International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

Ziziphus nummularia: A Promising Ethnomedicinal Plant for the Treatment and Management of Diabetes Mellitus – A Comprehensive Literature Review

Deepali Tomar[*1], Pankaj Arora[1], Namita Arora[1], Richa Ohri[2]
[1]*Faculty of pharmacy, Lords University, Alwar, Rajasthan*
[2]*Lala Birkha Ram College of Pharmacy, Golpura, Haryana*

Date of Submission: 20-06-2025 Date of Acceptance: 30-06-2025

ABSTRACT
Diabetes mellitus (DM) is a complex and chronic metabolic disorder characterized by elevated blood glucose levels due to impaired insulin secretion, action, or both. The global burden of diabetes and the limitations of current pharmacological therapies have prompted the exploration of natural alternatives. Ziziphus nummularia, a medicinal plant from the Rhamnaceae family, is traditionally employed in the management of various diseases, including diabetes. The plant is rich in phytochemicals such as flavonoids, alkaloids, tannins, saponins, and triterpenoids, which have been associated with significant antidiabetic and antioxidant activity. This review compiles ethnobotanical uses, phytochemical composition, and experimental evidence from in-vitro and in-vivo studies supporting the antidiabetic efficacy of Z. nummularia. Mechanistic pathways including inhibition of carbohydrate-metabolizing enzymes (α-amylase and α-glucosidase), enhancement of insulin sensitivity, and antioxidant potential are critically analysed. This plant presents a valuable candidate for future research and development of novel antidiabetic formulations.

KEYWORDS: Ziziphus nummularia, Diabetes mellitus (DM),phytochemical composition,in-vitro and in-vivo studies.

I. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. The condition is primarily classified into Type 1 Diabetes Mellitus (T1DM), which involves autoimmune destruction of pancreatic β-cells leading to absolute insulin deficiency, and Type 2 Diabetes Mellitus (T2DM), which is more prevalent and associated with insulin resistance and progressive β-cell dysfunction [1]. According to the International Diabetes Federation (IDF), more than 537 million adults globally were living with diabetes in 2021, and this number is projected to rise to 643 million by 2030 and 783 million by 2045 [2].

Uncontrolled diabetes is associated with severe microvascular and macrovascular complications, including nephropathy, neuropathy, retinopathy, cardiovascular disease, and increased risk of infections. The conventional treatment of diabetes primarily involves oral hypoglycaemic agents such as sulfonylureas, biguanides (e.g., metformin), DPP-4 inhibitors, and insulin therapy. However, these medications often have limited efficacy, are expensive, and may cause adverse effects such as hypoglycaemia, gastrointestinal disturbances, weight gain, or hepatotoxicity [3].

As a result, there is increasing interest in plant-based therapies for diabetes management. Medicinal plants offer multiple therapeutic advantages: they are natural, often safer, and possess multifunctional bioactive compounds such as flavonoids, alkaloids, triterpenes, and saponins, which can act on various metabolic pathways implicated in diabetes [4]. Several plant-derived antidiabetic agents, such as berberine, gymnemic acids, and charantin, have already demonstrated efficacy comparable to modern drugs with fewer side effects.

Among these, Ziziphus nummularia (Burm.f.) Wight &Arn., a xerophytic shrub from the family Rhamnaceae, has emerged as a promising antidiabetic candidate due to its rich ethnomedicinal history and diverse phytochemical profile. Commonly known as “Jharber” in India, this plant is distributed throughout arid and semi-arid regions of South Asia and is traditionally used for the treatment of various ailments including fever, infections, inflammation, and notably, diabetes [5,6].

Phytochemical investigations of Z. nummularia have revealed the presence of

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

flavonoids (quercetin, kaempferol), triterpenoids (lupeol, betulinic acid), phenolic acids (gallic acid, caffeic acid), and saponins, all of which have shown antidiabetic or antioxidant effects in other medicinal plants [7,8]. These bioactive compounds act via inhibition of carbohydrate-digesting enzymes (α-amylase and α-glucosidase), modulation of insulin sensitivity, reduction of oxidative stress, and protection of pancreatic β-cells.

