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DEVELOPMENT OF EVALUATION OF ANTI-DIABETES POLYHERBAL TABLETS FORMULATION

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ABSTRACT

The present study was aimed at the development, formulation, and evaluation of a polyherbal tablet with antidiabetic potential containing ethanolic extracts of *Combretum ovalifolium*, *Gardenia lucida*, and *Leea macrophylla*. The selected plants were subjected to extraction, percentage yield determination, and preliminary phytochemical screening. Quantitative estimation of total phenolic and flavonoid contents was also carried out to identify bioactive constituents. The polyherbal tablets were formulated and evaluated for pre-compression and post-compression parameters, including bulk density, flow properties, hardness, friability, weight variation, drug content, and disintegration time. *In vitro* antidiabetic activity was assessed using enzyme inhibition studies and compared with the standard drug acarbose. The *in vivo* antidiabetic potential of the polyherbal tablets was evaluated in experimentally induced diabetic rats by monitoring body weight and blood glucose levels over a 21-day treatment period, with glibenclamide used as the standard drug. Preliminary phytochemical analysis revealed the presence of flavonoids, phenolic compounds, saponins, and proteins in the extracts. The formulated tablets exhibited acceptable physicochemical properties and rapid disintegration. In vitro studies demonstrated concentration-dependent enzyme inhibition by the polyherbal tablets, while in vivo studies showed significant improvement in body weight and a marked reduction in blood glucose levels, particularly at higher doses. The findings of the study suggest that the developed polyherbal tablet formulation possesses significant antidiabetic activity, which may be attributed to the synergistic effects of bioactive phytoconstituents. The formulation represents a promising herbal alternative for the management of diabetes mellitus.

Keywords: Polyherbal tablets, Diabetes mellitus, *Combretum ovalifolium*, *Gardenia lucida*, *Leea macrophylla*, Antidiabetic activity, Phytochemical screening.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to impaired insulin secretion, insulin action, or both, and is associated with serious long-term complications affecting multiple organ systems (Sarkar *et al.*, 2019). The rising global prevalence of diabetes, particularly in developing countries, along with the limitations and adverse effects of long-term synthetic antidiabetic therapy, has led to increasing interest in plant-based and complementary treatment approaches. Herbal medicines, especially polyherbal formulations, are widely used in traditional

systems of medicine and are believed to provide synergistic therapeutic effects with improved safety and efficacy by acting on multiple targets involved in glucose regulation.

Combretum ovalifolium, *Gardenia lucida*, and *Leea macrophylla* are medicinal plants traditionally used for metabolic and inflammatory disorders and have been reported to possess antidiabetic, antioxidant, and cytoprotective properties. These plants are rich in bioactive phytoconstituents such as flavonoids, phenolic compounds, saponins, and glycosides, which are known to improve insulin sensitivity, enhance glucose utilization, and protect pancreatic β-cells. Considering their complementary mechanisms of action, the combination of these plants in a polyherbal formulation may offer enhanced antidiabetic efficacy (Ali *et al.*, 2024). Therefore, the present study was undertaken to develop and evaluate polyherbal tablets containing extracts of *Combretum ovalifolium*, *Gardenia lucida*, and *Leea macrophylla* for their antidiabetic potential.

MATERIALS AND METHODS

Materials

The materials used for the present investigation included plant materials, chemicals, reagents, and laboratory animals. The dried plant parts of *Combretum ovalifolium*, *Gardenia lucida*, and *Leea macrophylla* were collected, authenticated, and used for the preparation of ethanolic extracts. Analytical grade solvents and reagents such as ethanol, methanol, aluminium chloride, Folin–Ciocalteu reagent, gallic acid, quercetin, sodium carbonate, and other chemicals required for phytochemical screening were procured from standard commercial suppliers. Pharmaceutical excipients required for tablet formulation, including suitable diluents, binders, disintegrants, and lubricants, were used as per pharmacopoeial standards. Acarbose and glibenclamide were employed as standard antidiabetic drugs for in vitro and in vivo studies, respectively. Healthy Wistar albino rats were used for the evaluation of antidiabetic activity, and all experimental procedures were carried out following institutional ethical guidelines.

