

Research Article

Formulation and Evaluation of Herbal Antidiabetic Capsules Containing Standardized Extract of *Ficus racemosa* Bark

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Abstract

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. Despite the availability of various synthetic antidiabetic drugs, limitations such as adverse effects, high cost, and incomplete glycemic control necessitate the exploration of alternative therapeutic strategies. Herbal medicines have gained considerable attention due to their multi-target mechanisms, safety profile, and cost-effectiveness. The present study focuses on the formulation and evaluation of herbal antidiabetic capsules containing standardized bark extract of *Ficus racemosa*, a medicinal plant known for its hypoglycemic and antioxidant properties. The study involves collection, authentication, and processing of *Ficus racemosa* bark followed by extraction using a suitable solvent system. The obtained extract was evaluated for its physicochemical characteristics and incorporated into capsule formulations using appropriate pharmaceutical excipients. The formulated capsules were subjected to standard evaluation parameters including weight variation, disintegration time, and physical characteristics to assess their quality and performance. The rationale of the study is based on the pharmacological potential of *Ficus racemosa*, which contains bioactive compounds such as flavonoids, tannins, and phenolic constituents known to enhance insulin secretion, improve glucose utilization, and reduce oxidative stress. This study aims to bridge the gap between traditional herbal medicine and modern pharmaceutical formulation by developing a standardized, patient-friendly dosage form. The findings are expected to contribute to the development of safe, effective, and affordable herbal antidiabetic therapies.

Keywords: Diabetes Mellitus; *Ficus racemosa*; Herbal Capsules; Antidiabetic; Phytoconstituents

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both, leading to disturbances in carbohydrate, lipid, and protein metabolism¹. The global prevalence of diabetes has increased significantly over the past decades, particularly in developing countries such as India, where rapid urbanization, sedentary lifestyle, and dietary changes have contributed to its rising incidence². The disease is associated with severe complications, including retinopathy, nephropathy, neuropathy, and cardiovascular disorders, which significantly increase morbidity and mortality³.

The pathophysiology of diabetes involves complex mechanisms such as impaired insulin secretion, peripheral insulin resistance, increased hepatic glucose production, oxidative stress, and chronic inflammation⁴. These interconnected pathways contribute to progressive β -cell dysfunction and metabolic imbalance. Despite advancements in pharmacotherapy, achieving optimal glycemic control remains challenging due to the progressive nature of the disease and limitations of current treatment options⁵.

Conventional antidiabetic drugs, including insulin and oral hypoglycemic agents, are associated with several drawbacks such as hypoglycemia, weight gain, gastrointestinal disturbances, and long-term safety concerns⁶. Additionally, these therapies often target a single pathway and fail to address the multifactorial nature of diabetes. This has led to growing interest in herbal medicines, which offer a multi-target approach and improved safety profile⁷.

Medicinal plants have been widely used in traditional systems such as Ayurveda for the management of diabetes. These plants contain bioactive

phytoconstituents such as flavonoids, tannins, alkaloids, and phenolic compounds that exert antidiabetic effects through various mechanisms, including enhancement of insulin secretion, improvement of insulin sensitivity, inhibition of carbohydrate digestion enzymes, and reduction of oxidative stress⁸.

Among these, *Ficus racemosa* (family Moraceae) has gained attention due to its significant pharmacological properties. The bark of this plant is rich in flavonoids and phenolic compounds and has been reported to exhibit antidiabetic, antioxidant, and anti-inflammatory activities⁹. However, the therapeutic application of herbal extracts is often limited by lack of standardization and suitable dosage forms.

Therefore, the present study focuses on the formulation and evaluation of herbal capsules containing standardized extract of *Ficus racemosa* bark, aiming to develop a stable, effective, and patient-compliant dosage form.

2. Materials and Methods

2.1 Materials

The bark of *Ficus racemosa* was selected as the primary plant material for the present study due to its reported antidiabetic potential. The bark was collected from a suitable natural source and carefully cleaned to remove adhering dirt and extraneous matter. Preliminary identification of the plant material was performed through morphological evaluation based on physical characteristics such as color, texture, and appearance. The plant material was subsequently authenticated by a recognized botanical authority, and an authentication certificate was obtained to ensure its identity and purity.

All chemicals and reagents used in the study were of analytical grade. Distilled water and ethanol were used as solvents during the extraction process. The excipients used for formulation included lactose as a diluent, talc as a glidant, and magnesium stearate as a lubricant. These excipients were selected based on their compatibility and common usage in capsule formulations¹.

