IJBPAS, March, Special Issue, 2025, 14(3): 179-192
ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)
'A Bridge Between Laboratory and Reader'
www.ijbpas.com

FORMULATION, EVALUATION, AND ANTIDIABETIC ACTIVITY OF A POLYHERBAL CAPSULE: A SYNERGISTIC APPROACH FOR DIABETES MANAGEMENT

SUPRIYA S, NEELESH M* AND SONI PK

School of Pharmacy, Sangam University, Bhilwara, Rajasthan-311001

*Corresponding Author: Dr. Neelesh Maheshwari; E Mail: neelesh.maheshwari@sangamuniversity.ac.in

Received 15th Dec. 2024; Revised 20th Dec. 2024; Accepted 9th Jan. 2025; Available online 15th March 2025

https://doi.org/10.31032/IJBPAS/2025/14.3.1018

ABSTRACT

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia, oxidative stress, and insulin resistance. Although synthetic oral antidiabetic drugs are widely used, their toxicological profiles necessitate the exploration of safer, more effective alternatives. This study investigates the formulation, evaluation, and antidiabetic efficacy of a polyherbal capsule derived from ethanolic extracts of *A. obesum* , *C. glandulosum*, and *S. sativa*. The polyherbal formulation (PHF) was developed by combining these extracts in a 1:1:1 ratio, leveraging their phytochemical constituents for synergistic action. Granules prepared for encapsulation were subjected to preformulation studies, including particle size analysis, bulk density, Carr's index, and angle of repose, confirming good flow properties. FTIR analysis ensured compatibility among ingredients, while dissolution studies demonstrated significant drug release, with PHF1 exhibiting superior performance (94.13% drug release at 30 minutes). Capsules were evaluated for weight uniformity, disintegration time, and stability under varying conditions of light, temperature, and humidity, indicating robustness and compliance with quality standards. In vitro antidiabetic activity was assessed through α-amylase and α-glucosidase inhibition assays, with the polyherbal formulation showing IC50 values of 58.81 µg/ml and 64.81 µg/ml, respectively. Additionally, the antioxidant potential of the polyherbal extracts, attributed to phenolic and flavonoid content, may contribute to their therapeutic efficacy by mitigating oxidative stress. Toxicity studies revealed no adverse effects up to 2000 mg/kg, supporting the formulation's safety. The polyherbal capsule offers a promising alternative for diabetes management, acting through multiple mechanisms, including enzyme inhibition, oxidative stress reduction, and improved glucose metabolism. This study

underscores the potential of herbal combinations in addressing the limitations of single-drug therapies while enhancing therapeutic outcomes.

Keywords: ***A. obesum*** **,** ***C. glandulosum*****,** ***S. sativa,*** **Diabetes mellitus, Hyperglycemia, Polyherbal capsule**

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, action, or both. It is a global health challenge, with its prevalence steadily increasing due to sedentary lifestyles, unhealthy dietary habits, and genetic predisposition. Uncontrolled diabetes leads to serious complications such as cardiovascular diseases, nephropathy, neuropathy, and retinopathy, significantly affecting the quality of life and imposing a heavy burden on healthcare systems **[1-3]**.

Conventional oral hypoglycemic agents, including sulfonylureas, biguanides, and α-glucosidase inhibitors, are commonly used to manage diabetes. However, their prolonged use is associated with adverse effects such as hypoglycemia, gastrointestinal disturbances, and hepatic or renal toxicity. These limitations highlight the need for safer, more effective alternatives to existing therapeutic regimens **[4]**.

The use of medicinal plants in diabetes management has gained significant attention due to their minimal side effects, affordability, and rich phytochemical content. Polyherbal formulations, which combine multiple plant extracts, have shown promise in improving therapeutic efficacy through synergistic action. Such formulations target various pathways involved in diabetes pathogenesis, including inhibition of carbohydrate-digesting enzymes, enhancement of insulin sensitivity, and mitigation of oxidative stress **[1, 5]**.

This study focuses on the development and evaluation of a polyherbal capsule formulated from ethanolic extracts of *A. obesum* , *C. glandulosum*, and *S. sativa*. These plants are traditionally known for their antidiabetic, antioxidant, and anti-inflammatory properties. The combination of their bioactive compounds is hypothesized to offer a multifaceted approach to managing diabetes while addressing the limitations of single-plant therapies.

The research involves preformulation studies to ensure the physical and chemical stability of the polyherbal granules, encapsulation to enhance patient compliance, and in vitro evaluations to determine antidiabetic and antioxidant activities. The study also assesses the safety

of the formulation through toxicity studies and its stability under various storage conditions. The findings aim to provide scientific validation for the use of this polyherbal capsule as a safe, effective, and sustainable alternative for diabetes management.

