RESEARCH PAPER

Pharmacological Evaluation of Prunus armeniaca Leaf Extracts for type 2 diabetes and associated complications

Sheetal Choudhary1*, Dr. Kehar Singh Dhaker2

1Research scholar School of Pharmacy LNCT University, Kolar Road, Bhopal, Madhya Pradesh, India, 462042

2Professor LNCT University, Kolar Road, Bhopal, Madhya Pradesh, India, 462042

ABSTRACT

The present study investigated the antidiabetic activity and associated complications (inflammation and diabetic nephropathy) of Prunus armeniaca leaves extract. The ethyl acetate extract (EAPA) and methanol extract (MOPA) were selected for pharmacological evaluation after acute toxicity studies. Anti-inflammatory activity was assessed using the carrageenan-induced rat paw edema model, while analgesic activity was evaluated using the hot plate method. Antidiabetic activity was studied in streptozotocin-induced diabetic rats, followed by estimation of fasting blood glucose, glycosylated hemoglobin (HbA1c), and renal biomarkers (blood urea nitrogen and serum creatinine). Both extracts demonstrated significant and dose-dependent pharmacological activities. In the anti-inflammatory study, MOPA (200 mg/kg) showed the strongest inhibition of paw edema, approaching the effect of indomethacin, particularly in the late inflammatory phase. Analgesic evaluation revealed a time-dependent increase in reaction time, with MOPA (200 mg/kg) producing analgesic activity comparable to aspirin. In diabetic rats, both extracts significantly reduced fasting blood glucose levels and HbA1c, with MOPA (200 mg/kg) showing near-normalization comparable to the standard drug. Additionally, both extracts improved renal biomarkers, indicating protection against diabetic nephropathy, with methanol extract showing superior efficacy. The findings suggest that Prunus armeniaca possesses potent anti-inflammatory, analgesic, antihyperglycemic, and nephroprotective properties, likely due to the presence of polar phytoconstituents such as flavonoids and phenolic compounds. These results support the potential of the plant as a promising natural therapeutic candidate for the management of diabetes and its associated complications.

Keywords: Prunus armeniaca; Anti-inflammatory activity; Analgesic activity; Streptozotocin-induced diabetes; Antidiabetic activity; Natural products

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INTRODUCTION

Type 1 diabetes accounts for 5–10% of diabetes. Type 2 is noninsulin-dependent diabetes mellitus (NIDDM), in which the body does not produce enough, or improper use of secreted insulin is the most common form of the disease, accounting for 90–95% of diabetes. Type 2 diabetes is nearing epidemic proportions, due to an increased number of elderly people, and a greater prevalence of obesity and sedentary lifestyles [1-2]. The prevalence of diagnosed diabetes has increased dramatically over the past 40 years both in the United States and worldwide. In 1985, there were approximately 30 million people with diabetes worldwide by 1995, this number had escalated to 135 million (4% of the world population), and by 2025, it is projected that the incidence of diabetes will increase by 42%, affecting 300 million people (5.4% of the world population). Most of the expected increase will be in type 2 diabetes, which accounts for > 90% of cases of diabetes, while the incidence of type 1 diabetes is anticipated to remain stable [3-5].

By 2025, the countries with the largest number of people with diabetes will be India (> 57 million; prevalence 6%), China (> 37 million; prevalence 3.4%), and the United States (> 21 million; prevalence 8.9%). Currently, more than 17 million Americans have diagnosed diabetes, and 5.9 million are unaware that they have the disease. Based on prevalence rates predicted from 1980-1998 trends, the number with diagnosed diabetes in the United States will swell to 29 million by 2050. In industrialized countries, diabetes will be prevalent in persons older than age 65, whereas in industrializing countries, the majority of persons with diabetes will be 45 to 65 years old, which could negatively affect the economic productivity, fertility, and reproduction of these disadvantaged communities [7-9].

There is a growing interest in natural resources as a source for developing nutraceuticals, drugs, pharmaceuticals, and various cosmetics. However, different natural resources used in traditional medicine are not supported with sufficient scientific information about their chemical constituents and biological properties [2-3]. In the recent years, many natural plant-based antioxidants either in the form of crude extract or functional foods are studied for their therapeutic potential in health management, such as diabetes or inflammatory processes. Scientific research supports the role of polyphenols in the prevention of diabetes mellitus and inflammatory processes. The bioactive compounds from extracts interact in a synergistic way, and it is supposed to be advantageous in chronic, multifactorial diseases involving multiple pathways. Recent studies have shown that inflammation and oxidative stress are closely associated with diabetes, but the involved mechanism is not clearly established because of the dual role of oxidative stress as a signal and as a damaging agent [10]

P. armeniaca, known as “apricot”, contains a number of main secondary metabolites such as polyphenols, carotenoids, fatty acids, volatiles, and polysachharides. Apricot varieties have been shown to exert various biological activities desirable for human health. Especially, antioxidant activity of the plant is quite high due to its rich polyphenolic content and consumption of apricot has been suggested beneficial for human health. However, a caution about amygdalin, a cyanogenic glucoside present in the seeds of apricot should be taken into account before consumption [11-14].

The present study investigated the antidiabetic activity and associated complications (inflammation and diabetic nephropathy) of Prunus armeniaca leaves extract. The ethyl acetate extract (EAPA) and methanol extract (MOPA) were selected for pharmacological evaluation after acute toxicity studies.

MATERIAL AND METHODS

Procurement and authentication of plant materials

The leaves of Prunus armeniaca were procured from local geographical area of Bhopal and authenticated by botanist. The leaves of Prunus armeniaca was washed with water after dead cell scraping, chopped into small pieces for air-drying at room temperature for 7 days and coarsely powdered, stored in airtight containers and used for phytochemical and pharmacological studies.

Extraction of plant material

The powdered plant materials were subjected to successive solvent extraction using solvents of increasing polarity to obtain phytoconstituents based on their solubility. The powdered leaves were extracted in a Soxhlet apparatus using Petroleum ether (60–80°C), Ethyl acetate and Methanol. After each extraction, completion was confirmed by evaporating a few drops of extract on a watch glass to ensure absence of residue. The marc obtained after ethanol extraction was macerated with chloroform water for 24 hours. Solvents were removed using a rotary evaporator followed by vacuum drying. Extracts were weighed and percentage yield calculated.