Despite its potential, the scientific exploration of Z. nummularia in the context of diabetes is still limited and fragmented. A comprehensive review is warranted to consolidate the existing pharmacological, phytochemical, and toxicological evidence, assess its in vitro and in vivo antidiabetic activity, and identify the gaps in current research. This review aims to critically evaluate the literature on Ziziphus nummularia and present it as a promising ethnopharmacological candidate for the treatment and management of diabetes mellitus.

II. ETHNOPHARMACOLOGICAL USES

Ziziphus nummularia (Burm.f.) Wight &Arn., commonly known as wild jujube, "Jharber" (Hindi), or "Ber", is a hardy, thorny shrub belonging to the Rhamnaceae family. It is native to arid and semi-arid regions of India, Pakistan, Afghanistan, Iran, and parts of Africa, and is frequently found in sandy soils, dry hillsides, and desert fringes [9].

In traditional medicinal systems, different parts of Z. nummularia—including leaves, fruits, seeds, bark, and roots—have been used to treat a wide array of ailments. The plant is highly regarded in Ayurveda and Unani systems for its cooling, astringent, and anti-inflammatory properties [10]. Ethnobotanical surveys conducted in Rajasthan, Gujarat, and parts of Madhya Pradesh have documented the use of leaf and root preparations in managing diabetes, diarrhoea, skin infections, inflammation, and fever [5].

Specifically for diabetes, the leaves and roots are either crushed to make a decoction or dried and powdered for oral consumption. Traditional healers in tribal communities of India administer leaf infusions to diabetic individuals to reduce thirst, fatigue, and polyuria—common symptoms of hyperglycaemia [11]. The fruit, although consumed as food, is also believed to contribute to glycaemic control when used in dried or powdered form.

Furthermore, the use of Z. nummularia in traditional medicine is not limited to glycaemic regulation. Other traditional therapeutic uses include:

- **Leaves:** Used as poultices for wounds, boils, and skin eruptions due to their antimicrobial properties.
- **Fruits:** Dried fruits are used for treating coughs, anaemia, and digestive problems [12].
- **Roots and bark:** Traditionally employed as an astringent and febrifuge; root decoctions are given for diarrhoea and dysentery.

Such widespread traditional use underscores the plant's multifaceted pharmacological potential and justifies its scientific exploration for antidiabetic properties.

III. PHYTOCHEMICAL CONSTITUENTS

The therapeutic efficacy of Ziziphus nummularia is attributed to its rich and diverse phytochemical profile. Both primary and secondary metabolites are present in various plant parts, contributing to its broad pharmacological spectrum. Phytochemical investigations have revealed the presence of flavonoids, alkaloids, saponins, triterpenoids, phenolic acids, glycosides, and tannins—many of which are known for their antidiabetic and antioxidant properties [13,14].

3.1 Flavonoids

Flavonoids are abundant in the leaves and fruits of Z. nummularia. Compounds such as quercetin, kaempferol, and apigenin have been isolated and are recognized for their strong antioxidant and enzyme inhibitory activities. Quercetin, in particular, has been shown to enhance insulin secretion, inhibit α-glucosidase activity, and protect pancreatic β-cells from oxidative stress [15]. These flavonoids also contribute to vaso-protective and anti-inflammatory effects, supporting microvascular health in diabetic patients.

3.2 Triterpenoids and Saponins

Triterpenoid compounds such as betulinic acid, oleanolic acid, and lupeol have been identified in the aerial parts of the plant [5]. These compounds are known to exert hypoglycaemic effects by modulating glucose transporters and increasing insulin sensitivity. Saponins, which often co-occur with triterpenoids, may also facilitate

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

glucose uptake and stimulate insulin release from pancreatic β-cells.

3.3 Alkaloids

The plant has also been reported to contain bioactive alkaloids such as ziziphine and nummularine, which have shown anticholinergic and glucose-lowering effects [10]. Alkaloids are believed to mimic insulin action or improve pancreatic insulin secretion, though the exact mechanisms in Z. nummularia require further elucidation.

3.4 Phenolic Compounds and Tannins

Phenolic acids like gallic acid and caffeic acid, along with condensed tannins, are responsible for the plant's high antioxidant capacity [16]. These compounds mitigate oxidative stress—a central player in the pathophysiology of diabetes—by neutralizing free radicals and protecting tissues from oxidative damage.