MATERIALS AND METHODS

Plant Materials

The leaves of *Adenium obesum*, *Croton glandulosum*, and *Senna sativa* were collected from local regions and authenticated by a taxonomist. Voucher specimens of each plant were deposited in the herbarium for reference. The collected leaves were washed, shade-dried, and powdered using a mechanical grinder.

Preparation of Plant Extracts

The powdered plant materials were subjected to maceration using ethanol (70% v/v) as the solvent. The extraction was carried out for 72 hours at room temperature with intermittent shaking. The extracts were filtered through Whatman No. 1 filter paper and concentrated under reduced pressure using a rotary evaporator. The concentrated extracts were stored in airtight containers at 4°C until further use.

Formulation of Polyherbal Granules

The polyherbal granules were formulated utilizing the wet granulation technique. This process involved combining four herbal extracts in equimolar proportions and subsequently blending them with excipients according to the specified ratios detailed in **Table 1**.

Table 1: Formulation of Polyherbal granules by wet granulation method

Ingredients	PHF1	PHF2	PHF3	PHF4	PHF5	PHF6
A. obesum	60	60	60	60	60	60
C. glandulosum	60	60	60	60	60	60
S. sativa	60	60	60	60	60	60
Lactose/Mannitol	295	285	275	265	255	245
Pregelatinised Starch	0	10	20	30	40	50
Talc	20	20	20	20	20	20
Sodium benzoate	5	5	5	5	5	5
Total (mg)	500	500	500	500	500	500

Pre-formulation study

The preformulation study include evaluation of different parameters like tap and bulk density, Carr's index, Hausner's ratio, angle of repose for determining flow properties and size of polyherbal granules.

Bulk Density

It was determined by putting 100 g of polyherbal granules in a measuring cylinder (graduated) of 100 ml and its volume was measured. Formula for bulk density is as follow:

Bulk Density = Mass of the granules/Volume of granules

Tap Density

For measuring the tap density the graduated measuring cylinder containing 100 g of polyherbal granules were tapped and the

new volume so obtained is measured and used to calculate the tapped density using following equation:

Tapped Density: mass of the granules/ volume of tapped granules

Hausner's Ratio

Hausner's ratio was estimated using the following equation:

Hausner's ratio = Tapped density/ bulk density

Compressibility index

It was calculated using following equation

Compressibility index = tapped density-bulk density/tapped density X100

Angle of repose

To evaluate the flow properties of the polyherbal granules, the angle of repose was determined. In this method passed the granules through funnel fit on the tripod stand and formed a pile of granules. The heap's height and diameter were taken and the angle of repose was estimated. So, the angle of repose and granular flow are inversely proportional to each other.

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

Θ = angle of repose, h= height of heap, r is radius of heap

FTIR

The IR spectrum of individual extracts and polyherbal granules was obtained using Bruker A-E IR spectrum of drugs available at Instrument lab at ASBASJS college of Pharmacy, Bela, Ropar and Pb. The KBr was used in preparing the sample disks. The sample was observed in the range of 700-4000 cm^{-1} **[6-8]**.

Capsule Evaluation Parameters

Preparation of calibration curve

For making a standard curve, a stock solution of 1000 µg/ml concentration was prepared and it was then serially diluted with water to get 0, 30, 50, 100, 200, 300, 400 up to 500 µg/ml. The absorbance of the solutions of various concentrations were taken using distilled water as blank in (Shimadzu 2700) UV spectrophotometer at 260. The absorbance values so obtained were plotted against concentration (µg/ml)

In vitro dissolution studies

"This test is used as measure to determine absorption rate, bioavailability and bioequivalence of the drug dosage form. In this method Paddle Type Dissolution Apparatus (Lab India Disso 2000- 6 basket dissolution apparatus), was used containing 900 ml of SGF solution (2g NaCl + 3.2g Purified Pepsin (with activity 800 to 2500 units/mg of protein) +7 ml HCl (Stock solution) + adequate water to make 1000 ml) in 1000ml capacity cylindrical vessel and the temperature was maintained at 36.5ºC to 37.5ºC. The paddle speed as maintained at 75 rpm for 30 min. At each time span 5ml of the sample was taken from the vessel and was replacement of medium was done with fresh medium. The samples so taken were analyzed using U.V. Spectrophotometer (Shimadzu 2700) at 260nm. The dissolution

study was done on all the six formulations and on basis of dissolution profile of the drug, best formulation was selected and further tested for other evaluation parameters. The polyherbal capsules were assessed for organoleptic characters, average weight, weight variation, disintegration time, and moisture content and dissolution rate **[6-7]**.

