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Pharmacological Evaluation of Abutilon hirtum Leaves: Anti-diabetic, Anti-Inflammatory and Anti-oxidant Properties

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Abstract

The *Abutilon hirtum*, it is an medicinal plant belonging to the *malvaceae* family. Which is also known to be Indian mallow. It has anti-inflammatory, anti-bacterial, and wound-healing qualities, it has been utilized and frequently found in tropical and subtropical areas. *Abutilon hirtum* known for its bioactive compounds with health-promoting effects. This research is carried out to analyse the therapeutic uses through the *in-vitro* studies. This analysis confirmed the antioxidant, anti-inflammatory, and antidiabetic potential of *Abutilon hirtum*, indicating its possible role in preventing chronic diseases. Research into the antioxidant properties of *Abutilon hirtum* using the DPPH assay revealed that the plant is highly effective at neutralizing free radicals and protecting the body from oxidative stress. Its strong anti-inflammatory effects were evident through its ability to stabilize cell membranes and prevent protein denaturation, key factors in managing inflammation-related conditions. The plant also showed promising anti-diabetic potential by inhibiting the enzymes α-amylase and α-glucosidase, which play major roles in blood sugar regulation. These findings not only support its traditional use in herbal medicine but also suggest that *Abutilon hirtum* could be a valuable natural option for managing chronic diseases. However, further research is essential to fully understand and unlock its therapeutic benefits.

1. INTRODUCTION

Developing interest on plant-based therapies has brought attention to the potential medical benefits of several underutilized plants. *Abutilon hirtum* belonging to *Malvaceae* family, often known as Indian mallow, has known for its pharmacological uses in traditional medicine. Which grows in tropical and subtropical areas, has been usedd for its anti-inflammatory, anti-diabetic, and wound-healing qualities for several decades. It has bioactive substance, including flavonoids, phenolics, tannins, and alkaloids, which enhance its medicinal effectiveness. (Sharma et al., 2020).

The anti-inflammatory properties of this plant are especially important during the fight against diseases related to chronic inflammation. This results from the plant's capacity to stabilize cell membranes and suppress inflammatory mediators (Patel et al., 2018). These mechanisms provides a natural way to treat ailments including disease conditions like arthritis and other illnesses brought on by inflammation. Further, the plant has potential anti-diabetic properties, which is useful for the diabetes treatment. This plants leaf extracts has shown that the plant can successfully used to control the blood glucose levels by inhibiting essential enzymes that helps to break down carbohydrates, like α-amylase and α-glucosidase (Ravi et al., 2019).

The anti-oxidant activity of *Abutilon hirtum* is essential for scavenging free radicals, reduce oxidative damage among the cells, and helps to avoid the chronic health or disease conditions like cancer and cardiovascular diseases. According to Kumar et al., (2016), along with the plant's medicinal adaptability, it demonstrates to address potential health issues in our day to day life. This study analyse and evaluate the therapeutic uses of the *Abutilon hirtum* leaves, such as their anti-inflammatory, anti-diabetic, and antioxidant activities.

2. MATERIALS AND METHODS

The current study was handled to analyse and evaluate the *In vitro* anti oxidant activity, *In vitro* Anti inflammatory activity, *In vitro* anti-diabetic activity of the *Abutilon hirtum leaves.*

2.1 Collection of the sample :

The *Abutilon hirtum* (Lam.) Sweet leaves were collected from the nearby villages of the Tirupur district. The leaves selected is to be fresh. The dried or unmatured are to be avoided. These leaves are used to treat diseases like kidney gravel pain, diarrhoea, coughing, toothaches, bladder inflammation, wounds, and ulcers, as well as as an antipyretic, demulcent, diuretic, and mouthwash.

2.2 In vitro anti-oxidant study of the Fresh Abutilon hirtum leaves

DPPH radical scavenging activity:

Compounds known as antioxidants scavenge free radicals and guard against oxidative damage. They render free radicals innocuous by providing them with an electron. By slowing down the lipid peroxidation process, which is the primary reason why food products deteriorate during processing and storage, antioxidants increase the shelf life. Using the DPPH radical scavenging test (DPPH), the antioxidant capacity of fresh *Abutilon hirtum* (Lam) Sweet leaves was evaluated.

The extract's antioxidant activity was assessed by Blois (1958) using the stable radical DPPH to gauge its ability to scavenge radicals or donate hydrogen. Sample extracts were taken at various concentrations, and the volume was adjusted to 100 µL using methanol. Before being shaken quickly, the aliquots of the samples and standards (BHA, BHT, rutin, and quecertin) were combined with around 5 mL of a 0.1 mM methanolic solution of DPPH. The negative control was 5 mL of 0.1 mM methanol solution DPPH with 100 µL of methanol added. The tubes were allowed to stand at 27°C for 20 minutes. The sample's absorbance at 517 nm was measured and compared to the blank (methanol).