The study utilized standard laboratory equipment, including an analytical balance for accurate weighing, a hot air oven for drying, a mechanical grinder for pulverization, and sieves for particle size uniformity. Extraction was performed using a Soxhlet apparatus, while capsule formulation was carried out using a manual capsule filling machine. A disintegration test apparatus was employed for evaluating the performance of the formulated capsules.

2.2 Methods

2.2.1 Collection and Preparation of Plant Material

The collected bark of *Ficus racemosa* was thoroughly washed with water to remove impurities and dried under shade at room temperature to prevent degradation of heat-sensitive phytoconstituents. Drying was continued until a constant weight was achieved, indicating complete removal of moisture. The dried bark was then coarsely powdered using a mechanical grinder and passed through a sieve to obtain a uniform particle size. The powdered material was stored in an airtight container to protect it from moisture and environmental contamination until further use².



Figure 2.1: Fresh plant of *Ficus racemosa* collected for the study.

2.2.2 Morphological Evaluation

The plant material was subjected to morphological evaluation for preliminary identification. Parameters such as color, odor, texture, and overall appearance were observed and recorded. These characteristics were compared with standard botanical descriptions to confirm the identity of the plant at a preliminary level before authentication³.

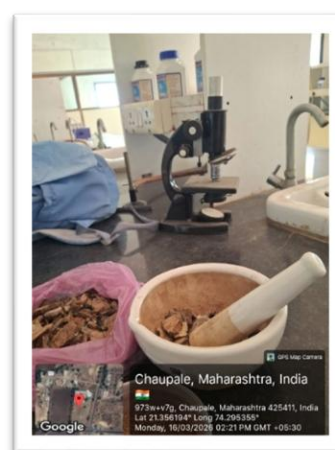


Figure 2.2: Bark of *Ficus racemosa* used for morphological evaluation.

2.2.3 Authentication of Plant Material

For scientific validation, the plant material was submitted to a recognized botanical institution for authentication. The specimen was confirmed as *Ficus racemosa*, and an authentication certificate was obtained and documented. This step ensured the authenticity and reproducibility of the study by eliminating the possibility of misidentification or adulteration⁴.

2.2.4 Extraction of Plant Material

The powdered bark of *Ficus racemosa* was subjected to extraction using the Soxhlet extraction method. A known quantity of the powdered plant material was placed in a Soxhlet apparatus, and extraction was carried out using ethanol as the solvent. The extraction process was continued for several cycles until complete extraction of the phytoconstituents was achieved.

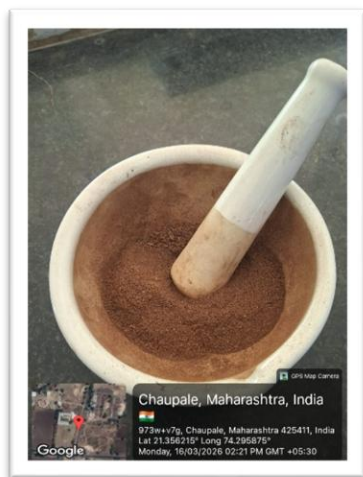


Figure 2.3: Powdered form of *Ficus racemosa* bark.

Following extraction, the solvent was evaporated using a water bath to obtain a concentrated extract. The concentrated extract was further dried and stored in a desiccator to prevent moisture absorption. The percentage yield of the extract was calculated using the following formula:

$$\text{Percentage Yield} = \frac{\text{Weight of Extract Obtained}}{\text{Weight of Plant Material Used}} \times 100$$

This step was crucial for determining the efficiency of the extraction process and ensuring reproducibility of results⁵.



Figure 2.4: Alcoholic extract of *Ficus racemosa* bark.

2.2.5 Preparation of Capsule Formulation

The dried extract of *Ficus racemosa* was used for the formulation of herbal capsules. The extract was blended with suitable pharmaceutical excipients, including lactose as a diluent, talc as a glidant, and magnesium stearate as a lubricant. All ingredients were accurately weighed and mixed uniformly using the geometric dilution method to ensure homogeneity of the formulation.

The prepared blend was evaluated for basic flow properties through visual observation. The final mixture was then filled into hard gelatin capsules using a manual capsule filling machine. Care was

taken to ensure uniform filling and consistency in capsule weight⁶.

