

Phytochemical Investigation In vitro Antioxidant Activity & Anti Diabetic Activity of Euphorbia Nivulia

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Abstract

Diabetes is one of the primary causes of mortality. In diabetics, free radicals can cause glucose tolerance, β -cell dysfunction, insulin resistance, decreased macrovascular and microvascular function, and other symptoms. Plant extracts can be efficient treatments because they include a variety of secondary metabolites with distinct medicinal characteristics. As a result, in our research, Euphorbia Nivulia (*E. nivulia*) is assessed for phytochemical contents, anti-oxidant activity (DPPH test, Superoxide and Nitric oxide scavenging activity), and anti-diabetic activity (α -Amylase Inhibition assay and α -Glucosidase assay). Furthermore, the plant is extracted successively with Ethyl acetate, Petroleum ether and Ethanol. The ethanolic extract produced the highest yield of *E. nivulia*. Thus, *E. nivulia*'s anti-oxidant and anti-diabetic properties may be beneficial due to the synergistic effects of phytochemicals present in it.

Keywords: Euphorbia nivulia, flavonoids, phytochemical, antioxidants and antidiabetic.

INTRODUCTION

Diabetes mellitus is a complicated metabolic disorder caused by increased blood sugar levels (Khan et al. 2019). Diabetes induces oxidative stress, which creates weak superoxide radicals such as reactive nitrogen and oxygen species, which contributes to the creation of insulin resistance (Gangwar et al. 2014; Asmat et al. 2016; Ononamadu et al. 2019). The presence of glucose in the bloodstream all the time tends to promote the generation of ROS in cells, which leads to long-term consequences such as microvascular and macrovascular dysfunction (Wright et al. 2006). Previous research has linked increased oxidative stress to glucose-induced insulin dysregulation (Kavya et al. 2019). Endogenous antioxidants or anti-oxidants obtained through food (exogenous anti-oxidants) diminish oxidative stress in normal physiology (Asmat et al. 2016). However, in diabetics, the amount of ROS generated surpasses the amount of antioxidants (Tiwari et al. 2013).

Diabetes therapy options now include either insulin enhancers or metabolite inhibitors. Plant extracts can be useful treatments because they include a variety of secondary metabolites that have distinct medicinal characteristics (Ononamadu et al. 2019). These bioactive elements can be used to battle numerous chronic illnesses such as cancer, diabetes, and Alzheimer's disease. Plant extracts have been employed for their therapeutic usefulness since ancient times as there is no adverse effects. Even in modern medicine, treatment targets for illnesses such as diabetes, cancer, and Alzheimer's are natural or synthetic or semisynthetic molecules with pharmacophores comparable to natural products. Secondary metabolites of plants are gaining popularity due to their diverse pharmacological properties (El Omari et al. 2019). Secondary metabolites of therapeutic significance in a variety of disorders (Kuruppu et al. 2019).

E. nivulia is a genus of Euphorbia species with a wide range of therapeutic properties. Many ailments can be treated with it, including respiratory infections, inflammation, bodily discomfort, microbiological sickness, traumas, birth difficulties, and sensory impairments (Kemboi et al. 2020). *E. nivulia* latex was used to cure jaundice, dropsy, leprosy, syphilis, enlargement of the liver and spleen, colic, and haemorrhoids and bronchitis.

Thus, the current study sought to assess the phytochemicals found in *E. nivulia*, as well as their anti-diabetic and anti-oxidant

activities. The most phytochemicals were found in the ethanolic extract of *E. nivulia*, followed by the ethyl acetate extract. Furthermore, in all three experiments, the ethanolic extract of *E. nivulia* demonstrated probable anti-oxidant activity when related to the Ethyl acetate extract. In addition, the ethanolic extract of *E. nivulia* shown significant anti-diabetic efficacy in both experiments.

MATERIALS AND METHODS

The aerial parts of *Euphorbia nivulia* were collected in the Sathuragiri hills of Tamil Nadu's Virudhunagar district and validated by the Central Council for Research in Siddha and Ayurveda, Government of India. For future extraction, the plant pieces were dried, crushed, and kept in an airtight container.

