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Review Article

Evaluation of In-Vivo Antidiabetic and Antihyperlipidemic Potential of *Bismarckia nobilis* Extract

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ABSTRACT

India has one of the world's highest diabetes burdens. As of 2024, an estimated 89.8 million individuals (20-79 years old) in India have diabetes, with the figure expected to climb to 156.7 million by 2050. Diabetes prevalence is influenced by urbanization, lifestyle changes, and rising obesity rates. Diabetes and high lipid levels are two closely associated diseases, with raised cholesterol levels being a typical side effect of diabetes. The aerial part of Bismarckia nobilis was dried using an electric blender, powder was macerated in petroleum ether, solid form was left to stand for 3-7 days, filtered, dried, and then macerated with ethanol and hot water to complete extraction. The hydroalcoholic extract of bismarckia nobilis (HEBN) was administered at dosages of 200 mg/kg and 400 mg/kg to normoglycemic Wistar rats, as well as a single and repeated dose to streptozotocin-induced diabetes models. Blood glucose levels were assessed in the normoglycemic, oral glucose-loaded, and single-dose streptozotocin models. Blood glucose levels, body weight, and lipid profiles were assessed in the diabetic animal treated with repeated doses. The abnormally high concentration of serum lipids in the diabetic condition is mainly due to an increase in the mobilization of free fatty acids from the peripheral fat depots, since insulin inhibits the hormone-sensitive lipase. In the present study, the blood sample was withdrawn on the 28th day, and it was found that 200 mg/kg was not effective for lowering the LDL level in diabetic-induced rats, but 400 mg/kg had a significant decrease in LDL levels. Both extracts (HEBN 200 and HEBN 400 mg/kg) showed a highly significant effect on triglyceride levels in the iii to v group. The study shows that Bismarckia nobilis extracts, especially at 400 mg/kg, may help control high blood sugar and improve fat levels in diabetics. More research is needed to understand its effects and to ensure safety. If successful, Bismarckia nobilis could enhance diabetes treatments and provide extra health benefits. These extracts might be a good option for new herbal medicines for diabetes and lipid issues.

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INTRODUCTION

Diabetes is on the rise globally, and the latest IDF Diabetes Atlas (2025) reports that 11.1%—or 1 in 9—of the adult population (20-79 years) is living with diabetes. Alarmingly, over 4 in 10 people with diabetes are unaware they have the condition. By 2050, projections indicate that 1 in 8 adults—approximately 853 million—will be living with diabetes, marking a 46% increase. India has one of the highest diabetes burdens in the world. As of 2024, an estimated 89.8 million adults (20–79 years) in India are living with diabetes, and this number is projected to rise to 156.7 million by 2050. The prevalence of diabetes is driven by factors such as urbanization, lifestyle changes, and increasing obesity rates (Harding et al., 2024). Diabetes and elevated lipid levels are two closely related illnesses, with elevated cholesterol levels being a common consequence of diabetes. Hyperlipidaemia, also known as dyslipidaemia, is defined as abnormal amounts of lipids (fats) in the blood, such as high cholesterol and triglycerides, as well as low HDL cholesterol. Hyperlipidaemia in diabetic patients can raise the risk of cardiovascular illnesses such as cardiovascular disease and stroke (O'Brien et al., 1998). Oxidative stress played underling associated with the pathogenesis of diseases, leading to increases risk of insulin resistance, dyslipidemia, elevated blood pressure, metabolic syndrome, inflammation and endothelial dysfunction. This reviewed support the oxidative stress contribution of the multifactorial etiology of oxidative stress and insulin resistance in the whole body. ROS act as the signal transduction factor and plays the important role in oxidative stress-mediated downstream signaling pathways and enhances the cell death. Furthermore, risk for several chronic disease's development associated with oxidative stress and metabolic syndrome including T2DM, hypertension, arthritis, congestive heart failure, chronic renal failure, cancer and Alzheimer's. These diseases may be substantially reduced by dietary modifications, increased physical activity and antioxidant drugs ameliorated oxidative stress. The therapeutic approaches target on oxidative stress may delay or prevent the progression and onset of diseases. Then, antioxidants supplementation may curtail the progression and onset of the metabolic disease complications. Antioxidant interventions, an importance goal of future clinical investigations should be implementation and to improve oral bioavailability targeted to the oxidant overproduction site (Henriksen et al.,2011) plant chemicals naturally occurring compounds found in plants, can lower blood glucose levels through a variety of mechanisms, including enhancing insulin sensitivity, increasing the intake of glucose by muscle and fatty tissue, blocking glucose absorption in the intestines, and boosting pancreatic beta cells to discharge insulin. Some phytochemicals function by blocking enzymes that break down carbs, such as alpha-amylase and alpha-glucosidase (Ames et al., 2015). Bismarckia nobilis (Arecaceae), often known as Silver Palm Tree or Fan Palm, is a popular medicinal plant in India due to its diverse folkloric uses by Hakims and traditional healers. Palms are a plant group with 183 genera and 23,00 species found in tropical and subtropical climates worldwide. Bismarck Palm measures 60 feet tall and 20 feet broad. It is native to Madagascar cultivated all over the world including America and south Asia (Mitchell.,2012). Bismarckia nobilis (Bismarck palm) contains various chemical constituents, including alkaloids, tannins, steroids, saponins, anthraquinones, and flavonoids. Some study also indicated the presence of cellulose, hemicellulose, lignin, and waxes. Although the fact that there are several drugs available to treat diabetes, they have been related to a number of unwanted side effects. Thus, it has been proposed to employ natural