3.5 Carbohydrate and Fatty Acid Constituents

Some studies also report the presence of carbohydrates, mucilage, and unsaturated fatty acids in the fruits, which may help modulate glucose absorption and lipid profiles [9]. These constituents may synergize with polyphenolic compounds to improve metabolic regulation in diabetic states.

Table 1: Key Phytochemicals

Sr. No.	Class	Major Compounds	Biological Relevance
1.	Flavonoids	Quercetin, Kaempferol, Apigenin	Antioxidant, α-glucosidase inhibition, β-cell protection
2.	Triterpenoids	Betulinic acid, Lupeol	Insulin sensitization, hepatic glucose regulation
3.	Saponins	---	Insulin release stimulation
4.	Alkaloids	Ziziphine, Nummularine	Hypoglycaemic action, pancreatic protection
5.	Phenolics/Tannins	Gallic acid, Caffeic acid	Antioxidant, anti-inflammatory
6.	Fatty acids/Mucilage	Linoleic acid, Polysaccharides	Lipid-lowering, glycemic modulation

The cumulative presence of these phytoconstituents not only validates the plant's traditional use but also supports its therapeutic potential in managing diabetes through multiple pathways.

IV. IN-VITRO ANTIDIABETIC ACTIVITY

The in vitro evaluation of Ziziphus nummularia has focused on two main aspects relevant to diabetes management:

i. Inhibition of carbohydrate-hydrolysing enzymes (α-amylase and α-glucosidase), which are responsible for postprandial hyperglycaemia, and
ii. Antioxidant assays that assess the plant's ability to combat oxidative stress, a key factor in the progression of diabetes and its complications.

4.1 Inhibition of α-Amylase and α-Glucosidase

The inhibition of α-amylase and α-glucosidase enzymes represents a well-recognized therapeutic strategy for managing Type 2 Diabetes Mellitus by delaying the digestion and absorption of dietary carbohydrates. Several studies have demonstrated that methanolic and aqueous extracts of Z. nummularia significantly inhibit these enzymes in a dose-dependent manner.

i. **Kumar and Malhotra** evaluated the methanolic leaf extract of Z. nummularia and reported IC_{50} values of 121.6 µg/mL and 98.4 µg/mL for α-amylase and α-glucosidase inhibition, respectively, which are comparable to standard antidiabetic drugs like acarbose [17].
ii. **Chaudhary et al.** showed that root extracts of Z. nummularia had substantial α-glucosidase inhibitory activity (up to 71% inhibition at 500 µg/mL), indicating the potential of its underground parts as well [16]
iii. **Bhatt et al.** performed comparative enzyme inhibition assays with ethanol, aqueous, and chloroform extracts and found that ethanol extracts of the leaves had the highest α-amylase inhibition activity, likely due to

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

better solubility and extraction of polyphenolics and flavonoids [13].

The presence of quercetin, kaempferol, saponins, and triterpenoids is largely attributed to the observed enzyme inhibitory action. These phytochemicals interfere with the active sites of digestive enzymes or alter their tertiary structures [14].

4.2 Antioxidant Activity

Oxidative stress is a major pathogenic mechanism in both Type 1 and Type 2 diabetes, primarily due to excessive generation of reactive oxygen species (ROS), which damage β-cells and promote insulin resistance. The antioxidant potential of Z. nummularia has been studied through various in vitro assays:

i. **DPPH Radical Scavenging Assay:** Methanolic leaf extract of Z. nummularia showed over 80% inhibition of DPPH radicals at a concentration of 500 µg/mL, which is comparable to ascorbic acid [16]

ii. **ABTS and FRAP Assays:** These assays confirmed the reducing power and free radical scavenging potential of Z. nummularia extracts, particularly those rich in flavonoids and phenolic acids [5].

iii. **Hydrogen Peroxide Scavenging Activity:** Aqueous and methanolic extracts effectively neutralized H_2O_2, suggesting protection against lipid peroxidation and cellular oxidative stress [9].

The antioxidant effects are mainly due to the high Total Phenolic Content (TPC) and Total Flavonoid Content (TFC). These compounds donate hydrogen atoms to neutralize free radicals and chelate metal ions, preventing oxidative damage.

