RESEARCH PAPER

Formulation And Evaluation of a Polyherbal Antidiabetic Churna

Mhaske S. R.[1*], Laddha P. R.[2*], Sitaphale G. R.[3], Tathe P. R.[4]

[1]Research Scholar, Department of Pharmacognosy, Samarth College of Pharmacy, Deulgaon Raja, Dist. Buldhana – 443204, Maharashtra, India
ORCID ID : 0009-0007-3062-8113,
[2]Professor, Samarth College of Pharmacy, Deulgaon Raja, Dist. Buldhana – 443204, Maharashtra, India
ORCID ID : 0000-0002-5847-866X,
[3]Professor & Head, Department of Parmacognosy, Samarth College of Pharmacy, Deulgaon Raja, Dist. Buldhana – 443204, Maharashtra, India
ORCID ID :0009-0001-4078-8539,
[4]Principal, Samarth College of Pharmacy, Deulgaon Raja, Dist. Buldhana – 443204, Maharashtra, India
ORCID ID :0000-0003-2163-2974
**Corresponding Author: Mhaske S. R. & Laddha P. R.*
Email: smitawagh0812@gmail.com & purushottamladdha@gmail.com

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ABSTRACT

Diabetes mellitus is a long-lasting disorder marked by the body's inability to properly control blood glucose, and it still poses a major health concern for millions of people around the world. Although several Several synthetic pharmacological agents have been developed for antidiabetic therapy for its management, their prolonged therapeutic use is commonly accompanied by various adverse reactions. limitations, which has led to growing interest in safer and more natural alternatives. In this context, Herbal preparations have emerged as promising alternatives in disease management. To gained significant attention due to their therapeutic potential and minimal adverse effects.

The current study target on the development and evaluation of a polyherbal churna formulated using selected medicinal plants known for their antidiabetic properties, namely Gymnemasylvestre, Momordica charantia, Syzygiumcumini, Azadirachta indica, and Emblica officinalis. These herbs have been traditionally used in various systems of medicine and are more bio effective compounds that may help maintain adequate blood glucose levels.

The formulation was prepared following standardized procedures to ensure uniformity and quality. It was further evaluated for various Parameters such as moisture content, ash values, and flow behavior were analyzed to assess the formulation's stability and its appropriateness for application. Phytochemical screening was carried out to identify the presence of important bioactive constituents like alkaloids, flavonoids, tannins, and glycosides, which are known to contribute to antidiabetic activity.

In addition, the in-vitro antidiabetic potential of the formulation was assessed through enzyme inhibition studies, particularly targeting carbohydrate-digesting enzymes. The results revealed significant inhibitory activity, indicating the formulation's ability to help control postprandial blood glucose levels. Overall, the findings suggest that the developed polyherbal churna is stable, rich in beneficial phytochemicals, and exhibits promising antidiabetic activity.

This study highlights the potential of the formulated herbal preparation as a safe and effective alternative or complementary approach for the management of diabetes mellitus, warranting further in-vivo and clinical investigations.Keywords: Food Vloggers, Influence, Intervention, Nutrition, Screen Time, Social Media

Keywords: Polyherbal formulation, Diabetes mellitus, Antidiabetic activity, Phytochemical screening, α-glucosidase inhibition, Glycemic control

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INTRODUCTION

Diabetes mellitus is a widespread and long-term metabolic disorder characterized by persistently increased in blood glucose levels and disturbances in the metabolism of carbohydrates, fats, and proteins. This condition mainly arises due to insufficient

**Author for Correspondence: smitawagh0812@gmail.com & purushottamladdha@gmail.com*

insulin production, impaired insulin action, or a combination of both [1]. Over the past few decades, the prevalence of diabetes has increased dramatically worldwide, making it a major public health concern [2]. If not properly managed, diabetes can lead to serious complications such as cardiovascular diseases, neuropathy, nephropathy, and retinopathy, thereby increasing morbidity and mortality rates [1].

