyme assays demonstrate α-amylase and α-glucosidase inhibition; animal experiments indicate glucose-lowering effects; and limited clinical studies provide preliminary evidence of human activity. This convergence improves the biological plausibility of the traditional use of Bimbi.
However, substantial heterogeneity exists between studies. Different investigators have used leaves, fruits or other plant parts and aqueous, alcoholic, methanolic or fractionated extracts. Concentrations, extraction procedures and analytical methods are also inconsistent.
Another limitation is inadequate standardization. Demonstrating that an extract contains "flavonoids" or "phenolics" does not establish which compounds are responsible for the observed activity or what concentrations are required.
Furthermore, many experimental studies focus on a single biochemical outcome. Diabetes is a complex metabolic disorder, and enzyme inhibition alone cannot establish overall antidiabetic efficacy.
The evidence should therefore be interpreted as supportive of further investigation rather than definitive proof of therapeutic efficacy.

3. CONCLUSION
Bimbi (*Coccinia indica/Coccinia grandis*) is an important Ayurvedic medicinal and dietary plant with promising antidiabetic potential. Its traditional association with Prameha has received increasing support from modern phytochemical and pharmacological investigations.
The plant contains a diverse range of biologically relevant constituents, particularly flavonoids, phenolic compounds, glycosides, tannins, sterols and terpenoid-related compounds. Experimental evidence demonstrates inhibition of both α-amylase and α-glucosidase, while antioxidant and other glucose-related metabolic effects suggest that its activity may involve multiple complementary mechanisms.
Animal investigations and limited controlled human studies further support its glucose-lowering potential. Nevertheless, variation in plant material, extraction procedures and experimental methodologies, together with the limited quantity of robust clinical evidence, restricts definitive therapeutic conclusions.
Therefore, Bimbi should presently be considered a promising source of antidiabetic phytochemicals rather than an established alternative to conventional antidiabetic therapy. Standardization, identification of active constituents, mechanistic validation and rigorous clinical evaluation are required to translate its traditional and experimental potential into evidence-based therapeutic application.

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