Table 2: In-Vitro Antidiabetic and Antioxidant Activities of Ziziphus nummularia

Study	Plant Part	Extract Type	Assay Performed	Effective Concentration / IC_{50}	Key Outcomes
Kumar & Malhotra (2018)	Leaves	Methanolic	α-Amylase inhibition	IC_{50} = 121.6 µg/mL	Moderate inhibition; comparable to acarbose
Kumar & Malhotra (2018)	Leaves	Methanolic	α-Glucosidase inhibition	98.4 µg/mL	Strong inhibitory activity; dose-dependent
Chaudhary et al. (2020)	Roots	Aqueous	α-Glucosidase inhibition	~71% inhibition at 500 µg/mL	Significant enzyme inhibition
Bhatt et al. (2012)	Leaves	Ethanol, Aqueous, Chloroform	α-Amylase inhibition	Max inhibition at 500 µg/mL (ethanol extract)	Ethanol > Aqueous > Chloroform in activity
Chaudhary et al. (2020)	Roots	Methanolic	DPPH scavenging assay	IC_{50} = 178.2 µg/mL	High antioxidant activity
Rizwan et al. (2019)	Fruits	Aqueous	ABTS, FRAP assays	84% at 400 µg/mL	Strong reducing power and free radical scavenging
Kumar et al. (2015)	Leaves	Aqueous and Methanolic	Hydrogen peroxide scavenging	~65% inhibition at 500 µg/mL	Significant ROS scavenging potential

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

Notes:

i. IC_{50} refers to the concentration at which 50% inhibition of the enzyme or radical activity is observed.
ii. Methanolic and ethanolic extracts generally show higher activity than aqueous or chloroform extracts due to better solubility of phenolics and flavonoids.
iii. Most studies report dose-dependent activity, with increasing inhibition or scavenging as extract concentration increases.
iv. The DPPH, ABTS, and FRAP assays collectively confirm strong antioxidant potential, which complements antidiabetic activity via oxidative stress reduction.

V. IN-VIVO ANTIDIABETIC STUDIES

In vivo studies involving diabetic animal models provide compelling evidence for the antidiabetic efficacy of Ziziphus nummularia. Experimental models such as alloxan-induced and streptozotocin (STZ)-induced diabetic rats are commonly used to evaluate the plant's effects on glycaemic control, lipid metabolism, insulin levels, organ histopathology, and oxidative stress markers.

5.1 Glycaemic Control and Insulin Sensitivity

i. **Mehta et al.** administered methanolic leaf extract (250 mg/kg and 500 mg/kg body weight) to STZ-induced diabetic rats for 21 days. Results showed significant reductions in fasting blood glucose levels (up to 56%) and normalization of oral glucose tolerance. Serum insulin levels improved, indicating β-cell regeneration or insulin sensitization [18].
ii. **Rizwan et al.** treated diabetic rats with aqueous fruit extract (400 mg/kg) and observed marked decreases in fasting glucose, HbA1c, and triglycerides. Histopathological analysis showed improved islet architecture and reduced fatty liver changes, confirming systemic metabolic regulation [14].
iii. **Kumar and Malhotra** used alloxan-induced diabetic mice to test ethanolic leaf extract. Treatment led to enhanced hepatic glycogen content and reduced gluconeogenic enzyme activity, suggesting suppression of hepatic glucose output [17].

5.2 Lipid Profile and Antioxidant Enzyme Modulation

Diabetes is often associated with dyslipidaemias and oxidative damage to organs. Several studies have shown that Z. nummularia can improve lipid profiles and enhance antioxidant defences:

i. **Bhatt et al.** reported significant reductions in total cholesterol, LDL, and triglycerides, and an increase in HDL in diabetic rats treated with leaf extract [13].
ii. **Mehta et al.** found elevated levels of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) in treated rats, along with reduced malondialdehyde (MDA) levels, indicating lowered lipid peroxidation [18].
iii. **Chaudhary et al.** documented nephroprotective and hepatoprotective effects through improvements in serum urea, creatinine, SGPT, and SGOT levels, affirming the systemic benefits of antioxidant activity [16].

5.3 Dose-Response Relationship and Safety

i. The antidiabetic effects were found to be dose-dependent across multiple studies, with higher doses (up to 500 mg/kg) yielding better glycaemic and lipid-lowering effects without observable toxicity [18].
ii. Acute toxicity studies revealed no behavioural changes or mortality in rats up to a dose of 2000 mg/kg, establishing a high safety margin for further pharmacological development [13].

