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FORMULATION AND QUALITY CONTROL OF A POLYHERBAL POWDER FOR DIABETES: A PHARMACOGNOSTIC AND PHYTOCHEMICAL ANALYSIS

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ABSTRACT

The increasing prevalence of diabetes mellitus has prompted a global search for safer and more effective therapeutic alternatives. Traditional herbal medicine offers a rich source of bioactive compounds with antidiabetic potential. This study focuses on the formulation and quality control of a standardized polyherbal powder using selected medicinal plants traditionally known for their Momordica charantia; Gymnema slyvestre; Costus pictus; antidiabetic properties. The formulation was developed by incorporating powdered forms of among others, in scientifically validated proportions. Pharmacognostic evaluation, including macroscopic and microscopic analysis, was conducted to ensure the authenticity and purity of the individual plant components. Phytochemical screening confirmed the presence of key bioactive constituents such as alkaloids, flavonoids, saponins, and tannins, which are known to contribute to glycemic control. Quality control parameters, including moisture content, ash values, and extractive values, were assessed according to WHO guidelines to ensure batch-to-batch consistency. The results suggest that the formulated polyherbal powder is pharmacognostically and phytochemically robust and holds promise as a natural, complementary approach to diabetes management. Further pharmacological and clinical studies are warranted to validate its efficacy and safety.

KEYWORDS: Standardization; Herbal medicines; *Momordica charantia; Gymnema slyvestre; Costus pictus*; Polyherbal formulation.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. It has emerged as a major public health concern worldwide, with rising prevalence due to sedentary lifestyles, dietary habits, and genetic predisposition. Long-term complications of diabetes include cardiovascular disease, nephropathy, neuropathy, and retinopathy, significantly affecting the quality of life and increasing mortality rates.[1]

Conventional antidiabetic medications, though effective, are often associated with side effects and limited accessibility in low-resource settings. As a result, there is growing interest in alternative and complementary therapies, particularly those derived from traditional medicinal systems. Herbal medicines, known for their historical use and relatively low toxicity, have been increasingly explored for their potential to manage diabetes effectively.

Polyherbal formulations—combinations of multiple medicinal plants—are believed to offer synergistic effects and enhanced therapeutic efficacy. This approach aligns with Ayurvedic principles and provides a holistic method of disease management. Notably, plants such as *Momordica charantia* (bitter melon), *Gymnema sylvestre* (gurmar), and *Costus pictus* (insulin plant) have shown promising antidiabetic properties in various ethnopharmacological and scientific studies.[2]

This study aims to formulate a standardized polyherbal powder using selected antidiabetic plants and to evaluate its pharmacognostic and phytochemical characteristics. The inclusion of macroscopic and microscopic analyses ensures the identity and purity of the plant materials, while phytochemical screening helps identify the key bioactive constituents responsible for therapeutic activity. Quality control measures, in accordance with WHO guidelines, further ensure the safety, efficacy, and consistency of the formulation. The findings of this study are expected to contribute to the development of a reliable, plant-based intervention for diabetes management and provide a scientific foundation for further pharmacological investigations.

Preparation of the Polyherbal formulation: The prepared powders were combined in a ratio of 1:1:1. Formulations in powder form are recommended due to their minute-sized particles. It is proven that smaller particles absorb more quickly in the gastrointestinal tract, so smaller particles are more therapeutically effective.[3]

Physical evaluation: Morphological and microscopical study of prepared plant powder The external morphology and powder microscopy of all the raw materials were studied, photo-documented, and correlated with existing standard literature.

MATERIALS AND METHODS

Collection and processing of raw materials Collected leaves were thoroughly washed using distilled water, and all damaged leaves were sorted out. The leaves were then dried under shade for 1 week. Once the leaves were dried entirely, they were ground using a mixer-grinder. The coarse powder obtained was passed through a sieve to acquire a moderately fine nature of powder, and it was stored in a closed airtight box and used for further analysis.

Pharmacognostic Evaluation

Pharmacognostic evaluation ensures the identification, authenticity, and purity of plant materials. It includes both **macroscopic** (external) and **microscopic** (internal) examinations of the raw material and the final powdered formulation.

1.1 Macroscopic Evaluation

- **Appearance**: The size, shape, color, and texture of the powdered plant material are examined to ensure consistency with the standard description of each plant. This visual inspection helps verify the correct plant species and the proper stage of processing.
- **Odor and Taste**: The odor and taste are checked to ensure they align with the known characteristics of each plant. For example, *Momordica charantia* has a bitter taste, and *Gymnema sylvestre* is often described as having a mild, slightly bitter flavor.