Extraction of plant Material:

The leaves of *Euphorbia nivulia* were properly cleaned in water to remove foreign debris before being shade dried at a humidity levels of 40-45 %. After that, the leaves were ground and sieved in a roller grinder (No 40). The powdered sample of 150 gm was then separated from the mixture using petroleum ether before being extracted for 72 hours at room temperature with 1 litre of 95 % ethanol using Soxhlet equipment. The resulting samples were filtered and concentrated in a rotary evaporator at decreased pressure, giving a thick semisolid brown paste that was stored at -20°C until needed. The extraction yield was determined to be 11.87 % w/w.

Phytochemical Screening:

The extracts of *E. nivulia* in petroleum ether, ethyl acetate, and ethanol were submitted to qualitative chemical analysis to determine the presence of carbohydrates, alkaloids, amino acids and proteins, glycosides, triterpenoids, flavonoids, saponins and phytosterols (Harborne 1998).

Estimate of total phenolic content

The total content of crude extracts was evaluated using the Folin-Ciocalteu method. The extracted samples (100 µl) were transferred to test tubes. 0.8 mL of sodium carbonate (7.5%) and 1 mL of Folin-Ciocalteu reagent were combined. After mixing the tubes, they were set aside for 30 minutes. Absorption was recorded as UV-visible spectrophotometer (Shimadzu UV 1800) set at 765 nm.

Estimation of total flavonoids

Kumaran and Karunakaran's (2006) method was used to calculate total flavonoids. 3.0 mL (50g/L) sodium acetate solution and 1.0 mL (2% AlCl₃ ethanol) were combined with 1.0 mL of extracts. After 2.5 hours at 20°C, the absorbance at 440 nm was observed to assess the total flavonol concentration of the crude extracts.

IN VITRO ANTIOXIDANT ACTIVITY

DPPH photometric assay

Using Mensor et al. (2001) approach, the effect of *E. nivulia* ethyl acetate and ethanol extracts on DPPH radical was investigated. A 0.5ml DPPH (0.4mM) methanolic solution was mixed with 1 ml of plant extract at various concentrations (100, 200, 400, and 800 µg/ml) and allowed to stand for 30 min at room temperature. The positive control was DPPH in methanol alone, whereas the negative control was methanol alone. After 30 minutes, absorbance at 518 nm was determined, and activity was calculated in percentage using the formula given.

$$\text{Scavenging activity(\%)} = \frac{A_{518} \text{ Control} - A_{518} \text{ Sample}}{A_{518} \text{ Control}} \times 100$$

where A518 control is the methanol + absorbance of DPPH radical;

A518 sample is the sample/standard extract + absorbance of DPPH radical.

Superoxide scavenging activity

The superoxide anion scavenging activity of *E. nivulia* ethyl acetate and ethanol extracts was measured using the technique reported by Winterbourne et al. (1975). The test combination contains varied concentrations of plant extract (100, 200, 400, and 800 µg/ml) with 0.2 ml of 0.1M EDTA, 0.1 ml of Nitro blue tetrazolium (1.5 mM NBT) solution, 0.05 ml of 0.12 mM riboflavin and 2.55 ml of phosphate buffer. In the control tube, DMSO was used instead of sample. The samples were kept at room temperature for 30 min prior to determining the absorbance at 560 nm. Ascorbate was used as the reference chemical. The inhibition percentage was estimated by reviewing the outcomes of test and control samples.

Nitric oxide scavenging activity

The nitric oxide scavenging activity of *E. nivulia* ethyl acetate and ethanol extracts was determined as follows: Three millilitres of reaction mixture containing varying concentrations of plant extract (100, 200, 400, and 800 µg/ml) with 2 ml of sodium nitroprusside (10mM) and were incubated at 25°C for 2.5 hours. As a result, 0.5 mL of the reaction mixture was pipetted out and treated with 1 mL of (0.33%) sulphanilic acid reagent for 5 minutes. After that, 1 mL of naphthalene diamine dihydrochloride (1% NEDA) was poured, stirred, and left for 0.5 hours before reading at 540nm.

IN VITRO ANTI-DIABETIC STUDY

α -Amylase Inhibition assay

The α -amylase inhibitory effect of ethanol extracts of *E. nivulia* was tested using the technique of (Uddin et al. 2014). In a nutshell, a reaction mixture including 390µL of phosphate buffer (pH 7.0), 10µL of α -amylase solution (0.25mg/L), and various concentrations of extract (2, 4, 8, 10, 15 µg/ml) was incubated at 37°C for 10 minutes. Then, as a substrate, 100L of 1% starch solution was poured and incubated for 1 hour at 37°C. Following the incubation time, 0.1ml of 1% iodine solution was added and stirred with 5ml of distilled water. A UV-visible spectrophotometer set at 565 nm was used to measure the absorbance of the resulting mixture. As a standard, acarbose at various concentrations (2, 4, 8, 10, 15 µg/ml) was utilised. The absence of α -amylase was designated as a blank, and a starch-free combination was used as a control. Each experiment was done three times, and the findings were represented as % of inhibition.