In few years, there has been more interest in the use of herbal medicines for the management of diabetes, largely due to their safety, affordability, and relatively fewer side effects. Medicinal plants contain a wide range of bioactive compounds that help regulate blood glucose levels through multiple mechanisms, including stimulation of insulin secretion, enhancement of insulin sensitivity, inhibition of carbohydrate-digesting enzymes, and reduction of oxidative stress [3].

Although standard antidiabetic interventions, such as insulin therapy and oral hypoglycemic agents, effectively maintain glycemic balance; however, extended use is frequently linked to limitations, including adverse reactions like hypoglycemia, weight gain, and gastrointestinal disturbances, and the development of drug resistance. Furthermore, the high cost of synthetic drugs can limit accessibility, especially in low- and middle-income regions [2].

Traditional systems of medicine have utilized plant-based therapies for centuries, and modern research continues to validate their therapeutic potential. Polyherbal formulations, which combine multiple medicinal plants, are considered more effective than single-herb preparations due to their synergistic action. In such formulations, different bioactive compounds work together to enhance therapeutic efficacy while minimizing adverse effects [4].

One of the commonly used Ayurvedic dosage forms is *churna*, which consists of finely powdered herbal ingredients. Churna formulations are valued for their ease of preparation, stability, convenient administration, and improved bioavailability. Scientific evidence suggests that standardized polyherbal formulations can provide consistent therapeutic outcomes while maintaining safety and quality [3,5].

AIM OF THE STUDY

The present investigation is aimed at the formulation and evaluation of a polyherbal antidiabetic *churna* using selected medicinal plants that are recognised for their blood glucose-lowering properties. The goal is to develop a safe, effective, and synergistic herbal preparation for the treatment and management of diabetes.

REVIEW OF LITERATURE:

Diabetes mellitus continues to be a major global health challenge, and the limitations associated with conventional therapies have encouraged researchers to explore alternative approaches, particularly herbal medicine. Among these, polyherbal formulations have attracted considerable attention due to their ability to act on multiple biological targets involved in glucose regulation and their potential synergistic effects [6].

Numerous medicinal plants have been widely investigated for their antidiabetic potential. Plants such as *Gymnemasylvestre*, *Momordica charantia*, *Syzygiumcumini*, *Azadirachta indica*, and *Emblica officinalis* have demonstrated significant glucose-lowering activity. These plants exert their effects through various mechanisms, including stimulation of insulin secretion, enhancement of peripheral glucose uptake, inhibition of carbohydrate-digesting

enzymes like α-glucosidase, and reduction of oxidative stress, which plays a key role in diabetes progression [7,8].

Research findings suggest that polyherbal formulations offer improved therapeutic outcomes compared to single-herb treatments. The combination of multiple herbs allows for a broader spectrum of action, thereby enhancing efficacy and reducing the likelihood of side effects. Traditional Ayurvedic formulations, in particular, have shown promising results in reducing blood glucose levels and improving metabolic parameters in experimental and preclinical studies [9].

Phytochemical studies have identified several bioactive constituents such as flavonoids, alkaloids, tannins, and polyphenols in medicinal plants. These compounds are known for their antioxidant properties and their ability to modulate glucose metabolism, thereby contributing significantly to antidiabetic activity [10].

Overall, the available literature supports the use of polyherbal formulations as safe, effective, and cost-efficient alternatives for diabetes management. However, further research, including clinical trials and standardization studies, is essential to validate their efficacy and ensure consistency in therapeutic outcomes [6].

MATERIALS AND METHODS

Selection of Medicinal Plants

Five medicinal plants were selected for the preparation of the polyherbal antidiabetic *churna* based on their traditional use in Ayurveda, documented pharmacological properties, and reported antidiabetic activity. The selection was made to ensure a synergistic combination targeting multiple pathways involved in glucose regulation.

The selected plants include:

- *Gymnemasylvestre* (Gudmar)
- *Momordica charantia* (Karela)
- *Syzygiumcumini* (Jamun)
- *Azadirachta indica* (Neem)
- *Emblica officinalis* (Amla)

a) Gymnemasylvestre (Gudmar)

Gymnemasylvestre is a well-known medicinal plant widely used in traditional medicine for the management of diabetes. It has the unique ability to reduce the perception of sweetness by interacting with taste receptors on the tongue. In addition, it has been reported to stimulate insulin secretion from pancreatic β-cells and may support the regeneration of pancreatic tissue, thereby improving glycemic control [11].