ingredients as viable pharmaceutical replacements.

METHODS AND MATERIALS

The experiment used absolute ethanol 99.9% (Labstream Instruments, India), streptozotocin (Otto Chemie Pvt Ltd India), Glibenclamide or Euglucon Tablet 5 mg (Abbott India limited), a blood glucose meter and strips (Accu-Chek, a brand owned by Roche Diabetes Care, India), lead acetate 1% (Guangdong Guanghua Chemicals Factory, China), sodium hydroxide 48% (BDH, chemical lab, England), ferric chloride 12%, and sulfuric acid. All materials were of analytical quality and came from government and private sources.

EXTRACTION

The aerial part of *Bismarckia nobilis* were taken from the garden near Indore, M.P. The plants were authenticated, Botanist, Dr. Sandeep K Verma Department of Botany, SAGE University Indore. The fine, coarse powder was obtained from dried aerial part of *Bismarckia nobilis* using an electric laboratory blender. Powder of of *Bismarckia nobilis* was macerated in petroleum ether. Solid form of *Bismarckia nobilis* are kept in a stoppered container with the whole solvent and left to stand for at least 3 days (3–7 days) with regular agitation until soluble stuff is dissolved et al., After that whole material was undergo for filtration then remove the fatty filtrate and dried the solid none filtration part. These solid parts undergo for 2nd Hot maceration with ethanol and hot water in a 70:30 v/v ratio was used to complete the extraction. After fifteen days of combining the powdered material with the hydroalcoholic solvent, the mixture was separated via filter paper by Whatman after being mixed with the powdered material. In an electric oven set to 50 degrees Centigrade, the specimen was heated with a magnetic stirrer and boiled for a total of 45 minutes. [Mathews et al., 2024]. The hydroalcoholic extract of *bismarckia nobilis (***HEBN)** was cooled and collected in a well-closed container in the form of a dry state. The extract underwent further drying while being kept in the shade [Yadav *et al*., 2012]. The phytochemical analysis of the extracts was performed under the protocols that are conventional [Trease and Evans., 1989, Kokate *et al*., 2006]. A preliminary phytochemical screening was performed on both extracts to determine the different Phyto-constituents that were present in both of it. A big variety of natural resources compounds, including alkaloids and terpenoids as well as glycosides and steroids as well as flavonoids, saponin, and tannin, were examined.

