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Research

Pharmacognostical, preliminary phytochemical and in vivo anti diabetic activity and biochemical parameters of Abutilon crispum

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Abstract

This study investigates the pharmacognostic, antioxidant, and anti-diabetic properties of *Abutilon crispum* leaves, a medicinal plant traditionally used for treating various ailments. *Abutilon crispum* is examined for its potential role in diabetes management, using ethanolic extracts tested on streptozotocin (STZ)-induced diabetic rats. The study outlines both antioxidant and anti-diabetic evaluations. For anti-diabetic evaluation, Wistar rats received oral doses of *Abutilon crispum* extract (200 mg/kg and 400 mg/kg), with blood glucose levels measured over 28 days. The 400 mg/kg dose demonstrated significant glucose-lowering effects, comparable to the standard anti-diabetic drug Glibenclamide. Biochemical analyses also revealed that *Abutilon crispum* extract improves liver function by reducing SGOT, SGPT, and alkaline phosphatase levels, and decreases oxidative stress by lowering lipid peroxidation and enhancing catalase and glutathione peroxidase activities. These findings underscore *Abutilon crispum* as a potential natural therapeutic agent for diabetes management and oxidative stress mitigation. Future research could further elucidate the mechanisms and isolate active compounds responsible for these effects.

Keywords: *Abutilon crispum*, anti-diabetic activity, herbal medicine, streptozotocin (STZ)-induced diabetic rats, blood glucose, natural therapeutic agent.

1. INTRODUCTION

Herbal medicine is the oldest type of healthcare known to mankind. Herbs have been employed by every society throughout history. It was an essential component of the evolution of modern civilization. The plant and its parts are the vital source which supplies nutrients, clothes, shelter, and drugs. Most of the medicinalusage of plants appears to have evolved from observation and application in animals by trial and error. Over time, each tribe expanded its knowledge base to include the medical properties of the herbs in their area. Many

medications available today are of herbal origin. Herbal medications are used in a wide range of medical applications, including the treatment for common colds to cancer. The herbal medicinal lore was passed down from generation to generation through word of mouth[1].

Since time immemorial, natural resources such as plants, animals, microorganisms, minerals, and marine sources have serviced not just for basic human requirements but also for health treatment[2]. Botanical medicines are universal, yet disease ideas and medical systems change throughout cultures and ages. The widespread usage of herbal remedies and healthcare preparations, as documented in ancient literature such as the Veda and the Bible, can be traced back to the emergence of natural ingredients having medical characteristics. Civilized nations have bequeathed stories and compendiums of therapeutic herbs, and people from preliterate communities continue to astonish us with their extensive green pharmacy[3].

India is a medical plant varietal emporium, as well as one of the world's richest countries in terms of genetic resources. All known forms of agro climatic, ecological, and edaphic environments are found in India. India's biogeography is unusual, making it rich in all three categories of biodiversity, namely species variety, genetic diversity, and habitat diversity[4]

Nearly, 75% of the rural population still relies on herbal drugs for health related problems[5]. In recent years, herbal medicine has been shown to have some impressive qualifications. In India, around 2600 plant species are considered valuable in traditional medicinal systems such as Ayurveda, Unani, Siddha, and home cures. Both ancient literature and modern medicine offer a variety of herbal medications and their formulations for treating human illnesses[6].

The study of natural products offers advantages over synthetic drug design since it produces materials with novel structural characteristics and biological activity. Higher plants continue to be a major source of novel pharmaceuticals, and phytochemicals produced from them are particularly valuable as lead molecules for synthetic alterations and bioactivity optimization. Natural sources provide the beginning materials for around half of today's medicines. Almost every pharmacological class of drug contains a natural product prototype. Undoubtedly, the history of herbal therapy is intricately linked to that of contemporary medicine. Many compounds labelled as conventional pharmaceuticals are originated from plants[7].Higher plants have a promisingfuture because they are the best providers of therapeutic compounds for treatment of diseases[7].

In recent years, there has been increasing attention and interest in the use of traditional medicines worldwide, due to fewer side effects over allopathic drugs. There are numerous techniques in identifying new physiologically active constituents in higher plants. One such approach is systematic screening, which entails collecting, identifying, and cleaning plant materials, making crude extracts from specific parts of the plant materials, subjecting these crude extracts to biological screening of their desired assays, and beginning the process of isolating and characterizing the active chemical compound, which may result in the discovery of novel Phytopharmaceutical compounds.

Diabetes

A condition in which sugars, polymers of amino acids, and lipid metabolism is inadequately regulated as a result of a relative or absolute lack of insulin production, insulin resistance, or both at one or more locations in the complicated hormone action pathways[8]. It is an inherited or acquired inability to transfer sugar from the bloodstream into cells. Without enough insulin, the body's cells are unable to absorb enough glucose from the blood; as a result, blood glucose levels rise, a condition known as hyperglycemia. Hyperglycemia can harm vital organs such as the kidneys, liver, eyes, nerves, heart, and blood vessels[9].

Diabetes mellitus is a clinically and hereditarily diverse set of illnesses distinguished by abnormally high amounts of glucose in the blood. Hyperglycemia can be caused by a lack of insulin secretion, resistance to insulin, or a combination of both. Carbohydrate, lipid, and protein metabolism are often disrupted. Glucose metabolism involves the small intestine, pancreas, muscle cells, and liver. If any problem with any of these diabetes organs, it can lead to a deficiency in glucose metabolism and the development of diabetes. Polydipsia, Polyuria, and Polyphagia are the characteristic signs of diabetes. Polydipsia, or extreme thirst, is a way of replenishing the water content of tissues that have been depleted by Polyuria. Polyuria is caused by the amount of glucose in circulating blood, and the accumulation of ketone bodies in the blood serves as a diuretic. Insulin- dependent diabetic symptoms can develop quickly in youngsters, but type 2 diabetes symptoms may be modest or absent[10].