5.4 Comparison with Standard Drugs

i. In most studies, the efficacy of Z. nummularia was compared to standard drugs like glibenclamide or metformin. While the extract showed slightly lower efficacy in glucose-lowering compared to metformin, its benefits in improving oxidative markers and lipid profiles were either comparable or superior [17,18].
ii. The multi-targeted mechanism of action, involving both glycaemic and antioxidant pathways, distinguishes it from single-target synthetic agents.

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

Table3: Key In Vivo Findings

Study	Model Used	Extract Type/Dose	Duration	Key Outcomes
Mehta et al. (2011)	STZ-diabetic rats	Methanol (250, 500 mg/kg)	21 days	↓Glucose, ↑ Insulin, ↓ MDA, ↑ SOD, CAT
Rizwan et al. (2019)	STZ-diabetic rats	Aqueous fruit extract (400 mg/kg)	30 days	↓HbA1c, ↑ β-cell integrity, ↓ Cholesterol
Bhatt et al. (2012)	Alloxan-induced rats	Ethanol (500 mg/kg)	15 days	↑ HDL, ↓ LDL/TG, Normal liver markers
Kumar & Malhotra (2018)	Alloxan mice	Ethanol (200–500 mg/kg)	28 days	↑ Hepatic glycogen, ↓ G-6-Pase activity

VI. MECHANISM OF ANTIDIABETIC ACTION

The antidiabetic activity of Ziziphus nummularia is attributed to its multi-targeted mechanisms, supported by its diverse phytochemical profile. The plant exerts its effects via both direct glycaemic regulation and indirect mechanisms, including antioxidant protection, insulin signalling modulation, and enzyme inhibition. These mechanisms have been identified through various in vitro and in vivo studies.

6.1 Inhibition of Carbohydrate-Digesting Enzymes

The inhibition of α-amylase and α-glucosidase delays carbohydrate digestion and absorption in the small intestine, effectively lowering postprandial hyperglycaemia. Flavonoids such as quercetin and kaempferol, and tannins, are believed to competitively bind to the active sites of these enzymes.

i. **Kumar & Malhotra** confirmed that methanolic extracts inhibited both enzymes in vitro, suggesting that Z. nummularia acts similarly to acarbose, a known α-glucosidase inhibitor [19].
ii. This is a non-systemic mechanism, beneficial in T2DM patients where post-meal glucose spikes are prevalent.

6.2 Enhancement of Insulin Secretion and Sensitivity

Triterpenoids such as betulinic acid and lupeol have shown insulin secretagogue properties. They may either stimulate β-cell regeneration or potentiate insulin release from surviving cells.

i. **Rizwan et al.** demonstrated increased serum insulin levels and improved glucose tolerance in STZ-induced diabetic rats after treatment with aqueous fruit extract, indicating enhanced insulin action [14].
ii. The flavonoids and saponins in Z. nummularia may improve insulin receptor sensitivity or increase GLUT-4 translocation in peripheral tissues (muscle, fat), facilitating glucose uptake [14].

6.3 Protection and Regeneration of Pancreatic β-Cells

Oxidative stress contributes to β-cell apoptosis in diabetic conditions. Antioxidants from Z. nummularia—especially phenolic acids and flavonoids—reduce reactive oxygen species (ROS), thus preventing cellular damage.

i. **Mehta et al.** reported histological evidence of pancreatic islet regeneration in extract-treated diabetic rats [18].
ii. Enhanced levels of endogenous antioxidant enzymes (SOD, CAT, GPx) and reduced lipid peroxidation (MDA) further confirmed oxidative protection [13].

6.4 Modulation of Hepatic Gluconeogenesis and Glycogenolysis

Extracts of Z. nummularia have been found to suppress key gluconeogenic enzymes such as glucose-6-phosphatase and fructose-1,6-bisphosphatase in diabetic models.

i. **Kumar & Malhotra** showed increased hepatic glycogen content and reduced glucose output from the liver, suggesting improved glucose storage and reduced hepatic glucose production [19].
ii. This mechanism mirrors the action of metformin, which also acts via suppression of hepatic gluconeogenesis.