Methods

Extraction of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla* by maceration method

The coarsely powdered crude drug undergoes grinding to increase the surface area for proper mixing of powdered materials with the solvent. 50 gram powdered of leaves of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla* has been extracted with ethanol solvent using maceration process for 48 hrs, filtered and dried using vacuum evaporator at 40°C (Mukherjee, 2007).

Determination of percentage yield

The extraction yield is an assessment of the efficiency of the solvent in extracting bioactive components from the selected natural plant samples and was defined as the quantity of plant extracts recovered after solvent extraction compared to the original quantity of plant samples. The yield of the collected plant extracts was measured in grams after extraction, and then converted into percentage. By using the following formula the percentage yield of extract was calculated:

Percentage yield = Weight of Extract/ Weight of powdered drug×100

Preliminary phytochemical studies

The phytochemical analysis was done qualitatively which involved the analysis of carbohydrates, flavonoids, alkaloids and protein using specific reagents.

Estimation of total phenol content

The total phenolic content of the extract was determined using the modified Folin–Ciocalteu colorimetric method as reported by Gaur Mishra *et al.,* (2017). Gallic acid was used as the reference standard for calibration. A standard stock solution was prepared by dissolving 10 mg of gallic acid in 10 ml of methanol, from which working standard solutions in the concentration range of 10–50 µg/ml were prepared using methanol. For sample preparation, 10 mg of the dried extract was dissolved in 10 ml of methanol and filtered to obtain a clear solution. From this solution, 2 ml of the extract (equivalent to 1 mg/ml) was used for phenolic estimation. The assay was carried out by mixing 2 ml of the extract or each standard solution with 1 ml of Folin–Ciocalteu reagent previously diluted with distilled water in a ratio of 1:10 (v/v), followed by the addition of 1 ml of sodium carbonate solution (7.5 g/L). The reaction mixture was vortexed for 15 seconds and allowed to stand for 10 minutes at room temperature for color development. The absorbance of the resulting blue-colored complex was measured at 765 nm using a UV–Visible spectrophotometer, and the total phenolic content was expressed as gallic acid equivalents.

Estimation of total flavonoids content

The determination of total flavonoid content was carried out using the aluminium chloride colorimetric method as described by Gaur Mishra *et al.,* (2017). Quercetin was used as the reference standard for calibration. A standard stock solution was prepared by dissolving 10 mg of quercetin in 10 ml of methanol, from which a series of working standard solutions in the concentration range of 5–25 µg/ml were prepared using methanol as the solvent. For sample preparation, 10 mg of the dried plant extract was dissolved in 10 ml of methanol and filtered to obtain a clear solution. From this, 3 ml of the extract solution (equivalent to 1 mg/ml) was used for flavonoid estimation. The assay was performed by adding 1 ml of 2% aluminium chloride ($AlCl_3$) solution to 3 ml of either the extract solution or each standard solution. The reaction mixture was allowed to stand for 15 minutes at room temperature to allow the formation of a flavonoid–aluminium complex. The absorbance of the resulting yellow-colored complex was then measured at 420 nm using a UV–Visible spectrophotometer, and the total flavonoid content of the extract was expressed as quercetin equivalents.

Formulation of polyherbal tablet of ethanolic extract of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla*

Polyherbal extract of ethanolic extract of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla* were prepared by direct compression method. All the ingredients (except granular directly compressible excipients) were passed through # 60-mesh separately (Tirath *et al.,* 2019). Then the ingredients were weighed and mixed in geometrical order. Powder blend was evaluated for bulk density, tapped density, Carr's index and Hauser's ratio. Compressed into tablets of 350 mg using 8mm round flat punches on 10-station rotary tablet machine (Clit).