Complications Of Diabetes Mellitus

Diabetes complications classified as microvascular disease and macro vascular disease, Individuals with diabetes are two to four times more likely to have a stroke. Young people with diabetes have heart disease death rates that are two to four times higher than adults without diabetes. Diabetes is the leading cause of innovative blindness in persons aged 20-74. Diabetes is also the leading cause of kidney failure, responsible for 45 percentages of new cases in 2009. Diabetes accounted for more than 65 percentages of limb and foot amputations that were not caused by accidents or injuries. Nearly 80% of diabetic patients suffer from

hypertension, whereas 5-25% of hypertensive people are diabetes. Diabetics are more likely to have high blood pressure, which has been shown to exacerbate their cardiovascular problems[11].

Streptozotocin (Stz) Induced Diabetes Mechanism

Streptozotocin enters the B cell via a glucose transporter (GLUT2) and causes alkylation of DNA. DNA damage induces activation of poly ADP-ribosylation, a process that is more important for the diabetogenicity of streptozotocin than DNA damage itself. Poly ADP-ribosylation leads to depletion of cellular NAD+ and ATP. Enhanced ATP dephosphorylation after streptozotocin treatment supplies asubstrate for xanthine oxidase resulting in the formation of superoxide radicals. Consequently, hydrogen peroxide and hydroxyl radicals are also generated. Furthermore, streptozotocin liberates toxic amounts of nitric oxide that inhibitsaconitase activity and participates in DNA damage. As a result of the streptozotocin action, B cells undergo the destruction by necrosis[12].

Diabetes Mellitus: Treatment And Management

Diabetes treatment aims to lower and control blood glucose levels, as well as to reduce illness symptoms and consequences. Diabetes is best treated and managed through food and exercise; alternatively, diet combined with herbal or oral hypoglycemic medicines or insulin. It has been demonstrated that weight loss and increased daily energy expenditure reduce insulin resistance and improve glucose tolerance. In reality, guidance on nutrition and exercise are an important element of the treatment for type 2 diabetes[13].

2. PLANT PROFILE

Fig 1: ***Abutilon crispum plant***

Scientific Classification Of *Abutilon Crispum*

Kingdom	:	Plantae
Clade	:	Tracheophytes
Clade	:	Angiosperms
Clade	:	Eudicots
Clade	:	Rosids
Order	:	Malvales
Family	:	Malvaceae
Genus	:	Herissantia
Species	:	H. crispa
Binomial name	:	Herissantia crispa (L.) Brizicky
Synonyms	:	Abutilon crispum, Gayoides crispum

Abutilon crispum(Linn) belonging to family Malvaceae is trailing perennial, weak, sub shrub the stems flexuous, stellate-pubescent.

Leaves are ovate or cordate, crenate, up to 7-3x 2-3.5cm, acute, tomentose, lowers: 0.5-cm across, pale yellow, jointed above the middle. Calyxes 4-7 mm long. Fruits are schizocarp, globose, bladdery, wrinkled, hirsute, 1.5-2cm across. Seeds reniform, blackish-brown. The plant is commonly distributed in the shady forest undergrown on hilly slopes found throughout India, It is known as Nelabenda in local area[14].

USES

The plant is used in the traditional system of medicine. The leaves are used to cure asthma, piles, ulcers, cough, jaundice and diabetics by tribal people of South Indians and fruits are used in the treatment of piles in Tamilanadu.[15] The various parts of plant is reported to have numerous medicinal uses, the author has taken upthe plant *A.crispum* to give scientific evidence and so was evaluated for antioxidant and Anti-diabetic activity.

3. MATERIALS AND METHODS

Identification, Collection And Authentication Of The Selected Plant

The plant *Abutilon crispum* was authenticated by Botanical Survey of India, T.N.A.U. Campus, Coimbatore**.** Authentication Number: (BSI/SRC/5/23/2024-25/Tech-1004).

Procurement Of Plant Materials

For the present investigation, *Abutilon crispum* plants were collected from Bhavani. Fresh leaves were washed with water and dried at room temperature, powdered with laboratory mixer, sieved and further studies were performed.

PHARMACOLOGICAL STUDIES (In VIVO Antidiabetic Activity And Biochemical Study) Experimental diabetes

Male Wistar albino rats (180-220 g) were fasted overnight (12-14 h), and their weight and fasting bloodglucose levels were measured using a glucometer before being turned them diabetic with a single intraperitoneal injection of freshly prepared Streptozotocin (STZ) solution (50 mg/kg body weight). Streptozotocin (STZ) was weighed according to individual animal weight and solubilized with 0.5 mL of pH 4.5 sodium citrate before injection. The animals were given food and water 30 minutes following STREPTOZOTOCIN (STZ) administration. After diabetes induction, animals with blood glucose levels higher than 350 mg/dL were chosen for the investigation.

The selected animals were classified according to their body weight. The animals were given Standard Glibenclamide and selected leaf extracts orally for 28 days. Blood glucose levels were measured at the end of the 28-day trial period in all animals. The findings of the investigation were stated as follows:

METHODOLOGY

In vivo Anti diabetic activity of the Ethanolic extracts of *Abutilon crispum* leaves were used inthe present study to evaluate on experimental animals.

ANIMAL SPECIES	Albino wistar Rats
GENDER	Male
AGE	2-3 months
WEIGHT	180-220 gm

Animal GroupingDiabetes

The Male Albino wistar rats were split up into the subsequent five sets of 6 animals respectively:

GROUP	ANTIDIABETIC TREATMENT
Group –I: Normal control (No diabetes induction & No treatment)	Received only food and Albino wistar rats.
Group –II: Diabetic control (Only Diabetic induction &No treatment)	Received Only Diabetic induction Streptozotocin (STZ) 50mg/kg b.w. & No treatment.
Group- III:	Received Streptozotocin (STZ) 50mg/kg b.w +

Standard	Glibenclamide (0.5mg/kg b.wt).
Group – IV: Test group	Received Streptozotocin (STZ) 50mg/kg b.w + 200 mg/kg of Ethanolic extract of *Abutilon crispum* leaves
Group- V: Test group	Received Streptozotocin (STZ) 50mg/kg b.w + 400 mg/kg of Ethanolic extract of *Abutilon crispum* leaves