α -Glucosidase assay

In a 96well plate, 20 µl of 2.5mM pNPG, 20 µl of 100mM phosphate buffer (pH 6.8), and 20 µl of ethanol extracts of *E. nivulia* (2, 4,8,10,15 µg/ml) were mixed together. For 15 minutes and at 37°C the reaction mixture was incubated. with 20µl of 10mM

phosphate buffer (pH. 8) containing 0.2U/ml α -Glucosidase. The process was halted by adding of 80 μ l of 0.2U/mm sodium carbonate. Using a Multiplate reader, the absorbance of the emitted p-nitrophenol was determined at 405nm. As a standard, acarbose at various doses (2, 4,8,10,15 μ g/ml) was used. The control will be the same reaction mixture but without the sample solution, and each experiment was done in triplicate. The outcome was expressed as % of inhibition.

EXPERIMENTAL RESULTS

Phytochemical analysis

E. nivulia's quantitative phytochemical analysis was performed. When ethanolic extract of *E. nivulia* was compared to ethyl acetate extracts and petroleum ether, the highest number of phytochemicals were identified. In ethyl acetate extract, *E. nivulia* has the second highest amount of phytochemicals. Only a few phytochemicals were detected in *E. nivulia* petroleum ether extracts. The qualitative phytochemical analysis of *E. nivulia* extracts is depicted in Table

Table 1. Qualitative Phytochemical analysis of extracts of *E. nivulia*

| S. No. | Parameter | Petroleum Ether Extract | Ethyl Acetate Extract | Ethanol Extract |
|--------|----------------|-------------------------|-----------------------|-----------------|
| 1 | Carbohydrates | - | + | - |
| 2. | Alkaloids | + | + | - |
| 3. | Terpenoids | - | - | + |
| 4. | Glycosides | + | + | - |
| 5. | Amino acids | + | - | + |
| 6. | Proteins | + | - | + |
| 7. | Flavonoids | - | - | + |
| 8. | Steroids | - | - | + |
| 9. | Saponins | - | - | + |
| 10. | Phenols | - | - | + |
| 11. | Quinones | - | + | - |
| 12 | Anthraquinones | - | + | + |
| 13 | Tannins | - | + | + |

Note: + = Positive; - = Negative

In vitro Antioxidant Activity

The ethanolic and ethyl acetate extracts of *E. nivulia* were chosen for in-vitro Antioxidant Activity screening tests because they contained the highest amount of phytochemicals. For three determinations, the values are given as mean standard error of the mean (S.E.M). A statistically significant difference was defined as a P value of < 0.05.

DPPH assay

The % of D-PPH radical scavenging activity of plant ethanolic and ethyl acetate extracts are shown (Table 2). The ethanolic extracts were shown to be more efficient than ethyl acetate extracts. The extract's DPPH radical scavenging activity rises with concentration. The IC₅₀ of *E. nivulia* ethanolic extract was 280µg/ml, respectively, whereas the IC₅₀ of standard Rutin was determined to be 480µg/ml.

Table 2. Effect of *E. nivulia* extracts on DPPH assay

| Concentration (µg/ml) | % of activity (±SEM) | | |
|--------------------------|---------------------------------------|--------------------------------------|--------------------------------------|
| | Ethyl acetate Extract | Standard (Rutin) | Ethanol Extract |
| 100 | 17.45 ± 0.16 | 18.28 ± 0.15 | 38.50 ± 0.45 |
| 200 | 29.40 ± 0.18 | 22.28 ± 0.47 | 48.65 ± 0.15 |
| 400 | 38.42 ± 0.11 | 52.14 ± 0.32 | 65.68 ± 0.21 |
| 800 | 41.23 ± 0.10 | 71.40 ± 0.40 | 71.18 ± 0.26 |
| | IC₅₀=1220 µg/ml | IC₅₀=480 µg/ml | IC₅₀=280 µg/ml |