2.2 *In vitro* Anti inflammatory activity of fresh *Abutilon hirtum*(Lam.) Sweet leaves

Heat-Induced Hemolysis:

The method was previously described in detail by Shinde et al., (1999), and it was somewhat modified by Henneh et al., (2018). The reaction mixture (2 ml) was added to each tube and gently mixed. It contained 1.0 ml of 10% HRBC and 1 ml of various solvent plant extracts (1 mg/ml). The positive control was 1.0 ml of HRBC and 1.0 ml of diclofenac sodium at varying doses (10 to 50 µg/ml). The negative control consisted of one millilitre of normal saline and one millilitre of 10% erythrocyte suspension. The

experiment was repeated three times. The resulting solution was heated to 56° C for 30 minutes, then allowed to cool to room temperature before being centrifuged for 10 minutes at 2500 rpm.

Each solution's absorbance was measured spectrophotometrically (using a Shimadzu UVmini 1240) at 560 nm following the collection of the supernatant in order to ascertain the degree of hemolysis. The formula was used to calculate the percentage of hemolysis inhibition.

$$\text{Percentage of inhibition} = \frac{Ac - At}{Ac} \times 100$$

Where ‘Ac’ is absorbance of control and ‘At’ is absorbance of the test.

2.3 *In vitro* anti-diabetic activity of fresh *Abutilon hirtum (* L am. *)* Sweet leaves

Inhibition assay for α-amylase activity:

Once extract was combined with α-amylase at varying doses (50–200 µg/mL), starch was added as a substrate (0.5% starch solution) to start the reaction. The reaction was halted by introducing two milliliters of DNS (3,5-dinitrosalicylic acid) reagent after five minutes at 37°C. Ten milliliters of distilled water were added to the reaction mixture in an ice bath after it had been heated to 100°C for fifteen minutes (Miller, 1959). The α-amylase activity was measured using the spectra at 540 nm. The IC50 value is the amount of α-amylase inhibitor required to inhibit 50% of its activity under test circumstances.

3. RESULT

3.1 *In vitro* Antioxidant activity of fresh *Abutilon hirtum* leaves

Table 3.1
DPPH radical scavenging activity of *Abutilon hirtum*

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Abutilon hirtum	50µl	6.46	72.59
	100µl	20.5	
	150µl	34.23	
	200µl	40.27	
	250µl	61.05	
Rutin	5µl	15.14	4.44
	10µl	19.36	
	15µl	36.61	
	20µl	59.97	
	25µl	76.05	
BHT	5µl	18.89	5.56
	10µl	34.27	
	15µl	44.71	
	20µl	63.84	
	25µl	67..13	

From the Table 3.1 presents the antioxidant activity of *Abutilon hirtum* leaves, Rutin, and BHT (Butylated Hydroxytoluene) using the DPPH radical scavenging assay. *Abutilon hirtum* exhibits a gradual increase in inhibition, reaching 61.05% at 250 µl, with an IC_{50} value of 72.59 µg/mL, indicating moderate antioxidant potential. Rutin, a known antioxidant, shows superior activity with 76.05% inhibition at 25 µl and a much lower IC_{50} of 4.44 µg/mL. BHT also demonstrates good antioxidant capacity, achieving 67.13% inhibition at 25 µl with an IC_{50} of 5.56 µg/mL.

The plant extract's ability to scavenge radicals is probably aided by the presence of flavonoids and polyphenols. Variations in extraction techniques, solvent systems, or sample concentrations could be the cause of the fluctuation in IC_{50} values. These results provide credence to *A. hirtum*'s therapeutic efficacy and call for more research into its bioactive components for use in medicine.

3.2 *In vitro* anti inflammatory activity of fresh *Abutilon hirtum* leaves :

Table 3.2
% Scavenging Activity IC50 of fresh *Abutilon hirtum*

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Abutilon hirtum	50µl	18.82	71.05
	100µl	33.25	
	150µl	42.75	
	200µl	48.44	
	250µl	54.07	
Diclofenac	50µl	47.43	27.92
	100µl	51.05	
	150µl	56.38	
	200µl	63.71	
	250µl	70.45	

From Table 3.2 In comparison to the common medication diclofenac (50–150 µL), the table shows the in vitro anti-inflammatory activity of fresh extracts from *Abutilon hirtum* leaves at different concentrations (50–250 µL). For both diclofenac and *Abutilon hirtum*, the percentage suppression of inflammation rises with concentration. The maximal inhibition of *Abutilon hirtum* is 54.07% at 250 µL, whereas diclofenac exhibits a little greater inhibition of 56.38% at 150 µL. In terms of scavenging activity, *Abutilon hirtum*'s IC_{50} (half-maximal inhibitory concentration) is 71.05 µg/mL, suggesting a moderate antioxidant potential, in contrast to diclofenac's IC_{50} of 27.92 µg/mL, which indicates a better scavenging efficacy. *A. hirtum* contains flavonoids, sterols, and phenolic acids, which perhaps help explain some of its anti-inflammatory qualities. Although both studies support its efficacy, variations in inhibition percentages could be explained by different methodologies. According to the results, *A. hirtum* shows promise as a natural anti-inflammatory. To investigate its bioactive components and therapeutic application processes, more research is required.