BIOCHEMICAL PARAMETERS

Estimation of SGOT (IFCC Method, 1986)

Methodology: IFCC Method

SGOT is an enzyme found mainly in heart muscle, liver cells, skeletal muscle and kidneys. When any of these organs is damaged or diseased, serum GOT levels rises. Elevated levels are associatedwith liver disease, myocardial infarction, muscular dystrophy and cholecystitis. The duration and extent of increase in level is proportional to the severity of attack. SGOT (ASAT) catalyzes the transfer of amino group between L-Aspartate and α-Ketoglutarate to form oxaloacetate and Glutamate. The oxaloacetate formed reacts with NADH in the presence of Malate dehydrogenase (MDH) to form NAD. The rate of oxidation of NADH to NAD is measured as a decrease in absorbance which is proportional to the SGOT (ASAT) activity in the sample.

$$\text{Aspartate} + \alpha\text{-Ketoglutarate} \xrightarrow{\text{SGOT}} \text{Oxaloacetate} + \text{L-lutamate}$$

$$\text{Oxaloacetate} + \text{NADH Malate} \xrightarrow{+\text{NAD}}$$

Assay Procedure

Set the parameters as per the kit protocol and the samples were prepared as shown in the table. Mixed well and measured the absorbance at 340nm after incubation at 37^0C for 60 seconds

Table 1: **Addition Sequences of SGOT Kit Reagents**

Pipette into test tubes	Volumes
Working reagent	1.0 ml
Sample	0.1ml

1. Estimation of SGPT (IFCC Method, 986) Methodology IFCC Method

SGPT is present in high concentrations in liver, kidneys, heart and skeletal muscle tissue. It is also present in lungs, spleen, pancreas, brain and erythrocytes at a lower concentration. Primary liver diseases (Cirrhosis, Viral or toxic hepatitis, Lymphoma, Obstructive Jaundice) as well as liver damage as secondary to other causes result in elevated SGPT levels. Slight elevation of the enzymes is also seen in Myocardial Infarction.

SGPT (ALAT) catalyzes the transfer of amino group between L-Alanineand α Ketoglutarate to form Pyruvate and Glutamate. The Pyruvate formed reacts with NADH in the presence of Lactate Dehydrogenase(LDH) to form NAD. The rate of oxidation of NADH to NAD is measured as a decrease in absorbance which is proportional to the SGPT (ALAT) activity in the sample.

$$\text{L-Alanine} + \alpha\text{ Ketoglutarate} \xrightarrow{\text{SGPT}} \text{Pyruvate} + \text{Glutamate.}$$

$$\text{Pyruvate} + \text{NADH acetate} + \text{NAD}^+ \xrightarrow{} \text{LDH}$$

2. Determination of Serum Alkaline Phosphatase (SALP)

The alkaline phosphates level was estimated by p-Nitrophenyl phosphate (PNPP) method. The determination of the activity of alkaline phosphatase in serum based on the hydrolysis of p- nitrophenyl phosphate (PNPP) by the enzyme with the formation of free p- nitrophenol. This compound was yellow in alkaline solution. The formation of yellow colour can be spectrophotometrically readapt 405 nm, which was directly proportional to the enzymatic activity of alkaline phosphatase in serum / plasma.

$$\text{PNPP} + H_2O \xrightarrow{\text{Alkaline Phosphatase}} \text{P- nitrophenol} + \text{Phosphate}$$

The method has been recommended by the German Society of Clinical Chemistry and by the committee on enzyme of the Scandinavian Society of Clinical Chemistry and Clinical Physiology.

3. Measurement of Lipid Peroxidation (LPO)

The concentration of thiobarbituric acid reactive substances (TBARS) was measured (lipid peroxidation product maondialdehyde (MDA) was estimated) in liver using the method of Okhawa *et al.*, (1979) [51]. One ml of the sample was mixed with 0.2 ml 4 % (w/v) sodium dodecyl sulfate, 1.5 ml 20% acetic acid in
0.27 M hydrochloric acid (pH 3.5) and 15 ml of 0.8% thiobarbituric acid (TBA, pH 7.4). The mixture was heated in a hot water bath at 85˚C for 1 hour. The intensity of the pink colour developed was read against areagent blank at 532 nm following centrifugation at 1200 g for 10 minutes. The concentration was expressed as *n* moles of MDA per mg of protein using 1,1,3,3,-tetra-ethoxypropane as the standard.

4. Determination of Glutathione- Peroxidase activity:

The reaction mixture contained 0.1 M reduced glutathione, 10 U/ml of glutathione reductase, 2 mM nicotinamide adenine dinucleotide phosphate reduced (NADPH), 0.05 M phosphate buffer (pH 7.0) and 7 Mm t-butyl hydroperoxide. Decrease in absorbance of NADPH was measured as GPx activity at 340 nm. One unit of GPx is equal to the number of nano moles of NADPH oxidized/utilized per minutes at 25˚C.

4. RESULTS AND DISCUSSION

PHARMACOGNOSTIC EVALUATION OF *ABUTILON CRISPUM* LEAVES

The macroscopy and microscopy of *Abutilon crispum leaves* were examined in this assessment. The following displays the findings from the investigations:

Macroscopical Evaluation

Organoleptic Characters

The plant's leaf was examined for its colour, flavour, and other organoleptic characteristics. The study's findings were displayed as follows:

Color	-	Greenish
Taste	-	Bitter
Odour	-	Characteristic

Microscopical Evaluation

Transverse section of *Abutilon crispum*

Petiole

- Petiole is covered with numerous stellate trichomes.
- The cortical tissues are formed of parenchymatous and collenchymatous cells.
- The rows of vascular bundles are surrounded by a group of rosette crystals, scattered in the parenchymatous tissues.