Role in Formulation:

Gudmar serves as a key antidiabetic component in the formulation by reducing intestinal glucose absorption and enhancing insulin secretion, thus helping in effective blood glucose regulation.

b) *Momordica charantia* (Karela)

Momordica charantia, commonly known as bitter gourd, is widely recognized for its potent antidiabetic properties. It contains important bioactive compounds such as charantin, vicine, and polypeptide-p, which contribute to its glucose-lowering effects. These constituents help enhance peripheral glucose utilization, improve insulin sensitivity, and exhibit insulin-like activity, thereby aiding in effective glycemic control [12].

Role in Formulation:

Karela plays a vital role by mimicking insulin action and promoting glucose uptake in body tissues.

c) *Syzygiumcumini* (Jamun)

Syzygiumcumini, commonly known as Jamun, has been traditionally used in diabetes management. Its seeds and fruits are rich in phytochemicals such as jamboline, jambosine, and ellagic acid. These compounds help regulate blood glucose levels by slowing down glucose absorption and improving insulin activity. Its antihyperglycemic effect makes it a valuable component in herbal formulations [13].

Role in Formulation:

Jamun helps regulate carbohydrate metabolism and is particularly useful in controlling postprandial blood glucose levels.

d) *Azadirachta indica* (Neem)

Azadirachta indica is well known for its broad spectrum of medicinal properties, including antidiabetic, antioxidant, and anti-inflammatory effects. It helps reduce oxidative stress, which is a major contributing factor in the progression of diabetes, and also supports glucose metabolism. Neem has been extensively used in traditional medicine for maintaining healthy blood sugar levels [14].

Role in Formulation:

Neem contributes by providing antihyperglycemic action and protecting the body against oxidative damage.

e) *Emblica officinalis* (Amla)

Emblica officinalis, commonly known as Amla, is a rich source of vitamin C, tannins, and polyphenols. It exhibits strong antioxidant activity, which helps protect pancreatic β-cells from oxidative damage. Additionally, it improves insulin sensitivity and supports overall metabolic balance [15].

Role in Formulation:

Amla enhances pancreatic function and provides antioxidant protection, supporting long-term glycemic control.

The combination of these selected herbs offers a comprehensive approach to diabetes management by targeting multiple pathways such as insulin secretion, glucose metabolism, oxidative stress reduction, and pancreatic protection. Polyherbal formulations are known to produce synergistic effects, thereby improving therapeutic efficacy compared to individual herbs [16].

Collection and Processing of Raw Materials

After procurement, all raw plant materials were carefully examined to remove foreign particles, damaged portions, and impurities. The materials were then washed thoroughly with clean water to eliminate dust and contaminants.

Processing Steps

- **Cleaning:** Removal of unwanted materials
- **Drying:** Shade drying to preserve active constituents
- **Pulverization:** Grinding into fine powder
- **Sieving:** Achieving uniform particle size

The cleaned materials were dried under shade at room temperature to protect heat-sensitive phytoconstituents from degradation. They were spread evenly in thin layers to ensure uniform drying and prevent microbial growth. Drying was continued until a constant weight was achieved, indicating complete removal of moisture.

The dried plant materials were then pulverized using a mechanical grinder to obtain fine powders. These powders were passed through a suitable sieve to ensure uniform particle size, which is essential for maintaining homogeneity, stability, and bioavailability of the final formulation [17].

Formulation of Herbal Antidiabetic Churna

Sr. No.	Common Name	Biological Name	Part Used	Quantity (g)
1	Gudmar	*Gymnemasylvestre*	Leaves	25 g
2	Karela	*Momordica charantia*	Fruit	25 g
3	Jamun	*Syzygiumcumini*	Seeds	20 g
4	Neem	*Azadirachta indica*	Leaves	15 g
5	Amla	*Emblica officinalis*	Fruit	15 g

Preparation of Polyherbal Churna

The formulation was prepared by accurately weighing each powdered ingredient according to the specified proportions. The powders were then blended thoroughly using the geometric dilution method to ensure uniform distribution of all components.