Sample code for extract

EAPA: Ethyl acetate extract of Prunus armeniaca

MOPA: Methanol extract of Prunus armeniaca

Pharmacological Studies

Acute Toxicity Studies:

The objective of this Acute toxicity Study on rats was to assess the toxicological profile of the test drug when given intraperitoneally once (single dose) to the test system and monitor the vital signs for 14 days.. Plants extracts administered in the dose of 50mg/kg, 100mg/kg and 2000mg/kg and observed for 14 days. Animals were observed for autonomic or behavioural response during this period. The body weight was also observed. Mortality was observed up to 14 days.

Anti-Inflammatory Activity

Anti-inflammatory activity was evaluated using the carrageenan-induced rat hind paw edema model. Carrageenan induces inflammation through release of mediators such as prostaglandins, leukotrienes, histamine, bradykinin, and TNF-α. Wistar rats (150–200 g) were administered indomethacin (10 mg/kg) or plant extracts (200 mg/kg) orally. Paw edema was measured at multiple time intervals using a plethysmometer. Percentage inhibition of edema was calculated.

Analgesic Activity (Hot Plate Method)

Analgesic activity was evaluated using the hot plate test (55°C). Reaction time was recorded at 0, 15, 30, 45, and 60 minutes. Maximum reaction time was set at 45 seconds to avoid tissue damage. Morphine and sodium salicylate served as standard drugs. Maximum possible analgesia (MPA) was calculated.

Antidiabetic activity

Induction of Diabetes

Type 2 diabetes was induced using streptozotocin (STZ, 40 mg/kg, i.p.) following fructose feeding for four weeks. Rats with fasting blood glucose >250 mg/dL were considered diabetic.

Experimental design for anti-diabetic study of *Prunus armeniaca*

Group	Treatment
Normal Control	Control rats gavaged with normal saline
Diabetic Control	Diabetic control rats gavaged with normal saline.
Standard treated	Diabetic rat gavaged with Glibenclamide 5mg/kg b.w
EAPA 100 mg/kg	Diabetic rat gavaged with ethyl acetate extract of *Prunus armeniaca* 100 mg/kg
EAPA 200 mg/kg	Diabetic rat gavaged with ethyl acetate extract of *Prunus armeniaca* 200 mg/kg
MOPA 100 mg/kg	Diabetic rat gavaged with Methanol extract of *Prunus armeniaca* 100 mg/kg
MOPA 200 mg/kg	Diabetic rat gavaged with Methanol extract of *Prunus armeniaca* 200 mg/kg

Estimation of biochemical parameters

The animals were sacrificed by cervical dislocation on 28th day for determining various biochemical parameters. Various biochemical parameters like glycosylated hemoglobin and renal serum biomarkers were estimated. These estimations done by usingcommercially available biochemical kits procured from Accurex, Biomedical (Mumbai, India)

RESULT AND DISCUSSION

Procurement and Authentication of Prunus armeniaca

Prunus armeniaca leaves are simple, ovate (egg-shaped) in shape, 5–9 cm long, with a rounded base and a pointed tip (apex). They have serrated margins and a smooth, dark green surface on top with a yellowish underside. The leaves are arranged alternately on the branches and are deciduous, meaning they fall off annually.

Acute Toxicity

OECD-423 toxicity study showed no mortality or behavioral changes up to 2000 mg/kg, confirming safety of extracts. Therefore, 1/10th and 1/20th doses were selected for experiments.

Anti-Inflammatory Activity

The anti-inflammatory activities of plant extract were evaluated by the carrageenan-induced rat hind paw edema method. Carrageenan is a strong chemical use for the release of inflammatory and proinflammatory mediators (prostaglandins, leukotrienes, histamine, bradykinin, TNF-α, etc). The course of acute inflammation is biphasic. First phase starts with the release of histamine, serotonin, and kinins after the injection of phlogistic agent in the first few hours. The second phase is related to the release of prostaglandins like substances in 2-3 hours. Second phase is sensitive to both the clinically useful steroidal and nonsteroidal anti-inflammatory agent.

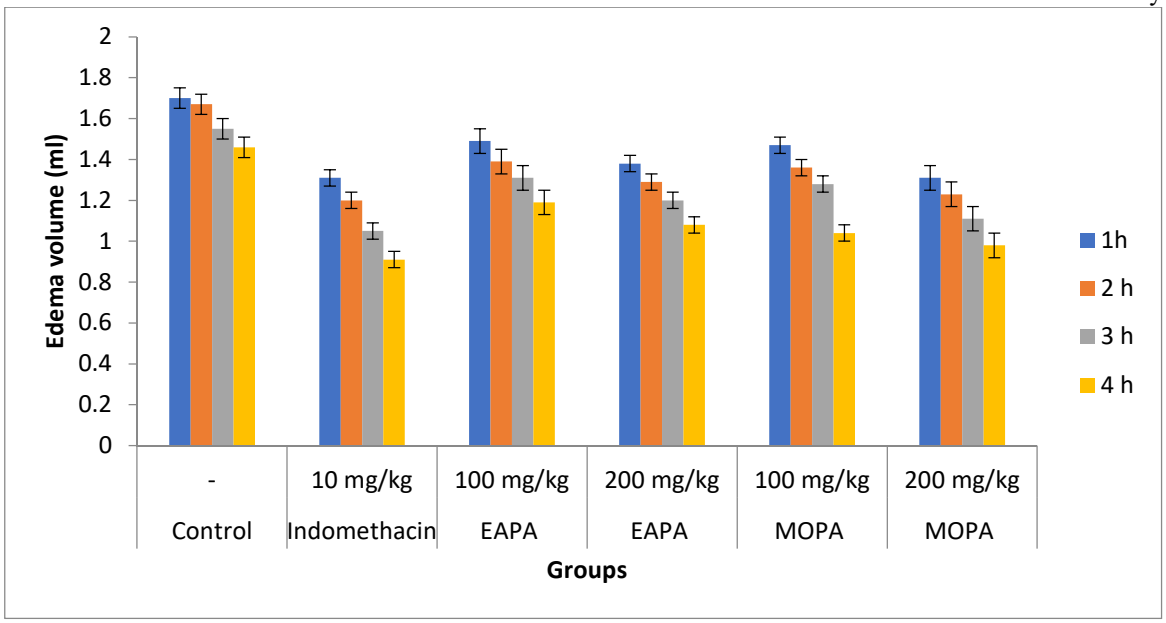

Figure 1: Effect of *Prunus armeniaca* extract on edema volume in carageenan induced rat paw edema method