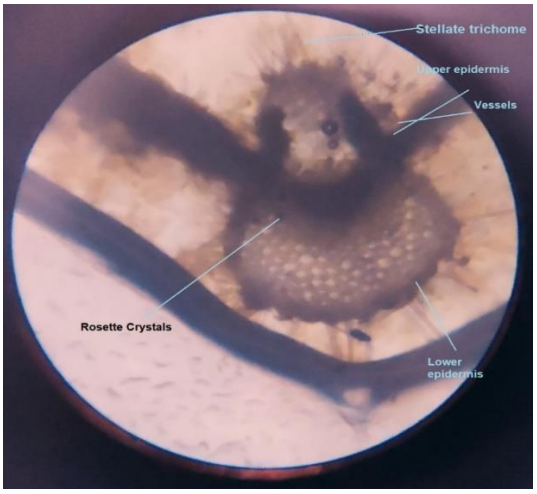

Fig 2: T.S. of *Abutilon Crispum* leaves

Midrib

- A single row of rectangular upper epidermal cells consists of group of stellate trichomes.
- Centre portion of midrib consists of xylem and phloem cells.
- Rosette crystals are scattered in the xylem and phloem region.

- Lower epidermal cells have greater number of stellate trichomes.

Lamina

- Bunches of stellate trichomes are visible in upper epidermis and more in lower epidermis.
- Mesophylls consists of rosette crystals and spongy parenchyma.

Stomatal Number and Stomatal Index

Actinocytic Stomata are present in *Abutilon crispum* leaves

Table 2: Stomatal Number and Stomatal Index on lower surface of the *Abutilon crispum* leaves

No. of Observation	No. of Stomata per Unit area (S) (40x)	No. of Epidermal cells (E) (40x)	$S.I. = \frac{S}{E+S} \times 100$
1	23	72	18.90%
2	17	66	
3	16	76	
4	12	87	
5	18	79	
6	22	73	
7	16	84	
8	23	73	
9	15	83	
10	17	75	
Total	179	768	

PRELIMINARY PHYTOCHEMICAL ANALYSIS OF *ABUTILON CRISPUM* LEAVES EXTRACT

Preparation of extracts

By using ethanolic leaves extracts of *Abutilon crispum* were dried and evaporated. Ethanolic extract of *Abutilon crispum* leaves colour, consistency and percentage yields were noted in the table.

Table 3: % yield and physical appearance of Ethanolic extracts of leaves of *Abutilon crispum*

S. No.	Extract	% Dry weight	Colour	Consistency
1.	Ethanolic Extract	12.4%w/w	Dark green	Resinous

Qualitative phytochemical screening

Here, Ethanolic Extracts of the leaves of *Abutilon crispum were* subjected to preliminaryphytochemical tests and responded positively for the presence of carbohydrates, proteins, flavanoids, phenolic and tannins, glycosides, steroids terpenoids and alkaloids.

Table 4: Preliminary Phytochemical Evaluation of *Abutilon crispum*

Test	Ethanolic extract
Carbohydrates	
Molish test	+
Fehlings test	+
Benedicts test	+
Barfoed test	-
Flavonoids	
Shinoda test	+
Alkaline test	+
Extract+NaoH	+
Extract+lead acetate	+
Proteins	
Biurat test	-
Millon's	+
Aminoacids	

Ninhydrine test	-
Steroids- Terpenoids	
Salkowski Reaction	+
Liebermann-burchard Reaction	+
Phenolics and Tannins	
ferric chloride test	+
lead acetate test	+
Alkaloids	
Mayer's test	-
Hager's test	-
Dragendorff	-
Wagner's	-
Glycosides	
Keller-killiani test	+
Brontrager test	-

' + ' Positive ' – ' negative

The preliminary phytochemical evaluation of *Abutilon crispum* leaves revealed the presence of several key bioactive compounds, including significant levels of alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolic compounds. Alkaloids Present in significant amounts, which are linked to various pharmacological activities. while flavonoids exhibit strong antioxidant activity, contributing to the plant's potential in reducing oxidative stress and chronic disease risk. Tannins provide astringent and antimicrobial effects, whereas saponins may support cardiovascular health through cholesterol-lowering effects. Terpenoids reinforce anti-inflammatory benefits, and high phenolic content enhances overall antioxidant capacity. The phytochemical evaluation confirms that *Abutilon crispum* is a rich source of bioactive compounds with considerable health benefits.

ANTI-DIABETIC ACTIVITY OF *ABUTILON CRISPUM* LEAVES EXTRACT

Table 5: Anti-Diabetic Activity of Ethanolic Extracts of *Abutilon crispum* Leaves on blood glucose level in Streptozotocin (STZ) - induced diabetic rats

TREATMENT	Blood Glucose level (mg/dl)				
	0 day	7th day	14th day	21st day	28th day
Group-I Normal control	**79.33±2.9**	**80.50±2.78**	**82.83±5.30**	**84.50±4.59**	**83.5±2.16**
Group-II Diabetic control Streptozotocin (STZ) (50mg/kg)	**252.83±6.86**	**268.33±3.26#**	**277.16±.4.74#**	**292.16±6.40#**	**295.50±1.26#**
Group-III Standard Drug Glibenclamide (5mg/kg)	**254.50±1.24**	**188.83±6.18*** **	**141.33±5.09*** **	**128.50±2.40*** **	**108.33±3.18*** **
Group-IV Ethanolic Extractsof *Abutilon crispum* Leaves (200mg/kg)	**255.50±4.29**	**218.33±3.54***	**191.5±2.08***	**166.33±1.86*** **	**164±1.04*** **
Group-V Ethanolic Extractsof *Abutilon crispum* Leaves (400mg/kg)	**258.16±6.49**	**213.50±3.36***	**178.16±2.72****	**155.66±2.13*** **	**126.53±2.78*** **

All the values are expressed as mean ± SEM n=6 in each group.
Data Analyzed by ONE WAY ANNOVA followed by Dunnett's multiple comparison test.
#P<0.001 : significant difference from diabetic control from normal control.
**P<0.05; **P<0.01; ***P<0.001. compared with respective diabetic control.*

The results from the anti-diabetic activity of the ethanolic extracts of Abutilon crispum leaves on blood glucose levels in streptozotocin (STZ)-induced diabetic rats show a significant reduction in blood glucose over time, particularly when compared to the diabetic control group. The study included five groups: a normal control group, a diabetic control group, a standard drug group treated with Glibenclamide (5 mg/kg), and two experimental groups treated with Abutilon crispum ethanolic extracts at doses of 200 mg/kg and 400 mg/kg.

