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Research Article

Development of a Bio-Enhanced Herbal Antidiabetic Tablet Using *Gymnema sylvestre*

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ABSTRACT

The present study focuses on the formulation and evaluation of herbal tablets containing Gymnema sylvestre, a medicinal plant known for its antidiabetic and hypoglycemic properties. The objective was to develop a stable, effective oral dosage form using the dried leaf powder of Gymnema sylvestre and to evaluate its physicochemical properties and dissolution profile. Tablets were prepared by direct compression using various excipients including microcrystalline cellulose, lactose, calcium carbonate, stearic acid, and magnesium stearate. Three different batches were formulated and evaluated for pre-compression parameters such as bulk density, tapped density, Carr's index, Hausner's ratio, and angle of repose, which indicated good flow properties. Post-compression studies included weight variation, hardness, friability, disintegration time, wetting time, and dissolution testing. Batch 3, Higher concentration of Gymnema sylvestre, showed superior mechanical strength, better dissolution rate, and improved tablet characteristics. A UV spectrophotometric method was also developed. The study successfully demonstrates the potential of Gymnema sylvestre as a natural therapeutic agent in tablet form and provides a basis for future development of standardized herbal formulations.

INTRODUCTION

Herbal medicine have attracted lot of interest in several years. Because of their natural origin, less side effect and ability to effectively treat chronic illness. One of the most thoroughly researched and traditionally used herbs in ayurvedic is *Gymnema sylvestre* which is well known for its diabetes mellitus[1,16]. It commonly known as "Gudmar" or "suger destroyer" which contain gymnemic acid, glycoside, saponin, terpenoids which show the various activity such as hypoglycemic, antioxidant, anti-inflammatory[13,14,15].

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The gymnemic acid useful in diabetes by various mechanism such as increase insulin production by suppress taste of sweetness and encouraging the regeneration of pancreatic beta cells, inhibits glucose absorption from intestinal, decrease peripheral insulin resistance, increase glucose absorption into cell and prevent insulin activation by acting on liver cell. *Gymnema sylvestre* extract are standardized for their gymnemic acid concentration which ranges from 25-75% depend upon extract gymnemic acid content daily therapeutic dose 300-700mg.

Diabetes is metabolic disorder which caused by insufficient and inadequate insulin production[5]. There three type of diabetes mellitus such as type1 diabetes caused due to body failure produce insulin and require person to insulin inject, type 2 diabetes is insulin resistance in that condition cells fails to use insulin properly and gestational diabetes is when pregnant women never diabetes before increase blood glucose level during the pregnancy. The diabetes mellitus affect millions people worldwide[6,7,12]. The treatment of diabetes is long term making herbal medicine are safer and alternative option. *Gymnema Sylvestre* play vital role in suppressing taste of sweetness, enhancing insulin production and promoting pancreatic beta cells[4,9,10,11].

Gymnema sylvestre has therapeutic benefits by using powdered or raw form. Therefore, the formulation of the *Gymnema sylvestre* into tablet is most effective and safe medication. Due to their controlled release capabilities, prolong shelf life, accurate dosing and easy to administration tablet formulation are preferred.

This research aim is to development of a Bio-Enhanced Herbal Antidiabetic Tablet Using *Gymnema sylvestre* by direct compression method. By adjusting the excipients and evaluating pre and post compression parameter the formulation was optimized. Additionally uv spectroscopic method was develop to quantify the cumulative drug release and active constituents. This study provide a groundwork for creating herbal antidiabetic tablet which both patient friendly and clinically proven.

MATERIAL AND METHOD

Materials

Gymnema Sylvestre leaves where collected from local area dried powdered, and used as antidiabetic, antioxidant and anti-inflammatory. The excipients used in the formulation are stearic acid is used as lubricant, microcrystalline cellulose is used as binder, calcium carbonate is used as anticaking, lactose is used as filler, magnesium stearate is used as glidant and gives peasant appearance to the tablet[17,18,19,20].

