Formulation and Evaluation of Antidiabetic Herbal Tablet

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***Abstract*—Diabetes mellitus is a rapidly escalating global metabolic disorder characterized by absolute or relative insulin deficiency, leading to chronic hyperglycemia. While synthetic antidiabetic agents effectively manage blood glucose, their long-term use is frequently limited by high financial cost, drug resistance, and systemic side effects. Consequently, herbal drug delivery systems utilizing biocompatible phytomedicines are gaining significant traction to optimize therapeutic efficacy and enhance patient compliance. Moringa oleifera represents a highly effective, multi-target botanical intervention for diabetes management. Standardizing its drying and processing protocols ensures a stable, nutrient-dense profile that mitigates synthetic side effects, presenting a viable foundation for advanced, sustained- release herbal drug formulations. Moringa oleifera leaves naturally contain exceptionally high concentrations of non-heme iron. In healthy individuals, this is a major nutritional benefit. However, in diabetic patients, excess iron accumulation can act as a catalyst for the Fenton Reaction, accelerating hydroxyl free radical production and exacerbating macrovascular tissue damage.**

***Index Terms*—Moringa oleifera, Diabetes Mellitus, Flavonoids, AGE-RAGE Axis, Herbal Drug Delivery, Phytomedicine.**

I. INTRODUCTION

Diabetes mellitus is a complex metabolic disorder characterized by elevated blood glucose levels resulting from defects in insulin secretion, insulin action, or both. It is one of the most prevalent chronic diseases worldwide and is associated with serious complications affecting the cardiovascular, renal, nervous, and visual systems. According to current medical classification, diabetes is broadly categorized into Type 1 Diabetes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM). Type 1 diabetes results from autoimmune destruction of pancreatic β-cells, leading to absolute insulin deficiency, whereas Type 2 diabetes is primarily associated with insulin resistance and progressive β-cell dysfunction.

The characteristic symptoms of diabetes include excessive thirst (polydipsia), frequent urination (polyuria), excessive hunger (polyphagia), fatigue, delayed wound healing, and blurred vision. Management of diabetes commonly involves insulin therapy, oral hypoglycemic agents, lifestyle modification, and dietary control. However, long-term treatment with synthetic drugs may lead to adverse effects, increased healthcare costs, and reduced patient adherence.

Herbal medicines have gained considerable attention as alternative therapeutic agents due to their natural origin, lower incidence of side effects, and potential for long-term use. Herbal drug delivery systems are designed to improve the bioavailability, stability, and therapeutic effectiveness of plant-derived bioactive compounds.

Moringa oleifera, commonly known as the drumstick tree, belongs to the family Moringaceae and is widely distributed in tropical and subtropical regions. The leaves of Moringa are rich in vitamins, minerals, flavonoids, phenolic compounds, and antioxidants. Several studies have demonstrated its antidiabetic, anti-inflammatory, antimicrobial, and antihyperlipidemic activities. Bioactive constituents such as quercetin and chlorogenic acid contribute significantly to glucose regulation by improving insulin sensitivity, reducing oxidative stress, and inhibiting hepatic glucose production.

The present study was undertaken to formulate and evaluate a herbal antidiabetic tablet containing Moringa oleifera leaf powder. The objective was to develop a stable and effective herbal dosage form with acceptable pharmaceutical properties and potential therapeutic benefits for diabetes management.

II. MATERIALS AND METHODS

A. Materials:

Moringa oleifra:

Fig No.1 – Moringa powder

Synonym: Moringa ptergosperma Guertin Guil Andina Moringa L.
Common Name: Drumstick Tree, Shevga
Species: Moringa oleifera
Family: Moringaceae.
Morphology: Moringa tree is medium sized evergreen tree. Moringa leaves are alternate 7-60cm long tripinnately compound with each pinnate bearing 4-6 leaflet that are dark green elliptical to obovate and 1-2 cm length.
Application:

- Antioxidant
- Antimicrobial
- Antidiabetic

Table No.1: Name of ingredients and their sources

Sr.no	Ingredients	Supplier
1	Moringa extract	Natu harvest Health U.P.
2	Talc	New Modern Chemicals Corporation, New Mumbai
3	Magnesium stearate	New Modern Chemicals Corporation, New Mumbai
4	Starch	K.R chemicals INDIA Nagpur.
5	Lactose	K.R chemicals INDIA Nagpur.