ACUTE TOXICITY STUDIES

All in vivo experiments creatures were given by the Swami Vivekanand college of pharmacy Indore (1627/PO/Re/S/12/CPCSEA). The Institutional Animal Ethical Committee (Protocol No. IAEC/SVCP/2025/Feb/01) endorsed the system. All creature research observed CPCSEA guidelines. Rodents had promotion limit um food and water (standard pellet). The exploratory work with the rodents started following a seven-day acclimation period. Each enclosure obliged two rodents, who were dispensed into two gatherings utilizing a randomized conveyance system. The treatment bunch got treatment (HEBN and standard), while the benchmark group got no treatment. Utilizing a 12-hour light/dull cycle, the rodents' lodging was kept at 24°C & 2°C (OECD,2001). The "Fixed Dosage Method" of the OECD 423 guideline was utilised in the current investigation to determine the acute toxicity of the substance. The rats were given HEBN extract orally, and three albinos female Wistar rats were chosen for each phase of the study. The rats were

given dosages of Five mg, Fifty mg, three hundred mg, and two thousand mg by oral administration. It may take anyway HEBN from two to four phases before a conclusion can be reached on the toxic effect of the test substance and/or the morbidity condition of the animals. This will depend on the death rate [Alfredo et al.,2004].

IN VIVO ANTIDIABETIC ACTIVITY

- **Induction of diabetes in wistar Rats**

In this study, 16-week-old normal (fasting blood glucose level of 90–110 mg/dl) rats were used. A single dose of intraperitoneal injection of STZ (60 mg/kg/i.p) dissolved in 0.1M citrate buffer (pH 4.5) was used to induce diabetes in overnight fasted male wistar rats weighing 170–200 gm. Rats were allowed to free access to 10% glucose water to prevent hypoglycaemia associate death. After 72 h (3 days), the rats were checked for the blood glucose level from the tail vein using glucometer (Accu-check, Roche Diagnostic, Indianapolis, IND, United states). Only the rats with fasting blood glucose levels ≥ 250 mg/dl were considered as diabetic-induced rats and included in this study [Saravanan et a.,2021].

- **Animal Experimental Design**

Six normal healthy rats were chosen randomly for the control group. Thirty diabetic-induced rats were selected, and six rats were randomly assigned for each group for the study.

Table 1.1 Study Design

Sr. No.	Group No	Group Name	Dose, drugs, and Schedule
1	Group –I	Control	Streptozotocin-induced diabetic rats administered orally with distilled water.
2	Group II	Negative control	Streptozotocin-induced diabetic rats administered orally with distilled water.
3	Group III	Diabetic control untreated	Streptozotocin-induced diabetic rats administered orally with *Glibenclamide* (05 mg/kg) dissolved in distilled water.
4	Group IV	HEBN Low dose	STZ induced diabetic rats administered orally with ethanolic extract of S. torvum fruit (200 mg/kg) dissolved in distilled water.
5	Group V	HEBN High dose	STZ induced diabetic rats administered orally with ethanolic extract of S. torvum fruit (400 mg/kg) dissolved in distilled water.

All the treatments were started on the fourth day after STZ injection and once a day continued for 28 days. Fasting blood glucose mg/dl was measure at 0 (fourth day after STZ injection) ,7,14,21,28 days

- **Biochemical Analysis**

After 28 days of treatment, blood samples were collected from the retro-orbital plexus, and blood glucose levels were estimated using glucometer (Accu-check, Roche Diagnostic, Indianapolis, IND, United states) [Mandoria et al.,2021]. The remaining blood was centrifuged at 3000 rpm for 5 min. Serum was collected immediately and stored at −70°C until the analysis of biochemical parameters.

- **Estimation of serum lipid profile**

Blood lipid profile (LDL—direct cholesterol and triglycerides or TG) was analysed after 28 days.

LDL cholesterol and TG were estimated using commercially available kits (Raj Biosis Pvt Ltd., India) and the results were recorded according to the manufacturer's instructions. The data obtained were then compared to baseline values to assess any significant changes in lipid levels over the study period. The findings indicated a notable variation in lipid levels, with a significant reduction in LDL cholesterol and triglycerides observed in the treatment group. Further statistical analysis will be conducted to determine the clinical implications of these changes on cardiovascular health. Estimation of serum lipid profile is essential for assessing cardiovascular risk and managing conditions such as hyperlipidaemia. Regular monitoring can help in making informed decisions regarding lifestyle changes and pharmacological interventions (Andargie et al., 2022).