Figure no 1: *Gymnema sylvestre*

Methods

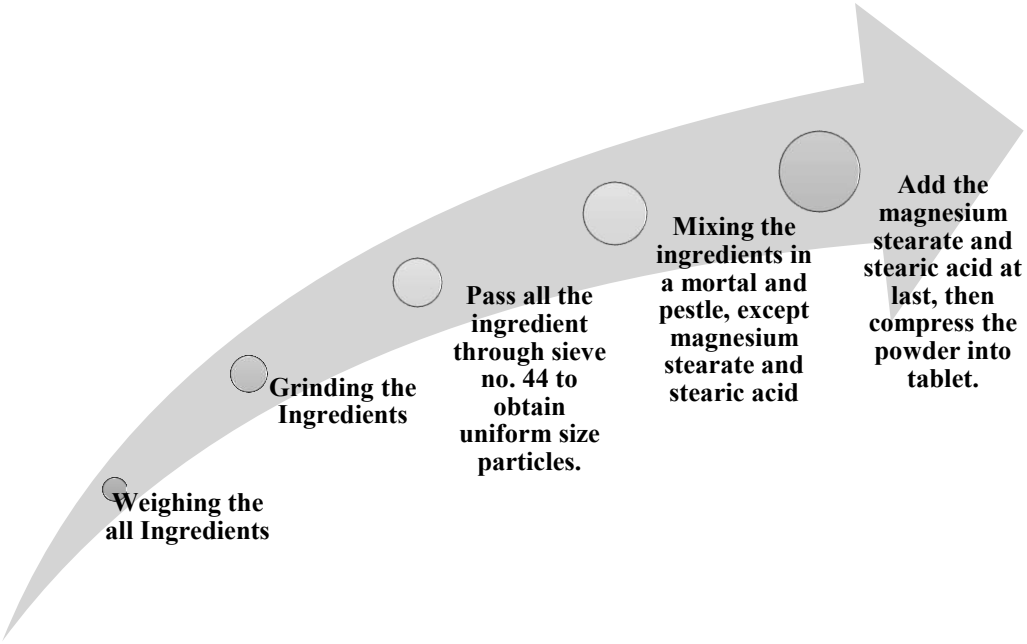
Preparation of dry powder of *Gymnema Sylvestre*

Collection of fresh leaves of *Gymnema Sylvestre* from the local area. wash the leaves by using water(distilled). Dry leaves at room tempreture for some days. The hot air oven or autoclave is used for complete dry of leaves. Then grind the leaves in mixer to make fine powder.

Preparation of 20 mM dibasic sodium phosphate buffer

Take 1000ml distilled water in a beaker. Take 3.58 g of dibasic sodium phosphate powder in 1000ml distilled water. Stir properly to mix well and adjust pH to desired value (6.8-7.4) using HCL or NACL.

PROCEDURE



FORMULATION OF TABLET

The *Gymnema sylvestre* dired powder leaves is were utilized in the formulation to make a tablet dosage form. With the help of direct compression to crate the *Gymnema sylvestre* tablet [22,23,28,29].

Table no 1: composition of formulation ingredients for herbal antidiabetic tablets (400mg)

Sr no	Ingredients (mg/tablet)	Batch 1	Batch 2	Batch 3
1	*Gymnema Sylvestre*	150	150	210
2	Stearic acid	05	05	04
3	Microcrystalline cellulose	150	150	100
4	Calcium carbonate	45	50	50
5	lactose	50	40	30
6	Magnesium stearate	-	05	05

The composition of Batch 1, which includes fine *Gymnema Sylvestre* particles, could not be compressed into tablets due to excessive sticking to the dies and punches.

The composition of Batch 2, containing gymnema particles within the desired size range, was easily compressible, but The tablet formulation exhibited an absorbance peak at 202 nm, which is marginally lower than the reference peak of 210 nm for *Gymnema sylvestre*. which may suggest issues with the bioavailability or solubility of the active ingredient.