Table No.2: Name of equipment's used & its Model

Sr.no	Equipment's	Model
1	Hardness tester	Monsanto type
2	Friability tester	Single drum type
3	Disintegration tester	Digital programmable disintegration type
4	Weighing balance	Digital Electronic type

B. Methodology:

- The herbal antidiabetic tablets were prepared by the direct compression method.
- Accurately weighed quantities of Moringa oleifera powder and excipients were passed through sieve number 60 and blended uniformly using a mortar and pestle.
- The prepared powder blend was then compressed using a tablet compression machine to obtain tablets of uniform weight and size.
- Twelve different formulations were prepared by varying the concentration of excipients while maintaining a constant amount of Moringa oleifera powder.
- The prepared tablets were subsequently subjected to various quality control evaluations including weight variation, hardness, friability, and disintegration tests to identify the optimized formulation.

III. PREFORMULATION STUDIES:

Pre-formulation studies are the preliminary investigations carried out to evaluate the physical and chemical properties of the drug substance before formulation development. These studies help in selecting suitable excipients and ensure stability, efficacy, and manufacturability of the dosage form. In the present study, pre-formulation studies were performed on Moringa oleifera powder before preparation of herbal antidiabetic tablets.

1. Organoleptic Properties

Organoleptic evaluation was carried out by visual inspection and sensory observation.
Parameters Evaluated:

- Color
- Odor
- Appearance

2. Solubility Study

The solubility of Moringa oleifera powder was checked in different solvents to determine its dissolution behavior.
Procedure:

- Small quantity of powder was added separately into water and alcohol.
- The mixtures were shaken properly and observed for solubility.

The powder showed good solubility in both solvents.

3. Angle of Repose

Angle of repose was determined to evaluate the flow property of herbal powder.

Procedure:

- Powder was allowed to flow through a funnel to form a cone.
- Height (h) and radius (r) of the cone were measured.

Formula:

$$\theta = \tan^{-1}\left(\frac{h}{r}\right)$$

4. Bulk Density

Bulk density indicates packing ability of powder particles.

Formula:

$$\rho_b = \frac{m}{V}$$

5. Tapped Density

Tapped density was determined after mechanically tapping the measuring cylinder.

Formula:

$$\rho_t = \frac{m}{V}$$

6. Hausner's Ratio

Hausner's ratio helps determine compressibility and flow characteristics of powder.

Formula:

$$\text{Hausner Ratio} = \rho_t$$

7. Moisture Content

Moisture content was determined to evaluate stability and dryness of herbal powder.

Formula:

$$\frac{W - D}{W} \times 100$$

Where:

- W= Weight before drying
- D= Weight after drying

IV. FORMULATION

1. All ingredients were weighed accurately.
2. Ingredients were passed through sieve no. 60.
3. Moringa powder and excipients were mixed uniformly using mortar and pestle.
4. Powder blend was compressed by direct compression method using tablet punching machine.
5. Tablets were collected and evaluated for quality parameters.

For the formulation of diabetic tablet from extraction moringa oleifera powder firstly all the ingredients were weighed and then passes through the sieve no. #60 and properly mixed in mortar pestle. And prepared their batches (i.e. 12 batches) finally to make moringa tablet with the help of direct compression machine.