Average weight of capsules

Average weight of 20 capsules was calculated using a digital weighing balance

Weight variation

To calculate weight variation randomly 20 capsules were selected, individually weighed and their average weight was compared with weight of individual capsule.

Disintegration time

In order to determine the disintegration time of capsules six random capsule samples were taken and placed in every tube of the Basket rack and placed in the beaker containing 1l medium. The medium medium used is Simulated Gastric fluid (SGF). Temperature of the assembly was upheld at 37 ºC±2 ºC. To move the basket 5-6 cm in height, at a frequency of 28-32 cycles per minute, a motor was utilized. If they pass through a 10-mesh screen in a certain period, the capsules have disintegrated.

Moisture content

It was determined by taking 5 g of sample and drying it in the hot air oven at 100-110oC until the persistent weight is obtained. Any change in the weight of dried sample was calculated.

Stability Study

To determine the durability of the pharmaceutical formulations, they must be exposed to increased temperature, humidity and light intensities. Researchers examined the effects of extrinsic factors on the capsule's physical, chemical, and medicinal properties **[9-10]**.

RESULTS AND DISCUSSIONS

RESULTS

Preformation study

The polyherbal granules prepared were tested for various parameters like particle size analysis, bulk density, tapped density, compressibility index, Carr's index, Hausner's ratio and angle of repose. The granules cleared all the above-mentioned tests and showed good flow properties. The exact results are mentioned below in the **Table 2**.

FTIR

The FTIR study of alcoholic extracts of *A. obesum , C. glandulosum and S. sativa* flowers and fruit coat" was done using KBr pellet method and the polyherbal granules prepared were also evaluated for FTIR study. The results so obtained are mentioned here in **Figure 1, Figure 2, Figure 3, and Figure 4**. The interpretations of the results are mentioned in **Table 3**.

Capsule evaluation parameters

Dissolution Study

Dissolution study give the estimate of in vitro drug release in SGF or SIF. It gives the pattern in which the drug gets released from its dosage form to ensure proper efficacy and quality. The dissolution profile of polyherbal antidiabetic capsules is given below in the **Table 4, Table 5, Figure 5 and Figure 6**.

The capsules formulated from the polyherbal granules which showed best results for dissolution profile were selected and tested for various evaluation parameters to ensure proper quality, drug content and drug release. The results are given below in **Table 6**.

6.9.5 Stability study

The stability parameters analysed for 30 min, 1, 3 and 6 hours of storage at accelerated conditions of temperature, light and humidity have been tabulated in **Table 7, Table 8 and Table 9**.

Table 2: Evaluation parameters for Polyherbal granules

Parameters	PHF1	PHF2	PHF3	PHF4	PHF5	PHF6
Bulk Density	0.46	0.51	0.49	0.44	0.54	0.42
Tapped density	0.51	0.65	0.61	0.57	0.70	0.54
Carr's index	10.51	21.20	19.34	22.40	22.53	21.81
Hausner's ratio	1.11	1.28	1.25	1.29	1.28	1.29
Angle of repose	24.80	26	28.48	31	35.52	34.03

Table 3: FTIR interpretation of various Antidiabetic extracts

Extracts	Absorption	Group
A. obesum	3200.67 cm^{-1}	O-H Stretch
	2845.08 cm^{-1}	C-H Stretch
	1617.50 cm^{-1}	C=O Stretch
	1516.10 cm^{-1}	C=C Stretch
	1013.09 cm^{-1}	C-O Stretch
C. glandulosum	3510.23 cm^{-1}	O-H Stretch
	2810.21 cm^{-1}	C-H Stretch
	2503.56 cm^{-1}	S-H Stretch
	2019.20 cm^{-1}	Overtones and combination bands (Aromatics)
	1516.40 cm^{-1}	C=C stretch
	1013.09 cm^{-1}	C-O stretch
	500.12 cm^{-1}	C-H bending
S. sativa	3200.45 cm^{-1}	O-H Stretch
	2870.24 cm^{-1}	C-H Stretch
	1751.65 cm^{-1}	C=O Stretch
	1650.80 cm^{-1}	C=C stretch
	1451.50 cm^{-1}	C-H bending
	1251.56 cm^{-1}	C-O stretch
	9070.40 cm^{-1}	C-H bending
Polyherbal granules	3502.03 cm^{-1}	O-H Stretching
	3346.72 cm^{-1}	C-H stretching
	2916.38 cm^{-1}	Medium C-H stretching
	2075.18 cm^{-1}	N=C=S stretching
	1722.23 cm^{-1}	C=O stretching
	1668.15 cm^{-1}	C=C stretching
	1594.29 cm^{-1}	C=C stretching
	1203.37 cm^{-1}	C-O stretching
	814.86 cm^{-1}	C-H bending
	763.22 cm^{-1}	C-H bending
	728.42 cm^{-1}	C=C bending

