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FORMULATION AND EVALUATION OF ANTIDIABETIC SYRUP CONTAINING *TINOSPORA CORDIFOLIA*

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ABSTRACT

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia and associated complications such as neuropathy, nephropathy, and cardiovascular diseases.[10] The limitations of synthetic antidiabetic drugs, including adverse effects and long-term toxicity, have led to increased interest in herbal alternatives.[17] Tinospora cordifolia (Giloy), a widely used medicinal plant in Ayurveda, has demonstrated significant antidiabetic potential due to its rich phytochemical profile.[12] This review provides a comprehensive overview of the phytochemistry, pharmacological activities, mechanisms of action, and formulation strategies of Tinospora cordifolia-based antidiabetic syrup.[10] The syrup dosage form offers improved patient compliance, stability, and bioavailability.[12] Additionally, evaluation parameters and clinical evidence supporting its efficacy are discussed. The review concludes that Tinospora *cordifolia* syrup represents a promising and safe herbal formulation for diabetes management, although further standardization and clinical validation are required.[17]

KEYWORD: Tinospora cordifolia, Antidiabetic syrup, Herbal formulation, Giloy, Diabetes mellitus, Phytochemistry.

1. INTRODUCTION

Diabetes mellitus is one of the fastest-growing global health concerns, affecting millions of people worldwide.[10] It is mainly classified into Type 1 (insulin-dependent) and Type 2 (non-

insulin-dependent) diabetes. Type 2 diabetes accounts for approximately 90–95% of cases and is strongly associated with lifestyle factors such as obesity sedentary habits, and poor diet.[17]

Diabetes mellitus is a multifactorial metabolic disorder characterized by chronic elevation of blood glucose levels due to defects in insulin secretion, insulin action, or both.[19] It is associated with long-term complications such as neuropathy, nephropathy, retinopathy, and cardiovascular diseases.[10] The global burden of diabetes continues to rise at an alarming rate, posing significant public health challenges. Conventional antidiabetic drugs, including insulin and oral hypoglycemic agents, are effective but often associated with adverse effects, high cost, and long-term dependency.[17] Therefore, there is increasing interest in plant-based therapies that are safer and economically feasible.[19]

Tinospora cordifolia, commonly known as Guduchi or Giloy, belongs to the family Menispermaceae and is widely used in traditional Ayurvedic medicine.[12] It contains bioactive compounds such as alkaloids, glycosides, diterpenoid lactones, steroids, and polysaccharides,[15] which contribute to its pharmacological activities. Previous experimental studies have demonstrated its hypoglycemic and antioxidant potential in diabetic animal models. The plant is believed to enhance insulin secretion, regenerate pancreatic β-cells, and improve peripheral glucose utilization.[12,15]

Considering its therapeutic significance, the present study focuses on the formulation and evaluation of a Tinospora cordifolia herbal syrup and the assessment of its antidiabetic activity using an experimental animal mode.[12]

Chronic hyperglycemia leads to complications such as

- Retinopathy (vision loss)
- Nephropathy (kidney damage)
- Neuropathy (nerve damage)
- Cardiovascular disorders

Conventional antidiabetic drugs like sulfonylureas, biguanides, and insulin therapy are effective but often associated with:

- Hypoglycemia
- Weight gain
- Gastrointestinal disturbances

Due to these limitations, herbal medicines have gained attention. Among them, Tinospora cordifolia has been extensively studied for its **multifunctional therapeutic properties**, especially in diabetes management.[13]

Chronic hyperglycemia in diabetes is associated with long-term damage and dysfunction of various organs, leading to serious complications such as:

- Microvascular complications: retinopathy, nephropathy, neuropathy
- Macrovascular complications: coronary artery disease, stroke, peripheral vascular disease

Despite the availability of several synthetic antidiabetic agents, including sulfonylureas, biguanides (e.g., metformin), thiazolidinediones, and insulin therapy, their long-term use is often associated with various limitations such as[14]

- Risk of hypoglycemia
- Weight gain
- Gastrointestinal disturbances
- Hepatic and renal toxicity

Reduced patient compliance These drawbacks have led to a growing interest in alternative and complementary therapies, particularly herbal medicines, which are considered to be safer, cost-effective, and culturally acceptable. Herbal drugs often exhibit **multi-targeted mechanisms of action**, making them especially useful in managing complex diseases like diabetes.[12,13]

Among the various medicinal plants explored for antidiabetic activity, Tinospora cordifolia (commonly known as Giloy) has gained considerable attention due to its extensive

therapeutic potential. It is an important herb in Ayurveda and is classified as a "Rasayana," meaning it promotes longevity, immunity, and overall health. Traditionally, it has been used for the treatment of fever, inflammation, infections, and metabolic disorders, including diabetes.

2. Botanical Description

Tinospora *cordifolia* is a large deciduous climbing shrub belonging to the family Menispermaceae. It is commonly found in India, Sri Lanka, and other tropical regions.

Morphological Characteristics

- **Stem**: Green, succulent, with warty projections
- **Leaves**: Heart-shaped (cordate), simple, alternate
- **Flowers**: Small, yellowish-green
- **Fruits**: Red drupe

Part Used

- Stem (most commonly used)
- Leaves
- Roots (less commonly)

The plant is often seen growing on neem or mango trees, which is believed to enhance its medicinal value in traditional systems.