The composition of Batch 3, Increase the quantity and reduce particle size of *Gymnema Sylvestre* powder to increase the surface area and dissolution rate

EVALUATION

Preformulation studies

1.Particle size

The average weight of tablet is affected their size. The technique used for identification of particle size is sieving (no 44)

2.Angle of repose

The angle of repose was determined by the funnel method. Firstly carefully weighed the mixture was drawn in to funnel. Using the funnel, the drug excipient combination was allowed to freely flow to the top. Adjust the height of the funnel such that the tip of funnel just reaches the peak of heap or mix head[3]. With help of following formula to measured the angle of repose after measuring powder cone diameter:

Tan θ = h/r
Where, h = height in (cm)
r = radius in (cm)

3.Bulk density (BD)

The bulk density is defined as the mass of the powder material to the volume of porous powder. In 100ml measuring cylinder weigh accurately 25g of powder which is sieved through #44. Then calculate bulk density in gm/ml formula is given below.

BD =M/V0
i.e Bulk density = Mass of powder / volume of powder

4.Tapped density (TD)

It is the ratio of the powder's total mass to its tapped volume. Weigh exactly 25 g of granules sieved with a 44# sieve and transferred to a 100 ml graduated cylinder of a tap density tester that had been run for a certain number of taps until the powder bed volume reached a minimum, as predicted by formula.

TD = (M) / (Vt)
Tapped density = Weigh of powder / Tapped volume
M = mass of the powder; Vt = tapped volume of the powder.

5.Carr's Index (Carr's Compressibility Index)

It is a simple test to evaluate the bulk density and tapped density of a powder and the rate at which it was packed down. The formula for Carr's index is as below:

100 × (Tapped density - Bulk density)/ Tapped density

6.Hausner's Ratio

Hausner's Ratio is a TD to the BD
Hausner's Ratio = Tapped Density/ BulkDensity

Physical evaluation of tablets

1.General appearance

The formulated tablets were assessed for its general appearance and observations were made for shape, colour, texture and odour

2.Weight Variation test

Twenty pills were chosen and weighed independently and collectively in a weight variation test. The aggregate weight was used to calculate the average weight. The average weight of each pill was then compared to check if it was within permissible limits.

Average weight = weight of 20 tablets/20

%weight variation = average weight - weight of each tablet/ Average weight×100

3.Thickness

A Vernier Calliper was used to measure the thickness of the tablets.

4. Hardness test

There various hardness tester available in market we used monsanto hardness tester was used to measure the hardness of the tablet. Placing the bottom plunger against the tablet resulted in a zero reading. When the spring is squeezed, a pointer in the barrel travels along with a gauge, indicating the force[30].

5. Friability test

Roche friability used for measure the tolerate abrasion during handling, packaging, and transporation. Then filled tablet in friabiltor, which are weighed and rotated at 25 rpm for 4 min. It should be in the range of 0.5 to 1.0 percent[2].

Friability as a percentage = [(B-A)/B] 100
Where,

B is the weight of the tablets before the test, A is the weight of the tablets after the test.

6.Disintegration test

The 900 ml of 20 mM dibasic sodium phosphate buffer was the disintegration medium and the time to disintegrate completely was noted. Six tablets were put in the pipe, raising and lowering the tube in such a way that 28 to 32 per minute repeated the full up and down motion. If there are no particles above the gage that pass through the mesh easily, then the tablets disintegrate

7.Wetting Time

Take five circular tissue paper which has 10 cm diameter. Then placed into petridish. Take 10 ml water to add in petridish. Tablet placed on surface of tissue paper. Note the time required to reach the upper surface of the tablet.

8.Dissolution profile (IP method)

Dissolution testing for the amount of gymnema was studied using the following dissolution parameters:

Dissolution parameters
Apparatus: type II USP, paddle
Speed: 50 rpm
Dissolution medium: pH 6.8 phosphate buffer
Sampling time point: 2, 5, 10, 15 and 30 min

Temperature: 37± 0.5oC.

One tablet was transferred to each vessel containing 900 ml of dissolution medium. 10 ml sample was withdrawn at each time interval and filtered through 10 micron filter. Then 5 ml of withdrawn sample was diluted up to 10 ml with dissolution medium released was calculated by estimating drug in dissolution medium using UV spectrophotometer.