3.3 *In vitro* anti diabetic activity of the fresh *Abutilon hirtum leaves* :

Table 3.3
In vitro anti diabetic activity of the fresh *Abutilon hirtum* leaves

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Abutilon hirtum	50µl	10.08	119.48
	100µl	16.99	
	150µl	25.11	
	200µl	31.27	
	250µl	37.57	
Acarbose	10µl	13.81	12.53
	20µl	28.70	
	30µl	43.66	
	40µl	52.53	
	50µl	64.72	

The Table 3.3 shows the in vitro anti-diabetic activity of fresh *Abutilon hirtum* leaf extracts compared to acarbose, a standard anti-diabetic drug, by measuring the percentage of inhibition at various concentrations (50–250 µL for *Abutilon hirtum* and 10–50 µL for acarbose). The inhibition percentage for *Abutilon hirtum* increases with concentration, reaching a maximum of 37.57% at 250 µL. Acarbose shows a stronger inhibition, with 64.72% at 50 µL. The IC_{50} value for *Abutilon hirtum* is 119.48 µg/mL, indicating a lower potency compared to acarbose, which has an IC_{50} of 12.53 µg/mL. This suggests that although *Abutilon hirtum* possesses anti-diabetic potential, acarbose is significantly more effective in this activity based on the IC_{50} values and inhibition percentages.

3.4. Discussion:

In the current study has evaluted the *Abutilon hirtum* leaves pharmacological properties using various in vitro studies, including antioxidant, anti-inflammatory, and anti-diabetic activities. This validation confirms the traditional usage of this plant in medicinal aspects and highlighting the potential as a natural therapeutic agent.

The antioxidant activity of *Abutilon hirtum* was evaluated ussing through the DPPH radical scavenging assay. The plant extract showed a dose-dependent increase in radical scavenging activity, achieving a maximum inhibition of 61.05% at 250 µL with an IC_{50} of 72.59 µg/mL. These assessments are consistent with the results of Qari (2023), who also reported dose-dependent antioxidant effects of *A. hirtum*, albeit with stronger activity at higher concentrations. The moderate antioxidant capacity of *A. hirtum* may be

attributed to its high content of flavonoids, phenolics, and tannins, which are known as free radical scavengers. Compared to the standard antioxidants such as Rutin (IC_{50}: 4.44 µg/mL) and BHT (IC_{50}: 5.56 µg/mL), this *A. hirtum* shows relatively lower potency. Howeverr the natural origin and the wide availability of this plant make it a significant ingredient for inclusion in functional foods or natural antioxidant formulations, specifically in regions where synthetic antioxidants are less desirable.

The anti-inflammatory potential of *Abutilon hirtum* was done using the heat-induced hemolysis assay. The extract showed increasing inhibition with rising concentrations, with a maximum inhibition of 54.07% at 250 µL and an IC_{50} of 71.05 µg/mL. The activity this plant were moderate compared to the standard drug diclofenac (maximum inhibition of 56.38% and IC_{50} of 27.92 µg/mL),which indicates that the plant possesses bioactive compounds, those are capable for the stabilizing red blood cell membranes and mitigating inflammatory responses. These results applies with the previous findings by Gomaa et al., (2018), who observed anti-inflammatory effects of the plant in animal models. The presence of bioactive compoubds like flavonoids, terpenoids, and phenolic acids are contributes to the anti-inflammatory action by modulating pro-inflammatory mediators such as TNF-α and IL-6. The *Abutilon hirtum* may offer a safer alternative with fewer side effects, warranting further pharmacological and mechanistic investigations.

Furthermore, the anti-diabetic activity of *Abutilon hirtum* was done through the α-amylase inhibition assay. The extract inhibited α-amylase activity in a concentration dependent manner, achieving 37.57% inhibition at 250 µL with an IC_{50} of 119.48 µg/mL. Meanwhile the inhibitory effect was significantly lower than that of the standard drug acarbose (64.72% inhibition, IC_{50} of 12.53 µg/mL), the results suggest that *A. hirtum* will serve as a supportive or adjunct therapy for diabetes management. This is supported by Gomaa et al., (2018), who reported substantial hypoglycemic activity in diabetic rats treated with *A. hirtum* extracts. The bioactive compounds present in it, includes flavonoids and polysaccharides likely inhibit carbohydrate digesting enzymes and which reduce post prandial glucose spikes. The typically high IC_{50} value in this study may be affected by extraction methods, solvent systems, and differences in assay conditions.

Other promising perspective aspect of *Abutilon hirtum* is its potential role in reducing the risk of oxidative stress induced diseases. Oxidative stress is well-known factor, which leada to cellular damage in chronic illnesses such as cancer, neurodegenerative diseases, and cardiovascular disorders. The occurence of the strong radical scavenging activity in the plant *A. hirtum* demonstrates that it can help in lowering oxidative load and managing cellular integrity. These kind of properties make it optimum for the future applications in functional foods focused to boost the immunity and overall healthy lifestyle. Additionally, the traditional uses of the *Abutilon hirtum* in ethnomedicine it is involved in the trreatment of wounds, infections, and inflammation and are now scientifically validated through these study.