Table no.3: Formulation table

Batch	Moringa extract (mg)	Starch (mg)	Talc (mg)	Mg. stearate(mg)	Lactose (Mg)
A	60	45	5.1	3	86.9
B	60	25.5	9	1.5	104
C	60	45	9	2.25	83.75
D	60	6	5.1	1.5	127.4
E	60	25.5	1.2	3	110.3
F	60	45	1.2	2.25	91.55
G	60	45	5.1	1.5	88.4
H	60	25.5	1.2	1.5	111.8
I	60	6	5.1	3	125.9
J	60	6	1.2	2.25	130.55
K	60	25.5	9	3	102.5
L	60	6	9	2.25	122.75

V. EVALUATION OF HERBAL ANTIDIABETIC TABLETS

Evaluation tests were carried out to determine the quality, stability, and performance of the formulated herbal tablets. The prepared tablets were evaluated for weight variation, hardness, friability, and disintegration time according to standard pharmacopeial procedures.

1. Weight Variation Test Purpose:

To ensure uniformity of tablet weight and proper distribution of active ingredient.

Procedure:

- Select 20 tablets randomly.
- Weigh each tablet individually.
- Calculate average weight.
- Determine percentage deviation.

2. Hardness Test Purpose:

To determine the mechanical strength of tablets and resistance to handling.

Procedure:

- Tablet is placed between anvils of Monsanto hardness tester.
- Force required to break the tablet is measured.

Unit:

kg/cm²

Acceptable Range:

Generally 3–5 kg/cm² for conventional tablets.

3. Friability Test

Purpose:

To evaluate resistance of tablets to abrasion and mechanical shock.

Procedure:

- Weigh 10 tablets initially.
- Place in Roche friabilator.
- Rotate at 25 rpm for 4 minutes.
- Reweigh tablets after dedusting.

Formula:

$$\% \, Friability = \frac{W_i - W_f}{W_i} \times 100$$

Where:

- W_i= Initial weight
- Wf= Final weight

Acceptable Limit: Less than 1%

4. Disintegration Test Purpose:

To determine the time required for tablets to break down into smaller particles.

Procedure:

- Tablets are placed in disintegration apparatus.
- Medium maintained at 37 ± 0.5°C.
- Time required for complete disintegration is recorded.

Standard Limit:

Immediate release tablets should disintegrate within 15 minutes.

VI. RESULT AND DISCUSSION

A. Pre-formulation Studies:

1. Organoleptic Property

Sr. No	Specification	Observation
1	Color	Green
2	Odor	Aromatic

2. Solubility Test

Sr. No	Solvent	Specification	Observation
1	Alcohol	Soluble	Pass
2	Water	Soluble	Pass

3. Flow Properties

a) Angle of repose:

Sr. No	Specification	Observation	Flow of powder
1	30-40	pass	Good Flow

Formula:

$$\Theta = \tan^{-1} (h/r)$$

$\text{Tan}\ \Theta = 2.3/3.1$ $\Theta = \text{Tan}^{-1}(0.741)$ $\Theta = 36.4$

b) Bulk Density

Sr. no.	Specification	Observation	Flow of powder
1	0.30 -0.55	pass	Good Flow

Formula: bulk density =mass/ volume

Bd = m/v

= 10/19

= 0.526 gm/ml

c) Tapped density:

Sr.no	Specification	Observation	Flow of powder
1	0.40 -0.65	pass	Good Flow

Formula: tapped density = mass/ tapped vol.

Td = m/v

= 10/14

= 0.714 gm/ml

d) Hausner's Ratio

Sr.no	Specification	Observation	Flow of powder
1	1.00 - 1.11	Pass	Excellent flow

Hausner Ratio = Tapped Density / Bulk Density
= 0.714/0.526
= 1.357

e) Carr's index:

Sr no.	Specification	Observation	Flow of powder
1	14.26% - 19.33%	26.3%	Poor flow

Carr's Index= TD-BD/TD × 100
= 0.714-0.526/0714 × 100
= 0.188/0714× 100
= 0.263 × 100
= 26.3%

f) Moisture Content Given Data: Empty dish= 28.72mg
Dish and drug= 38.73mg
%MC = W-D/W × 100
= 38.73-38.38/38.73 .100
%MC = 0.903 %

B. Evaluation parameter:

1. Weight Variation Test:

This test is done for ensuring good manufacturing practice and appropriate size of tablet.