Table 1: Formulation for different batches of polyherbal of extracts

Ingredients	F1
Combretum ovalifolium extract	100
Gardenia lucida extract	100
Leea macrophylla extract	100
Mannitol	6
CP	10
CCS	-
Aerosil	30
Pre-gelatinised Starch	1.5
Menthol	1.5
Magnesium stearate	1.0
Total weight	350

Pre-compression Studies of blend powder

Various formulations and process variables were involved in mixing of ingredients and all these can affect the properties of the blends produced (Mahapatra and Verma, 2023).

Bulk density: The sample under test was screened through sieve no.20, the sample equivalent to 25 gm (50 cm^3) was accurately weighed and filled in a 100 ml graduated cylinder, the powder was leveled and the unsettled volume, V_o was noted. The bulk density was calculated in g/cm^3 by the formula:

$$\text{Bulk density} = M/V_o$$

Where, M = mass of powder taken, and V_o = apparent unstirred volume

Tapped Density: The sample under test was screened through sieve no.20 and the weight of sample equivalent to 25 g was filled in 100 ml graduated cylinder. The mechanical tapping of the cylinder was carried out using tapped density tester at a nominal rate of 300 drops per minute for 500 times initially and the tapped volume V_o was noted. Tapping was proceeding further for an additional tapping 750 times and tapped volume V_b was noted (Pandey *et al.,* 2018). The difference between two tapping volume was less than 2%, so V_b was considered as a tapped volume V_f. The tapped density was calculated in g/ cm^3 by the formula:

$$\text{Tapped density} = M/V_f$$

Where, M = weight of sample taken, and V_f = tapped volume

Compressibility Index: The bulk density and tapped density was measured and compressibility index was calculated using the formula:

$$\text{Compressibility Index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

Hausner ratio: Tapped density and bulk density were measured and the Hausner ratio was calculated using the formula:

$$\text{Hausner ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

If the value for Hausner ratio < 1.24 than it shows good flow properties.

Angle of repose

Angle of repose indicates the frictional forces in a loose powder. It can be defined as the maximum angle between the slope of pile of powder and its base. The Angle of repose was determined using funnel method, designed by Newmann. The blend was poured through a funnel that could be raised vertically until a specified cone height (h) was obtained. Radius of the heap (r) was measured and angle of repose (θ) was calculated using the formula:

$$\mathbf{\tan \theta = h / r}$$

$$\mathbf{\text{Therefore } \theta = \tan\text{-}1\ h / r}$$

Where

θ = angle of repose

H = height of cone

R = radius of cone

Evaluation of fast dissolving Tablet

Hardness: Hardness is amount of strength of tablet to withstand mechanical shocks of handling in manufacture, packaging and shipping and tablet should be able to withstand reasonable abuse when in the hand of consumer (Pal *et al.,* 2014). Hardness of tablet was evaluated by Monsanto hardness tester or Pfizer tester. Hardness was measured in kg/cm^2 and for tablet it is above 4-6 kg/cm^2.

Friability: This test is applicable to compressed tablets and is intended to determine the physical strength of tablets (Shriwas *et al.,* 2019). It was evaluated by Roche Friabilator with 100 revolution rotating 25 per minute for 4 min by using 6 tablets. According to USP tablet should have limit < 1% for acceptance. Following formula was used to calculate the friability.

% F=1- (loss in weight/initial weight) 100

Weight variation:

Weight variation was calculated as per method describe in USP. 20 tablets were weighed individually and the average was calculated (Tiwari and Sharma, 2017). The requirements are met if the weight of not more than 2 of tablets differ by more than percentage listed in the tablet and no tablets differ by in weight by more than double that percentage.

Disintegration test

Disintegration test was measured using disintegration test apparatus. One tablet was placed in each of the six tubes of disintegration test apparatus. I.P. method was followed without using disc. The time required for complete disintegration of tablet in each tube was determined using stop watch.

Thickness variation

Ten tablets from each formulation were taken randomly and their thickness was measured with a micrometer screw gauge (Mishra *et al.,* 2011).

Uniformity of drug content

The test is mandatory for tablets with 10 mg or less weight of active ingredient. Ten randomly selected tablets from each formulation (F1 to F6) were finely powdered and Drug equivalent to 10mg of drug dissolved in 10 ml 0.1 N HCl, sonicate it for 20 minutes, till the entire drug leached out from complex, then the solution was filtered through whatman filter paper No. 41. From this Solution take 1 ml and Diluted up to 100 ml with 0.1 N HCl and the drug content was determined spectrophotometrically at 313nm.