- **Biostatistical analysis**

The values are expressed in mean ± SEM. The results were analyzed by using one way analysis of variance (ANOVA) followed by Dunnet's "t" test to determine the statistical significance. $p < 0.05$ was chosen as the level of significance. Statistical analysis was performed using Graph Pad Prism Software 5.0 version.

RESULT

- **Characterization of *aerial part of bismarckia nobilis* extracts or HEBN**

After preparing a hydroalcoholic extract of *bismarckia nobilis* in the manner outlined in the "Materials and Methods" section, the substance's physical and chemical characteristics were analysed to characterize it. These observations are included in table that is 1.2

Table 1.2: Characterization of *Bismarckia nobilis flower* extracts or HEBN

Sr. No.	Extract	% Yield	Colour	Odour	Texture
1.	Hydroalcoholic Extract of *bismarckia nobilis*	20	Light brown	Aromatic	Smooth

Phytochemicals testing of the extract

Table 1.3: Phytochemicals testing of the extract	
Carbohydrates	
○ Molish examination	+
○ Fehling's examination	+
○ Bareford's examination	+
Alkaloids	
○ Mayer's examination:	-
○ Hager's examination	-
○ Wagner's examination	-
Terpenoids	
○ Salkowski examination	+
○ Libermann Burchard's examination	+
Flavonoids	
○ Lead Acetate examination	+
○ Alkaline Reagent examination	+
○ Shinoda examination	+
Tannins and phenolic compounds	
○ $FeCl_3$ Solution examination	+
○ Lead Acetate examination	+
○ Gelatin examination	+
Saponins	
○ Froth examination	-
○ Sterol examination	-
Protein and Amino acids	+
○ Ninhydrin examination	+
○ Biuret's examination	+
Glycosides	
○ Legal's examination	+
○ Keller Killani examination	+
Fats and lipids	
○ Spot examination	+

Acute toxicity studies

Toxicity testing was carried out on HEBN extract under OECD 423 criteria. Toxicological tests

HEBN were supplied orally to the rats at doses ranging from 5 mg/kg to ranging from 300-2000 mg/kg. The rats showed no preclinical symptoms of toxicity or mortality after being given the tests HEBN. All the animals gained weight and showed no signs of behavioural alteration, indicating that the administration on HEBN extracts had a minor effect on the animals' growth. LD50 values were shown to have concentrations of more than 2,000 mg/kg across all of the dosages tested and whole toxicity studies found that HEBN is no deaths or clinical symptoms of toxicity at any of the doses examined When given to rats at a dosage of 2000 mg/kg, it has been shown that the extract HEBN are not deadly. As per guideline of OECD, a 1/10th dose of 200 mg/kg was chosen as the lower dose and 400 mg/kg as higher dose. The results of the observations are listed in the following table:

Table 1.4: Mortality at various doses in Acute oral toxicity studies

Sr. No	Test Sample (mg/kg)	05	50	300	2000
1	HEBN	None	None	None	None

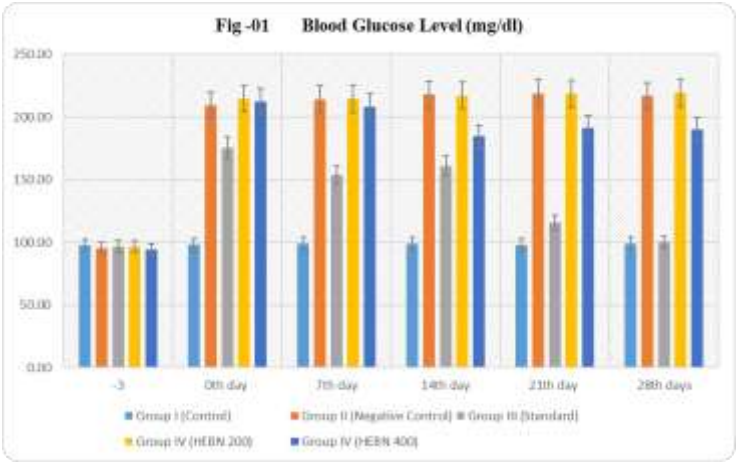
7. Streptozotocin induced antidiabetic activity