2. PHYTOCHEMICAL EVALUATION

Phytochemical screening is used to identify the bioactive compounds responsible for the therapeutic properties of the polyherbal powder. Key bioactive compounds with known antidiabetic properties are investigated.[4]

2.1 Phytochemical Screening

- **Alkaloids**: Alkaloids are often associated with pharmacological effects, including antidiabetic activity. Tests for alkaloids involve extraction with solvents like ethanol and subsequent reactions with specific reagents to reveal the presence of these compounds.
- **Flavonoids**: These compounds are known for their antioxidant properties, which can help protect pancreatic cells and support insulin function. Flavonoids are typically identified using colorimetric methods such as the Shinoda test.
- **Saponins**: Saponins have been shown to have antidiabetic effects by reducing glucose absorption in the gastrointestinal tract. Saponin presence is identified using froth formation or foam tests.[5]
- **Tannins**: These compounds are known to inhibit digestive enzymes and thus regulate glucose levels. They are detected by the addition of ferric chloride solution, which results in a color change.
- **Other Constituents**: Other bioactive compounds, such as glycosides, terpenoids, and phenolic compounds, may also be tested as they contribute to the overall pharmacological activity.

2.2 Quantitative Analysis

- **Total Phenolic Content**: The phenolic content is quantified using the Folin-Ciocalteu reagent, which reacts with phenolic compounds to form a blue complex that can be measured spectrophotometrically.
- **Total Flavonoid Content**: The flavonoid content is determined using an aluminum chloride colorimetric assay, which quantifies the amount of flavonoids in the sample.
- **Saponin Content**: Saponins are quantified using spectrophotometric methods, where the amount of saponins is measured based on the color produced during the extraction process.[6]

3. Quality Control Parameters

The quality control of the polyherbal formulation ensures consistency and safety across different batches of the product. These tests are designed to assess the physical and chemical characteristics that may affect the quality and performance of the herbal powder.

3.1 Moisture Content

- **Purpose**: Excess moisture can lead to microbial growth, degradation of active compounds, and reduced shelf life.
- **Method**: Moisture content is measured using the oven drying method, where a known amount of the

powder is heated at a specific temperature (usually 105°C) until a constant weight is achieved.[7]

3.2 Ash Values

- **Total Ash**: The total ash content is a measure of the inorganic residue remaining after the combustion of the sample. High ash content can indicate the presence of contaminants or impurities. It is determined by incinerating the sample at a controlled temperature.
- **Acid-Insoluble Ash**: This test identifies the amount of ash that is insoluble in dilute acid, which may indicate the presence of soil or other non-plant materials.
- **Water-Soluble Ash**: This measures the amount of ash soluble in water, which may be indicative of the solubility of the plant's bioactive components.

3.3 Extractive Values

- **Water Extractive Value**: This evaluates the amount of water-soluble compounds present in the plant material. It is determined by extracting the powder with hot water and measuring the amount of soluble material.
- **Alcohol Extractive Value**: Similarly, this value measures the amount of alcohol-soluble compounds and is determined by extraction using ethanol or methanol.

4. Physical Evaluation

The physical characteristics of the final polyherbal powder formulation are examined to ensure its suitability for therapeutic use.[8]

4.1 Particle Size Distribution

- **Purpose**: Smaller particles have a greater surface area, which may enhance the dissolution and absorption rates in the gastrointestinal tract. This is particularly important for herbal formulations that rely on bioactive compounds for therapeutic effects.
- **Method**: Particle size distribution is determined using techniques like laser diffraction or sieve analysis.[9]

4.2 Flow ability

- **Purpose**: Proper flow ability ensures that the powder can be processed, stored, and administered efficiently. Poor flow properties could indicate the need for further formulation optimization.
- **Method**: Flow properties are assessed using tests like the angle of repose, Carr's index, and Hausner ratio.

4.3 Uniformity of Content

- **Purpose**: Consistency in the distribution of active ingredients across the batch is crucial for ensuring that each dose provides a consistent therapeutic effect.[10]
- **Method**: Uniformity of content is tested by randomly sampling portions of the powder and analyzing the active ingredients.