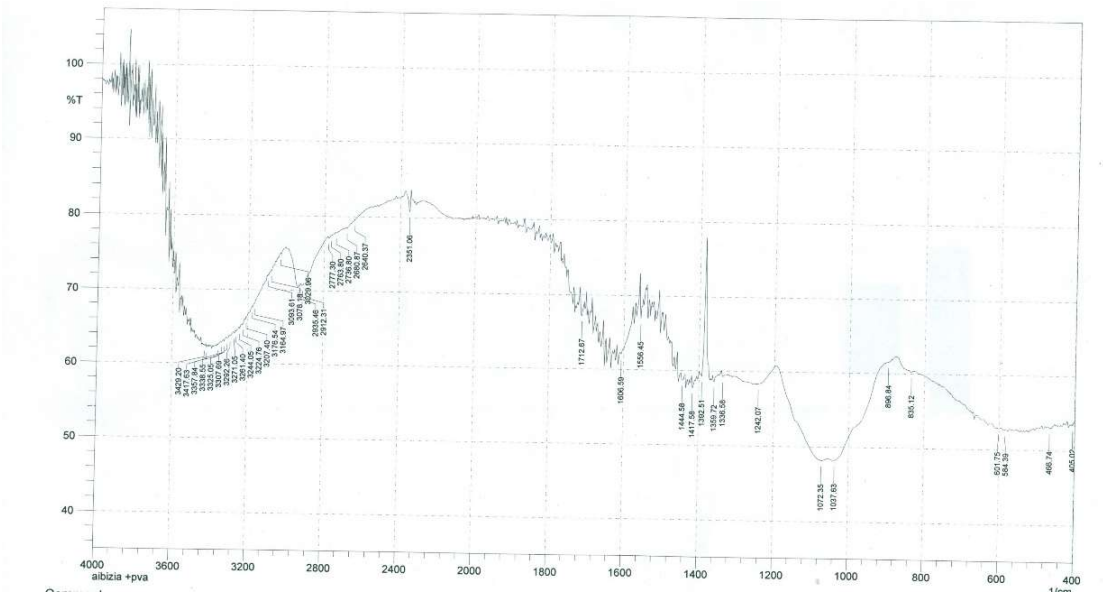

Figure 1: FTIR of *A. obesum*

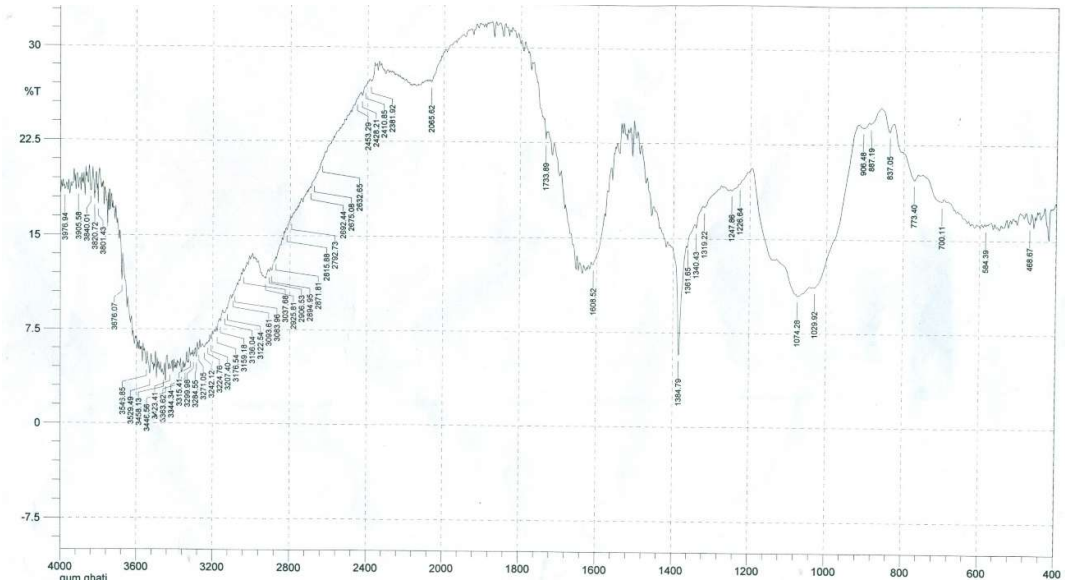

Figure 2: FTIR of *C. glandulosum*

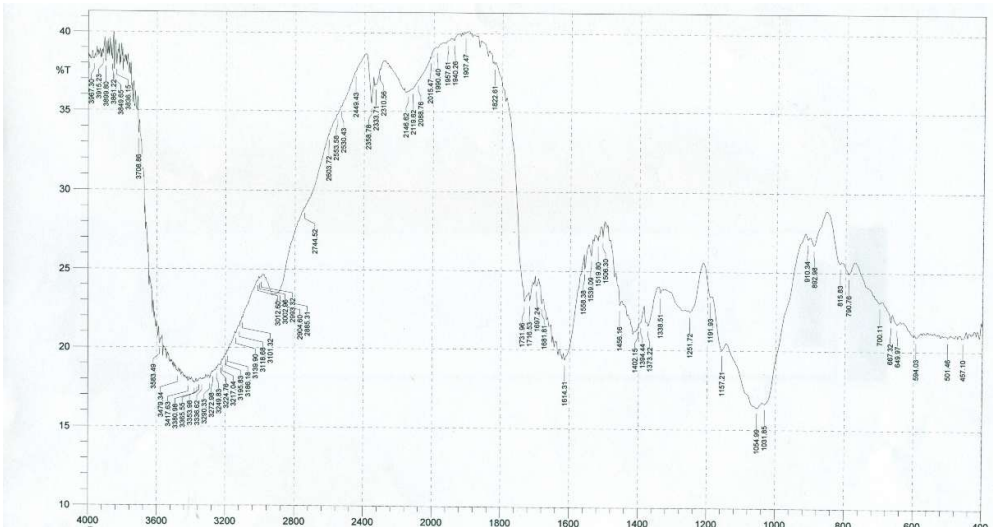

Figure 3: FTIR of *S. sativa*