The hypoglycemic effects of HEBN (at doses of 200 and 400 mg/kg body weight) were examined in Wistar rats with STZ-induced hyperglycaemia (Table 1.5). The results showed a considerable drop in blood glucose levels (Fig. 1) compared to the negative control group (STZ induced) on the 14th, 21st, and 28th days. The statistical tests were not passed before 14 days. HEBN 200 mg/kg dose, not significant in whole studies. Glibenclamide (Group III) was highly significant and markedly decreased glucose levels all days. The findings suggest that while HEBN at a 200 mg/kg dose did not show significant effects throughout the study, the 400 mg/kg dosage may warrant further investigation due to its potential benefits. Additionally, the consistent efficacy of Glibenclamide reinforces its role as a standard treatment in managing hyperglycaemia in this model.

Table 1.5 Streptozotocin induced antidiabetic activity

Groups	-3th days Mean±SD	0th day Mean±SD	7th day Mean±SD	14th day Mean±SD	21st day Mean±SD	28th days Mean±SD
Group I (Control)	97.77± 2.46	98.05±1.81	99.05±1.48	98.97 ±1.95	97.94±1.03	99.05±0.78
Group II (Negative Control)	95.31±2.34	209.42±3.12[b]**	214.12±2.30[b]**	217.94±1.70[b]**	218.85±1.83[b]**	216.65±2.40[b]**
Group III (Standard)	96.73±3.61	175.52±3.46[a]**	154.00±2.94[a]**	161.10±3.70[a]**	115.704±3.37[a]**	100.474±3.00[a]**
Group IV (HEBN 200)	96.55±2.89	214.67±3.99[a]	214.51±4.26[a]	217.17±2.51[a]	218.47±2.50[a]	219.27±3.53[a]
Group IV (HEBN 400)	94.08±2.85	212.42±4.14[a]	208.22±4.44[a]	184.55±2.88[a]**	191.44±3.84[a]**	190.04±4.10[a]**

Statistical significance was evaluated by one-way analysis of variance (ANOVA) and Bonferroni multiple pairwise comparisons between group means by Bio-stat 4.0 version Each Value represent in Mean±SD and n=5. 'a' indicates that the value is compare with negative control groups. 'b' indicate the value is compare with control group and 'c' is indicate the value is compare with standard group. asterisk (*) is represent significant (P<0.05) and double asterisk, (**) High Significance ($p < 0.001$).



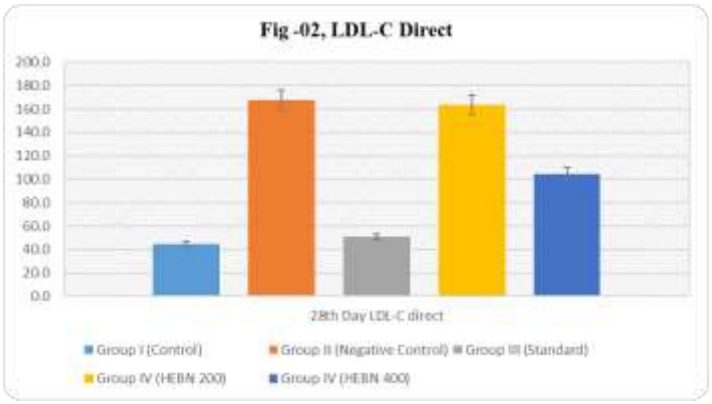
Estimation of serum lipid profile by LDL—Direct cholesterol and Triglycerides (TG)