The carrageenan-induced paw edema model is a well-established experimental model for evaluating anti-inflammatory activity of natural products and synthetic drugs. The model is biphasic: the early phase (0–2 h) is mainly mediated by histamine, serotonin and bradykinin release, whereas the late phase (2–4 h) is largely associated with prostaglandin synthesis, leukocyte infiltration and oxidative stress. Therefore, agents that significantly reduce edema in the later phase are considered to possess strong anti-inflammatory activity, often linked with inhibition of prostaglandins and cyclooxygenase pathways. The ethyl acetate extract showed dose-dependent anti-inflammatory activity. EAPA 100 mg/kg produced moderate inhibition, reducing edema to 1.19 ± 0.08 ml at 4 h, indicating partial suppression of inflammatory mediators. EAPA 200 mg/kg showed significantly greater activity, reducing edema to 1.08 ± 0.07 ml at 4 h, suggesting enhanced anti-inflammatory potential at higher dose.

The progressive reduction from 1 h to 4 h suggests that EAPA exerts stronger effects during the late inflammatory phase, indicating probable inhibition of prostaglandin synthesis and oxidative stress. The methanolic extract demonstrated comparatively stronger anti-inflammatory activity. MOPA 100 mg/kg significantly reduced edema to 1.04 ± 0.18 ml at 4 h, indicating notable activity. MOPA 200 mg/kg exhibited the highest inhibition among the extracts, reducing edema to 0.98 ± 0.07 ml, approaching the effect of indomethacin. The stronger effect of the methanol extract suggests that polar phytoconstituents may be responsible for the anti-inflammatory activity. Both extracts demonstrated dose-dependent anti-inflammatory activity, with the following order of efficacy: Indomethacin > MOPA 200 mg/kg > MOPA 100 mg/kg > EAPA 200 mg/kg > EAPA 100 mg/kg. The results indicate that Prunus armeniaca possesses significant anti-inflammatory potential, particularly the methanolic extract, which showed activity comparable to the standard drug in the late inflammatory phase. The study provides experimental evidence supporting the traditional use of Prunus armeniaca in inflammatory conditions. The methanol extract exhibited superior anti-inflammatory activity, suggesting that further studies focusing on isolation of active phytoconstituents and mechanistic investigations are warranted.

Carrageenan-induced rat paw edema model is a suitable test for evaluating anti-inflammatory drugs, which has frequently been used to assess the antiedematous effect of the drug. Inflammation has been recognized as a key player in the pathophysiology of both type 1 and type 2 diabetes and its secondary complications. Chronic low-grade inflammation and an activation of the various immune reactions are particularly involved in the pathogenesis of obesity-linked insulin resistance and type 2 diabetes. Therefore, targeting the inflammation and its signaling pathways may be an active target to prevent/manage diabetes mellitus and its associated complications. Existing therapeutic drugs used for diabetes, which increase various secondary complications including cardiovascular disease, kidney failure, liver injury, dizziness, mental disorders, weight gain, and skin diseases. Natural products and its derived active compounds may be achievable alternatives for the treatment of type 2 diabetes and its complications without any adverse effects.

Analgesic activity

Evaluation of analgesic activity of the extract was carried out using hot plate method. The rats were placed on a hot plate maintained at 55°C within the restrainer. The reaction time (in seconds) or latency period was determined as the time taken for the rats to react to the thermal pain by licking their paws or jumping.