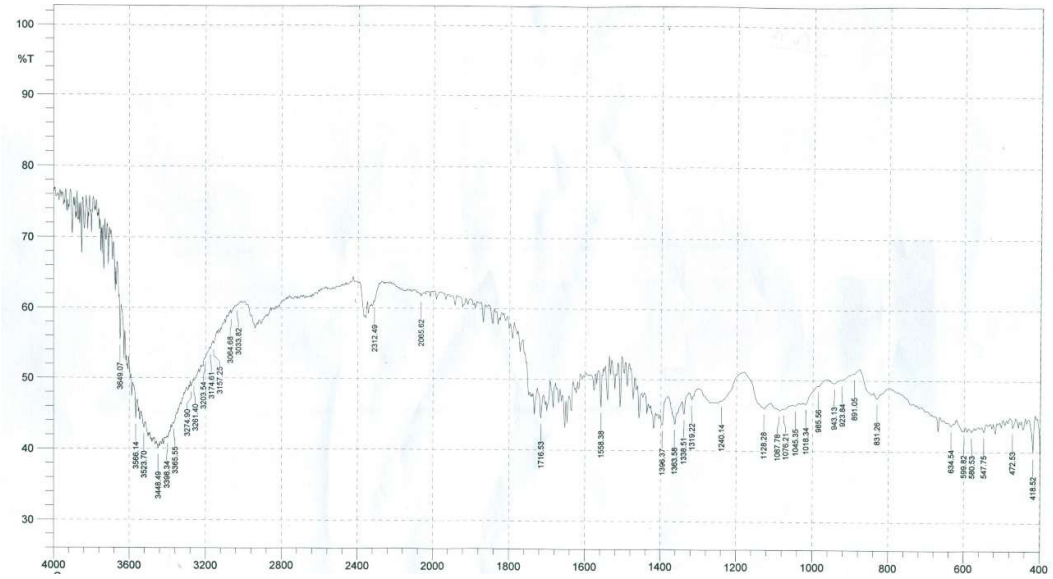

Figure 4: Polyherbal granules FTIR

Table 4: Calibration curve of Polyherbal antidiabetic capsules

Conc. (µg/ml)	Absorbance 260nm
0	0
30	0.094
50	0.145
100	0.267
200	0.511
300	0.764
400	1.010
500	1.266