Comparison with Diabetic Control

The diabetic control group (Group II), which received STZ (50 mg/kg) without treatment, showed a progressive increase in blood glucose levels from 252.83 ± 6.86 mg/dL on day 0 to 295.50 ± 1.26 mg/dL by day 28. This rise in glucose levels over time illustrates the hyperglycemic state induced by STZ and provides a baseline for comparing the effectiveness of the treatments. In contrast, both groups treated with the ethanolic extracts of Abutilon crispum leaves (Groups IV and V) demonstrated a significant reduction in blood glucose levels. At the lower dose (200 mg/kg), the extract reduced glucose levels from 255.50 ± 4.29 mg/dL on day 0 to 164.00 ± 1.04 mg/dL by day 28. At the higher dose (400 mg/kg), the reduction was more pronounced, with glucose levels dropping from 258.16 ± 6.49 mg/dL to 126.53 ± 2.78 mg/dL by day 28. The statistical significance of these reductions was confirmed by ANOVA followed by Dunnett's multiple comparison test, with p-values of $p < 0.05$ for day 7, $p < 0.01$ for day 14, and $p < 0.001$ for days 21 and 28. These results suggest that the extract exhibits dose-dependent anti-diabetic effects, with the higher dose being more effective in controlling blood glucose.

Comparison with Standard Drug

The Glibenclamide group (Group III), which served as the standard treatment, showed the most significant glucose reduction, starting at 254.50 ± 1.24 mg/dL on day 0 and dropping to 108.33 ± 3.18 mg/dL by day 28. The statistical analysis reveals that this reduction is highly significant throughout the study, with $p < 0.001$ at each time point. Although Glibenclamide outperformed both doses of the Abutilon crispum extract, the high-dose extract (400 mg/kg) approached the efficacy of the drug by the end of the experiment, particularly on days 21 and 28, where the blood glucose levels reached 155.66 ± 2.13 mg/dL and 126.53 ± 2.78 mg/dL, respectively. Overall, the ethanolic extract of Abutilon crispum leaves exhibits significant anti-diabetic activity, reducing blood glucose levels in STZ-induced diabetic rats in a dose-dependent manner. While the extract at 400 mg/kg is not as potent as the standard drug Glibenclamide, it shows promising glucose-lowering effects, especially in the long term. These findings suggest that Abutilon crispum leaves could serve as a natural alternative for managing diabetes, particularly when used in higher doses.

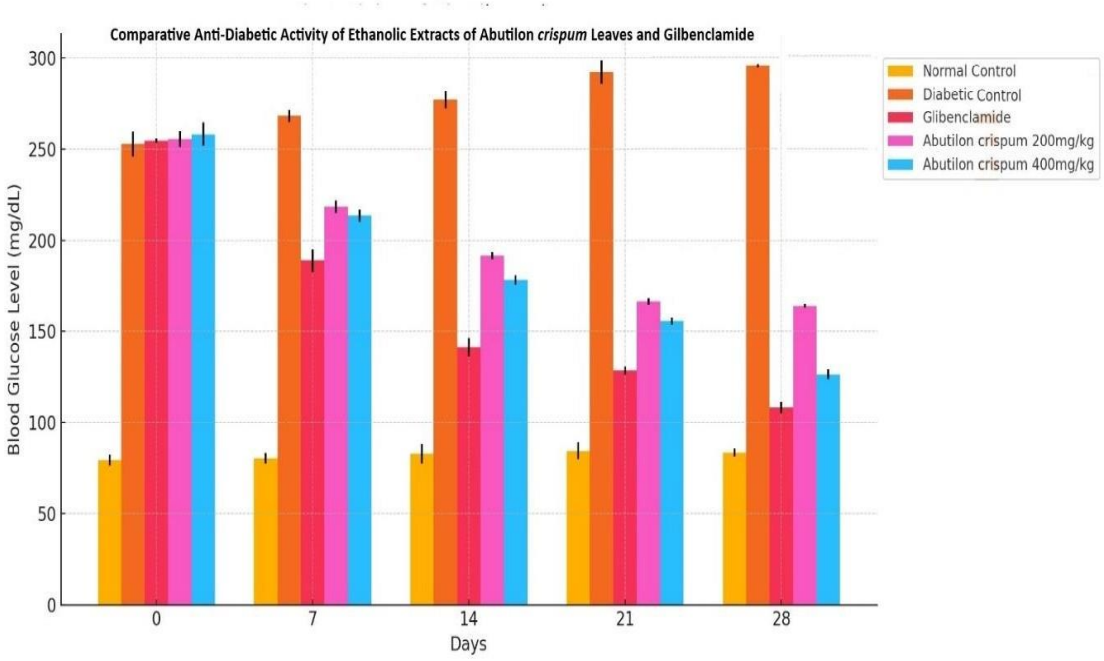

Fig 3: Anti-Diabetic Activity of Ethanolic Extracts of *Abutilon crispum* Leaves on blood glucose level in Streptozotocin (STZ) - induced diabetic rats

Table 6: Effect of Ethanolic Extracts of *Abutilon crispum* Leaves on serum biochemical parameter in streptozotocin induced diabetic rats