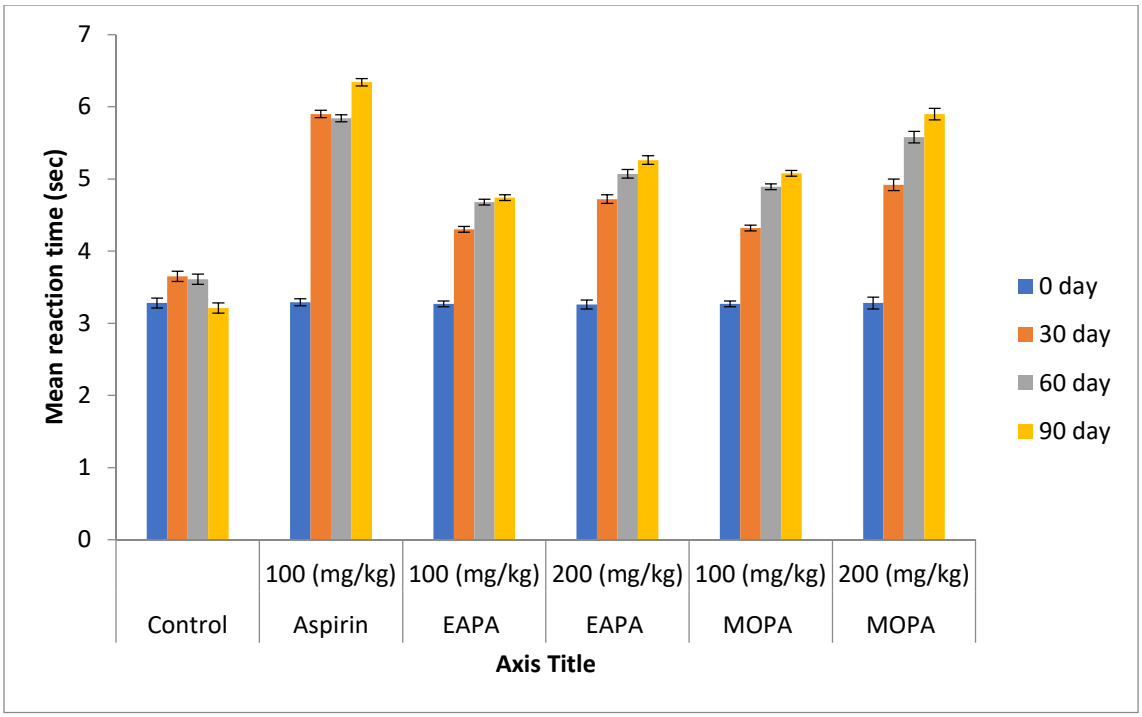

Figure 2: Effect of *Prunus armeniaca* extract on hot plate test

The results clearly demonstrate that the plant extracts possess significant central analgesic activity, with the methanol extract showing the most potent effect. The activity is dose-dependent and time-dependent, supporting the traditional use of the plant in pain management and indicating its potential as a source of natural analgesic agents. The hot plate test is a well-established model for evaluating central analgesic activity, as it measures the response to a thermal nociceptive stimulus. An increase in reaction time indicates suppression of pain perception through central mechanisms. The control group showed nearly constant reaction times throughout the experiment (3.28–3.21 sec), confirming that repeated exposure to the hot plate did not significantly alter pain threshold. This validates the reliability of the model. Aspirin (100 mg/kg) produced a marked increase in reaction time from 3.29 sec (0 min) to 6.34 sec (90 min). This significant elevation confirms the sensitivity of the test and serves as a positive reference for evaluating the analgesic potential of the extracts.

Both doses of Ethyl acetate extract (EAPA) showed time-dependent analgesic activity. EAPA (100 mg/kg) Increased from 3.27 sec to 4.74 sec at 90 min. (EAPA 200 mg/kg) increased from 3.26 sec to 5.26 sec at 90 min. Analgesic effect appeared after 30 min and continued to rise up to 90 min. The 200 mg/kg dose produced stronger activity, indicating a dose-dependent effect. Although less potent than aspirin, EAPA demonstrated significant central analgesic potential. Methanol extract (MOPA) exhibited the highest analgesic activity among the extracts. The increase in reaction time was greater than EAPA at both doses. At 200 mg/kg, MOPA approached the effect of aspirin (5.90 vs 6.34 sec at 90 min). This suggests the methanol extract contains a higher concentration of centrally acting bioactive compounds. All extracts showed Stronger activity at higher dose (200 mg/kg). This pattern indicates Gradual absorption and onset of action. The central analgesic activity may be attributed to phytoconstituents known to be present in the plant extracts such as flavonoids, alkaloids and phenolic compounds. These compounds are reported to Inhibit prostaglandin synthesis, modulate opioid receptors, reduce oxidative stress involved in nociception. The stronger activity of the methanol extract suggests that polar phytochemicals are primarily responsible for the analgesic effect.

Diabetic peripheral neuropathy, which is one of the most frequent long-term complications of DM, is frequently accompanied with inferior quality of life. This complication occurs in about one-quarter of diabetic patients. Painful diabetic neuropathy is associated with symptoms and signs such as burning, tingling, or lancing type of spontaneous pain, allodynia, and hyperalgesia. Thus, novel therapeutic targets are required for the satisfactory treatment of diabetic neuropathic pain.

The hot plate test results strongly suggest that *Prunus armeniaca*, particularly the methanolic extract at 200 mg/kg, possesses significant central analgesic and neuroprotective activity. These effects are highly relevant to diabetic neuropathy, where oxidative stress,

inflammation, and nerve damage lead to chronic pain. The findings support further investigation of this plant as a promising herbal candidate for managing diabetes-induced pain.

Antidiabetic activity

Rats with a fasting glucose level >250 mg dL−1 were classified as diabetic Animals with fasting blood glucose (FBG) level above 250 mg/dL with typical diabetic symptoms of polyuria, polydipsia and polyphagia were selected for the study.

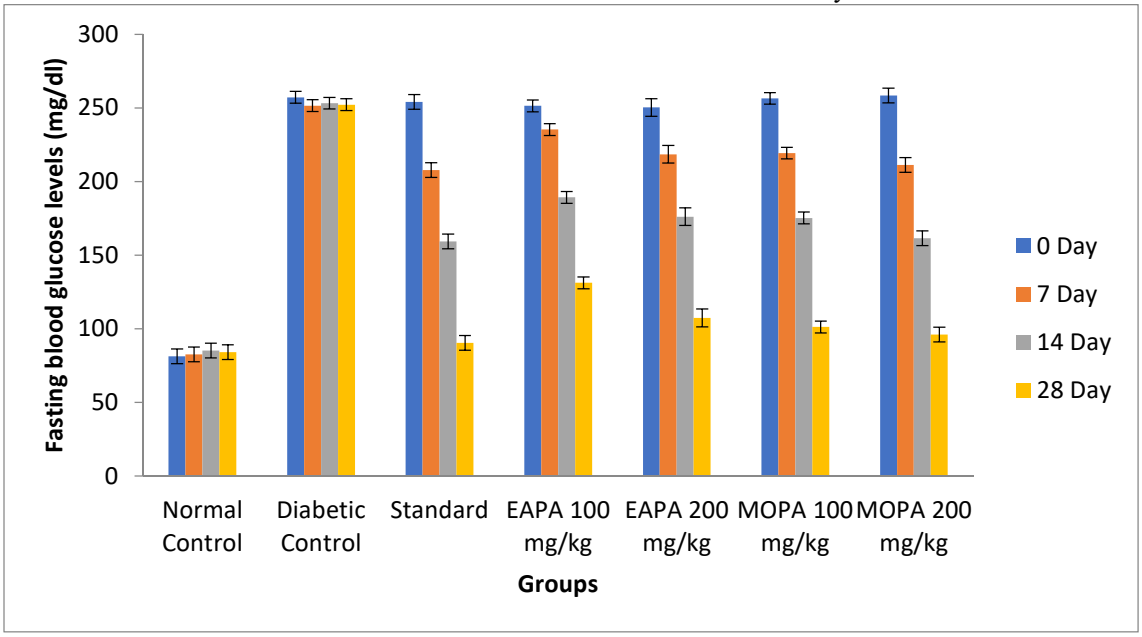

Figure 3: Effect of *Prunus armeniaca* on the blood glucose levels in diabetic rats

