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Pharmacological Evaluation Of Some Medicinal Plants For Hypoglycemic Activity

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ABSTRACT

Diabetes mellitus is a long-term metabolic disorder marked by ongoing hyperglycemia and related issues, such as dyslipidaemia and oxidative stress. The current study sought to assess the antidiabetic and antioxidant properties of specific medicinal plants—Glycyrrhiza glabra, Pterocarpus marsupium, Syzygium aromaticum, and Aegle marmelos—both individually and as a polyherbal formulation. We used DPPH, ABTS radical scavenging assays, and total antioxidant capacity to test the antioxidant activities in vitro. Syzygium aromaticum exhibited the highest antioxidant activity among individual extracts, whereas the polyherbal formulation displayed increased efficacy, indicating a synergistic effect.

To test the polyherbal formulation in living animals, Wistar rats with diabetes caused by streptozotocin were given doses of 200 mg/kg and 400 mg/kg for 30 days. We kept an eye on the levels of blood glucose, triglycerides, and VLDL. The polyherbal extract caused blood glucose levels to go down in a dose-dependent and statistically significant way, with the 400 mg/kg group showing the strongest effect. Moreover, triglyceride and VLDL levels enhanced in the treated groups, suggesting hypolipidemic potential. The polyherbal formulation was not as strong as the standard antidiabetic drug (glibenclamide), but it worked well every time.

These results indicate that the polyherbal formulation, abundant in bioactive phytochemicals such as flavonoids, tannins, and alkaloids, may serve as a promising candidate for the management of diabetes and its complications. More research is needed to find the active ingredients and test their long-term safety and effectiveness.

Keywords: *Polyherbal formulation; antidiabetic activity; antioxidant assay; Syzygium aromaticum; Pterocarpus marsupium; streptozotocin; lipid profile; medicinal plants.*

1. INTRODUCTION

Diabetes mellitus is a complex metabolic disorder primarily characterised by chronic hyperglycemia resulting from deficiencies in insulin secretion, insulin action, or both.[1,2] The condition is linked to problems with how the body breaks down carbohydrates, fats, and proteins, and it often causes long-term damage to organs like the eyes, kidneys, nerves, heart, and blood vessels.[3,4] The International Diabetes Federation (IDF) says that diabetes is becoming more common around the world at an alarming rate. By 2030, an estimated 643 million adults will have the disease. This growing burden shows how important it is to find safe, effective, and cheap ways to prevent and treat diabetes and its complications.[5,6]

There are a number of synthetic antidiabetic drugs on the market right now, including sulfonylureas, biguanides, and thiazolidinediones. However, these drugs often have side effects like hypoglycemia, weight gain, gastrointestinal problems, and in some cases, liver and kidney toxicity. In addition, using these drugs for a long time can make them less effective because the body builds up resistance to them. These limitations have led to a lot of interest around the world in alternative and complementary therapies, especially plant-based ones, which are thought to be better for you overall and have fewer side effects.[7]

For hundreds of years, Ayurveda, Unani, and Siddha have used medicinal plants to treat diabetes. These plants are rich sources of bioactive compounds including flavonoids, alkaloids, tannins, terpenoids, and glycosides, many of which possess antioxidant, anti-inflammatory, and insulin-mimetic properties. Oxidative stress has been associated with the pathogenesis and progression of diabetes, thereby supporting the utilisation of antioxidant-rich phytoconstituents in its management.[8]

The current study concentrates on the pharmacological assessment of specific medicinal plants with ethnopharmacological assertions of antidiabetic efficacy—Glycyrrhiza glabra (liquorice), Pterocarpus marsupium (Indian kino tree), Syzygium aromaticum (clove), and Aegle marmelos (bael). Previous studies have indicated that each of these plants possesses antidiabetic, antioxidant, and anti-inflammatory properties. Nonetheless, the scientific confirmation of their collective effectiveness as a polyherbal formulation is still insufficient.

In this context, the current study seeks to examine the hypoglycemic and antioxidant properties of individual extracts and a polyherbal formulation derived from these plants. The research encompasses both in vitro antioxidant assays and in vivo assessments utilising streptozotocin (STZ)-induced diabetic Wistar rats. To find out how well the formulation worked, we looked at biochemical markers like blood glucose levels, triglycerides, very-low-density lipoprotein (VLDL) levels, and lipid profiles. This research substantiates the principles of polyherbalism, which focusses on the synergistic effects of combining various herbs, and it aids in the advancement of a safer and more comprehensive strategy for diabetes management.