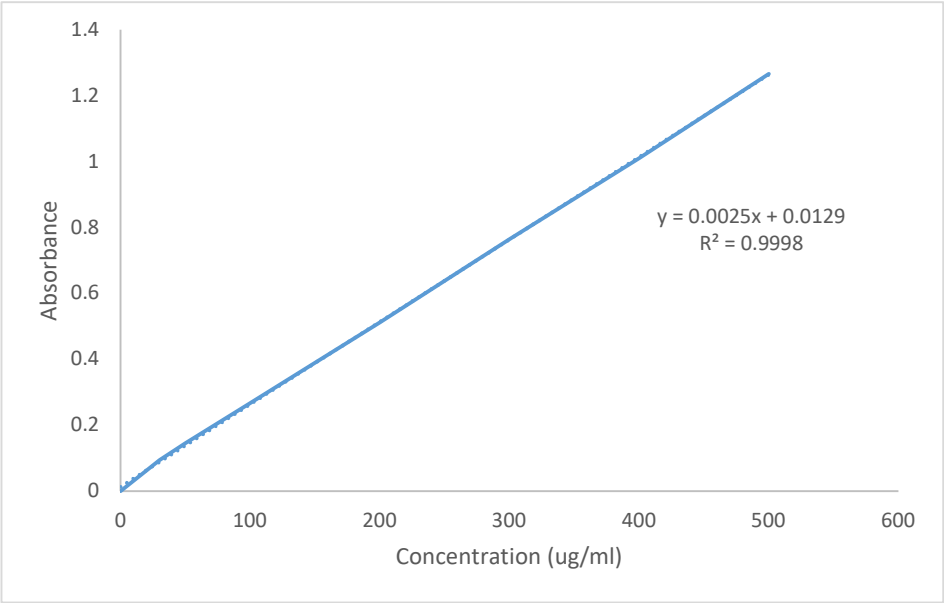

Figure 5: Calibration curve of Polyherbal antidiabetic capsule

Table 5: Dissolution study of Polyherbal antidiabetic capsule

Time	PHF1	PHF2	PHF3	PHF4	PHF5	PHF6
0	0	0	0	0	0	0
5	35.05	32.76	29.51	25.85	21.51	18.65
10	56.72	52.22	48.95	45.31	40.97	38.11
15	69.51	67.29	64.97	60.35	57.30	52.34
20	81.58	77.54	74.34	75.34	71.02	68.16
25	88.344	85.30	83.65	79.98	75.66	72.82
30	94.13	91.14	88.64	84.96	80.64	75.32

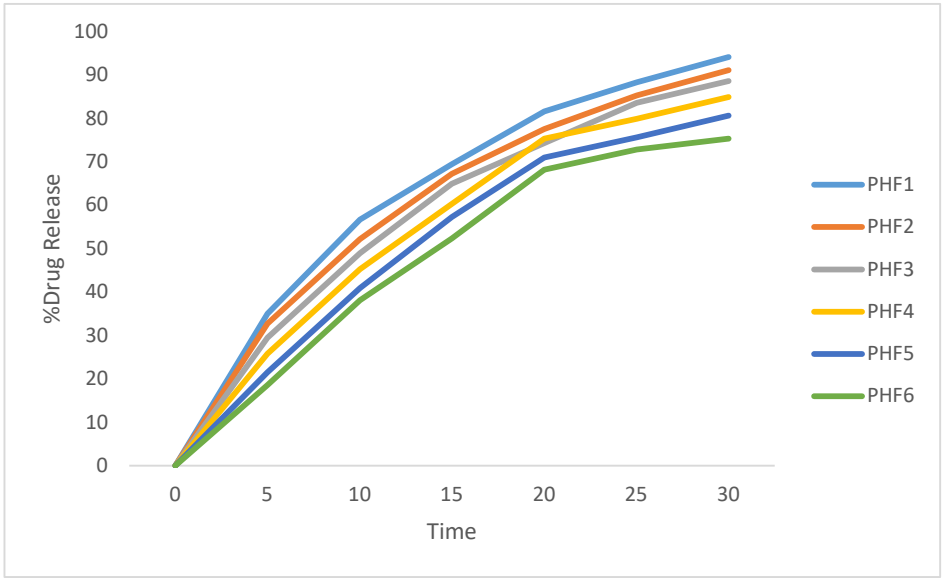

Figure 6: Drug Dissolution profile

Table 6: Evaluation of parameters of Polyherbal capsules

Parameters	Observation
Organoleptic characters	Capsules are of blue coloured cap and transparent body filled with brown coloured powder
Size	0 size
Taste	Bitter
Odour	Characteristics
Average weight	503
Weight variation	475-553
Disintegration time	10.32
Moisture content	3.24%

Table 7: Effect of different types of light on Polyherbal capsules

Light Source	Sunlight				Fluorescence				Tube light				UV light				Infra-Red light				Lamp light			
Exposure time (h)	1/2	1	3	6	1/2	1	3	6	1/2	1	3	6	1/2	1	3	6	1/2	1	3	6	½	1	3	6
Polyherbal capsule	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8: Stability test of Polyherbal capsule at different temperature

Storage Condition	Testing Condition °C	Time Duration (h)				Results
		½	1	3	6	
Ambient	30	-	-	-	-	No degradation in 6h
Warm (30-40°C)	35	-	-	-	-	No degradation in 6h
Accelerated	50	-	-	-	-	No degradation in 6h
Accelerated	55	-	-	-	-	Degraded after 4h
Accelerated	60	-	-	-	-	Degraded after 2h