***In-vitro* anti-diabetic activity of polyherbal tablet using alpha amylase inhibition assay**

10 mg acarbose was dissolved in 10 ml methanol, and various aliquots of 10-100µg/ml were prepared in methanol (Kumar *et al.,* 2021). 100 mg of test samples was extracted with 100 ml methanol, filter, and make up the volume up to 100 ml. 500 µl of this extract was for the estimation of enzyme inhibition. A total of 500 µl of test samples and standard drug (10-50µg/ml) were added to 500 µl of 0.20 mM phosphate buffer (pH 6.9) containing α-amylase (0.5mg/ml) solution and were incubated at 25℃ for 10 min. After these, 500 µl of a 1% starch solution in 0.02 M sodium phosphate buffer (pH 6.9) was added to each tube. The reaction mixtures were then incubated at 25°C for 10 min. The reaction was stopped with 1.0 ml of 3, 5 dinitrosalicylic acid colour reagent. The test tubes were then incubated in a boiling

water bath for 5 min, cooled to room temperature. The reaction mixture was then diluted after adding 10 ml distilled water and absorbance was measured at 540 nm. Control represent 100% enzyme activity and were conducted in similar way by replacing test samples with vehicle.

***In vivo* anti-diabetic activity of polyherbal tablet**

Animal care and handling

The study involved Wistar albino rats, male and female, aged 4 months, and weighing between 110 to 160 grams. The rats were acclimatized under standard laboratory conditions in a cross-ventilated animal house, where the temperature was maintained at 25±2°C, relative humidity ranged between 44% to 56%, and a light and dark cycle of 12:12 hours was implemented. Throughout the experiment, the rats were provided with a standard pellet diet and had unrestricted access to water. The experimental protocol received approval from the institutional ethics committee, and all procedures were conducted following the guidelines set by the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

Acute oral toxicity studies

Oral Acute toxicity study was evaluated as per OECD guidelines (425) on Wistar albino rats. Three animals were selected for maximum tolerable dose (2000mg/kg) of Polyherbal preparation. Animals were observed individually for any toxicity sign of gross changes like convulsion, tremor, circling, depression and mortality after dosing for 24 hours. All observations were systematically recorded with individual records being maintained for each animal. No toxic signs were noticed in animals till day 7. Hence administered dose was considered tolerable.

Streptozotocin induced diabetes

Procedure: Diabetes was induced in animals by a single intraperitoneal injection of a freshly prepared Streptozotocin (STZ). STZ solution of 10 mg/ ml was prepared in ice-cold citrate buffer 0.1 M, pH 4.5 kept in ice and was administered at a dose of 60mg/kg body weight on day 1st. Treatment was given after diabetes induction (day 3rd) for 21 days (Pinakini *et al*, 2005; Vogel, 2002).

Grouping and dosing

Table 2: Animals were divided into five groups containing six animals in each

Group	Dosing and treatment
I	Normal control (vehicle only, 1ml/100gm)
II	Diabetic control, Streptozotocin60g/kg, i.p.
III	Standard, Diabetic rats were treated with Glibenclamide 0.25 mg/kg once daily for 21 days
IV	Diabetic rats were treated with polyherbal tablet at 50 mg/kg once daily
V	Diabetic rats were treated with polyherbal tablet at 100 mg/kg once daily
VI	Diabetic rats were treated with polyherbal tablet at 200 mg/kg once daily

Physiological Parameters: Body weight of animals was measured using animal weighing balance.

Biochemical Parameters

Samples collection and storage

At the end of the experimental, animals were anaesthetized with intraperitoneal injection of Ketamine (50 mg/Kg i.p.) and blood was

collected from retro-orbital puncture in blank (for serum) and EDTA containing apendorff tube (for plasma). The one drop of blood samples was immediately spread on the marked end of the gluco-strip. After few seconds the gluco-meter was display the blood glucose level. Serum and plasma were obtained by blood centrifugation at 3000rpm for 15 min. Animals were then sacrificed and pancreas were collected in 10% formalin for histopathology. Allbiological samples were store at −20ºC until analysis.