Treatment	SGOT (IU/L)	SGPT (IU/L)	Alkaline Phosphatase (IU/L)	%Lipid Peroxidation	GPx (U/mg)
Group-I Normal control	56.25±4.11	42.51±3.02	97.75±4.13	59±1.87	8.58±0.25
Group-II Diabetic control	110.50±5.62	72.50±2.53	142.00±3.34	98.00±2.38	5.38±0.21
Group-III Glibenclamide (5mg/kg)	68.25±3.90	50.75±2.84	123.23±6.48	70.65±1.25	6.78±0.14***
Group-IV Ethanolic Extracts of *Abutilon crispum* Leaves (200mg/kg)	77.50±4.74	54.75±3.38	124.98±3.37	73.72±2.52	6.02±0.72**
Group-V Ethanolic Extracts of*Abutilon crispum* Leaves (400mg/kg)	68.50±2.60	53.5±3.12	103.7±5.48	63.75±2.20	7.83±0.28***

Values are expressed as mean ± SEM, n=6. [a] P<0.05; [b] P<0.01; [c] P<0.001 Vs Group I. [d] P<0.05; [e] P<0.01; [f] P<0.001 Vs Group II. Data were analyzed by one way ANOVA followed by post hoc Dunnett's multiple comparison tests.

The results from the study examining the effects of ethanolic extracts of Abutilon crispum leaves on serum biochemical parameters in streptozotocin (STZ)-induced diabetic rats indicate significant improvementsin liver function markers. The key biochemical parameters examined were SGOT (serum glutamic-oxaloacetic transaminase), SGPT (serum glutamic-pyruvic transaminase), and alkaline phosphatase, all of which are important indicators of liver function and damage.

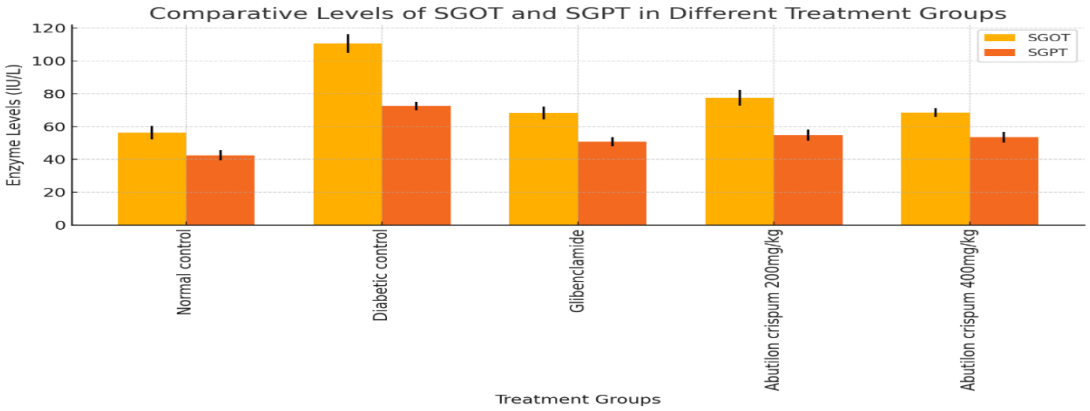

Fig 4

SGOT (Serum Glutamic-Oxaloacetic Transaminase)

In the normal control group (Group I), SGOT levels were 56.25 ± 4.11 IU/L, reflecting normal liver enzyme levels. However, in the diabetic control group (Group II), there was a significant rise in SGOT to 110.50 ± 5.62 IU/L, indicating liver damage due to STZ-induced diabetes ($p < 0.001$). Treatment with Glibenclamide (Group III) resulted in a significant reduction in SGOT to 68.25 ± 3.90 IU/L ($p < 0.001$ vs Group II), demonstrating the effectiveness of the standard drug in mitigating liver damage.

Similarly, treatment with the ethanolic extract of Abutilon crispum at 200 mg/kg (Group IV) and 400 mg/kg (Group V) also reduced SGOT levels to 77.50 ± 4.74 IU/L and 68.50 ± 2.60 IU/L, respectively. The higher dose (400 mg/kg) produced a reduction comparable to Glibenclamide ($p < 0.05$ vs Group II), indicating that Abutilon crispum has a protective effect on liver function, especially at higher doses.

SGPT (Serum Glutamic-Pyruvic Transaminase)

SGPT levels followed a similar trend. In the normal control group, SGPT was 42.51 ± 3.02 IU/L, whilein the diabetic control group, it rose to 72.50 ± 2.53 IU/L ($p < 0.001$). Treatment with Glibenclamide significantly reduced SGPT levels to 50.75 ± 2.84 IU/L ($p < 0.001$ vs Group II), demonstrating the drug's abilityto restore liver enzyme balance.

The ethanolic extract of Abutilon crispum also reduced SGPT levels, with the 200 mg/kg dose bringingit down to 54.75 ± 3.38 IU/L, and the 400 mg/kg dose further reducing it to 53.50 ± 3.12 IU/L. Both doses showed

significant reductions ($p < 0.05$ vs Group II), with the higher dose nearing the effectiveness of Glibenclamide. These results suggest that Abutilon crispum extract can alleviate liver stress caused by diabetes, similar to the standard anti-diabetic drug.

Alkaline Phosphatase

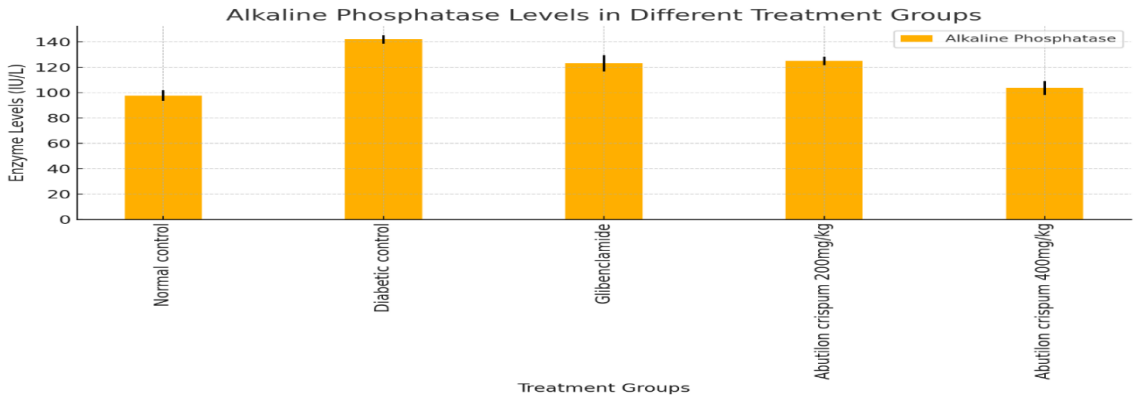

Fig 5

Alkaline phosphatase is another important enzyme related to liver function, and it was elevated in the diabetic control group (142.00 ± 3.34 IU/L) compared to the normal control group (97.75 ± 4.13 IU/L, $p < 0.001$). Glibenclamide treatment reduced alkaline phosphatase levels to 123.23 ± 6.48 IU/L ($p < 0.001$ vs Group II), indicating improved liver function.