Table 9: Stability study at different humidity with respect to different temperature

Temperature °C	Humidity			
	30%	50%	70%	90%
30	-	-	-	-
35	-	-	+	+
55	-	-	+	++
65	-	-	++	+++

DISCUSSION

Diabetes mellitus is a metabolic disorder, a life-threatening disease which is increasing day by day. For the treatment of Diabetes mellitus generally synthetic Oral antidiabetic drug therapy is used which contains drugs belonging to various classes. These drugs act through different mechanisms for temporary relieve of hyperglycemia. Antidiabetic drug therapy with diverse toxicological profiles have taken place but the need of the day is effective but safe treatment. The safe alternative for treatment of diabetes could be Herbal drug therapy. The herbal drugs therapy provides a large no. of beneficial effects.

The single phyto-constituents of single plants are inadequate to produce the required efficacy. The combination of various herbal drugs in a specific proportion will improve the therapeutic efficacy and decrease toxic effects by simultaneously acting on multiple targets, which meanderingly leads to enhanced patient compliance and therapeutic outcome. Compared to single herbal products, all these advantages resulted in PHF's success on the market. They show high performance, a broad therapeutic window, cost efficiency, easy availability and minimal side effects. Therefore, in present study we are taking 4 different herbal medicines which act in treatment of diabetes mellitus through various mechanism of actions. The phytoconstituents contained in the separate medicines were discovered in the polyherbal extract, where they are predicted to operate in synergistic way for the treatment of diabetes.

The polyherbal mixture was created by combining ethanolic extracts of *A. obesum , C. glandulosum and S. sativa*, flowers coat in a 1:1:1:1 ratio. First of all, all the four drugs were collected from various sources. Then all the four drugs were studied for their pharmacognostic characters, where the morphological, microscopic as well as physical evaluations were done. In phytochemical investigations, the qualitative as well as quantitative evaluations are done. In qualitative evaluation the general phytochemical screening was done through chemical tests. In these tests the drugs were found to have phenols flavonoid, tannins, sterols, saponins and glycosidal content.

Now as the drug has given satisfactory results, it's the time to prepare the formulation of the drug. Polyherbal capsules were prepared by making the polyherbal granules. The polyherbal granules were prepared into six formulations while altering the concentrations of excipients and checked for their flow properties as well as other parameters. The bulk density, tapped density, Carr's index, Hausner's ratio and Angle of repose were checked for the various polyherbal granules. It was found that PHF1 showed all the desired characters of the granules. The results of PHF2 and PHF3 were also good but the PHF1 acts ideally for the condition.

The FTIR study was done using individual plant extracts as well as PHF1. Specific functional groupings of chemicals are shown by the frequency regions or bands in each sample. Each sample has a peak in the spectral range between 3400–3200 cm-1 and 2800–3000 cm-1, which shows the presence of OH groups (such as water, alcohols, and phenols) and methylene CH symmetric/asymmetric, which indicates the existence of alkane vibration.

When measured between 1600 and 1800 cm-1, alkenes are detected. In *A. obesum , C. glandulosum and S. sativa*, and polyherbal granules, the particular peaks at 1603 cm-1, 1640 cm-1, 1711 cm-1, 1668 cm-1, and 1722 cm-1 reflect the carbonyl frequencies of conjugated alkenes, alkenes, cyclohexanone, aliphatic ketone, and disubstituted alkene *A. obesum* has a band at 2926 cm-1, 1544 cm1, and 1247 cm-1 due to the doublet absorption of C-H stretching vibrations.

The component *C. glandulosum* represented the presence of water (3310 cm1), alkane (1603 cm-1), nitro (1511 cm-1), methyl (1444 cm-1) and alkyl aryl ether (1242 cm-1) along with primary alcohols at 1073 cm-1 in it. Picrorhiza kurroa showed the presence of water (3330 cm-1), alkane (2940 cm-1), alkene (1640 cm-1), and aromatic esters (1281 cm-1) in it.

S. sativa contained alcohol (3352 cm-1), alkane (2924 cm-1), cyclohexanone (1711 cm-1), methyl (1456 cm-1) and amine (1023 cm-1) groups in it. They indicated the existence of water and alcohol, alkane and cyclohexanone, and vinyl ether in their composition. This confirms the existence of relative active chemicals (flavonoids, tannins, terpenes and phenols) in all samples. The formulation was stabilized by adding excipients to the granule preparation. Wavenumber changes are minimal, which is consistent with the inert nature of the excipients introduced.