Table no.4: Weight Variation Test:

Batch no.	Actual weight (mg)	Max. % deviation	Observation
A	336	13.69	Fail
B	329	6.38	Pass
C	304	5.26	Pass
D	304	5.26	Pass
E	328	12.80	Fail
F	301	-10.29	Fail
G	300	6.66	Pass
H	285	-12.3	Fail
I	323	-16.4	Fail
J	298	7.38	Pass
K	320	-18.75	Fail
L	292	9.58	Pass

Weight variation = (Iw-Aw)/Aw × 100

2. Hardness test:

Table no. 5: Hardness testing of herbal tablet:

Batch no.	Hardness (kg/cm)	Observation
A	5	Pass
B	5	Pass
C	4.8	pass
D	4.6	pass
E	5	pass
F	4	pass
G	5	Pass
H	4.6	pass
I	4	Pass
J	3	fail
K	3.8	fail
L	3.2	fail

3. Friability test:

This test is performed for measurement of physical strength of tablet. The friability of tablets was measured in Roche friabi

Table no. 6: friability test of herbal tablet:

Batch no.	% friability	Observation
A	5.5%	Fail
B	1%	pass
C	2.1%	fail
D	1.06%	pass
E	4%	fail
F	0%	pass
G	3.1%	fail
H	0%	pass
I	3.8%	fail
J	8.6%	fail
K	6%	fail
L	4.5%	Fail

4. Disintegration test:

The disintegration test for tablets helps to ensure that they break down properly in the body. allowing the active ingredients to be absorbed effectively. It's crucial for assessing the tablet's quality efficacy and safety.

Table no. 7: Disintegration test of herbal tablet:

Batch no.	Disintegration time (min)	Observation
A	18	Fail
B	12	Pass
C	15	Pass
D	15	Pass
E	17	Fail
F	8	pass
G	9	pass
H	10	Pass
I	18	Fail
J	17	Fail
K	17	Fail
L	18	fail

VII. CONCLUSION

The present investigation successfully formulated and evaluated herbal antidiabetic tablets using Moringa oleifera leaf powder as the active ingredient. Pre-formulation studies demonstrated acceptable physicochemical characteristics of the herbal powder, supporting its suitability for tablet formulation. Various batches were prepared using different concentrations of pharmaceutical excipients and evaluated for weight variation, hardness, friability, and disintegration time.

Among all formulations, Batch F exhibited the most desirable pharmaceutical properties, including satisfactory hardness, low friability, acceptable weight variation, and rapid disintegration. These findings indicate that the selected formulation possesses adequate mechanical strength and performance characteristics required for oral tablet dosage forms.

The therapeutic potential of the formulation may be attributed to the presence of bioactive phytochemicals such as flavonoids, phenolic compounds, alkaloids, quercetin, and chlorogenic acid. These constituents are known to exert antidiabetic effects through antioxidant activity, enhancement of insulin sensitivity, inhibition of carbohydrate-digesting enzymes, and regulation of glucose metabolism.

Overall, the formulated Moringa oleifera herbal tablet represents a promising, economical, and plant-based approach for diabetes management. Nevertheless, further in vivo studies, toxicity assessments, and clinical trials are necessary to confirm its efficacy, safety, and therapeutic applicability in human subjects

REFERENCES

[1] Vijay, K., & Sriram, S. (2010). Antioxidant activity of seed extracts of Annona reticulata and Carica papaya. Nutrition & Food Science, 40(4), 403–408.

[2] Alali, F. Q., Liu, X. X., & McLaughlin, J. L. (1999). Annonaceous acetogenins: Recent progress. Journal of Natural Products, 62(3), 504–540.

[3] Kalidindi, N., Thimmaiah, N. V., Jagadeesh, N. V., Nandeep, R., Swetha, S., & Kalidindi, B. (2015). Antifungal and antioxidant activities of organic and aqueous extracts of Annona squamosa Linn. leaves. Journal of Food and Drug Analysis, 23(4), 795–802.