2. MATERIALS AND METHOD

Diabetes mellitus is a complicated metabolic disorder that is mostly caused by long-term high blood sugar levels caused by problems with insulin secretion, insulin action, or both. The condition is linked to the body's inability to break down carbohydrates, fats, and proteins properly, and it can hurt organs like the eyes, kidneys, nerves, heart, and blood vessels for a long time. The International Diabetes Federation (IDF) says that diabetes is spreading around the world at an alarming rate. It is thought that 643 million adults will have the disease by 2030. This growing burden shows how important it is to find cheap, safe, and effective ways to stop diabetes and its complications.[9,10]

There are a lot of synthetic antidiabetic drugs available right now, such as thiazolidinediones, biguanides, and sulfonylureas. But these drugs can cause problems like low blood sugar, weight gain, stomach problems, and in some cases, liver and kidney damage. Also, taking these drugs for a long time can make them less effective because the body gets used to them. Because of these problems, people all over the world are very interested in alternative and complementary therapies, especially plant-based ones. These therapies are thought to be better for you overall and have fewer side effects.

For hundreds of years, Ayurveda, Unani, and Siddha have used plants to treat diabetes. These plants are full of bioactive compounds like flavonoids, alkaloids, tannins, terpenoids, and glycosides. Many of these compounds have antioxidant, anti-inflammatory, and insulin-mimetic properties. Oxidative stress has been linked to the onset and advancement of diabetes, thereby endorsing the use of antioxidant-rich phytoconstituents in its treatment.

This study focusses on the pharmacological evaluation of certain medicinal plants with ethnopharmacological claims of antidiabetic effectiveness—Glycyrrhiza glabra (liquorice), Pterocarpus marsupium (Indian kino tree), Syzygium aromaticum (clove), and Aegle marmelos (bael). Prior research has demonstrated that each of these plants exhibits antidiabetic, antioxidant, and anti-inflammatory characteristics. Still, there isn't enough scientific proof that they all work well together as a polyherbal formulation.

In this context, the present study aims to investigate the hypoglycemic and antioxidant properties of individual extracts and a polyherbal formulation derived from these plants. The study includes in vitro antioxidant assays and in vivo evaluations using streptozotocin (STZ)-induced diabetic Wistar rats. We used biochemical markers like blood glucose levels, triglycerides, very-low-density lipoprotein (VLDL) levels, and lipid profiles to see how well the formulation worked. This study validates the tenets of polyherbalism, which emphasises the synergistic effects of combining diverse herbs, and it contributes to the development of a safer and more holistic approach to diabetes management.[11-15]