The ethanolic extract of Abutilon crispum at 200 mg/kg resulted in a decrease in alkaline phosphatase levels to 124.98 ± 3.37 IU/L ($p < 0.05$ vs Group II), while the 400 mg/kg dose reduced it to 103.7 ± 5.48 IU/L ($p < 0.01$ vs Group II). The higher dose (400 mg/kg) showed a more pronounced effect, approaching the levels observed in the normal control group. These results indicate that Abutilon crispum extract not only improves glucose metabolism but also helps protect liver function by lowering elevated alkaline phosphatase levels in diabetic rats.

In summary, the ethanolic extracts of Abutilon crispum leaves demonstrated a dose-dependent protective effect on liver function, as evidenced by the reduction in SGOT, SGPT, and alkaline phosphatase levels in STZ-induced diabetic rats. The 400 mg/kg dose was particularly effective, showing results comparable to the standard drug Glibenclamide. These findings suggest that Abutilon crispum leaves have hepatoprotective properties, in addition to their anti-diabetic activity, and could be beneficial in managing liver dysfunction associated with diabetes.

The results of the study examining the effects of ethanolic extracts of *Abutilon crispum* leaves on serum biochemical parameters in streptozotocin (STZ)-induced diabetic rats show significant improvements in oxidative stress markers, such as lipid Peroxidation and Glutathione Peroxidase (GPx) levels. These markers are critical in understanding the antioxidant capacity of the extracts and their ability to mitigate oxidative damage caused by diabetes.

Lipid Peroxidation (%)

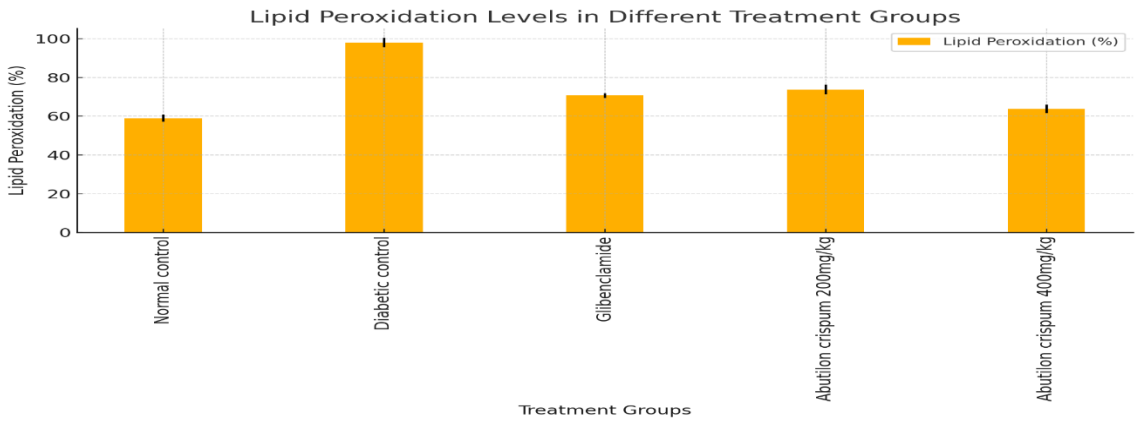

Fig 6

Lipid peroxidation is a key indicator of oxidative stress and cell membrane damage. In the normal control group (Group I), lipid peroxidation was 59.00 ± 1.87%, reflecting normal oxidative status. In the diabetic control group (Group II), lipid peroxidation significantly increased to 98.00 ± 2.38% ($p < 0.001$ vs Group I), indicating elevated oxidative stress due to diabetes. This rise suggests that STZ-induced diabetes leads to excessive free radical production and lipid peroxidation. Treatment with the standard anti-diabetic drug Glibenclamide (Group III) reduced lipid peroxidation to 70.65 ± 1.25% ($p < 0.001$ vs Group II), showing its efficacy in reducing oxidative stress. Similarly, *Abutilon crispum* extracts also demonstrated a dose-dependent reduction in lipid peroxidation. The 200 mg/kg dose (Group IV) reduced lipid peroxidation to 73.72 ± 2.52% ($p< 0.001$ vs Group II), while the 400 mg/kg dose (Group V) lowered it further to 63.75 ± 2.20% ($p < 0.001$ vs Group II). The high-dose extract showed a reduction similar to Glibenclamide, indicating that *Abutilon crispum* possesses potent antioxidant properties that help in minimizing lipid peroxidation and oxidative damage in diabetic rats.