Superoxide scavenging assay

During different pathological situations, super oxide anions directly or indirectly damage biomolecules by producing ROS, RNS, hydrogen peroxide or singlet oxygen.. The % of scavenging superoxide anion was evaluated at various concentrations of ethanolic and ethyl acetate extracts of the plant (100, 200, 400, and 800 µg/ml) (Table 3). Although ethyl acetate demonstrated little action when compared to normal Ascorbate, the IC₅₀ values of *E. nivulia* ethanolic extract shows considerable superoxide radical scavenging activity. The IC₅₀ of *E.*

nivulia ethanolic extract was determined as 400µg/ml respectively, whereas ascorbate was found to be 80µg/ml.

Table 3. Superoxide anion scavenging activity of *E. nivulia* extracts

| Concentration (µg/ml) | % of activity (±SEM) | | |
|--------------------------|---------------------------------------|-----------------------------------|-----------------------------------|
| | Ethyl acetate Extract | Ethanol extract | Standard (Ascorbate) |
| 100 | 12.50 ± 0.28 | 28.31 ± 0.25 | 72.29 ± 0.20 |
| 200 | 21.40 ± 0.65 | 35.21 ± 0.40 | 90.19 ± 0.15 |
| 400 | 28.40 ± 0.20 | 60.20 ± 0.27 | 91.11 ± 0.12 |
| 800 | 45.60 ± 0.20 | 75.35 ± 0.56 | 96.62 ± 0.72 |
| | IC₅₀=1100 µg/ml | IC₅₀= 400 µg/ml | IC₅₀ = 80 µg/ml |

Nitric oxide scavenging assay

Nitric oxide is a very volatile substance that, when combined with an oxygen molecule, generates standard – nitrate, that may be measured using Gerrat's reagent. Table 4 shows that the nitric oxide radical reduction by ethyl acetate and ethanolic extracts of the suggested plant and ascorbate is concentration dependant.

Table 4. Nitric oxide scavenging activity of *E. nivulia* extracts

| Concentration ($\mu\text{g/ml}$) | % of activity ($\pm\text{SEM}$) | | |
|---------------------------------------|---|--|--|
| | Ethyl acetate Extract | Standard (Ascorbate) | Ethanol Extract |
| 100 | 18.71 \pm 0.40 | 26.12 \pm 0.13 | 41.63 \pm 0.33 |
| 200 | 23.29 \pm 0.15 | 32.25 \pm 0.08 | 48.12 \pm 0.17 |
| 400 | 31.557 \pm 0.26 | 62.60 \pm 0.13 | 60.52 \pm 0.22 |
| 800 | 38.26 \pm 0.21 | 55.75 \pm 0.18 | 65.67 \pm 0.24 |
| | IC₅₀ = 1160 $\mu\text{g/ml}$ | IC₅₀ = 410 $\mu\text{g/ml}$ | IC₅₀ = 250 $\mu\text{g/ml}$ |

In vitro Anti-diabetic assays

The ethanolic extracts of *E. nivulia* were considered for further in-vitro Anti-diabetic Activity screening tests because they exhibited potential anti-oxidant activity when compared to Ethyl acetate Extract. For three determinations, the values are represented as mean standard error of the mean (S.E.M). A statistically significant difference was defined as a P value of < 0.05.

Alpha- amylase inhibition assay

The Ethanolic extracts (2-15 $\mu\text{g/ml}$) of the plants demonstrated potential α -amylase inhibitory action in a dose-dependent manner (Table 5). *E. nivulia* ethanolic extract inhibited from 3.24 \pm 0.04 to 19.46 \pm 0.02% and from 2.91 \pm 0.06 to 19.84 \pm 0.02% respectively. Acarbose standard drug for α -amylase inhibitor and inhibited α -amylase activity from 6.14 \pm 0.05 to 56.14 \pm 0.05% at various concentrations ranging from 2 to 15 $\mu\text{g/ml}$. In our investigation, the Ethanol extracts of the plant shown the greatest α -amylase inhibitory action, which may be attributable to the presence of flavonoids and polyphenols. Polyphenols have the capacity to attach to proteins and limit carbohydrate hydrolysis while also reducing oxidative stress.