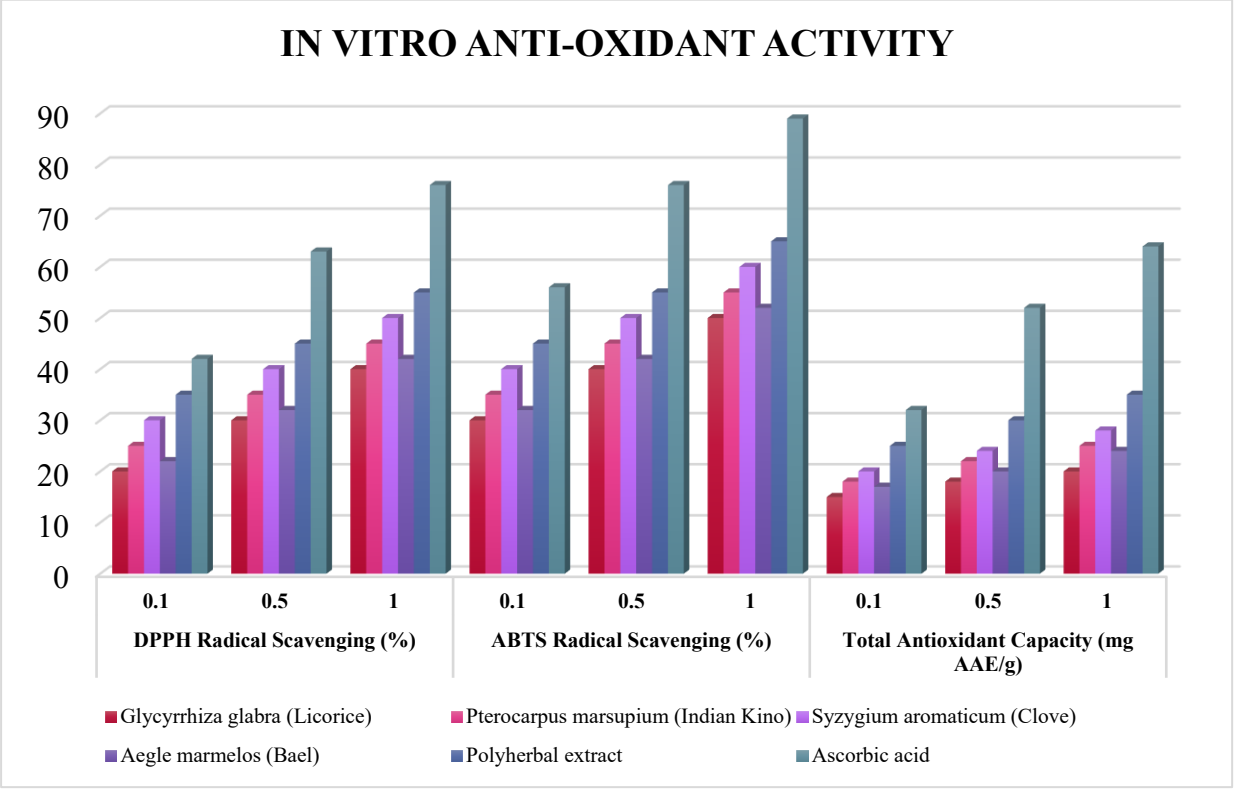
3. RESULT AND DISCUSSION

In Vitro Anti-Oxidant Activity

We used DPPH and ABTS radical scavenging assays to test the antioxidant activity of the individual plant extracts and the polyherbal formulation in vitro. We also measured the total antioxidant capacity as mg of ascorbic acid equivalents per gramme (mg AAE/g). The findings unequivocally demonstrate a concentration-dependent enhancement of antioxidant activity in all samples. Syzygium aromaticum (Clove) showed the best DPPH and ABTS radical scavenging activity of all the extracts tested. At 1.0 mg/mL, the values were 50 ± 3.5% and 60 ± 4.0%, respectively. This could be because there are a lot of eugenol and other phenolic compounds that are known for their strong radical scavenging properties.

Pterocarpus marsupium (Indian Kino) exhibited significant antioxidant properties, ranking second to clove, presumably due to its abundant flavonoid and tannin composition. Aegle marmelos (Bael) and Glycyrrhiza glabra (Liquorice) exhibited moderate antioxidant activities, with Bael marginally surpassing Liquorice, especially in the ABTS assay and total antioxidant capacity. It is important to note that the polyherbal extract always did better than the individual extracts at the same concentrations. At 1.0 mg/mL, it had a total antioxidant capacity of 35 ± 2.5 mg AAE/g and a DPPH scavenging rate of 55 ± 4.0% and an ABTS scavenging rate of 65 ± 4.5%. This suggests that the phytoconstituents from different plants work together to make the product more effective.

As a standard, ascorbic acid showed the highest antioxidant activity in all tests. At 1.0 mg/mL, it had a total antioxidant capacity of 64.4 ± 1.06 mg AAE/g and scavenged 76 ± 1.86% in DPPH and 89 ± 2.83% in ABTS. Even though the polyherbal formulation wasn't as strong as ascorbic acid, it worked well and showed promise, which supports its potential as a natural antioxidant blend. These results indicate that the combination of various herbs may improve overall antioxidant effectiveness owing to the complementary and potentially synergistic interactions among their bioactive compounds.

