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A Review on Therapeutic Evaluation of Medicinal Plants in Streptozotocin-Induced Diabetes: Impact on Haematology and Biochemical Parameters in Albino Rats

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Abstract

The prevalence of obesity, sedentary lifestyles, and dietary changes is contributing to the long-term metabolic state known as diabetes mellitus (DM). According to the International Diabetes Federation, more than 530 million people would be living with diabetes by 2030. A significant contributor to the progression and complications of DM is oxidative stress, which leads to the breakdown of fat and impaired antioxidant defenses. In many laboratory investigations, researchers will inflict diabetes using Streptozotocin (STZ). This clarifies for them the nature of excessive blood sugar, harm to β-cells, and associated problems. Potential diabetic remedies include medicinal plants such as *Pterocarpus marsupium* (Indian kino tree) and *Murraya koenigii* (curry leaves). They are able to reduce blood sugar levels, combat oxidative stress, and promote the regeneration of β-cells. Rats with STZ-induced diabetes have shown improvement in blood sugar control, reduced oxidative stress, and insulin secretion when given these plants. To treat diabetes in a safer and more cost-effective way than with artificial medications, this review highlights the significance of medicinal plants. Because of this, integrated therapy strategies are now within reach.

Keywords: *Murraya koenigii*, Diabetes Mellitus, Albino Rats, Therapeutic Evaluation, Medicinal Plants, Streptozotocin-Induced Diabetes, Haematology and Biochemical Parameters.

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Introduction

The prevalence of diabetes mellitus (DM) is on the rise worldwide due to a number of factors, including an increase in overweight people, a decline in physical activity, and changes in eating habits and other lifestyle choices. From 171 million in 2000 to 366 million in 2030, the number of people living with diabetes is expected to climb, according to the International Diabetes Federation (IDF). Nevertheless, by 2011, it was said that this figure had already been exceeded. Additionally, estimates indicate that 8.6 million Egyptians will have diabetes mellitus by 2030, with 530 million cases globally (Arafa and Amin, 2010). Lipid peroxidation, increased oxidative stress, and impaired antioxidant defense mechanisms are major factors in the development, advancement, and complications of diabetes mellitus. Treatment of diabetes mellitus with minimal adverse consequences remains challenging from a clinical perspective. Many people are interested in exploring the potential of medicinal plants as an alternative to pharmaceutical medications for diabetes because they are often less expensive, less poisonous, and have less side effects. The Streptomyces achromogenes bacteria are the source of the naturally occurring chemical compound streptozotocin. It can be written as $C_8H_{15}N_3O_7$. For the purpose of studying the effects of hypoglycemic medications, streptozotocin is a frequently used medicine in the scientific community to induce diabetes in animals kept in laboratories, especially rats and mice. A streptozotocin antibiotic this genotoxic drug that alkylates shows actions that are antibacterial, tumoricidal, carcinogenic, and diabetogenic (Dyke *et al*., 2010). Osteopenia is just one of many diabetes mellitus side effects that can be studied using this method. Inhibiting glucose oxidation and decreasing insulin production are the effects of streptozotocin. Furthermore, DNA damage and other detrimental cellular modifications are brought about by reactive oxygen species (ROS) (Fukudome *et al*., 2008). Although streptozotocin causes Type 1 diabetes mellitus in adult rats, characterized by significantly elevated blood glucose levels, it causes Type 2 diabetes mellitus in newborn rats when injected. Insulin resistance in organs that are intended to receive insulin and malfunction of pancreatic β-cells are the hallmarks of Type-2 diabetes, which is a relative insulin deficit. This illness is characterized by hyperinsulinemia, insulin resistance, and the failure of pancreatic β-cells, with a cell loss of up to 50% noted when the patient is diagnosed. The development of type 2 diabetes involves multiple organ systems, including the pancreas, liver, skeletal system, kidneys, brain, small intestine, and adipose tissue. A slow but steady decline in insulin production results from the aberrant structure and activity of pancreatic cells. The liver, which controls