Mixing was performed under clean and dry conditions to avoid contamination and moisture absorption. Proper blending ensures consistency in dose and therapeutic effect across the formulation [18].

After mixing, the final product was evaluated for uniformity in color, texture, and appearance. The prepared churna was stored in airtight, moisture-resistant containers to protect it from environmental factors such as humidity, light, and air exposure, which could otherwise affect stability.

Proper labeling and storage conditions were maintained to preserve the quality, shelf life, and effectiveness of the formulation. Appropriate storage is essential for maintaining the physicochemical stability and therapeutic activity of polyherbal preparations [18,16].

EVALUATION PARAMETERS

1. Organoleptic Evaluation

Parameter	Observation
Color	Brownish-green
Odor	Characteristic herbal
Appearance	Uniform
Texture	Fine powder

2. Physicochemical Analysis

Parameter	Result	Standard Limit
Loss on Drying	4.20%	< 5%
Total Ash	6.50%	< 10%
Acid Insoluble Ash	1.20%	< 2%
Water Soluble Extractive	18.40%	—
Alcohol Soluble Extractive	12.30%	—
pH (1% solution)	6.3	Neutral

Interpretation:

The moisture content was within acceptable limits, indicating low risk of microbial growth. Ash values confirmed minimal inorganic impurities, while low acid-insoluble ash indicated negligible contamination with siliceous matter. Higher water-soluble extractive values suggest the dominance of hydrophilic constituents. The near-neutral pH indicates suitability for oral use without irritation. Overall, results confirm good quality and stability of the formulation.

3. Flow Properties of Churna

Parameter	Result	Significance
Bulk Density	0.48 g/mL	Good packing ability

Tapped Density	0.58 g/mL	—
Angle of Repose	28.5°	Good flowability
Carr's Index	17.24%	Acceptable flow

Interpretation:

The formulation exhibits good flow properties, as indicated by the angle of repose (<30°) and Carr's index within acceptable limits. These characteristics ensure ease of handling and suitability for large-scale manufacturing.

4. Phytochemical Screening

Phytoconstituent	**Test**	**Observation**	**Result**
Alkaloids	Mayer's/Dragendorff's	Cream/orange ppt	Present
Flavonoids	Shinoda	Pink/red color	Present
Tannins	Ferric chloride	Blue-black/green	Present
Saponins	Foam test	Persistent froth	Present
Glycosides	Keller–Killiani	Brown ring	Present
Phenolics	Ferric chloride	Bluish-black	Present

Interpretation:

The presence of key phytoconstituents such as flavonoids, alkaloids, tannins, and phenolic compounds supports the formulation's antidiabetic potential. These compounds are known to enhance insulin activity, improve glucose utilization, and provide antioxidant protection, thereby reducing oxidative stress associated with diabetes [19].

1. In-vitro Antidiabetic Activity

➢ *α-Amylase Inhibition Assay*

The α-amylase inhibitory activity of the polyherbalchurna was evaluated at different concentrations (20–100 µg/mL). A concentration-dependent increase in percentage inhibition was observed.

Conc. (µg/mL)	**Ac**	**As**	**% Inhibition**
20	0.85	0.58	31.76%
40	0.85	0.47	44.70%
60	0.85	0.38	55.29%
80	0.85	0.32	62.35%
100	0.85	0.27	68.23%