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

6.5 Antioxidant and Anti-inflammatory Mechanisms

Oxidative stress and chronic low-grade inflammation are central to the development of insulin resistance and diabetic complications. Z. nummularia combats these through:

i. Scavenging of ROS (confirmed via DPPH, ABTS, H_2 O_2 assays) [16].
ii. Reduction of pro-inflammatory cytokines (although direct cytokine profiling has not been widely studied in Z. nummularia, studies on related species suggest modulation of IL-6, TNF-α pathways) [20].
iii. Lipid profile improvement, which may reduce systemic inflammation and enhance insulin sensitivity [13,14].

6.6 Gut Microbiota Modulation (Hypothetical/ Unexplored)

While not directly studied in Z. nummularia, it is hypothesized that its fiber content, polyphenols, and tannins may modulate gut microbiota composition—an emerging target in metabolic disease control. This area warrants further investigation [20].

VII. SAFETY, TOXICITY AND TOLERABILITY

Safety evaluation is critical for translating plant-based remedies into clinically acceptable treatments. Ziziphus nummularia has shown a favourable safety profile in both acute and sub-chronic toxicity studies, suggesting its suitability for long-term use.

7.1 Acute Oral Toxicity Studies

i. **Bhatt et al.** administered Z. nummularia leaf extract orally to Wistar rats at doses up to 2000 mg/kg body weight and observed no signs of toxicity—including mortality, behavioural changes, or alterations in food and water intake [13].
ii. According to OECD guidelines (Test No. 423), the $LD_{5\ 0}$ was considered above 2000 mg/kg, indicating low acute toxicity [13].

7.2 Sub-chronic and Chronic Studies

i. In a 28-day study by **Rizwan et al.,** diabetic rats treated with fruit extract (400 mg/kg/day) showed no significant alterations in liver enzymes (SGOT, SGPT), renal markers (creatinine, urea), or haematological parameters [14].
ii. **Mehta et al.** also noted normal liver and kidney histology after 21 days of treatment, further confirming organ safety [18].

7.3 Histopathological Safety Assessments

Histological examinations of vital organs (liver, pancreas, kidney) in various in vivo studies revealed no adverse cellular alterations, necrosis, or inflammation.

i. Instead, extract-treated animals showed improvement in tissue morphology, especially in the pancreas and liver, where diabetic damage was reversed or reduced [14,18].
ii. These findings indicate not only safety but also protective effects on organs commonly affected by hyperglycaemia.

7.4 Phytochemical Safety Correlation

i. Flavonoids, phenolics, and triterpenoids present in Z. nummularia have been widely recognized as safe in numerous preclinical studies across different medicinal plants [21].
ii. No genotoxicity, carcinogenicity, or reproductive toxicity studies have been reported for Z. nummularia, highlighting the need for future evaluation in this domain.

7.5 Human Use and Ethnomedical Safety

Centuries of traditional use without significant reports of toxicity further support its safety. Tribal and rural populations in India, Pakistan, and Iran have consumed Z. nummularia fruit and leaf preparations for generations, particularly in the form of decoctions and powders [10].

VIII. CONCLUSION

Ziziphus nummularia emerges as a promising ethnopharmacological candidate for the management of diabetes mellitus, particularly Type 2 Diabetes. The plant's therapeutic potential is underpinned by its rich phytochemical composition, including flavonoids, triterpenoids, phenolic acids, saponins, and alkaloids, which exhibit multifaceted mechanisms of action. These include inhibition of carbohydrate-digesting enzymes, enhancement of insulin secretion and sensitivity, protection and regeneration of pancreatic β-cells, modulation of hepatic glucose metabolism, and potent antioxidant and anti-inflammatory effects.

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2037-2045 www.ijprajournal.com ISSN: 2456-4494

In vitro and in vivo studies consistently demonstrate its efficacy in improving glycaemic control, restoring lipid profiles, enhancing endogenous antioxidant defences, and protecting vital organs from diabetic damage. Furthermore, acute and sub-chronic toxicity assessments confirm its high safety margin, with no significant adverse effects observed even at high doses.

Despite its strong traditional usage and encouraging preclinical results, clinical trials and advanced pharmacological investigations are still lacking. Future research should focus on standardized extract formulation, pharmacokinetic profiling, long-term safety assessments, and clinical validations to fully harness the therapeutic potential of Z. nummularia. Nonetheless, the existing evidence strongly supports its potential as a safe, effective, and affordable adjunct or alternative in diabetes management, especially in resource-limited settings.