2.2.6 Evaluation of Capsules

The formulated capsules were evaluated for their physicochemical properties to ensure quality and performance. Physical appearance was assessed by visual inspection, considering parameters such as color, shape, surface texture, and uniformity. The capsules were also evaluated for weight variation to ensure consistency in drug content.

Disintegration testing was performed using a standard disintegration test apparatus to determine the time required for the capsules to break down under specified conditions. The results obtained from the evaluation studies were recorded and expressed in tabular form. No advanced statistical analysis was performed in the present study, as the evaluation was primarily based on pharmacopeial standards⁷.

3. Results and Discussion

3.1 Authentication of Plant Material

The collected plant material was authenticated by a recognized botanical authority and confirmed as *Ficus racemosa*. The authentication certificate validated the identity and purity of the plant material, ensuring the reliability and reproducibility of the study. Proper authentication is a critical step in herbal drug development, as it eliminates the risk of adulteration and misidentification, which can significantly affect therapeutic outcomes¹.

3.2 Morphological Evaluation

The morphological characteristics of the collected bark were evaluated based on standard parameters, including color, odor, texture, and appearance. The observations are presented in Table 1.

Table 1: Morphological Characteristics of *Ficus racemosa* Bark

Parameter	Observation
Color	Brown to dark brown
Odor	Characteristic
Texture	Rough
Appearance	Fibrous bark

The observed characteristics were consistent with standard pharmacognostic descriptions of *Ficus racemosa* bark reported in the literature². Such preliminary evaluation is essential for ensuring the quality and authenticity of crude plant material prior to further processing.

3.3 Extraction and Yield of Plant Material

The dried and powdered bark was subjected to Soxhlet extraction using ethanol as the solvent. The extraction parameters and results are summarized in Table 2.

Table 2: Extraction Details and Yield

Parameter	Observation
Weight of plant material	100 g
Solvent used	Ethanol
Method	Soxhlet extraction
Duration	6–8 hours

Weight of extract obtained	12 g
Percentage yield	12%

The percentage yield of 12% indicates efficient extraction of phytoconstituents from the plant material. The use of ethanol as a solvent is advantageous due to its ability to extract both polar and moderately non-polar compounds, including flavonoids and phenolic constituents³. The yield obtained in this study is comparable with previously reported extraction efficiencies for *Ficus racemosa* bark, suggesting adequate recovery of bioactive compounds⁴.

3.4 Organoleptic Properties of Extract

The obtained extract was evaluated for its organoleptic characteristics, which are important indicators of quality and consistency. The results are shown in Table 3.

Table 3: Organoleptic Properties of Extract

Parameter	Observation
Color	Dark brown
Odor	Characteristic
Consistency	Semi-solid

The dark brown color and semi-solid consistency of the extract indicate the presence of concentrated phytoconstituents, including tannins and phenolic compounds. These characteristics are consistent with previous reports on *Ficus racemosa* extracts⁵. Organoleptic evaluation serves as a preliminary

quality control measure before formulation development.

3.5 Formulation of Herbal Capsules

The extract was successfully incorporated into capsule dosage form using suitable pharmaceutical excipients. The composition of the formulation is presented in Table 4.

Table 4: Composition of Capsule Formulation

Ingredient	Quantity (mg/capsule)	Function
Plant extract	250 mg	Active ingredient
Lactose	100 mg	Diluent
Talc	10 mg	Glidant
Magnesium stearate	5 mg	Lubricant
Total weight	365 mg	—

The formulation was designed to ensure uniform drug content, adequate flow properties, and ease of capsule filling. Lactose was used as a diluent to increase bulk, while talc and magnesium stearate improved flowability and prevented sticking during capsule filling⁶. The selected composition was found to be suitable for producing uniform and stable capsules.

3.6 Evaluation of Capsules

3.6.1 Physical Appearance

The formulated capsules were evaluated for physical characteristics, and the observations are summarized in Table 5.

Table 5: Physical Evaluation of Capsules

Parameter	Observation
Color	Light brown
Shape	Uniform
Surface	Smooth
Defects	None observed

The capsules exhibited uniform color, smooth surface, and absence of visible defects, indicating good formulation quality and proper handling during manufacturing. The uniformity in appearance reflects consistent mixing and filling of the formulation blend⁷.

4. Discussion

The present study was designed to develop and evaluate a herbal capsule formulation containing *Ficus racemosa* bark extract with potential antidiabetic activity. The findings obtained from authentication, extraction, formulation, and evaluation collectively support the feasibility of developing a standardized herbal dosage form.