The *in vitro* results signifies the foundational support for formulating the herbal products like topical gels, herbal teas, or dietary supplements incorporating *A. hirtum* extracts. Moreover, the formulation development must take into account the acceptable extraction method, bioavailability, and stability of

the bioactive compound present in it. Studying the plant's interaction with existing pharmaceutical drugs could be valuable in avoiding contraindications. Investigating its synergistic effects with other herbs may also unlock new therapeutic combinations in integrative medicine. Overall, the results shows the *Abutilon hirtum* has contains numerous bioactive compounds, which is contribute to its therapeutic activities.

Although the efficacy of the extract was consistently lower than that of standard drugs in all assays, its natural origin and broad-spectrum bioactivity make it a valuable candidate for future development. The moderate levels of antioxidant, anti-inflammatory, and anti-diabetic activities observed in vitro support its use in traditional medicine and point to its potential in developing plant-based pharmaceuticals or nutraceuticals. However, further studies, particularly *in vivo* trials and compound isolation, are required to fully elucidate its pharmacodynamic properties, toxicity profile, and mechanism of action.

4. CONCLUSION

The *in-vitro* studies of *Abutilon hirtum* leaves reveal significant therapeutic potential through its anti-diabetic, anti-inflammatory, and antioxidant activities. The anti-diabetic assay showed a maximum inhibition of 37.57% at 250 µL, with an IC_{50} value of 119.48 µg/mL, demonstrating moderate efficacy compared to acarbose (IC_{50}: 12.53 µg/mL). Similarly, the anti-inflammatory activity achieved 54.07% inhibition at 250 µL, slightly lower than diclofenac's 56.38% at 150 µL. The antioxidant analysis showed 61.05% inhibition at 250 µL, with an IC_{50} value of 72.59 µg/mL, indicating moderate scavenging potential compared to Rutin (IC_{50}: 4.44 µg/mL) and BHT (IC_{50}: 5.56 µg/mL). These findings suggest that *Abutilon hirtum* possesses bioactive compounds with promising therapeutic effects against diabetes, inflammation, and oxidative stress. While its potency is lower than standard drugs, its natural origin makes it a potential candidate for further research into plant-based medicines, warranting more detailed studies on its bioactive components and pharmacological applications.

Declarations

Author Contribution

Author Subathra Laxmanan wrote the manuscript text and Jancy Rani guided all other laboratory works. All authors reviewed the manuscript.