Table 5. Alpha- amylase inhibition activity of *E. nivulia*

| Concentration $\mu\text{g/ml}$ | % of Inhibition ($\pm\text{SEM}$) | |
|-----------------------------------|-------------------------------------|----------|
| | Ethanolic <i>E. nivulia</i> | Acarbose |

| | | |
|----|--------------|------------|
| 2 | 3.24 ± 0.04 | 6.45±0.03 |
| 4 | 5.12 ± 0.06 | 1.24±0.05 |
| 8 | 10.42 ± 0.03 | 6.45±0.02 |
| 10 | 14.41 ± 0.06 | 40.42±0.02 |
| 15 | 19.46 ± 0.02 | 56.14±0.05 |

Alpha- Glucosidase inhibitory assay

Table 6 shows the anti-diabetic activity of the Ethanol extract of *E. nivulia* as determined by the α -glucosidase inhibitory test. The extracts inhibited α - glucosidase enzyme activity significantly. The % inhibition of *E. nivulia* extract increased dose dependently at doses ranging from 2 to 15 μ g/ml. For *E. nivulia*, the percentage inhibition ranged from 5.6±0.09 to 19.12±0.11 and acarbose inhibited from 28.57±0.14 to 42.81±0.08% at concentrations ranging from 2 to 15 μ g/ml.

Table 6. α - Glucosidase inhibition activity of *E. nivulia*

| Concentration μ g/ml | % of Inhibition (\pm SEM) | |
|-----------------------------|---------------------------------|------------|
| | Ethanollic <i>E. nivulia</i> | Acarbose |
| 2 | 5.6±0.09 | 28.57±0.14 |
| 4 | 8.24±0.07 | 31.50±0.16 |
| 8 | 13.56±0.12 | 31.92±0.12 |
| 10 | 14.42±0.09 | 38.44±0.09 |
| 15 | 19.12±0.11 | 41.81±0.08 |

DISCUSSION

Diabetes is a condition characterised by blood glucose levels that are higher than normal. Currently, the diabetic treatment choices available maintain glucose levels; nevertheless, there is no medication that can entirely cure diabetes (El Omari et al. 2019). The disadvantages of commercially accessible synthetic medications are their high cost and adverse effects. Many scientific investigations have recently shown that the therapeutic parts of plants can be an excellent substitute for manmade medications. Because of their safety, efficacy, and cost effectiveness, naturally occurring plants are more dependable (El Omari et al. 2019).

Natural products have been found to offer anti-diabetic and anti-hyperlipidemic activities in recent years. Secondary metabolites in plants such as alkaloids, glycosides, flavonoids, terpenoids, and carotenoids have been studied for their anti-diabetic properties. Plant compounds exert their activity by their capacity to repair pancreatic beta cells, enhance insulin production, or facilitate metabolites in an insulin-dependent way. More than 400 plant species have been discovered as having anti-diabetic potential (Patel et al. 2012).

In this study, several extracts of *E. nivulia* are tested for phytochemical content, anti-oxidant activity, and anti-diabetic activity. There were two anti-diabetic studies, alpha-amylase and alpha glucosidase assays, and three anti-oxidant studies, DPPH test, Superoxide and Nitric oxide scavenging activity. Plant phenolic compounds are significant because they have a variety of defensive qualities (Miguel-Chávez 2017). Phenols are widely recognised for their anti-oxidant properties as well as their ability to modify cellular events. Flavonoids are anti-oxidants that scavenge ROS, maintain endogenous anti-oxidant levels, and inhibit

calcium influx (Herrera et al. 2009). Furthermore, saponins, steroids, and terpenoids have anti-microbial, anti-diabetic, anti-tumor, anti-oxidant and anti-inflammatory properties (Chen et al. 2014). Polyphenols have been shown to stimulate insulin release by reducing glucose concentrations (Younus et al. 2020a).

According to the DPPH assay results, the ethanolic extract of *E. nivulia* has high antioxidant activity than the ethyl acetate extract. The ethanolic extract of *E. nivulia* exhibited dose-dependent DPPH scavenging activity when concentration was increased. This indicates that our extract contains bioactive components capable of scavenging oxidative damage. The ethanolic extract of *E. nivulia* has a higher scavenging capacity (IC_{50} of $280\mu\text{g/ml}$). However, when ethanolic extracts of *E. nivulia* were compared to standard rutin (IC_{50} of $470\mu\text{g/ml}$), they demonstrated a strong scavenging ability.