The present study evaluated the antihyperglycemic potential of different extracts of Prunus armeniaca in streptozotocin-induced diabetic rats over a period of 28 days. The extracts studied were petroleum ether extract (PEPA), ethyl acetate extract (EAPA), and methanol extract (MOPA), and their activity was compared with a standard antidiabetic drug. At day 0, all diabetic groups exhibited markedly elevated fasting blood glucose levels (≈250–258 mg/dl) compared with the normal control group (≈81 mg/dl), confirming successful induction of diabetes. Throughout the study, the normal control group maintained stable glucose levels (≈81–85 mg/dl), indicating no metabolic disturbances. In contrast, the diabetic control group showed persistently high glucose levels (≈251–253 mg/dl) with no significant reduction over 28 days, demonstrating progressive untreated hyperglycaemia. The standard treated group showed a significant and progressive reduction in blood glucose levels from 254.10 mg/dl (day 0) to 90.5 mg/dl (day 28). This represents near normalization of glucose levels and validates the experimental model and study design. Ethyl Acetate Extract (EAPA) produced a dose-dependent antihyperglycemic effect. EAPA 100 mg/kg: Glucose levels decreased from 251.43 to 131.21 mg/dl by day 28. EAPA 200 mg/kg: A stronger reduction was observed, reaching 107.41 mg/dl by day 28. The higher dose showed marked improvement and approached near-normal glucose levels, suggesting the presence of moderately polar bioactive constituents responsible for glucose-lowering activity.

Methanol Extract (MOPA) showed the most potent activity among plant extracts. MOPA 100 mg/kg reduced glucose from 256.43 to 101.21 mg/dl. MOPA 200 mg/kg reduced glucose from 258.46 to 96.2 mg/dl. The reduction at 200 mg/kg was very close to the standard drug, indicating strong antihyperglycemic potential. Methanol extract likely contains higher amounts of polyphenols, flavonoids, and other polar phytoconstituents known to improve insulin sensitivity and glucose utilization.

Overall antihyperglycemic efficacy after 28 days followed the order: Standard > MOPA 200 mg/kg > MOPA 100 mg/kg ≈ EAPA 200 mg/kg > EAPA 100 mg/kg > Diabetic Control. This trend indicates clear dose-dependent activity for both EAPA and MOPA. Methanol extract (MOPA) demonstrated superior glucose-lowering activity compared to ethyl acetate extract. Petroleum ether extract (PEPA) results were not included in the table, suggesting minimal or insignificant activity relative to polar extracts. The study clearly demonstrates that Prunus armeniaca possesses significant antidiabetic potential. Among the tested extracts, the methanol extract at 200 mg/kg showed the strongest antihyperglycemic

effect, approaching the efficacy of the standard drug. These findings support the therapeutic potential of Prunus armeniaca as a natural source for antidiabetic agents and justify further phytochemical and mechanistic investigations.

Estimation of biochemical parameters

Estimation of glycosylated haemoglobin (HbA1c)

Diabetes is one of the most common diseases worldwide. This serious complication may result from increased glycation of healthy proteins as a consequence of associated chronic hyperglycaemia. Most proteins (including haemoglobin) react with glucose and form covalent combinations without the requirement of enzymes. HbA1C is an inductor combination, which is reversible, but after the inner reformation of this combination, stable HbA1C is formed. When haemoglobin is glycated, its efficiency is reduced, which leads to a pathologic condition

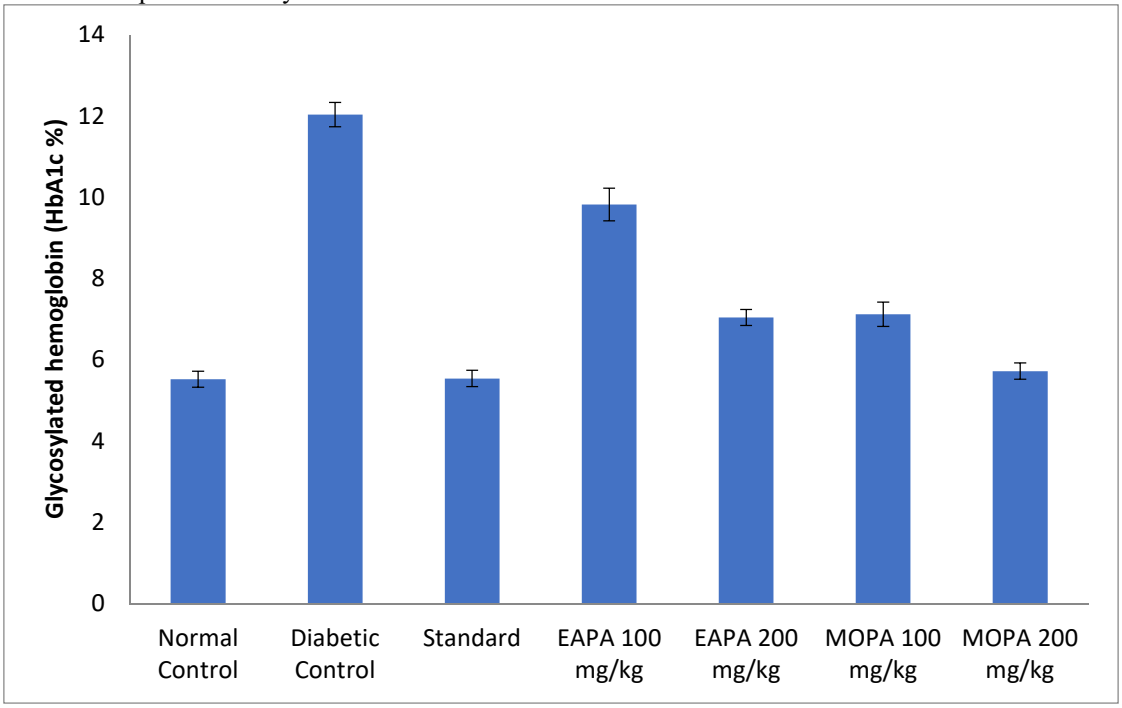

Figure 4: Effect of Prunus armeniaca on glycosylated hemoglobin levels in animals

Glycosylated hemoglobin (HbA1c) is a reliable biomarker for long-term glycemic control because it reflects the average blood glucose level over the lifespan of erythrocytes (approximately 2–3 months in animals). Persistent hyperglycemia leads to non-enzymatic glycation of hemoglobin, resulting in elevated HbA1c levels in diabetic conditions.