RESULTS AND DISCUSSION

The present study focused on the development, evaluation, and antidiabetic assessment of a polyherbal tablet formulation containing ethanolic extracts of *Combretum ovalifolium*, *Gardenia lucida*, and *Leea macrophylla*. The results obtained from phytochemical analysis, formulation evaluation, in vitro antidiabetic studies, and in vivo pharmacological assessment collectively demonstrate the therapeutic potential of the developed polyherbal tablets.

The percentage yield of ethanolic extracts varied among the selected plants, with *Combretum ovalifolium* showing the highest yield (11.20% w/w), followed by *Leea macrophylla* (10.52% w/w) and *Gardenia lucida* (8.96% w/w). These variations may be attributed to differences in plant matrix composition and solubility of phytoconstituents in ethanol. A reasonably high yield in all three extracts indicates efficient extraction of bioactive constituents, justifying their selection for formulation development.

Preliminary phytochemical screening revealed the presence of several biologically active secondary metabolites. Flavonoids, phenolic compounds, saponins, and proteins/amino acids were prominently detected across the extracts, although with some variation among individual plants. *Combretum ovalifolium* and *Leea macrophylla* showed positive results for proteins and flavonoids, while *Gardenia lucida* was particularly rich in phenolic compounds and flavonoids. The presence of flavonoids and phenolics is of particular importance, as these compounds are known to exert antidiabetic effects through antioxidant activity, enhancement of insulin secretion, improvement of insulin sensitivity, and inhibition of carbohydrate-digesting enzymes. The absence of alkaloids, phytosterols, and fixed oils suggests that the antidiabetic activity may primarily be mediated through polyphenolic constituents rather than lipophilic or alkaloidal compounds.

Quantitative estimation further supported the phytochemical findings. *Leea macrophylla* exhibited the highest total phenolic content (0.32 mg/100 mg of dried extract), while *Gardenia lucida* showed the highest flavonoid content (0.62 mg/100 mg). *Combretum ovalifolium* also contributed appreciable amounts of both phenols and flavonoids. The combined presence of these bioactive constituents in the polyherbal formulation supports the concept of synergistic action, where multiple phytochemicals collectively contribute to enhanced antidiabetic efficacy.

Pre-compression parameters of the polyherbal tablet blend indicated satisfactory flow and compressibility characteristics. The Carr's Index (14.118%) and Hausner's ratio (1.164) suggest good flowability and packing ability of the powder blend, making it suitable for direct compression. Adequate bulk density values further confirmed uniform particle

distribution, which is essential for consistent tablet weight and drug content.

Post-compression evaluation of the formulated tablets (F1) demonstrated acceptable physicochemical properties. The tablets exhibited adequate hardness (3.7 ± 0.3 kg/cm²), indicating sufficient mechanical strength to withstand handling and transportation. Friability was well within pharmacopoeial limits (<1%), confirming tablet robustness. Uniformity of weight, acceptable thickness, and high drug content (98.85 ± 0.15%) indicated good manufacturing consistency and homogeneity of the formulation. The disintegration time of 85 ± 5 seconds suggests rapid tablet disintegration, which is desirable for faster drug release and onset of therapeutic action.

In vitro antidiabetic evaluation using α-amylase/α-glucosidase inhibition (represented by comparison with acarbose) demonstrated concentration-dependent inhibition by the polyherbal tablets. Although the inhibitory activity of the formulation was lower than that of acarbose, the polyherbal tablets showed significant enzyme inhibition, with an IC_{50} value of 62.55 µg/ml. This suggests moderate but meaningful antidiabetic potential, likely mediated through delayed carbohydrate digestion and reduced postprandial glucose absorption.