RESULT AND DISCUSSION

1.Analysis of phytoconstituents

In table 4 which show the both Molisch's and fehling's test indicate the presence of gymnemic acid and glycone part of the glycoside in *Gymnema sylvestre*. The lead acetate test contains the flavonoid compound such as kaempferol which are used in the anti-inflammatory and antioxidant activity. Saponin test indicate the positive froth test confirm the saponin in the *Gymnema sylvestre*. Terpenoids test shows the presence of gymnemagenin in the extract[21,24,25,26,27,31,32]

Table no 2: Analysis of phytoconstituents

Sr no	Phytochemical Class	Test Name	Observation	Inference
1	Glycosides	Molisch's Test	Brownish-red ring at junction	Indicates presence of glycosides (e.g., gymnemic acids)
		Fehling's Test	Brick-red precipitate	Indicates presence of reducing sugars (glycone part of glycosides)
2	Flavonoids	Lead Acetate Test	Yellow precipitate	Indicates presence of flavonoids (e.g., kaempferol)
3	Saponins	Froth Test	Persistent froth formation	Indicates presence of saponins
4	Terpenoids	Salkowski Test	Pink coloration	Indicates presence of terpenoids (e.g., gymnemagenin)

Figure no 2: Analysis of phytoconstituents

2. Preformulation parameter for herbal tablet

In table 5 which shows the precompression properties in that batch 3 show the best flow property instead of other two batch. In that batch the lowest carr's index shows the best compressibility, lowest Hausner ratio shows the excellent flow and good angle of repose (26.7°) which is acceptable flow[33].

Table no 3: Preformulation parameters for herbal tablets

Sr no	Pre-formulation parameters	Batch 1	Batch2	Batch 3
1	Bulk density (gm/ml)	0.48	0.50	0.50
2	Tapped density (gm/ml)	0.57	0.56	0.54
3	Carr's index (%)	15.78	10.71	7.41
4	Hausner's ratio	1.18	1.12	1.08
5	Angle of repose	36.30	25.92	26.70

Table no 4: Physical parameter for herbal tablets

Sr no	General appearance	Batch 2	Batch 3
1	Colour	Greenish gray	Light green
2	Shape	Round	Round
3	Odour	Characteristic	Characteristic
4	Surface	Rough	Smooth

Figure no 3: Batch 2

Figure no 4: Batch 3

3. Post formulation parameter

In table 7 shows the post formulation parameter which assess the tablet quality, safety, durability, and after compression performance. Batch 3 shows favorable result reason is that consistent weight, mechanically more strong, better wetting time[34,35].

Table no 5: Postformulation– Tablet Evaluation Tests

Sr no	Postformulation parameter	Batch 2	Batch 3
1	Average weight(mg)	400	400
2	Hardness (kg/cm2)	6.51	7.3
3	Friability test (%)	1.25	0.7
4	Disintegration test (min)	6.12	14.44
5	Wetting Time (min)	5.43	10.49