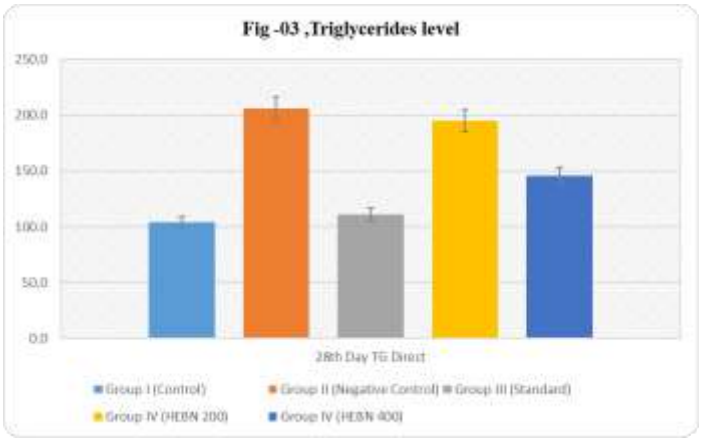
As the results of the study showed that the LDL-C at the 28th day increases significantly as compared to the normal control group. Similarly, group V HEBN 400 mg/kg has shown (Table .02) a highly significant decrease in the LDL level compared to the negative control group, whereas group IV HEBN 200 mg/kg has not shown a significant difference compared to the negative control group. These findings suggest that the administration of HEBN may have a beneficial effect on lipid profiles, particularly at the higher dosage. Further research is necessary to understand the underlying mechanisms and to explore the potential clinical implications of these results. In the same way, the study showed (Fig 03.) that the triglyceride level increased in all induction groups after treatment; both Group IV and Group V have found a significant decrease in the triglyceride level compared to the negative control group. This suggests that the treatments applied in these groups may be effective in managing triglyceride levels, potentially offering a therapeutic benefit for individuals with elevated levels.

Tabe.1.6 Lipid Profile Level

	28th days	
Groups	(LDL-direct) Mean±SD	Triglycerides Mean±SD
Group (Control)	44.8±2.8	104.1±3.5
Group II (Negative Control)	167.7±3.6	206.2±3.4
Group III (Standard)	50.8±2.5 a**	110.7±2.4 a**
Group IV (HEBN 200)	163.7±4.8	194.8±3.8 a**
Group IV (HEBN 400)	104.6±3.1 a**	145.8±3.3a**

Statistical significance was evaluated by one-way analysis of variance (ANOVA) and Bonferroni multiple pairwise comparisons between group means by Bio-stat 4.0 version Each Value represent in Mean±SD and n=5. ‘a’ indicates that the value is compare with negative control groups. asterisk (*) is represent significant (P<0.05) and double asterisk, (**) High Significance (p < 0.001).





DISCUSSION

Diabetes, a chronic metabolic illness, develops when the body either generates insufficient insulin or is unable to efficiently use the insulin it produces, resulting in excessive blood sugar levels. The reasons differ by kind, with type 1 being an autoimmune disorder and type 2 being connected to genetics, lifestyle choices, and insulin resistance. Phytochemicals, naturally occurring molecules found in plants, show promise in diabetes control by possibly improving insulin sensitivity, lowering oxidative stress, and regulating blood sugar levels, providing a natural alternative to standard therapies. In diabetes, elevated blood sugar (hyperglycaemia) causes excessive free radical generation and oxidative stress, which contribute to the development and progression of diabetic complications by harming cells and tissues. Various types of phytochemicals for antidiabetic activity have been extensively studied in recent years. Researchers are particularly interested in compounds such as flavonoids, phenolic acids, and terpenoids, which have shown promising effects in regulating blood sugar levels and improving insulin sensitivity. These compounds not only contribute to glycemic control but also offer additional health benefits, including antioxidant and anti-inflammatory properties. As a result, they are gaining attention for their potential role in the prevention and management of diabetes.

After treating the powder of *Bismarckia nobilis* with ethanolic solution, some phytochemicals were found to be positive like, Terpenoids, Flavonoids, Tannins and phenolic compounds etc. The LD50 value of the hydroalcoholic extract of *Bismarckia nobilis* (HEBN) is 2000 mg/kg. This indicates that the extract can be administered at relatively high doses before reaching a lethal threshold in experimental subjects.