[4] Singh, Y., Bhatnagar, P., & Thakur, N. (2019). A review on insight of immense nutraceutical and medicinal potential of custard apple (Annona squamosa Linn.). International Journal of Chemical Studies, 7(2), 1237–1245.

[5] Mazahery, A. R. F., Dator, R. P., Concepcion, G. P., & Jacinto, S. D. (2009). Murihexocin C from the leaves of Annona squamosa Linn. induces apoptosis in human colon carcinoma Col 2 cell line. Philippine Agricultural Scientist, 92(2), 122–132.

[6] Ramachandran, C., Peter, K. V., & Gopalakrishnan, P. K. (1980). Drumstick (Moringa oleifera): A multi-purpose Indian vegetable. Economic Botany, 34(3), 276–283.

[7] Adedapo, A. A., Mogbojuri, O. M., & Emikpe, B. O. (2009). Safety evaluations of the aqueous extract of leaves of Moringa oleifera in rats. Journal of Medicinal Plants Research, 3(8), 586–591.

[8] Faizi, S., Siddiqui, B., Saleem, R., Siddiqui, S., & Aftab, K. (1994). Isolation and structure elucidation of new nitrile and mustard oil glycosides from Moringa oleifera and their effect on blood pressure. Journal of Natural Products, 57(9), 1256–1261.

[9] Dillard, C. J., & German, J. B. (2000). Phytochemicals, nutraceuticals and human health: A review. Journal of the Science of Food and Agriculture, 80(12), 1744–1756.

[10] Abdulkarim, S. M., Long, K., Lai, O. M., Muhammad, S. K. S., & Ghazali, H. M. (2005). Some physico-chemical properties of Moringa oleifera seed oil extracted using solvent and aqueous enzymatic methods. Food Chemistry, 93(2), 253–263.

[11] Xu, Y. B., Chen, G. L., & Guo, M. Q. (2019). Antioxidant and anti-inflammatory activities of the crude extracts of Moringa oleifera from Kenya and their correlations with flavonoids. Antioxidants, 8(8), 296.

[12] Panche, A. N., Diwan, A. D., & Chandra, S. R. (2016). Flavonoids: An overview. Journal of Nutritional Science, 5, e47.

[13] Nguyen, T. P., Tran, C. L., Vuong, C. H., Do, T. H., Le, T. D., Mai, D. T., et al. (2017). Flavonoids with hepatoprotective activity from the leaves of Cleome viscosa L. Natural Product

Research, 31(22), 2587–2592.
[14] Rajesh, A., & Yadav, N. (2011). Pharmaceutical processing – A review on wet granulation technology. International Journal of Pharmaceutical Frontier Research, 1(1), 65–83.
[15] Boerefijn, R., & Hounslow, M. J. (2005). Studies of fluid bed granulation in an industrial R&D context. Chemical Engineering Science, 60(14), 3879–3890.
[16] Monica, G. M. (2005). Miracle Tree. Houston: KOS Health Publications.
[17] Singh, S., Mishra, S. P., Singh, P., Prasad, R. S., & Das, R. (2012). Potential and Prospects of Moringa oleifera Lam. (Sahjan) (Report No. IFP/2012/01). Ranchi: Institute of Forest Productivity.
[18] Mishra, S. P., Singh, P., & Singh, S. (2011). Nutritional and medicinal value of Moringa oleifera leaves: Potential and prospects. Forestry Bulletin, 11(1), 46–58.
[19] Duke, J. A. (1987). Moringaceae: Horseradish-tree, benzolive-tree, drumstick-tree, sohnja, Moringa, murunga-kai, malunggay. In M. Benge (Ed.), Moringa: A Multipurpose Vegetable and Tree That Purifies Water (pp. 19–28). Washington, D.C.: US AID.
[20] Fuglie, L. J. (1999). The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. Dakar: Church World Service.