Glutathione Peroxidase (GPx)

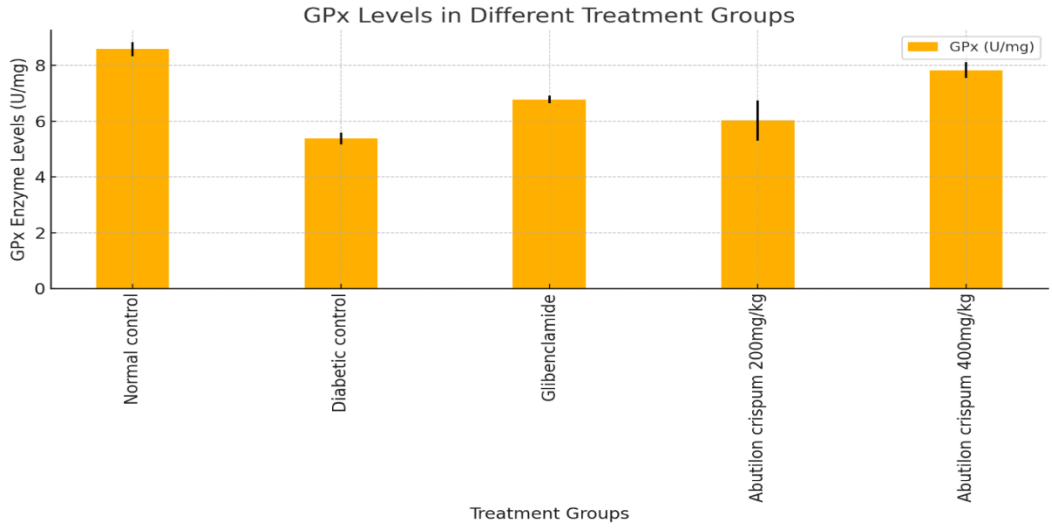

Fig 7

Glutathione peroxidase is another critical antioxidant enzyme that protects cells by reducing lipid hydroperoxides and hydrogen peroxide. In the normal control group, GPx levels were 8.58 ± 0.25 U/mg, indicating robust antioxidant activity. In the diabetic control group, GPx activity was significantly reduced to 5.38 ± 0.21 U/mg ($p < 0.001$ vs Group I), reflecting compromised antioxidant defenses in STZ-induced diabetic rats. Glibenclamide treatment significantly restored GPx activity to 6.78 ± 0.14 U/mg ($p < 0.001$ vs Group II). The ethanolic extract of *Abutilon crispum* also improved GPx levels, with the 200 mg/kg dose raising GPx activity to 6.02 ± 0.72 U/mg ($p < 0.01$ vs Group II) and the 400 mg/kg dose further increasing it to 7.83 ± 0.28 U/mg ($p < 0.001$ vs Group II). The higher dose showed results close to the normal control group, indicating that *Abutilon crispum* leaves can significantly enhance GPx activity, protecting cells from oxidative damage by improving the body's antioxidant capacity. Overall, the ethanolic extracts of *Abutilon crispum* leaves demonstrated significant antioxidant effects in STZ-induced diabetic rats by reducing lipid peroxidation and enhancing the activity of key antioxidant enzymes such as catalase and glutathione peroxidase. The higher dose of *Abutilon crispum* (400 mg/kg) was particularly effective, showing results comparable to the standard drug Glibenclamide. These findings suggest that *Abutilon crispum* has potent antioxidant properties, which can help mitigate oxidative stress and protect against diabetes-related complications.

5. SUMMARY AND CONCLUSION

The pharmacognostical study is a major and reliable criterion of identification of plant drugs. The pharmacognostic parameters are necessary for confirmation of the identity and determination of quality and purity of a crude drugs.

The present study may be useful to supplement information in respect to its identification, authentication and standardization of herbal drugs. In other words, the pharmacognostic features in this study may serve as a valuable source of information tool for identification of the plant for validation of the raw material and for standardization of its formulations at herbal industrial level in the coming days. Studies on physico-chemical constants can serve as a valuable source of information and provide suitable standards to determine the quality of this plant.

The preliminary phytochemical evaluation of *Abutilon crispum* leaves revealed the presence of several key bioactive compounds, including significant levels of alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolic compounds. These phytochemical evaluation confirms that *Abutilon crispum* is a rich source of bioactive compounds with considerable health benefits.In the nitric oxide assay, the extract's performance improved notably at higher doses, indicating its potential as a natural alternative for free radical scavenging.

The study of the ethanolic extracts of *Abutilon crispum* leaves in streptozotocin (STZ)-induced diabetic rats presents promising insights into the plant's potential as a natural anti-diabetic and hepatoprotective agent. The observed effects on blood glucose regulation, liver function, and oxidative stress suggest that *Abutilon crispum* could play a significant role in managing diabetes and its associated complications.

The ethanolic extracts showed a notable reduction in blood glucose levels, particularly at higher doses, indicating dose-dependent anti-diabetic properties. This glucose-lowering effect, comparable to the standard drug Glibenclamide at higher concentrations, suggests that *Abutilon crispum* may serve as a natural alternative for diabetes management. Additionally, the improvement in liver function, as evidenced by the reductions in liver enzymes like SGOT, SGPT, and alkaline phosphatase, points to the extract's hepatoprotective properties, offering protection against liver damage commonly seen in diabetic conditions.

Oxidative stress plays a crucial role in the progression of diabetes and its complications. The study's findings highlight that *Abutilon crispum* extracts significantly reduce oxidative stress by decreasing lipid peroxidation and enhancing the activities of key antioxidant enzymes like glutathione peroxidase (GPx). These effects suggest that the plant extract not only helps in controlling blood glucose but also improves the body's antioxidant defenses, reducing the risk of diabetes-related complications such as cardiovascular disease and neuropathy.

Future research could focus on isolating and characterizing the bioactive compounds in *Abutilon crispum* responsible for its anti-diabetic and antioxidant effects. Understanding the mechanisms of action could lead to the development of targeted therapeutic agents based on the plant's components. Additionally, longer-term studies involving larger sample sizes and different animal models or clinical trials in humans would be beneficial to further validate the efficacy and safety of *Abutilon crispum* extracts.

Another potential area of exploration could involve investigating the synergistic effects of *Abutilon crispum* when combined with other natural anti-diabetic agents or standard drugs, which could enhance its therapeutic potential. Moreover, studying the plant's effects on other diabetes-related parameters, such as lipid profiles and insulin sensitivity, could provide a more comprehensive understanding of its benefits.

In conclusion, the study paves the way for considering *Abutilon crispum* as a valuable natural resource in the fight against diabetes, with significant potential for further development into therapeutic applications.

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