The percentage inhibition was calculated using the formula:

$$\% \text{ Inhibition} = \frac{\text{Ac} - \text{As}}{\text{Ac}} \times 100$$

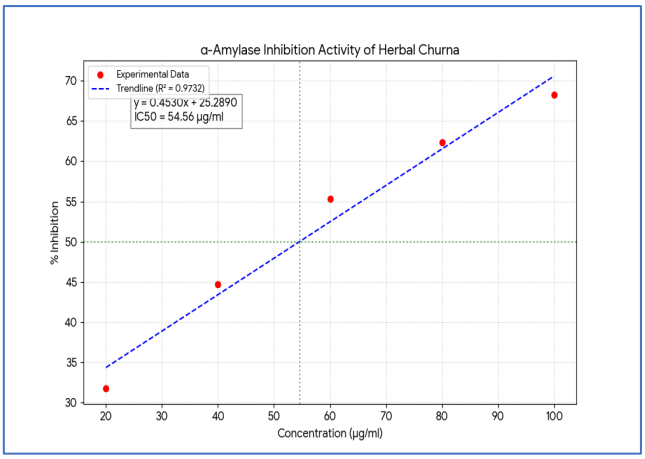

Figure: Graph of α-Amylase Inhibition Assay

The formulation exhibited a maximum inhibition of 68% at 100 µg/mL. Regression analysis showed a strong linear relationship (R^2 = 0.9732) with the equation $y = 0.4578x + 25.023$. The IC_{50} value was found to be 54.56 µg/mL, indicating moderate inhibitory activity.

Interpretation:

The results confirm that the formulation effectively inhibits α-amylase in a dose-dependent manner,

suggesting its potential to delay carbohydrate digestion and reduce postprandial glucose levels.

➢ *α-Glucosidase Inhibition Assay*

The α-glucosidase inhibitory activity was assessed similarly, and the formulation demonstrated a higher inhibitory effect compared to α-amylase.

Conc. (µg/mL)	*Ac*	*As*	*% Inhibition*
20	*0.90*	*0.58*	*35.55%*
40	*0.90*	*0.45*	*50.00%*
60	*0.90*	*0.36*	*60.00%*
80	*0.90*	*0.30*	*66.66%*
100	*0.90*	*0.25*	*72.22%*

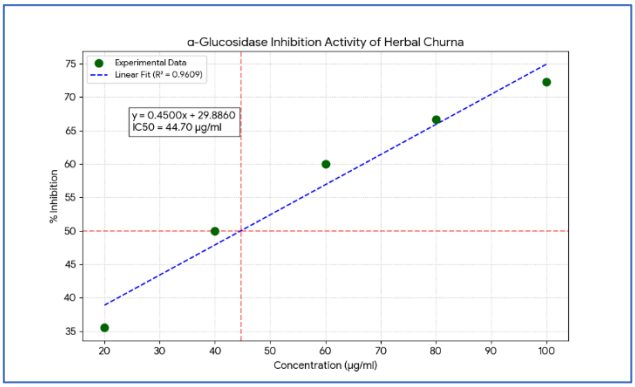

Figure: Graph of α-glucosidase inhibition Assay

The formulation showed a maximum inhibition of 72% at 100 µg/mL. The regression equation was $y = 0.449x + 29.93$ with a correlation coefficient (R^2) of 0.9609. The IC_{50} value was calculated as 44.70 µg/mL.

Interpretation:

The higher inhibitory activity against α-glucosidase indicates that the formulation is more effective in inhibiting glucose absorption at the intestinal level.

Combined Interpretation (Dual Enzyme Inhibition)

The polyherbalchurna demonstrated significant dual enzyme inhibitory activity:

- **α-amylase IC_{50}:** 54.56 µg/mL
- **α-glucosidase IC_{50}:** 44.70 µg/mL

The results indicate that the formulation acts at two key stages of carbohydrate digestion—starch breakdown and glucose absorption—thereby enhancing overall glycemic control. The comparatively stronger inhibition of α-glucosidase is advantageous, as it helps in reducing postprandial hyperglycemia with fewer gastrointestinal side effects commonly associated with strong α-amylase inhibitors.

These results suggest that the formulation can effectively delay carbohydrate digestion and glucose absorption, thereby helping in glycemic control.