In the present study, the diabetic control group exhibited a marked increase in HbA1c (12.03 ± 0.57%) compared with the normal control group (5.52 ± 0.19%), confirming successful induction of chronic hyperglycemia. The near-normal HbA1c value observed in the standard treated group (5.54 ± 0.23%) demonstrates effective glycemic control by the reference drug and validates the experimental model.

Administration of the ethyl acetate extract of Prunus armeniaca produced a dose-dependent reduction in HbA1c levels. The lower dose showed only moderate improvement, indicating partial control of chronic hyperglycemia. However, the higher dose significantly reduced HbA1c, suggesting improved long-term glucose regulation. This effect may be attributed to the presence of semi-polar phytoconstituents such as flavonoids and phenolic compounds known for enhancing insulin sensitivity and reducing oxidative stress.

The methanol extract demonstrated more pronounced antihyperglycemic activity. MOPA 100 mg/kg showed 7.12 ± 0.19% (highly significant). MOPA 200 mg/kg showed 5.72 ± 0.12% (highly significant)

Notably, the higher dose of MOPA reduced HbA1c nearly to normal levels and was comparable to the standard drug. Methanol extracts typically contain a wider range of polar phytochemicals such as polyphenols, tannins, and glycosides, which may exert synergistic antidiabetic effects through improved insulin secretion and sensitivity , inhibition of carbohydrate-digesting enzymes and reduction of oxidative stress and glycation processes. MOPA showed greater efficacy than EAPA at equivalent doses. The significant decrease in HbA1c indicates that Prunus armeniaca extracts not only reduce acute blood

glucose levels but also improve long-term glycemic control. This suggests a protective role against chronic diabetic complications associated with protein glycation.

Overall, the findings demonstrate that Prunus armeniaca, particularly the methanol extract, possesses strong antidiabetic potential. The ability to normalize HbA1c highlights its promise as a natural therapeutic candidate for the management of chronic diabetes and prevention of long-term complications.

Effect of plant extract on renal serum biomarkers

Increases of blood urea and serum creatinine are due to abnormal renal function and also reduction in glomerular filtration rate. So, Urea and Creatinine are the ideal biomarkers to correlate the progression of diabetic nephropathy. Abnormal renal functions like abnormal blood urea and serum creatinine are some of the characteristic features of Diabetic Nephropathy. In uncontrolled diabetes, there may be hyperglycemia associated abnormal increase of blood urea and serum creatinine. So, urea and creatinine are the two important factors to find any abnormality in the kidney.

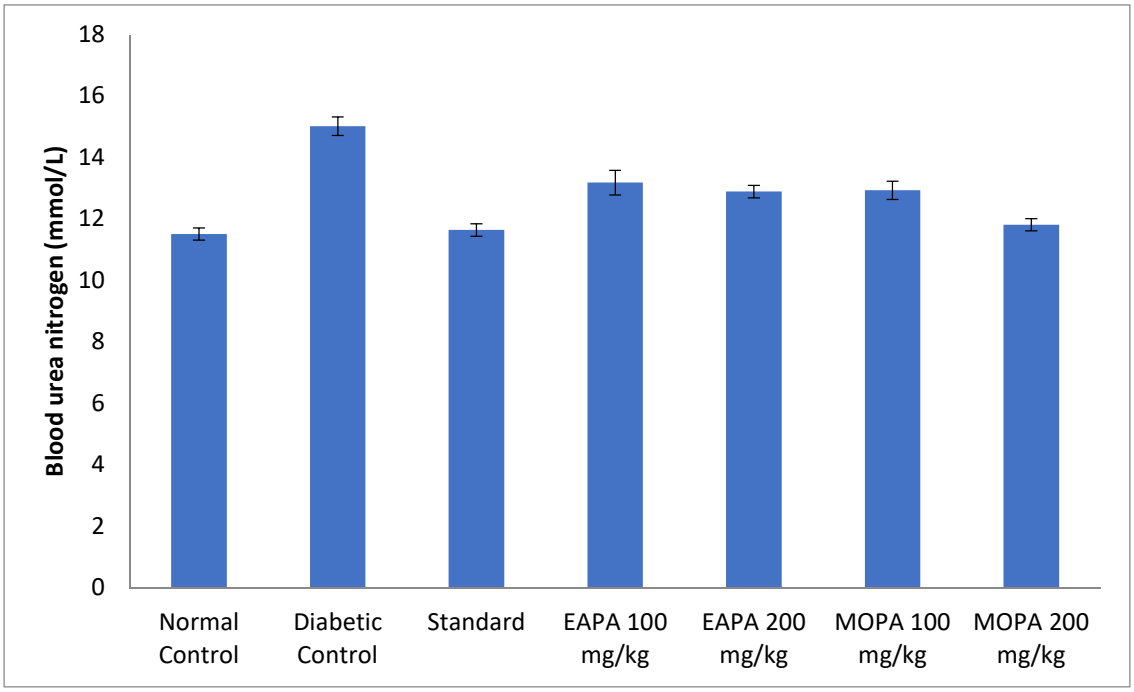

Figure 5: Effect of Prunus armeniaca on Blood urea nitrogen

Blood urea nitrogen (BUN) is an important biochemical marker used to assess renal function and protein metabolism. Elevated BUN levels are commonly observed in diabetic conditions due to increased protein catabolism, impaired renal filtration, and diabetic nephropathy. In the present study, diabetic control animals showed a marked elevation in BUN levels compared with the normal control group, confirming the development of renal impairment associated with diabetes.

The diabetic control group exhibited a significantly increased BUN level (15.02 ± 0.46 mmol/L) compared to the normal control group (11.51 ± 0.36 mmol/L). This rise may be attributed to enhanced gluconeogenesis from amino acids, oxidative stress, and glomerular dysfunction caused by chronic hyperglycemia. Such findings are consistent with previous reports that uncontrolled diabetes leads to deterioration of kidney function.