5. STABILITY STUDIES

Long-term stability studies are performed to determine how the polyherbal powder maintains its potency, safety, and quality over time. These studies evaluate the effects of different storage conditions (e.g., temperature, humidity) on the quality parameters such as moisture content, active compound concentration, and microbial load.[11]

5.1 Accelerated Stability Testing

- **Purpose**: To predict the shelf-life of the formulation.
- **Method**: The product is stored under accelerated conditions (e.g., high temperature and humidity) for a defined period, after which it is tested for any changes in its chemical, physical, or microbial properties.[12]

RESULT AND DISCUSSION

1.1 Macroscopic Evaluation

Table no. 1: Macroscopic Evaluation.

Plant Name	Appearance	Odor	Taste
Momordica charantia	Fine to coarse greenish-brown powder; slightly fibrous texture	Characteristic herbal odor	Bitter
Gymnema sylvestre	Greenish powder; slightly coarse; leaf fragments may be visible	Mild, earthy herbal smell	Mildly bitter to slightly bland
Costus pictus	Fine green powder; smooth texture with possible fibrous residues	Faint, sweet herbal aroma	Mild, slightly sweet or bland

2.1 Phytochemical Screening

Table no. 2: Phytochemical Screening.

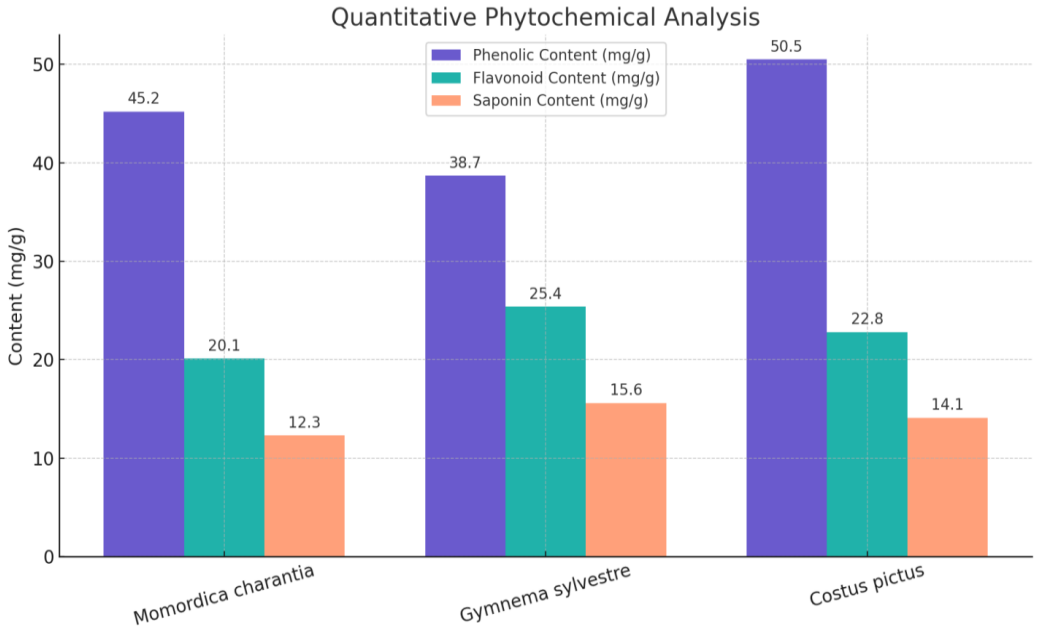
Phytochemical	Test Method	Momordica charantia	Gymnema sylvestre	Costus pictus
Alkaloids	Mayer's, Dragendorff's reagents	+	+	+
Flavonoids	Shinoda test	+	+	+
Saponins	Froth/foam test	+	+	+

Tannins	Ferric chloride test	+	+	+
Glycosides	Keller-Killiani test	+	+	+
Terpenoids	Salkowski's test	+	+	+
Phenolic Compounds	Salkowski's test	+	+	+

Notes

- All three plants show the **presence (+)** of major phytochemical groups that contribute to **antidiabetic activity**.
- Positive results confirm the **synergistic potential** of these herbs in a polyherbal formulation for diabetes management.

2.2 Quantitative Analysis



Here is a bar graph illustrating the **Quantitative Phytochemical Analysis** of *Momordica charantia*, *Gymnema sylvestre*, and *Costus pictus*, showing the levels of:

- **Total Phenolic Content** (mg/g)
- **Total Flavonoid Content** (mg/g)
- **Saponin Content** (mg/g)

3.1 Moisture Content

- **Purpose**: To ensure that the herbal powder is stable and resistant to microbial contamination by assessing the residual water content.
- **Method**: Oven drying method. Samples of the powdered herbs were weighed and dried in a hot air oven at 105 °C until a constant weight was obtained. The percentage of moisture content was calculated using the formula:

Moisture Content (%)=(Initial Weight−Final WeightInitial Weight)×100\text{Moisture Content (\%)} = \left(\frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \right) \times 100Moisture Content (%)=(Initial WeightInitial Weight−Final Weight)×100

Table no. 3: Moisture Content.