In this experiment, rats were given STZ, which caused hyperglycaemia. Injecting STZ intraperitoneally disrupts the DNA strands of pancreatic cells responsible for insulin synthesis. This action reduces insulin production and secretion. STZ is hypothesized to cause hyperglycaemia due to its toxic effects on pancreatic β-cells. This impairs blood glucose regulation and leads to problems in multiple organs. These complications can result in symptoms such as increased thirst, frequent urination, and fatigue. Over time, chronic hyperglycaemia may contribute to the development of diabetes-related complications, including neuropathy, nephropathy, and cardiovascular disease. Streptozotocin (60 mg/kg/i.p.) successfully produced hyperglycaemia in all groups except group in the vehicle-treated control group. Both extracts (HEBN 200 and HEBN 400 mg/kg) had no effect on glucose levels from days 0 to 7 on each group. Sample extract HEBN 400 mg/kg shows a significant reduction of hyperglycaemia from the 14th to the 28th days. Whereas HEBN 200 mg/kg has not shown a reduction of blood glucose level on all days. Both extracts (HEBN 200 and HEBN 400 mg/kg) had no effect on glucose levels from days 0 to 7 in each group. Sample extract HEBN 400 mg/kg shows a significant reduction of hyperglycemia from the 14th to the 28th days. Whereas HEBN 200 mg/kg has not shown a reduction of blood glucose level on all days. This indicates that the higher dosage of the extract may be more effective in managing blood sugar levels over time. Further studies could explore the mechanisms behind this difference in efficacy and assess the long-term safety of HEBN at various dosages. Additionally, it would be beneficial to examine the potential side effects associated with prolonged use of HEBN, particularly at the higher dosage. Understanding the optimal dosage for efficacy while minimizing adverse effects will be crucial for its development as a therapeutic option for hyperglycaemia.

Generally, diabetes is accompanied by hyperglycemia and hyperlipidemia. Hypercholesterolemia and hypertriglyceridemia are major risk factors for atherosclerosis, which could be prevented by hypocholesterolaemia drugs. During diabetic conditions, serum fatty acids are produced in excess and converted into phospholipids and cholesterol in the liver. These two substances, along with excess triglycerides formed at the same time in the liver, may be discharged into the blood in the form of lipoproteins. The abnormally high concentration of serum lipids in the diabetic condition is mainly due to an increase in the mobilization of free fatty acids from the peripheral fat depots, since insulin inhibits the hormone-sensitive lipase. In the present study, the blood sample was withdrawn on the 28th day, and it was found that 200 mg/kg was not effective for lowering the LDL level in diabetic-induced rats, but 400 mg/kg had a significant decrease in LDL levels. Both extracts (HEBN 200 and HEBN 400 mg/kg) showed a highly significant effect on triglyceride levels in the iii to v group. This suggests that these extracts may play a crucial role in lipid metabolism, potentially offering therapeutic benefits for conditions associated with elevated triglyceride levels. Further studies are warranted to explore the underlying mechanisms and long-term effects of these treatments.

CONCLUSION

In short, the study highlights the potential of *Bismarckia nobilis* extracts, particularly at higher dosages (400 mg/kg), in managing hyperglycaemia and improving lipid profiles in diabetic conditions, suggesting a promising natural alternative for diabetes management. Further research is needed to fully understand the

mechanisms behind these effects and to determine the optimal dosages for effectiveness and safety. Moreover, research is essential to elucidate the mechanisms of action and ensure the safety and efficacy of these extracts for long-term therapeutic use. If validated through clinical trials, *Bismarckia nobilis* could become a valuable addition to diabetes treatment regimens. Incorporating Bismarckia nobilis into standard treatment protocols may not only enhance glycemic control but also offer additional health benefits, such as improved cardiovascular health. Thus, Bismarckia nobilis extracts may be a promising candidate for innovative phytomedicines used to treat diabetes and dyslipidemia. More study is required to completely understand their mechanisms of action and maximize their efficacy. Furthermore, clinical trials will be required to determine the safety and efficacy of these extracts in human populations.

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