Treatment with the standard drug significantly reduced BUN levels (11.64 ± 0.82 mmol/L), restoring them close to normal values. This confirms the validity of the experimental model and indicates the effectiveness of the standard treatment in preventing renal damage. Both extracts of Prunus armeniaca demonstrated a protective effect against elevated BUN levels:

Ethyl acetate extract (EAPA) 100 mg/kg and 200 mg/kg significantly reduced BUN levels to 13.18 ± 0.26 and 12.89 ± 0.79 mmol/L, respectively. The reduction was dose-dependent, suggesting that increasing the dose improves renal protection. However, the effect remained moderate compared to the standard and methanol extract.

Methanol extract (MOPA) showed a stronger nephroprotective effect than EAPA. MOPA 100 mg/kg significantly reduced BUN to 12.93 ± 0.71 mmol/L, while MOPA 200 mg/kg brought the value near normal (11.81 ± 0.96 mmol/L). The higher dose of MOPA produced

results comparable to the standard drug, indicating potent renal protective activity.

The superior activity of the methanol extract may be due to its higher content of polar phytoconstituents such as flavonoids, phenolic compounds, and glycosides. These phytochemicals are known for their antioxidant, anti-inflammatory, and nephroprotective properties. By reducing oxidative stress and improving renal blood flow, these compounds may help in preventing protein catabolism and improving urea clearance.

Overall, the findings suggest that Prunus armeniaca extracts possess significant nephroprotective potential in diabetic conditions. Among the tested extracts, the methanol extract at 200 mg/kg demonstrated the most pronounced effect, nearly normalizing BUN levels. This indicates that Prunus armeniaca may help in preventing diabetes-induced renal dysfunction and supports its potential use in the management of diabetic complications.

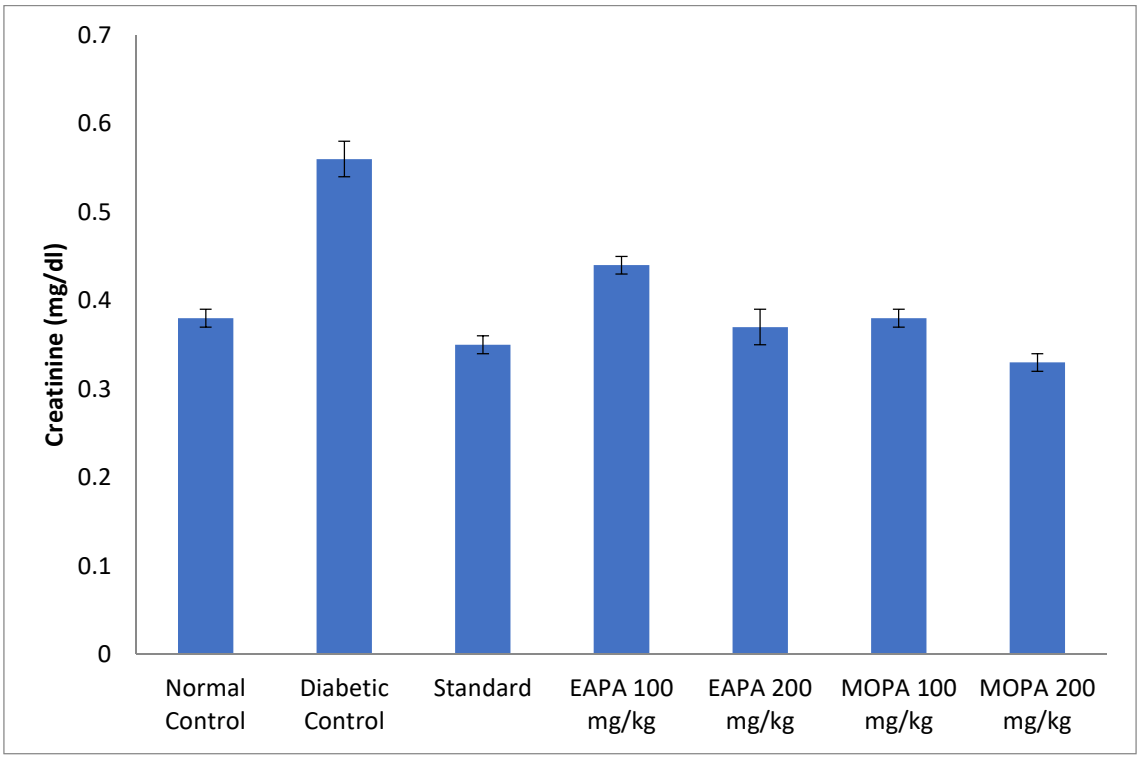

Figure 6: Effect of Prunus armeniaca on Creatinine

Serum creatinine is an important biochemical marker used to evaluate renal function. Elevated creatinine levels indicate impaired kidney function, which is a common complication associated with diabetes mellitus due to diabetic nephropathy. In the present study, the effect of ethyl acetate (EAPA) and methanol (MOPA) extracts of Prunus armeniaca on serum creatinine levels in diabetic animals was evaluated.

The normal control group showed a creatinine level of 0.38 ± 0.02 mg/dl, representing normal renal function. In contrast, the diabetic control group exhibited a marked elevation (0.56 ± 0.03 mg/dl), confirming the development of diabetes-induced renal impairment. Hyperglycemia is known to cause glomerular damage, oxidative stress, and reduced filtration efficiency, leading to increased serum creatinine levels.

The standard treated group significantly reduced creatinine to 0.35 ± 0.04 mg/dl ($p<0.01$), restoring values close to the normal control. This confirms the reliability of the experimental model and the effectiveness of the standard drug in protecting renal function.

Treatment with Ethyl Acetate Extract (EAPA) showed a dose-dependent improvement. EAPA 100 mg/kg: Creatinine decreased to 0.44 ± 0.05 mg/dl, indicating mild renal protection. EAPA 200 mg/kg: Creatinine further decreased to 0.37 ± 0.04 mg/dl ($p<0.05$), approaching normal levels.