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Figures

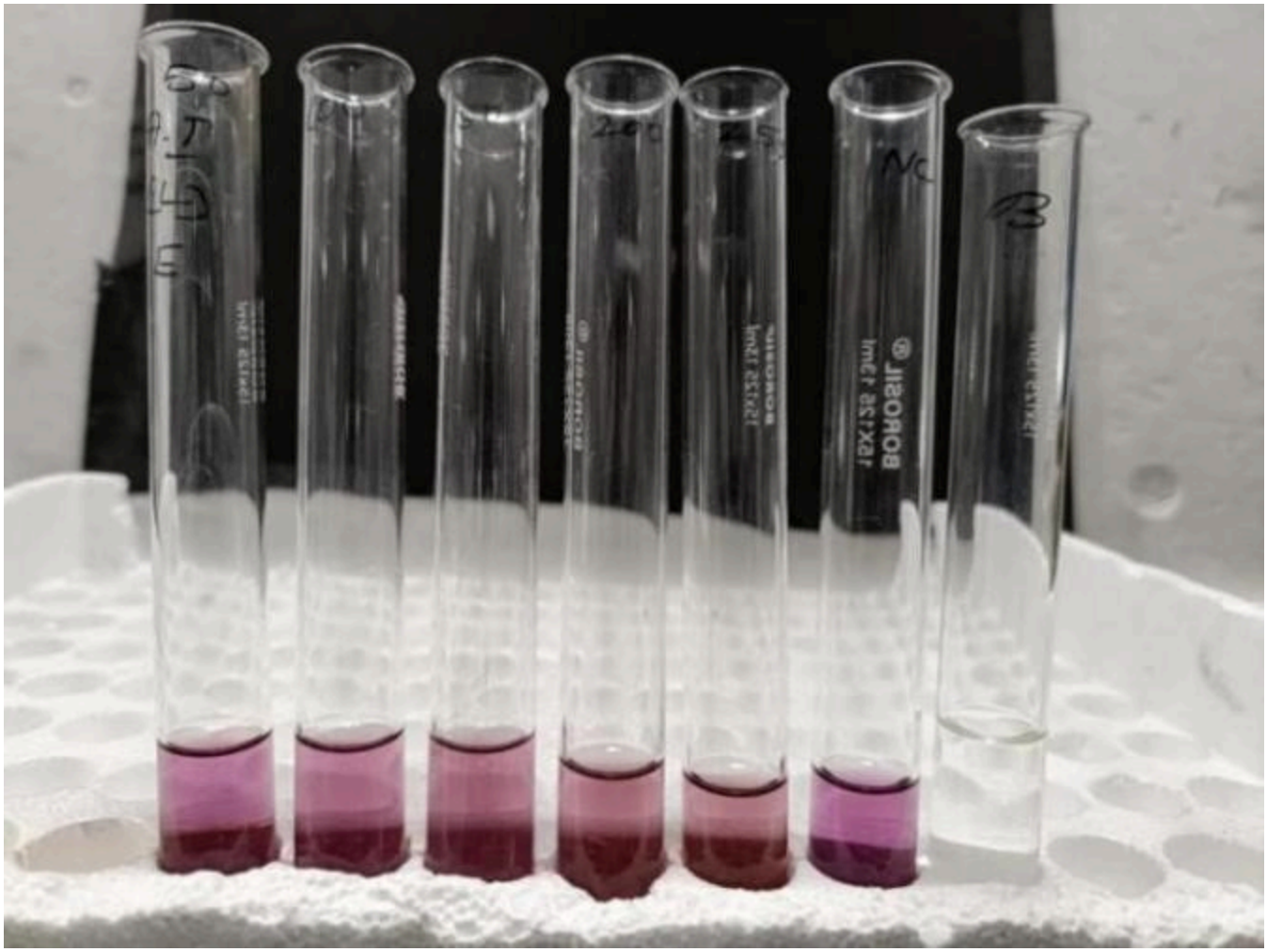

Figure 1

Figure 2.1. DPPH radical scavenging activity of fresh *Abutilon hirtum* leaves