In vivo evaluation further substantiated the antidiabetic efficacy of the polyherbal tablets. Diabetic control animals showed a progressive decline in body weight, which is a typical manifestation of uncontrolled diabetes due to enhanced protein and fat catabolism. Treatment with polyherbal tablets at doses of 100 and 200 mg/kg significantly improved body weight over the 21-day study period, indicating better glycemic control and improved metabolic status. The effect was dose-dependent, with the highest dose showing results comparable to the standard drug glibenclamide.

Blood glucose level estimation revealed a significant and sustained reduction in glucose levels in polyherbal tablet–treated groups compared to diabetic controls. The 200 mg/kg dose exhibited the most pronounced antihyperglycemic effect, particularly by day 21, indicating effective long-term glycemic control. Although glibenclamide showed superior glucose-lowering activity, the polyherbal formulation demonstrated significant efficacy with a gradual and sustained reduction in blood glucose, suggesting a safer and more physiological mode of action.

Table 3: % Yield of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla*

S. No.	Ethanolic extracts	% Yield (w/w)
1.	*Combretum ovalifolium*	11.20
2.	*Gardenia lucida*	8.96
3.	*Leea macrophylla*	10.52

Table 4: Preliminary phytochemical studies of extracts of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla*

S. No.	Constituents	Tests	*Combretum ovalifolium* extract	*Gardenia lucida* extract	*Leea macrophylla* extract
1.	Carbohydrates	Molisch's test	-	-	+
		Fehling's test	-	-	+
2.	Glycosides	Legal's test	-	-	-
		Borntrager's test	-	-	-
		Baljet test	-	-	-
3.	Fixed oil and Fats	Spot test	-	-	-
		Saponification test	-	-	-
4.	Proteins & Amino acids	Millon's test	+	-	+
		Ninhydrin test	+	+	+
		Biuret test	+	-	+
5.	Saponins	Foam test	+	+	+
6.	Phenolic comp. and Tannins	$FeCl_3$ test	-	+	+
		Lead acetate test	+	+	+
7.	Phytosterols	Salkowski test	-	-	-
		Libermann-bucchard test	-	-	-
8.	Alkaloids	Dragendorff's test	-	-	-
		Mayer's test	+	-	-
		Wagner's test	-	+	-
		Hager's test	-	-	-
9.	Gums & Mucilage	Froth test	-	-	-
		Alcoholic test	-	-	-
10.	Flavonoids	Lead acetate test	+	+	+
		Con. H_2SO_4 test	-	+	+
		$FeCl_3$ test	+	+	+

['+' = Positive; '-' = Negative]

Table 5: Estimation of total phenolic and flavonoids content of *Combretum ovalifolium*, *Gardenia lucida* and *Leea macrophylla* extract

S. No.	Ethanolic extract	Total phenol content	Total flavonoids content
		(mg/100mg of dried extract)	
1.	*Combretum ovalifolium*	0.23	0.41
2.	*Gardenia lucida*	0.17	0.62
3.	*Leea macrophylla*	0.32	0.54

Table 6: Results of pre-compression parameters of polyherbal tablets

Formulation code	Parameters			
	Loose Bulk density(gm/ml)	Tapped bulk density(gm/ml)	Carr's Index (%)	Hausner's Ratio
F1	0.365	0.425	14.118	1.164

Table 7: Results of post-compression parameters of polyherbal tablets formulations

F. Code	Hardness test (kg/cm^2)	Friability (%)	Weight variation (%)	Thickness (mm)	Drug content (%)
F1	3.7±0.3	0.658±0.025	350±5	1.32±0.05	98.85±0.15

Table 8: Results of disintegration time parameters of all formulations

Formulation code	Disintegration Time (Sec.) Mean ± SD
F1	85±5

Table 9: Results of *in vitro* antidiabetic studies of Acarbose and polyherbal tablets

S. No.	Concentration (µg/ml)	% Inhibition	
		Acarbose	Polyherbal tablets
1.	10	41.52	27.12
2.	20	45.97	34.05
3.	40	53.15	38.72
4.	60	64.69	48.96
5.	80	92.34	57.84
6.	100	90.42	62.51
IC_{50} value (µg/ml)		**27.96**	**62.55**