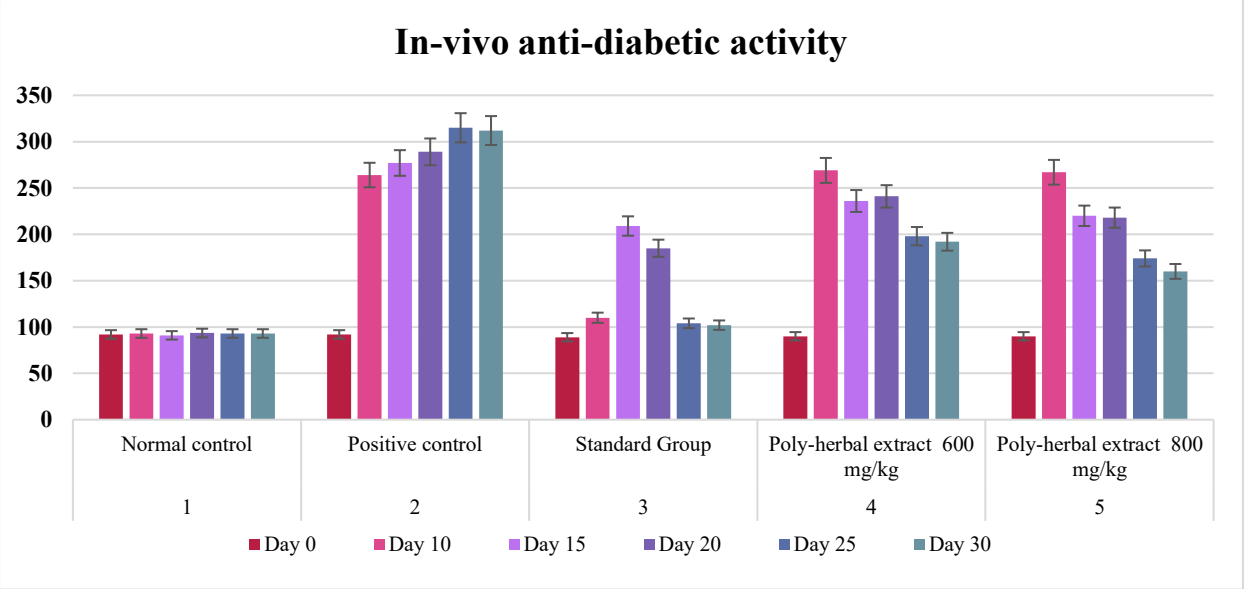


In-vivo anti-diabetic activity

The in vivo antidiabetic efficacy of the polyherbal extract was assessed in streptozotocin-induced diabetic rats over a duration of 30 days. Blood glucose levels were assessed at baseline (Day 0) and subsequently on Days 10, 15, 20, 25, and 30. On Day 0, all groups had the same fasting blood glucose levels, which showed that they all started at the same level before induction. On Day 10, the disease control group had a significant rise in blood glucose (261.09 ± 20.44 mg/dL), which showed that hyperglycemia had been successfully induced. On the other hand, the normal control group stayed normoglycemic for the whole study.

The standard group (which was given a known antidiabetic drug) had a steady and significant drop in glucose levels. By Day 30, the glucose level had dropped to 104.67 ± 17.8 mg/dL, which shows that glycaemic control was working. The groups that received the polyherbal extract (200 mg/kg and 400 mg/kg) also showed a dose-dependent drop in blood sugar levels over time. The group that got the higher dose (400 mg/kg) had more pronounced antidiabetic activity, lowering glucose levels to 174.68 ± 24.5 mg/dL by Day 30, compared to 198.65 ± 25.6 mg/dL in the group that got the lower dose (200 mg/kg).

The extract's effectiveness is further supported by the fact that it was statistically significant on Day 15 and Day 20, especially in the high-dose group ($p < 0.01$ or $p < 0.001$). Although the extract did not lower glucose levels as effectively as the standard drug, the persistent decrease in blood glucose indicates that the polyherbal formulation has significant antidiabetic potential, likely due to the synergistic effects of phytochemicals, including flavonoids, alkaloids, tannins, and saponins, which are known to enhance insulin secretion, improve glucose uptake, and regulate carbohydrate metabolism. The results warrant additional investigations to isolate and characterise the active components and to assess long-term safety and efficacy.