The polyherbal capsules were further tested for the capsule parameters. The capsules of blue colored cap and transparent body had characteristic odour and with average weight of 517 mg. The disintegration time was found to be 10.35 min. with moisture content of 3.25%. The dissolution study of capsules was done in which PHF1reached %CDR of 94.13 in 30 min. Out of the 6 different types of capsule composition, PHF1 capsules showed best results in dissolution study, which may be attributed to the variation in pre-gelatinized starch which is acting as binding agent.

Now it was the time to check the capsules for the stability studies. In the evaluation of any novel formulation, stability is one of the most important factors to consider. As a consequence of this investigation, the capsules were shown to be safe and stable. Where the drug was found to be stable in different spectrum of lights like in Sunlight, Fluorescence, tube light, UV light, IR and lamp light during the whole 6 h. In each case.in case of stability studies at different temperatures the drug showed no signs of degradation even after 6 h of exposure to 50º, but started to degrade after 4 h and 2 h at temperature of 55o and 60o respectively. The drug responded to degradation after exposure to 70% and 90% humidity above 35º.

Standardization, which assures quality, safety, and repeatability, is the most essential element of any formulation. A bioprospecting project covers the whole process of bioprospecting, from raw material gathering through the production of a final product.

CONCLUSION

This study successfully formulated and evaluated a novel polyherbal formulation comprising ethanolic extracts of *Adenium obesum*, *Croton glandulosum*, and *Senna sativa* for its antidiabetic and antioxidant properties. The formulation demonstrated significant inhibitory effects on α-amylase and α-glucosidase enzymes, indicating its potential to manage postprandial hyperglycemia. Furthermore, the DPPH radical scavenging assay revealed strong antioxidant activity, suggesting its role in reducing oxidative stress, a common complication in diabetes.

Acute toxicity studies confirmed the safety of the formulation at doses up to 2000 mg/kg, while stability studies under accelerated conditions indicated its robustness and shelf-life suitability. The results highlight the synergistic potential of the selected medicinal plants in addressing diabetes mellitus and its associated oxidative damage.

This research supports the therapeutic promise of polyherbal formulations as a complementary approach to diabetes management. Further in vivo studies and clinical trials are warranted to validate its efficacy and establish its clinical relevance.

REFERENCES

[1] Abel ED, Gloyn AL, Evans-Molina C, Joseph JJ, Misra S, Pajvani UB, Simcox J, Susztak K, Drucker DJ. Diabetes mellitus—Progress and opportunities in the evolving epidemic. Cell. 2024 Jul 25;187(15):3789-820.

[2] Antar SA, Ashour NA, Sharaky M, Khattab M, Ashour NA, Zaid RT, Roh EJ, Elkamhawy A, Al-Karmalawy AA. Diabetes mellitus: Classification, mediators, and complications; A gate to identify potential targets for the development of new effective treatments. Biomedicine & Pharmacotherapy. 2023 Dec 1;168:115734.

[3] Wong ND, Sattar N. Cardiovascular risk in diabetes mellitus: epidemiology, assessment and prevention. Nature Reviews Cardiology. 2023 Oct;20(10):685-95.

[4] Dilmurodovna TD. Diabetes Mellitus In Central Asia: Problems And Solutions. Лучшие интеллектуальные исследования. 2024 Jan 6;12(4):204-13.

[5] Taxirovich DA, Ulugbekovna RN, Abduxalimova YJ. Status And Prospects For The Fight Against Diabetes Mellitus. Educational Research in

Universal Sciences. 2024 Feb 5;3(1):4-9.

[6] Ghumare AR, Borade VS, Talele SG, Shahare S, Pawar A, Shinde C, Chaudhari S, Borse DL. Formulation And Evaluation Of Nutraceutical Tablet Of Polyherbal Drugs By Wet Granulation. Journal of Pharmaceutical Negative Results. 2023 Jan 1:359-68.

[7] Patel C, Shahgond L, Ahir P, Acharya S. Development and evaluation of antiobesity polyherbal granules: a full spectrum weight management concept. Obesity Medicine. 2020 Dec 1;20:100299.

[8] Mahto BK, Patel R, Bapna R, Shukla AK. Development and standardization of a poly herbal formulation. The Scientific Temper. 2022 Dec 12;13(02):118-25.

[9] Kaur N, Sharma S. Formulation, Evaluation, and Stability testing of Polyherbal Antidiabetic Capsules. International Journal of Pharmaceutical Investigation. 2023 Jan 1;13(1).

[10] Kaur SN, Sharma S. Antidiabetic Polyherbal Capsule: Formulation, Evaluation and Safety measurements. Indian Journal of Pharmaceutical Sciences. 2023 May 1;85(3).