Table 10: Effect of polyherbal tablet on body weight of diabetic rats

Groups	Treatment	Initial	Day 7	Day 14	Day 21
I	Normal Control	128.2 ± 5.36	128.7 ± 5.66	129.4 ± 5.55	130.1 ± 5.42
II	Diabetic Control	133.1 ± 6.22	130.2 ± 6.59	127.3 ± 6.48	124.5 ± 6.32
III	Standard (Glibenclamide 0.25 mg/kg)	133.3 ± 4.28	131.8 ± 4.46	132.6 ± 4.52	134.2 ± 4.61
IV	Polyherbal tablet (50 mg/kg)	130.6 ± 3.24	128.3 ± 3.52	126.1 ± 3.44	125.2 ± 3.67
V	Polyherbal tablet (100 mg/kg)	132.9 ± 7.56	133.8 ± 7.42	135.4 ± 7.65	136.7 ± 7.74
VI	Polyherbal tablet (200 mg/kg)	136.4 ± 4.24	137.9 ± 4.33	139.6 ± 4.55	141.2 ± 4.68

Table 11: Effect of polyherbal tablet on blood glucose level in diabetic rats

Groups	Treatment	Day 3	Day 7	Day 14	Day 21
I	Normal Control (NC)	83.4 ± 4.12	85.1 ± 3.85	86.3 ± 3.74	85.6 ± 4.01
II	Diabetic Control	168.5 ± 4.26***	176.8 ± 4.51***	185.9 ± 4.63***	194.7 ± 4.82***
III	Standard (Glibenclamide 0.25 mg/kg)	154.2 ± 3.88***	132.6 ± 3.45***	118.5 ± 3.14***	106.4 ± 3.37***

IV	Polyherbal tablet (50 mg/kg)	160.3 ± 4.15***	158.7 ± 4.21*	154.2 ± 4.58**	149.8 ± 4.66**
V	Polyherbal tablet (100 mg/kg)	159.4 ± 4.42***	151.5 ± 4.36**	142.3 ± 4.74**	131.7 ± 4.88**
VI	Polyherbal tablet (200 mg/kg)	157.2 ± 4.18***	146.2 ± 4.01**	128.5 ± 4.37**	114.8 ± 4.42***

Values are mean ± SEM from a group of six animals. *p<0.05, **p<0.01 and***p<0.001

a- Significance difference as compare to normal control group

b- Significance difference as compare to Diabetic control group

c- Significance difference as compare to standard treated group

CONCLUSION

The present study successfully demonstrated the development and comprehensive evaluation of an anti-diabetic polyherbal tablet formulation containing ethanolic extracts of *Combretum ovalifolium*, *Gardenia lucida*, and *Leea macrophylla*. Phytochemical investigations confirmed the presence of biologically active constituents, particularly flavonoids and phenolic compounds, which are well known for their antidiabetic potential through antioxidant mechanisms, enhancement of insulin action, and inhibition of carbohydrate-digesting enzymes. The satisfactory percentage yield of all three extracts indicated efficient extraction and justified their selection for formulation development, while quantitative estimations supported the concept of synergistic interaction among the herbal components.

The formulated polyherbal tablets exhibited acceptable pre- and post-compression parameters, reflecting good flow properties, mechanical strength, uniformity, and rapid disintegration, thereby ensuring quality, stability, and patient compliance. In vitro antidiabetic studies revealed significant α-amylase/α-glucosidase inhibitory activity, indicating the formulation's ability to modulate postprandial hyperglycemia. Furthermore, in vivo pharmacological evaluation in diabetic animal models demonstrated a dose-dependent improvement in body weight and a significant reduction in blood glucose levels, with the higher dose showing effects comparable to the standard drug glibenclamide. The findings suggest that the developed polyherbal tablet formulation possesses promising antidiabetic efficacy with a gradual and sustained glucose-lowering effect, supporting its potential as a safe and effective herbal therapeutic option for the management of diabetes mellitus.

DECLARATION OF INTEREST

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

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