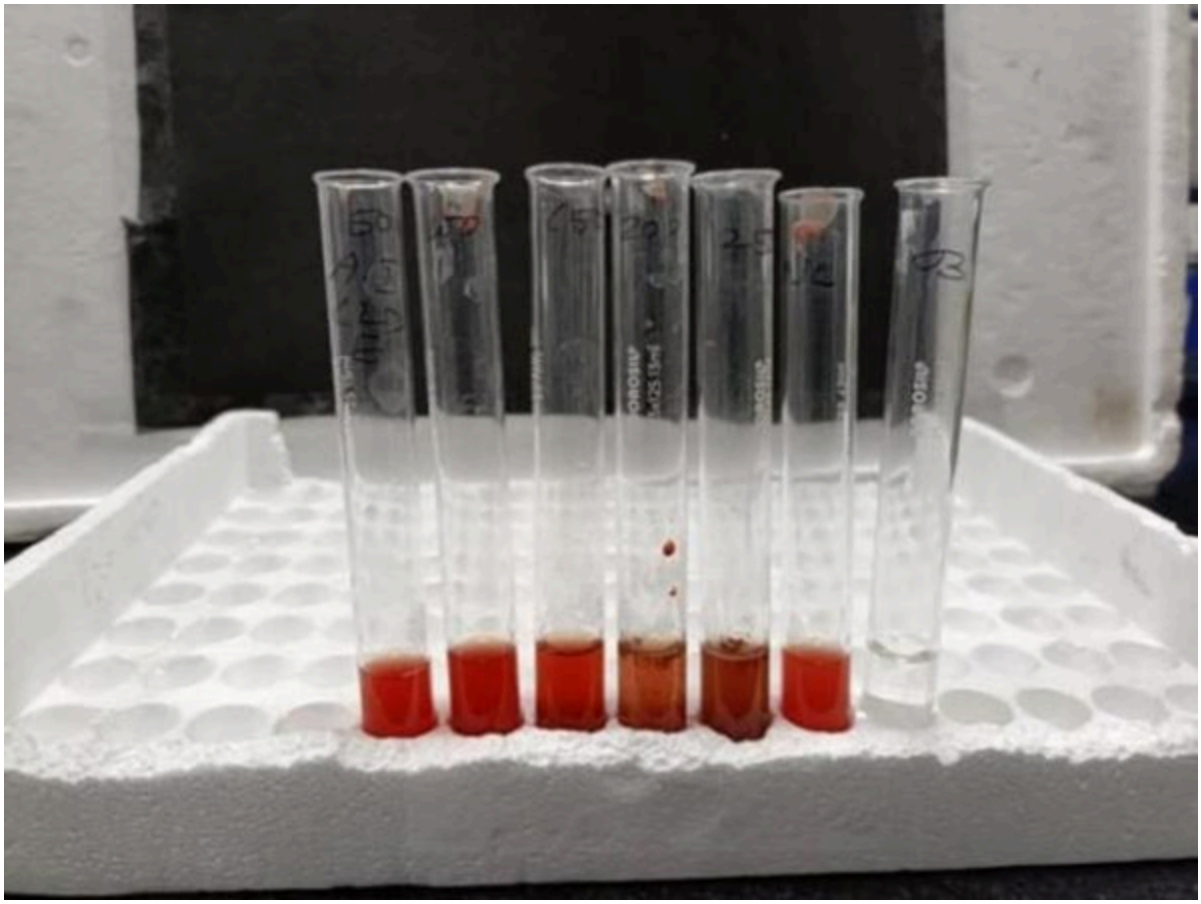

Figure 2

Figure 2.2. Heat-Induced Hemolysis of fresh *Abutilon hirtum* leaves

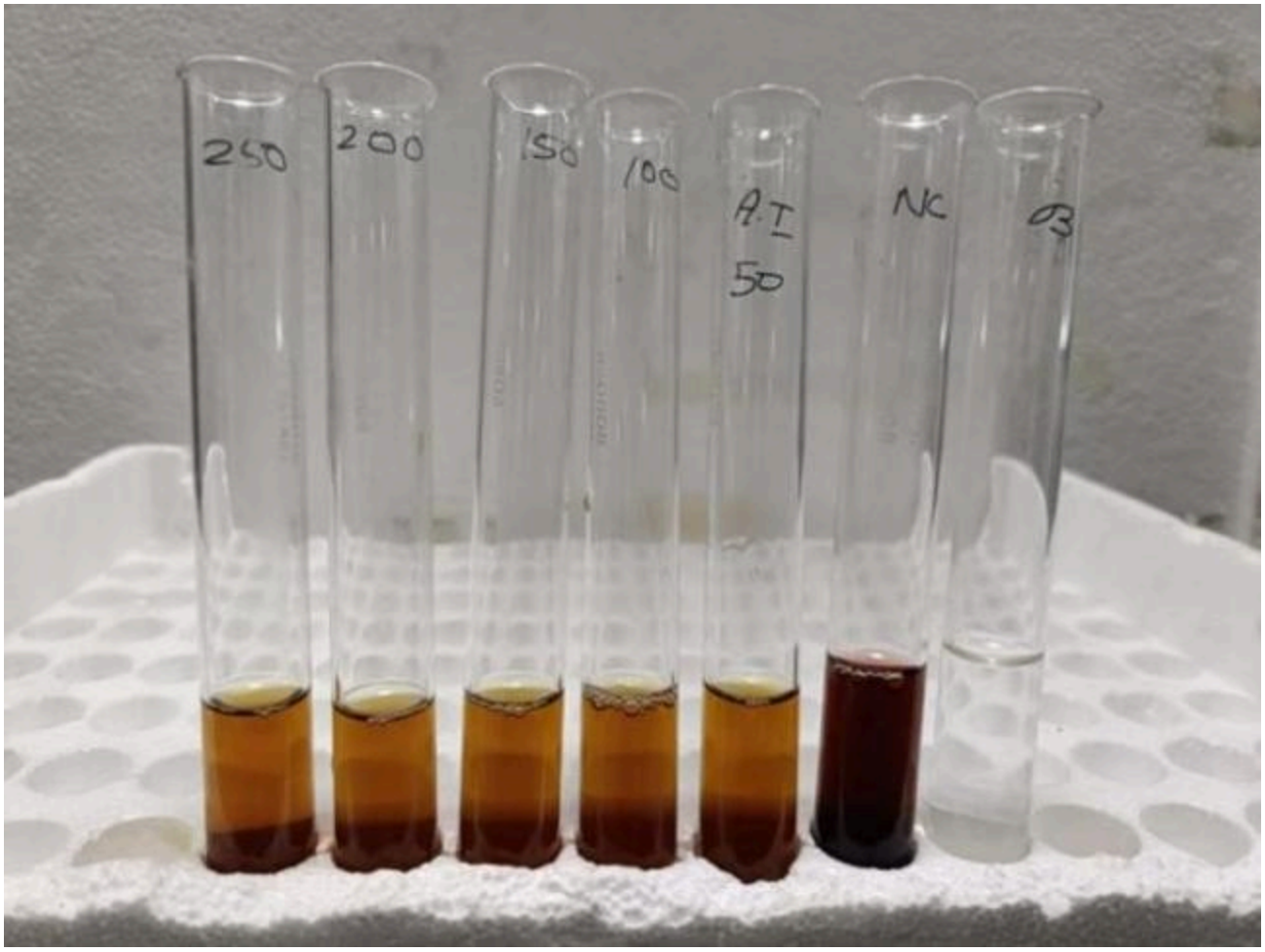

Figure 3

Figure 2.3. α-amylase activity of