Stability Studies

Parameter	*Initial*	*After 3 Months*	*Interpretation*
Color	*Brownish green*	*No change*	*Physically stable*
Odor	*Characteristic*	*No change*	*No degradation*
pH	*6.3*	*6.2*	*Chemically stable*
Moisture Content	*4.20%*	*4.35%*	*Within limits*
Phytochemicals	*Present*	*No change*	*No degradation*

Interpretation

- *No change in color and odor confirms **physical stability***
- *Minimal moisture increase does not affect quality*
- *Stable pH indicates **chemical integrity***
- *Retention of phytochemicals confirms **no degradation of active constituents***

The formulation remained stable over three months, with no significant changes in color, pH, or phytochemical composition. This confirms the formulation's stability under normal storage conditions.

RESULTS

The formulated churna showed:

- Good flowability and compressibility
- Acceptable physicochemical properties
- Uniformity in composition
- Presence of bioactive phytoconstituents
- Significant enzyme inhibition activity

DISCUSSION

The present study successfully developed a polyherbalantidiabeticchurna with desirable characteristics. Each selected herb contributes to antidiabetic activity through different mechanisms:

- Gymnemasylvestre stimulates insulin secretion
- Momordicacharantia improves glucose utilization
- Syzygiumcumini delays glucose absorption
- Azadirachtaindica reduces oxidative stress
- Emblicaofficinalis protects pancreatic cells

The synergistic effect of these herbs enhances therapeutic efficacy. The good flow properties indicated suitability for large-scale production. Low moisture content ensures stability and prevents microbial growth.

The presence of flavonoids, tannins, and alkaloids supports the observed antidiabetic activity. The α-glucosidase inhibition assay confirms the formulation's ability to control postprandial hyperglycemia.

SUMMARY

The present investigation was undertaken to develop and systematically evaluate a polyherbal antidiabetic *churna* formulated from carefully selected medicinal plants known for their established therapeutic efficacy in the management of diabetes mellitus. The formulation process was carried out using standardized and reproducible procedures to ensure consistency, quality, and uniformity of the final product. Preformulation studies, particularly the assessment of flow characteristics, demonstrated favorable flow behavior, indicating that the prepared

formulation is suitable for efficient handling, processing, and potential large-scale manufacturing.

Comprehensive physicochemical evaluation was performed to determine key quality parameters of the formulation. The results indicated that values for moisture content, ash content, and pH were within pharmaceutically acceptable limits, thereby confirming the formulation's purity, stability, and appropriateness for oral administration. Preliminary phytochemical screening revealed the presence of multiple bioactive constituents, including alkaloids, flavonoids, tannins, saponins, glycosides, and phenolic compounds. These phytoconstituents are well recognized for their synergistic roles in exerting antihyperglycemic and antioxidant effects, which are crucial in the management of diabetes and its associated complications.

The in vitro enzymatic inhibition studies demonstrated that the developed polyherbal formulation exhibited significant and concentration-dependent inhibitory activity against key carbohydrate-metabolizing enzymes, namely α-amylase and α-glucosidase. Notably, the formulation showed comparatively stronger inhibition of α-glucosidase, suggesting its potential effectiveness in reducing postprandial glucose spikes by delaying carbohydrate digestion and glucose absorption. Furthermore, stability studies conducted over the designated period revealed no significant alterations in physicochemical properties, indicating that the formulation maintains its integrity and efficacy under storage conditions.

CONCLUSION

In summary, the present study successfully developed and evaluated a polyherbal antidiabetic *churna* with desirable physicochemical attributes, satisfactory flow properties, and confirmed stability. The presence of a diverse range of phytoconstituents supports the likelihood of a synergistic mechanism contributing to its therapeutic potential.

The significant inhibitory activity observed against α-amylase and α-glucosidase enzymes highlights the formulation's capability to modulate carbohydrate digestion and control glucose absorption. The relatively higher inhibition of α-glucosidase further emphasizes its potential role in managing postprandial hyperglycemia, possibly with reduced risk of adverse effects compared to conventional therapies.

In comparison to synthetic antidiabetic drugs, the developed polyherbal formulation offers several advantages, including its natural origin, economic feasibility, and a potentially improved safety profile. These attributes make it a promising candidate for complementary or alternative management of diabetes mellitus.

However, despite the encouraging in vitro findings, further investigations involving in vivo studies and well-designed clinical trials are essential to establish its safety, therapeutic efficacy, and clinical applicability in human subjects.

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