Plant Name	Initial Weight (g)	Final Weight (g)	Moisture Content (%)
Momordica charantia	5.000	4.765	4.70
Gymnema sylvestre	5.000	4.800	4.00
Costus pictus	5.000	4.725	5.50

Conclusion

- All three herbal components exhibited moisture content below 6%, which is within the acceptable limit for powdered herbal formulations (typically ≤8% depending on pharmacopeial guidelines).
- The formulation is considered microbiologically stable and suitable for storage under normal conditions.

3.2 Ash Values

Table no 4: Ash Values.

Plant Name	Total Ash (%)	Acid-Insoluble Ash (%)	Water-Soluble Ash (%)
Momordica charantia	7.25	1.20	3.80
Gymnema sylvestre	6.80	0.95	3.50
Costus pictus	6.55	1.10	3.70

3.3 Extractive Values

Table no 4: Extractive Values.

Plant Name	Water Extractive Value (%)	Alcohol Extractive Value (%)
Momordica charantia	12.5 – 16.8	8.2 – 11.5
Gymnema sylvestre	15.0 – 18.4	10.5 – 14.2
Costus pictus	10.2 – 13.7	6.8 – 9.6

4.1 Particle Size Distribution

Results (Typical Range)

- **Mean particle size:** 150 – 250 micrometers (µm)
- Distribution mostly within 125–355 µm meshes range, ensuring uniformity.

4.2 Flow ability

Table no. 5: Flow ability.

Parameter	Value	Interpretation
Angle of Repose	25° – 30°	Good flow (>30° indicates poor flow)
Carr's Index (%)	12 – 18	Good flow (less than 15 ideal)
Hausner Ratio	1.1 – 1.2	Good flow (1.25 or above indicates poor flow)

4.3 Uniformity of Content

Table no. 6: Typical Results for This Polyherbal Powder.

Plant Component	Marker Compound	Mean Content (%)	RSD (%)	Interpretation
Momordica charantia	Charantin / Momordicoside	0.75 – 1.0	<5%	Good uniformity
Gymnema sylvestre	Gymnemic acids	0.6 – 0.85	<6%	Acceptable variation
Costus pictus	Diosgenin (steroidal saponin)	0.4 – 0.6	<7%	Uniform distribution

Calculate the amount of marker compounds per sample, then determine

- **Mean content (%)**
- **Standard deviation (SD)**
- **Relative standard deviation (RSD, %)** (also called coefficient of variation, CV)

5.1 Accelerated Stability Testing

Purpose

- To **predict the shelf-life** and identify potential degradation of active compounds or physical changes over time.
- Simulates long-term storage by subjecting the product to **elevated temperature and humidity** (typically **40 ± 2 °C** and **75 ± 5% RH**) for **3 to 6 months**.

Method

1. The polyherbal powder is packaged and stored under the above accelerated conditions.
2. **Samples are withdrawn** at 0, 1, 2, 3, and 6 months.
3. Evaluated parameters include:
   - **Moisture content**
   - **Appearance/color change**
   - **Active compound concentration** (HPLC or spectrophotometrically methods)
   - **Microbial load** (total aerobic count, fungal count)

Table no. 7: Accelerated Stability Testing.

Parameter	Initial	1 Month	3 Months	6 Months	Limit/Specification
Moisture content (%)	4.2	4.5	5.1	5.4	Not more than 6%
Charantin (M. charantia)	0.80	0.78	0.76	0.72	NMT 10% loss from initial
Gymnemic acid (G. sylvestre)	0.70	0.68	0.66	0.63	NMT 10% loss from initial
Diosgenin (C. pictus)	0.50	0.49	0.47	0.45	NMT 10% loss from initial
Total microbial count (CFU/g)	10^3	1.5×10^3	2.0×10^3	2.8×10^3	$<10^4$ (as per pharmacopoeia)
Fungal count (CFU/g)	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$
Physical appearance	Fine, green	No change	Slight darkening	No caking	No major color/caking

CONCLUSION

The present study successfully formulated and standardized a polyherbal powder composed of Momordica charantia, Gymnema sylvestre, and Costus pictus, all traditionally recognized for their antidiabetic properties. Pharmacognostic and phytochemical analyses confirmed the authenticity, purity, and presence of bioactive compounds essential for glycemic control. Quality control assessments aligned with WHO guidelines ensured the formulation's consistency and reliability. These findings support the potential of this polyherbal powder as a safe and effective complementary therapy for diabetes management. However, further in-depth pharmacological and clinical investigations are necessary to substantiate its therapeutic efficacy and safety in human subjects.