fresh *Abutilon hirtum* leaves

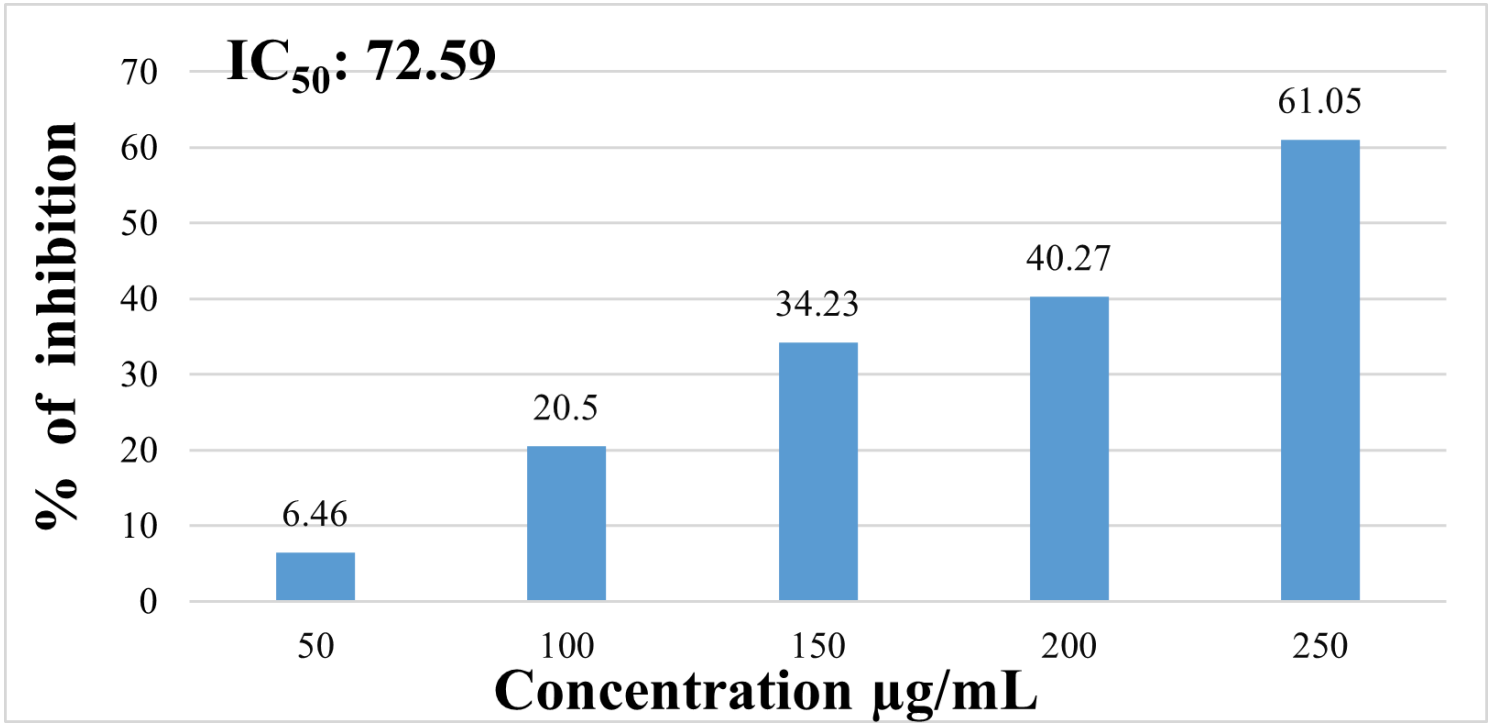

Figure 4

Figure 3.1. DPPH radical scavenging activity of *Abutilon hirtum*

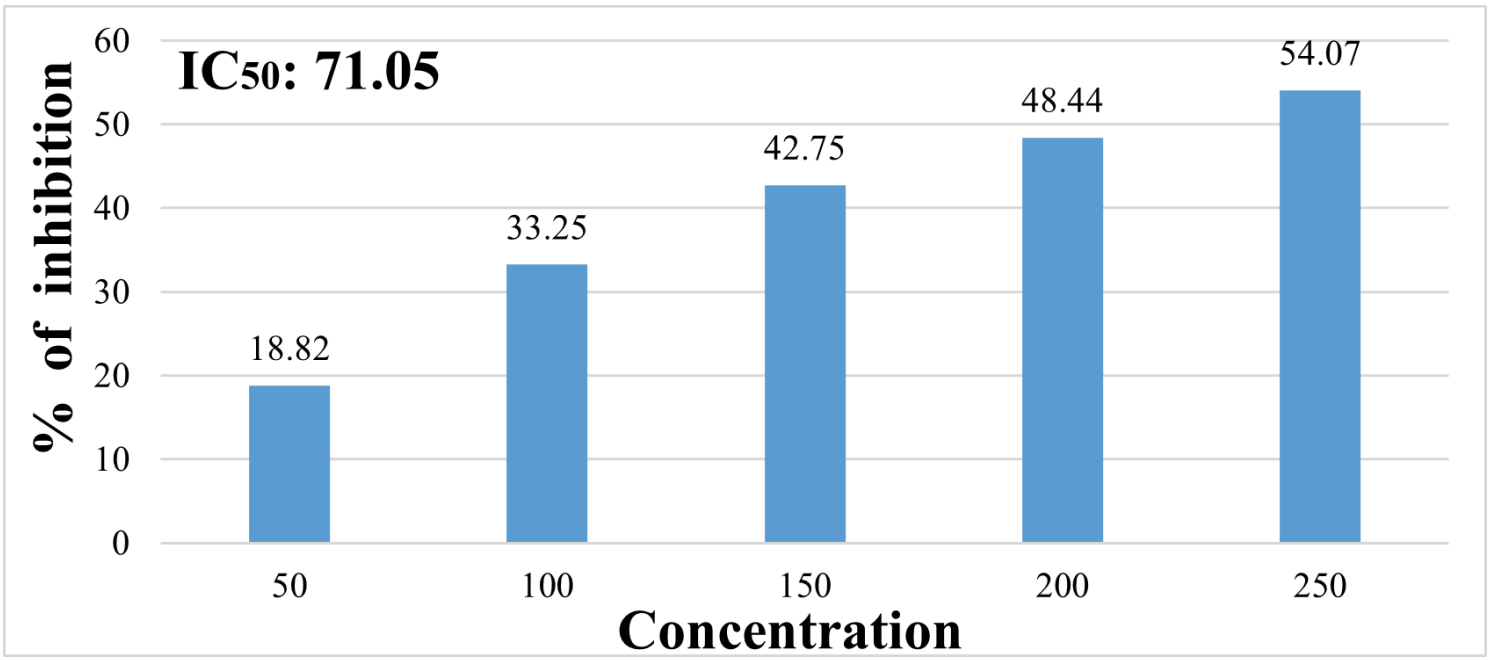

Figure 5