This suggests that the ethyl acetate extract possesses nephroprotective activity, likely due to the presence of moderately polar phytoconstituents such as flavonoids and phenolic compounds, which may reduce oxidative stress and glomerular damage.

The methanol extract (MOPA)demonstrated stronger activity MOPA 100 mg/kg: Creatinine reduced to 0.38 ± 0.01 mg/dl ($p<0.01$), almost identical to the normal control. MOPA 200 mg/kg: Showed the greatest reduction (0.33 ± 0.04 mg/dl, $p<0.01$), even slightly lower than the normal control and comparable to the standard drug.

The superior efficacy of the methanol extract may be attributed to its ability to extract a wider range of polar bioactive compounds such as polyphenols, flavonoids, tannins, and glycosides. These compounds are well known for their antioxidant, anti-inflammatory, and nephroprotective properties, which help prevent renal tissue damage and improve kidney filtration.

The results clearly indicate diabetes significantly elevates creatinine levels, confirming kidney dysfunction. Both extracts of Prunus armeniaca improve renal function in diabetic animals. Methanol extract (MOPA) > Ethyl acetate extract (EAPA) in nephroprotective efficacy. The effect is dose-dependent, with 200 mg/kg showing better protection than 100 mg/kg. The highest dose of MOPA exhibited an effect comparable to the standard drug.

The findings suggest that Prunus armeniaca possesses significant nephroprotective potential, particularly the methanol extract, which may help prevent diabetic nephropathy by reducing oxidative stress and improving kidney function. These results support the traditional use of the plant and warrant further studies to isolate and characterize the active phytoconstituents responsible for the observed activity.

CONCLUSION

The present investigation provides comprehensive experimental evidence supporting the pharmacological potential of *Prunus armeniaca* leaf extracts. The extraction process successfully yielded bioactive fractions, and acute toxicity studies confirmed the safety of the extracts at the tested doses.

The methanol extract exhibited the most pronounced biological activities across all experimental models. Significant anti-inflammatory effects observed in the carrageenan-induced paw edema model suggest inhibition of prostaglandin-mediated pathways and oxidative stress. The hot plate test confirmed central analgesic activity, indicating possible modulation of pain pathways and neuroprotective potential relevant to diabetic neuropathy.

In streptozotocin-induced diabetic rats, both extracts demonstrated strong antihyperglycemic activity, with the methanol extract showing near-normalization of blood glucose and HbA1c levels. Furthermore, improvement in blood urea nitrogen and serum creatinine levels indicates notable nephroprotective effects and prevention of diabetes-associated renal dysfunction.

Overall, the results highlight that *Prunus armeniaca*, particularly its methanolic extract, is a promising source of bioactive phytoconstituents with multifunctional therapeutic potential. These findings justify further phytochemical isolation, mechanistic studies, and clinical investigations to develop safe and effective plant-based therapies for inflammation, pain, diabetes, and its complications.

REFERENCES

1. Ranilla LG, Kwon YI, Apostolidis E, Shetty K. Phenolic compounds, antioxidant activity and in vitro inhibitory potential against key enzymes relevant for hyperglycemia and hypertension of commonly used medicinal plants, herbs and spices in Latin America. Bioresour Technol. 2010;101:4676–4689.
2. McCue P, Kwon YI, Shetty K. Anti-amylase, anti-glucosidase and anti-angiotensin I-converting enzyme potential of selected foods. J Food Biochem. 2005;29:278–294.
3. Solomon H. Antidiabetic herbal medicines rebranded as dietary supplements. In: Medicinal Foods as Potential Therapies for Type-2 Diabetes and Associated Diseases. Academic Press; 2019. p. 1049–1134.
4. Pantidos N, Boath A, Lund V, Conner S, McDougall GJ. Phenolic-rich extracts from the edible seaweed, Ascophyllum nodosum, inhibit α-amylase and α-glucosidase: Potential anti-hyperglycemic effects. J Funct Foods. 2014;10:201–209.
5. Tiwari PK, Kori ML, Jain N. In-vitro antioxidant and antidiabetic activity evaluation of Vitex peduncularis leaves extracts. Adv Bioresearch. 2023;14(5):301–306.
6. Altemimi A, Lakhssassi N, Baharlouei A, Watson DG, Lightfoot DA. Phytochemicals: extraction, isolation, and identification of bioactive compounds from plant extracts. Plants. 2017;6(4):42.
7. Srivastav VK, Egbuna C, Tiwari M. Plant secondary metabolites as lead compounds for the production of potent drugs. In: Phytochemicals as Lead Compounds for New Drug Discovery. Elsevier; 2020. p. 3–14.
8. Jain N, Kori ML. Comparative pharmacognostic, physicochemical and phytochemical studies of different samples of Plumbago zeylanica L.

roots. Int J Pharm Sci Drug Res. 2017;9(6):286–290.
9. Tiwari PK, Kori ML, Jain N. Assessment of in vitro anti-diabetic and anti-oxidant potential of Syzygium nervosum leaves extracts. Int J Zool Investig. 2024;10(1):751–759.
10. Mukherjee PK, Bahadur S, Harwansh RK, Biswas S, Banerjee S. Paradigm shift in natural product research: traditional medicine inspired approaches. Phytochem Rev. 2017;16:803–826.
11. Yildirim H, Tilkat E, Onay A, Ozen HS. In vitro embryo culture of apricot, Prunus armeniaca L. cv. Hacihaliloglu. Int J Sci Technol. 2007;2:99–104.
12. Yigit D, Yigit N, Mavi A. Antioxidant and antimicrobial activities of bitter and sweet apricot (Prunus armeniaca L.) kernels. Braz J Med Biol Res. 2009;42:346–352.
13. Yamamoto K, Osaki Y, Kato T, Miyazaki T. Antimutagenic substances in the Armeniacae semen and Persicae semen. Yakugaku Zasshi. 1992;112:934–939.
14. Parlakpinar H, Olmez E, Acet A, Ozturk F, Tasdemir S, Ates B, et al. Beneficial effects of apricot-feeding on myocardial ischemia–reperfusion injury in rats. Food Chem Toxicol. 2009;47:802–809.