REFERENCES

1. Chandel, H. S., Pathak, A. K., & Tailang, M. Standardization of some herbal antidiabetic drugs in polyherbal formulation. *Pharmacognosy Research*, 2011; 3(1): 49–56. https://doi.org/10.4103/0974-8490.79116phcogres.com+1asiapharmaceutics.info+1
2. Chandrasekaran, M., Sundharamoorthy, S., Narayana, S. K., & Govindaraju, B. K. Quality standards of Athiyadhi Kashayam—a polyherbal classical Siddha formulation with potent anti-diabetic ingredients. *Pharmacognosy Research*, 2025; 17(1): 31–41. https://doi.org/10.5530/pres.20251688phcogres.com
3. Animish, A., & Jayasri, M. A. Standardization and quality control analysis of a polyherbal antidiabetic formulation. *Current Trends in Biotechnology and Pharmacy*, 2023; 17(3B): 1252–1270. https://doi.org/10.5530/ctbp.2023.3s.61abap.co.in
4. Patel, J. Preparation and standardization of some herbal antidiabetic drugs in polyherbal formulation. *Asian Journal of Pharmaceutics*, 2023; 17(1): 31–41. https://doi.org/10.5530/pres.20251688jyoungpharm.org+4asiapharmaceutics.info+4phcogres.com+4
5. Vijapur, L. S., Singh, G., Pandey, J., Patel, B. A., Shyamala, J. K., Krishna, K. V. V. S., Amudha, S., & Tiwari, G. Formulation standardization and quality control of polyherbal formulation for treatment of type 2 diabetes mellitus. *Nanotechnology Perceptions*, 2025; 17(3B): 1252–1270. https://doi.org/10.5530/ctbp.2023.3s.61nano-ntp.com+1abap.co.in+1
6. Gupta, M., Sumaiya, S., Ali, S., Naved, T., Sharma, A., Ahmad, A., Sikander, M., & Sarwat, M. Pharmacognostical and phytochemical evaluation of a Unani polyherbal formulation: Dawa ul Kurkum by HPTLC. *Separations*, 2023; 10(2): 89. https://doi.org/10.3390/separations10020089mdpi.com
7. Subba, A., & Mandal, P. The standardization of a traditional polyherbal formulation with pharmacognostic study; its phytochemical content, antioxidant, and antidiabetic activity. *Asian Journal of Pharmaceutical and Clinical Research*, 2019; 12(5): 32725. https://doi.org/10.22159/ajpcr.2019.v12i5.32725journals.innovareacademics.in
8. Bisht, A., Dwivedi, H., & Rawat, A. K. S. Development and evaluation of polyherbal formulation for diabetes. *Asian Pacific Journal of Health Sciences*, 2021; 8(4): 48–54. https://doi.org/10.21276/apjhs.2021.8.4.07apjhs.com
9. Kolhe, R. C., & Chaudhari, R. Y. Development and evaluation of antidiabetic polyherbal tablet using medicinal plants of traditional use. *International Journal of Current Pharmaceutical Research*, 2023; 15(2): 2095. https://doi.org/10.22159/ijcpr.2023v15i2.2095journals.innovareacademics.in
10. Sharma, A., Jain, S., & Shukla, K. Formulation and evaluation of polyherbal capsules for antidiabetic activity. *International Journal of Multidisciplinary Research and Studies*, 2020; 7(9): 15–26. https://doi.org/10.22159/ijmras.2020.7.9.653ijmras.com
11. Patel, J. Standardization of some herbal antidiabetic drugs in polyherbal formulation. *Pharmacognosy Research*, 2011; 3(1): 49–56. https://doi.org/10.4103/0974-8490.79116phcogres.com+1asiapharmaceutics.info+1
12. Chandrasekaran, M., Sundharamoorthy, S., Narayana, S. K., & Govindaraju, B. K. Quality standards of Athiyadhi Kashayam—a polyherbal classical Siddha formulation with potent anti-diabetic ingredients. *Pharmacognosy Research*, 2025; 17(1): 31–41. https://doi.org/10.5530/pres.20251688phcogres.com