Figure 3.2. % Scavenging Activity IC50 of fresh *Abutilon hirtum*

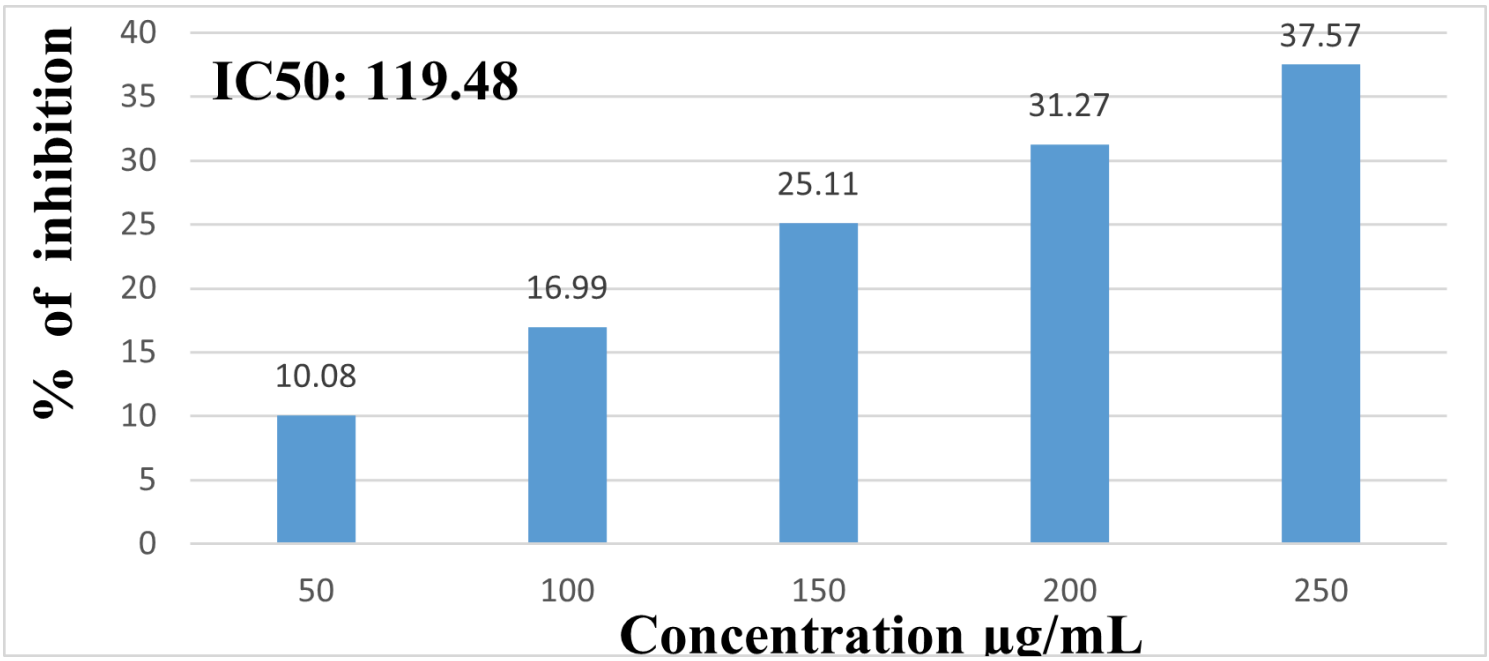

Figure 6

Figure 3.3. *In vitro* anti diabetic activity of the fresh *Abutilon hirtum*leaves