3. Phytochemical Constituents

The therapeutic activity of Tinospora cordifolia is due to a wide range of bioactive compounds.

3.1 Alkaloids

- Berberine
- Magnoflorine
- Palmatine

These compounds exhibit hypoglycemic and antimicrobial activity.[16]

3.2 Glycosides

- Cordifolioside A
- Tinocordiside

They contribute to immunomodulatory and antioxidant effects.[12]

3.3 Diterpenoid Lactones

- Tinosporin
- Columbin
- Tinosporide

These compounds are responsible for anti-inflammatory and antidiabetic activity.[12]

3.4 Steroids and Phenolics

- β-sitosterol
- Flavonoids

They act as antioxidants and help in reducing oxidative stress.[16]

3.5 Polysaccharides

- Arabinogalactan

These enhance immune response and metabolic activity.

4. Pharmacological Activities

4.1 Antidiabetic Activity

Numerous in vivo and clinical studies confirm that *Tinospora cordifolia* significantly lowers blood glucose levels.[13]

Mechanisms include

- Increasing insulin secretion
- Improving insulin sensitivity
- Enhancing glycogen storage

Animal studies have shown a significant reduction in fasting blood glucose levels after administration of the extract.[14]

4.2 Antioxidant Activity

Oxidative stress plays a major role in diabetes complications. Tinospora cordifolia.[6,7]

- Scavenges free radicals
- Reduces lipid peroxidation
- Enhances antioxidant enzymes like SOD and catalase

4.3 Hypolipidemic Activity

It helps in

- Reducing LDL and triglycerides
- Increasing HDL levels

This reduces the risk of atherosclerosis and cardiovascular diseases.[18]

4.4 Anti-inflammatory Activity

Chronic inflammation is linked with insulin resistance. The plant inhibits inflammatory mediators such as[12]

- TNF-α
- IL-6

5. Mechanism of Antidiabetic Action

The antidiabetic effect is multifactorial

1. **Pancreatic β-cell regeneration[10]**

Helps restore insulin-producing cells.

2. **Enzyme inhibition[5]**

   - α-amylase
   - α-glucosidase

→ Slows carbohydrate digestion

3. Glucose uptake enhancement[16]

Improves peripheral utilization of glucose.

4. Insulin mimetic action[10]

Some compounds act like insulin.

5. Antioxidant defense[6]

Protects pancreatic cells from oxidative damage.

6. Rationale for Syrup Formulation

Syrup dosage form is highly suitable for herbal drugs.

Advantages

- Easy swallowing (pediatric & geriatric use)
- Improved taste masking of bitter extracts
- Uniform distribution of drug
- Rapid absorption

Why Syrup for Tinospora cordifolia?

- Bitter taste → masked by sweeteners
- Liquid extract compatibility
- Better patient adherence

7. Formulation of Antidiabetic Syrup

7.1 Detailed Composition (Example for 100 mL)

Ingredient	Quantity	Role
T. cordifolia extract	5–10 g	Active
Sucrose	60–70 g	Sweetener
Sorbitol	10 mL	Humectant
Glycerin	5 mL	Viscosity enhancer
Sodium benzoate	0.1 g	Preservative
Flavor	q.s.	Taste
Water	q.s. to 100 mL	Vehicle

7.2 Step-by-Step Method

1. Dry and powder the stem.
2. Perform aqueous extraction (decoction method).
3. Filter using muslin cloth.

4. Concentrate using water bath.
5. Prepare syrup base by dissolving sucrose in water.
6. Add extract slowly with stirring.
7. Add excipients (preservatives, glycerin).
8. Adjust volume.
9. Filter and fill in amber bottles.

8. Evaluation of Syrup

8.1 Organoleptic Properties

- Color: Brownish
- Odor: Characteristic
- Taste: Sweet

8.2 Physicochemical Tests

- **pH**: 4–7
- **Viscosity**: Brookfield viscometer
- **Specific gravity**

8.3 Chemical Evaluation

- Drug content uniformity
- Stability under accelerated conditions

8.4 Microbial Tests

- Total bacterial count
- Fungal count
- Absence of pathogens (E. coli, Salmonella)

9. Clinical Evidence

Clinical and experimental studies indicate:

- Reduction in fasting blood glucose
- Improvement in HbA1c levels[8]
- Better lipid profile
- Reduced oxidative stress markers

Some studies also show improved insulin secretion and pancreatic function.[10]

10. Advantages

- Herbal and safe
- Multi-target action
- Minimal side effects
- Cost-effective
- Easily scalable for industry

11. Limitations

- Variability in plant composition
- Lack of standard dosage
- Stability issues in liquid form
- Limited large-scale clinical trials

12. Future Perspectives

- Standardized extract development
- Nano-herbal syrup formulations
- Combination with other antidiabetic herbs
- Clinical trials for regulatory approval
- Industrial-scale production

13. CONCLUSION

Tinospora cordifolia is a promising herbal drug for diabetes management. Its incorporation into syrup formulation enhances patient compliance and therapeutic efficacy. Scientific validation through clinical studies supports its role as a potential antidiabetic agent. Further research is required for standardization and commercialization.

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