The superoxide scavenging assay results show that ethanolic extracts of both plants scavenge superoxide anions, although ethyl acetate extracts were weak. The ethanolic extract of *E. nivulia* (IC_{50} of $400\mu\text{g/ml}$) exhibited more superoxide scavenging activity than conventional ascorbate (IC_{50} of $70\mu\text{g/ml}$). Previous research indicates that the presence of phenolic chemicals, particularly flavonoids, contributes to the scavenging of superoxide radicals in plant extracts (Robak and Gryglewski 1988). This is consistent with our findings, since the phenol and flavonoid positive ethanolic extract of the plants had more potential activity than the phenol and flavonoid negative ethyl acetate extract.

Phagocytes and endothelial cells create nitric oxides, which play an important role in inflammation. NOs are created by the reduction of oxygen and superoxides, which results in the formation of NO_2 , N_2O_4 and N_3O_4 (Boora et al. 2014). The ethanolic extract of *E. nivulia* (IC_{50} value of $250\mu\text{g/ml}$) was shown to be effective in scavenging nitric oxide than standard ascorbate (IC_{50} value of $410\mu\text{g/ml}$) and ethyl acetate extracts.

Several drugs that are now used to treat or control diabetes are either insulin sensitizers or enzyme inhibitors. The inhibitors work by targeting enzymes such as alpha-glucosidase, alpha amylase and lipase. These enzymes breakdown complex oligosaccharides into simple glucose, increasing postprandial glucose levels (Zeng et al. 2020).

The alpha amylase inhibition assay findings show that the ethanolic extract of *E. nivulia* has alpha amylase inhibitory action that is concentration dependent. For *E. nivulia*, the percentage inhibitory varies from 3.24 to 19.46%. The typical acarbose medication, on the other hand, demonstrated 6.45-56.14% activity from lowest to highest. Similarly, a prior research found that the methanolic extract of *Euphorbia hirta* (*Euphorbia* family) had a lower alpha amylase inhibitory percentage ($33.49 \pm 3.6\%$), than the conventional medicine acarbose (73.48 ± 2.7). This demonstrates that the plant extract has the ability to block alpha amylase (Sheliya et al. 2016).

The ethanolic extract of *E. nivulia* showed a concentration dependent increase in alpha Glucosidase activity (*E. nivulia* - 5.6 ± 0.09 to 19.12 ± 0.11). Previous research by Younus et al. indicated that at 0.5mg/ml concentrations of *E. nivulia* inhibited alpha Glucosidase by $97.81\% \pm 1.87\%$. However, in our investigation, the concentration of *E. nivulia* was reduced to 2, 4, 8, 10, 15 $\mu\text{g/ml}$, resulting in a lower % inhibition (Younus et al. 2020a). In previous research, a 70% hydroalcoholic extract of *E. nivulia* shown antioxidant and anti-diabetic properties in vitro through influencing enzymes.

Overall, the in-vitro research indicates that *E. nivulia* possesses anti-diabetic and anti-oxidant activities. The inclusion of polyphenolic components such as flavonoids, phenols, saponins, and tannins in *E. nivulia* ethanolic extract is proposed for its anti-oxidant and anti-diabetic effect. Thus, *E. nivulia*'s anti-oxidant and anti-diabetic properties may be related to the synergistic actions of phytochemicals. Several studies have revealed that medicinal plants that block the alpha glucosidase enzyme might be a possible target for maintaining glucose levels (Younus et al. 2020a). As a result, the ethanolic extract of *E. nivulia* has been proven to be a potential anti-diabetic candidate, which may be investigated subsequently.

CONCLUSION

In this paper, we investigated the phytochemical activities of *Euphorbia nivulia* in In vitro anti-diabetic and anti-oxidant activities of the Ethanolic extract has been analyzed. *E. nivulia*'s defensive capabilities are most likely attributable to its phytochemical profile and antioxidant potential. As a consequence, we discovered that the extract of *E. nivulia* has inhibitory action against α -glucosidase and α -amylase and this therapeutic potentiality might be used in the type 2 diabetes mellitus treatment to regulate postprandial hyperglycemia. Because the plant exhibited strong enzyme inhibitory activity, the compounds responsible for inhibiting activity must be isolated, purified, and characterised before being used as an antidiabetic medication. We propose subjecting this natural plant to bioassay-guided isolation in order to determine the bioactive constituents. The

extract might be a promising anti-diabetic and anti-oxidant agent for future formulations.

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