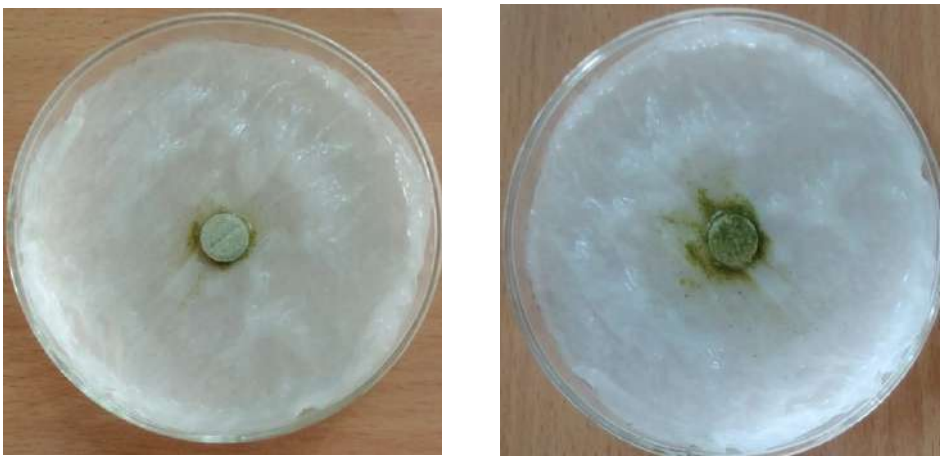


Figure no 5: wetting time of batch 3

4. Dissolution profile

The in vitro drug release profile data which shows the by 15 min more than 50% drug is release which indicate fast initial release this helpful for fast acting. At 30 min 100% drug released which show the complete and efficient dissolution. The wavelength range from 190 nm to 210 nm which are typical uv absorbance for phytoconstituent like gymnemic acid[8,36,37]

Table no 6: % dissolution profile of gymnema tablet

Sr no	Time (min)	Absorbance	Wavelength (nm)	Drug Released (mg)	% Cumulative Drug Release
1	2	0.071	190	2.62	7.28%
2	5	0.146	195	5.36	14.89%
3	10	0.231	200	8.48	23.56%
4	15	0.561	205	20.59	57.19%
5	20	0.739	207	27.11	75.31%
6	30	0.981	210	36.00	100.00%

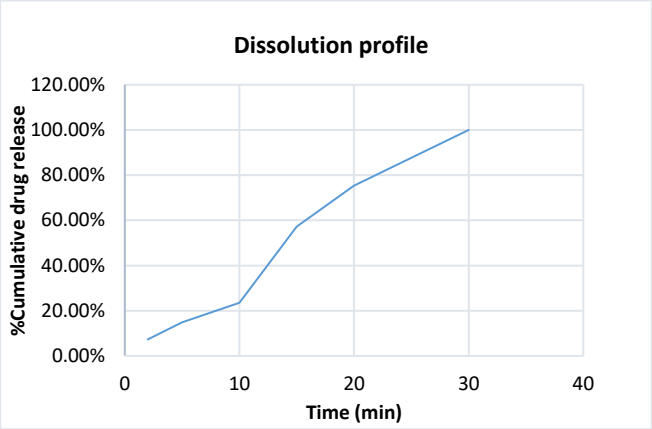


Figure no 6: % dissolution profile of gymnema tablet

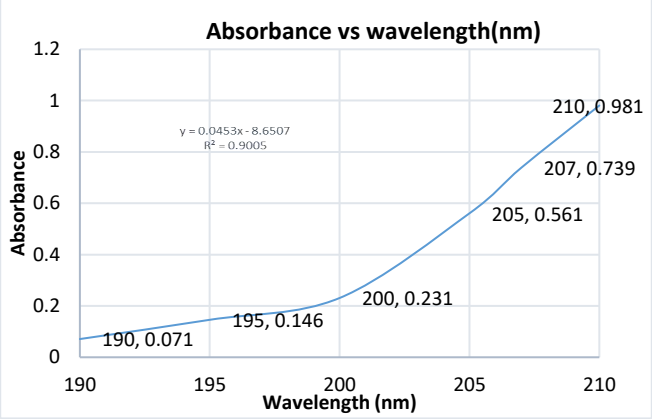


Figure no 7: Absorbance vs wavelength(nm)

CONCLUSION

The present study successfully demonstrated the formulation and evaluation of *Gymnema sylvestre* herbal tablets using the direct compression method. Among the three formulations prepared, Batch 3 showed the most favorable results in terms of flow properties, mechanical strength, disintegration, and dissolution characteristics. The increase quantity and reduction in particle size of *Gymnema sylvestre* powder significantly improved the tablet's performance.

Preformulation and postformulation evaluations confirmed the suitability of the selected excipients and manufacturing method. Additionally, the UV spectroscopic method provided accurate quantification of the active constituents, ensuring standardization of the formulation.

Overall, the developed herbal tablets of *Gymnema sylvestre* exhibited good quality, stability, and potential antidiabetic efficacy. This study provides a strong foundation for further development and clinical evaluation of standardized herbal dosage forms for the management of diabetes**.**

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

ETHICS APPROVAL

Not applicable.

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