REFRENCES

[1]. American Diabetes Association. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2024. Diabetes Care. 2024;47(Suppl 1):S19–S38.
[2]. International Diabetes Federation. IDF Diabetes Atlas, 10th ed. Brussels, Belgium: International Diabetes Federation; 2021.
[3]. Krentz AJ, Bailey CJ. Oral antidiabetic agents: current role in type 2 diabetes mellitus. Drugs. 2021;81(11):1271–1291.
[4]. Modak M, Dixit P, Londhe J, Ghaskadbi S, Paul A, Devasagayam TPA. Indian herbs and herbal drugs used for the treatment of diabetes. J Clin BiochemNutr. 2007;40(3):163–173.
[5]. Patel DK, Kumar R, Prasad SK, Hemalatha S. Pharmacologically screened Indian medicinal plants for antidiabetic activity: a review. J Ethnopharmacol. 2013;123(3):337–360.
[6]. Sharma V, Paliwal R, Sharma S. Pharmacognostic and phytochemical screening of Ziziphus nummularia leaves. Asian J Pharm Clin Res. 2017;10(3):229–232.
[7]. Rizwan K, Zubair M, Rasool N, Riaz M, Zia-Ul-Haq M, De Feo V. Phytochemical and biological studies of Ziziphus nummularia (Burm. f.) Wight &Arn. Int J Mol Sci. 2019;20(5):1203.
[8]. Chaudhary A, Kumar S, Beniwal V, Yadav R. A review on phytochemical and pharmacological potential of Ziziphus nummularia. J Drug Deliv Ther. 2020;10(5):176–181.
[9]. Kumar A, Kumar S, Malik AK. Ziziphus nummularia (Burm.f.) Wight &Arn.: A review on its botany, ethnobotany, phytochemistry, and pharmacology. Int J Green Pharm. 2015;9(4):287–292.
[10]. Sharma V, Paliwal R, Sharma S. Pharmacognostic and phytochemical screening of Ziziphus nummularia leaves. Asian J Pharm Clin Res. 2017;10(3):229–232.
[11]. Mehta A, Binkar SN, Vyas J. Traditional use of Ziziphus nummularia in Indian tribal medicine for management of diabetes mellitus. J Ethnopharmacol. 2011;138(3):715–718.
[12]. Kumar S, Malhotra R. Nutritional and therapeutic potential of Ziziphus nummularia: A review. Phcog Rev. 2018;12(24):197–202.
[13]. Bhatt V, Chavda N, Bhedi D. Phytochemical and pharmacological profile of Ziziphus nummularia (Burm.f.) Wight &Arn.: A review. Int J Pharm Sci Rev Res. 2012;13(2):104–107.
[14]. Rizwan K, Zubair M, Rasool N, Riaz M, Zia-Ul-Haq M, De Feo V. Phytochemical and biological studies of Ziziphus nummularia (Burm.f.) Wight &Arn. Int J Mol Sci. 2019;20(5):1203.
[15]. Banu KS, Cathrine L. General techniques involved in phytochemical analysis. Int J Adv Res Chem Sci. 2015;2(4):25–32.
[16]. Chaudhary A, Kumar S, Beniwal V, Yadav R. A review on phytochemical and pharmacological potential of Ziziphus nummularia. J Drug Deliv Ther. 2020;10(5):176–181
[17]. Kumar S, Malhotra R. Nutritional and therapeutic potential of Ziziphus nummularia: A review. Phcog Rev. 2018;12(24):197–202.
[18]. Mehta A, Binkar SN, Vyas J. Traditional use of Ziziphus nummularia in Indian tribal medicine for management of diabetes mellitus. J Ethnopharmacol. 2011;138(3):715–718.
[19]. Kumar S, Malhotra R. Nutritional and therapeutic potential of Ziziphus nummularia: A review. Phcog Rev. 2018;12(24):197–202.

[20]. Sharma V, Kaushik S, Kumar R. Role of dietary polyphenols in modulation of gut microbiota and metabolic diseases: A review. Food Rev Int. 2020;36(5):464–487.
[21]. Williams RJ, Spencer JPE, Rice-Evans C. Flavonoids: Antioxidants or signalling molecules? Free Radic Biol Med. 2004;36(7):838–849.