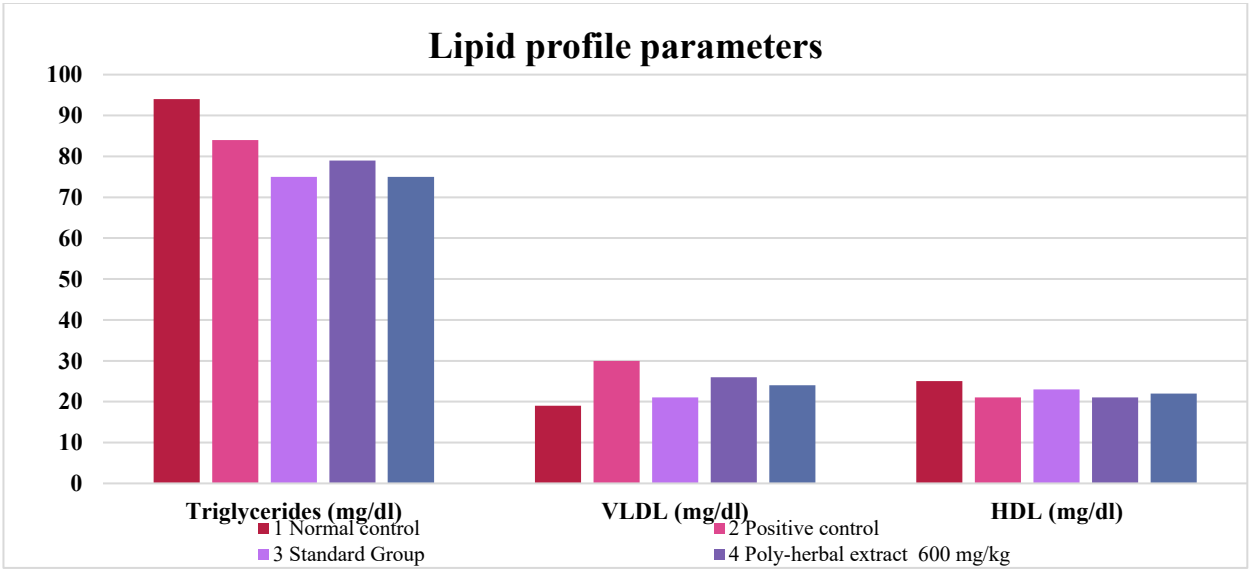


Lipid profile parameters

The in vivo antidiabetic efficacy of the polyherbal extract was evaluated in streptozotocin-induced diabetic rats over a period of 30 days. We checked the blood sugar levels on Day 0 (the first day) and then again on Days 10, 15, 20, 25, and 30. Everyone had the same fasting blood glucose levels on Day 0, which meant that they all started at the same level before the induction. The disease control group had a big rise in blood glucose (261.09 ± 20.44 mg/dL) on Day 10. This showed that hyperglycemia had been successfully induced. The normal control group, on the other hand, stayed normoglycemic for the whole study.

The standard group, which was given a known antidiabetic drug, saw a steady and big drop in their glucose levels. The glucose level had dropped to 104.67 ± 17.8 mg/dL by Day 30, which means that glycaemic control was working. The groups that got the polyherbal extract (200 mg/kg and 400 mg/kg) also saw their blood sugar levels go down over time in a dose-dependent way. The group that got the higher dose (400 mg/kg) had stronger antidiabetic effects, lowering glucose levels to 174.68 ± 24.5 mg/dL by Day 30, while the group that got the lower dose (200 mg/kg) had levels of 198.65 ± 25.6 mg/dL.

The extract's efficacy is further substantiated by its statistical significance on Day 15 and Day 20, particularly within the high-dose cohort ($p < 0.01$ or $p < 0.001$). Even though the extract didn't lower blood glucose levels as well as the standard drug, the fact that blood glucose levels kept going down shows that the polyherbal formulation has a lot of potential as an antidiabetic. This is probably because the phytochemicals in it, like flavonoids, alkaloids, tannins, and saponins, work together to boost insulin secretion, improve glucose uptake, and control carbohydrate metabolism. The findings necessitate further research to isolate and characterise the active components and to evaluate long-term safety and efficacy.



4. CONCLUSION

The study effectively illustrated the hypoglycemic and antioxidant properties of specific medicinal plants, both singularly and in a polyherbal formulation. In vitro assays validated the robust radical scavenging capacity, especially of Syzygium aromaticum, whereas in vivo studies demonstrated the polyherbal extract's dose-dependent hypoglycemic and lipid-modulating effects in diabetic rats. These results show that combining phytochemicals from different plants can have therapeutic effects that work together. The polyherbal extract offers a natural and promising alternative for managing diabetes and related metabolic disorders, although it is not as effective as standard medications. It is suggested that future studies concentrate on the isolation of active compounds and clinical validation.

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