Authentication of the plant material is a critical step in herbal drug development, as the therapeutic efficacy of plant-based formulations is highly dependent on the authenticity and purity of the raw material. In this study, the plant was confirmed as *Ficus racemosa*, ensuring reliability and reproducibility of the experimental work.

Morphological evaluation further supported the identity of the plant, as the observed characteristics were consistent with standard pharmacognostic descriptions reported in the literature (1,2).

The extraction process yielded 12% extract using ethanol as the solvent, indicating efficient recovery of phytoconstituents. Ethanol is widely used in herbal extraction due to its ability to dissolve a broad spectrum of bioactive compounds, including flavonoids, tannins, and phenolic compounds (3). These compounds are known to play a significant role in the antidiabetic activity of medicinal plants through mechanisms such as antioxidant activity, enhancement of insulin secretion, and improvement of glucose uptake (4,5). The yield obtained in the present study is comparable with previously reported studies on *Ficus racemosa*, suggesting that the extraction method employed was appropriate and effective (6).

The organoleptic evaluation of the extract revealed a dark brown color, characteristic odor, and semi-solid consistency, which are indicative of concentrated phytochemical content. These findings align with earlier reports highlighting the presence of phenolic and tannin-rich fractions in *Ficus racemosa* bark extracts (7). Such phytoconstituents are known to contribute to the reduction of oxidative stress, a major factor in the pathogenesis of diabetes and its complications (8).

The formulation of herbal capsules was successfully achieved using standard pharmaceutical excipients. Lactose was incorporated as a diluent to provide bulk, while talc and magnesium stearate improved flow properties and ensured uniform filling of capsules. The use of capsules as a dosage form offers several advantages, including accurate dosing, improved stability, and enhanced patient compliance (9). The selected formulation demonstrated

satisfactory physical characteristics, indicating compatibility between the extract and excipients.

Evaluation of the capsules showed uniform color, smooth surface, and absence of defects, suggesting good formulation quality. These parameters are important indicators of consistency and acceptability of the dosage form. Although advanced evaluation tests such as dissolution and stability studies were not performed in this study, the preliminary results indicate that the formulation meets basic pharmacopeial standards (10).

The antidiabetic potential of *Ficus racemosa* has been widely reported in experimental studies, where it has shown significant hypoglycemic, antioxidant, and anti-inflammatory activities (11,12). The presence of flavonoids and phenolic compounds contributes to its ability to modulate multiple pathways involved in diabetes, including insulin secretion, glucose metabolism, and oxidative stress (13). Therefore, the developed formulation has the potential to act as a multi-target therapeutic agent, addressing the complex pathophysiology of diabetes.

However, the study has certain limitations. The absence of in vivo pharmacological evaluation and advanced analytical characterization restricts the ability to confirm the therapeutic efficacy of the formulation. Future studies should focus on pharmacological validation, standardization of active constituents, and clinical evaluation to establish its safety and effectiveness.

5. Conclusion

The present study successfully demonstrated the formulation and preliminary evaluation of herbal antidiabetic capsules containing *Ficus racemosa* bark extract. The study highlights the potential of herbal medicines as safe, cost-effective, and multi-target

therapeutic options for the management of diabetes mellitus.

The extraction process yielded a satisfactory amount of phytoconstituents, indicating the efficiency of the selected method. The formulated capsules exhibited acceptable physicochemical properties, including uniform appearance and absence of defects, suggesting good formulation quality and compatibility of excipients. These findings indicate that the developed capsule formulation is suitable for oral administration and has the potential for further pharmaceutical development.

The pharmacological significance of *Ficus racemosa*, particularly its antidiabetic, antioxidant, and anti-inflammatory properties, supports its use in the management of diabetes. The presence of bioactive compounds such as flavonoids, tannins, and phenolic constituents contributes to its therapeutic potential through multiple mechanisms, including enhancement of insulin secretion and reduction of oxidative stress.

Despite the promising results, the study is limited to preliminary formulation and evaluation. Further research is required to validate the efficacy and safety of the formulation through in vitro and in vivo studies. Additionally, standardization of the extract and identification of active constituents are essential for ensuring consistency and reproducibility.

In conclusion, the developed herbal capsule formulation represents a promising approach for integrating traditional herbal medicine with modern pharmaceutical technology. It has the potential to provide an effective and patient-friendly alternative for the management of diabetes, particularly in resource-limited settings.

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