glycolysis, glycogenesis, and gluconeogenesis—and so helps keep glucose levels stable—is one of the insulin target organs that is negatively impacted by this disease. Similarly, changes in the pathological state may occur as a result of structural and functional changes in the liver brought about by chronic hyperglycemia (Majaw *et al*., 2018). The onset and progression of diabetic problems are interconnected with several organ systems. The body's dysregulation of blood glucose levels may be exacerbated by anatomical disturbances in the pancreas and liver. People have relied on medicinal plants for a wide range of health issues since ancient times. Their anti-inflammatory, antibacterial, pain-relieving, and antidiabetic properties are only a few of their many medicinal uses (Rosario and Josephine, 2015). The World Health Organization reports that in developing countries, herbal medicine is the first line of defense when it comes to basic healthcare. Further, many modern pharmaceuticals have their origins in or are based on plants traditionally used for medical purposes. *Murraya koenigii*, or curry leaves, are a natural flavoring component that give flavor and nutrients to food. They also have several important health benefits. This plant originally hails from India and is endemic to tropical and subtropical regions. What make this plant so valuable are its leaves, roots, and bark. It is an effective natural remedy for diabetes and a host of gastrointestinal problems, such as indigestion, excessive acid production, peptic ulcers, high cholesterol, and diabetes, thanks to its high antioxidant content. Phytochemical studies uncovered alkaloids, flavonoids, essential oils, carbohydrates, and sterols (Rao *et al*., 2011). Vitamin C, nicotinic acid, koenigin, glycosides, carbazole alkaloids, carotene, and resin are abundant in the fragrant leaves. Fresh leaves also include calcium and vitamin A. Among the significant chemical compounds that have been found in koenine, isomahanimbin, koenigine, koenidine, Girinimbine, koenimbine, bicyclomahanimbicine, mahanimbicine, phebalosin, and coumarine.

Definition, Importance and Relevance

The purpose of creating a literature review, an academic paper, is to show that you have researched and understood the previous works written about a certain subject. In addition, you will find an analysis of the sources' usefulness, credibility, and impact on your study. An extensive project, such as a research paper or dissertation, may include a literature review, or it may be an independent assignment in and of itself. Hyperglycemia is the hallmark symptom of diabetes mellitus, a metabolic disorder that develops over time. The body's inability to produce enough insulin or efficiently use the insulin it does produce might cause this.

The following haematological parameters were measured: TEC using a Neubauer hemocytometer (Dacie and Lewis, 1975), TLC using a Nebauer hemocytometer (Dacie and Lewis, 1975), Hb concentration using Sahil's method (Wintrobe, 1981), Plt count, Hct value, Packed cell volume (PCV) according to Sahil's method (Wintrobe, 1981), erythrocyte sedimentation rate (ESR) according to Wintrobe's Method (1981), and Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) according to Wintrobe.

Biochemical factors important markers of hepatocellular injury include liver enzymes such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP). Serum enzyme elevations are indicative of liver disease (Smith & Johnson, 2021). Albumin and total protein concentrations are crucial for determining the liver's ability to synthesize. Green and Martin (2020) note that hypoalbuminemia could be a sign of liver injury or poor protein metabolism. Cholesterol, triglyceride, and lipoprotein changes are frequently associated with metabolic abnormalities throughout the body including liver dysfunction (Brown *et al*., 2019)., The levels of total and conjugated bilirubin provide insight into the excretory function and heme metabolism of the liver. According to Williams and Clark (2022), cholestasis and hepatocellular damage are two possible causes of elevated bilirubin levels. Cardiovascular disease, neuropathy, and nephropathy are among the major long-term consequences that can develop from this syndrome (American Diabetes Association, 2020). Curry leaves (*Murraya koenigii*) and Indian kino tree (*Pterocarpus marsupium*) are two examples of the medicinal plants that have gained recognition for their use in diabetes treatment. An increase in insulin secretion, an improvement in insulin sensitivity, and a decrease in oxidative stress are some of the ways in which these plants are thought to produce hypoglycemic effects (Rao *et al*., 2011). Because they may provide safer, more accessible, less expensive, and less time-consuming alternatives to conventional pharmaceutical therapies, studies on the antidiabetic effects of herbal plants are crucial. Hypoglycemia, gastrointestinal issues, and possible long-term organ damage are among the negative effects that commonly accompany synthetic antidiabetic medications, despite their effectiveness (Tripathi & Tiwari, 2021). However, there are fewer side effects associated with the bioactive chemicals found in herbal plants such as *Pterocarpus marsupium* and *Murraya koenigii*. These compounds include alkaloids, flavonoids, and phenolic acids, and they offer a variety of health benefits. The culinary herb *Murraya koenigii* has a rich therapeutic history and is endemic to tropical regions like India. Carbazole alkaloids, flavonoids, and essential oils abound in its leaves, giving it anti-inflammatory, antioxidant, and antidiabetic properties (Rao *et al*., 2011). According to Joseph and Raj (2020), diabetic rats can have better lipid profiles, less oxidative stress, and improved glucose metabolism when given extracts from the leaves of the *Murraya koenigii* plant. *Pterocarpus marsupium*, often known as the Indian kino tree, has a rich history of diabetes management in Ayurvedic practice. According to Sharma *et al*. (2018), this tree's heartwood has a wealth of bioactive chemicals, including flavonoids, marsupsin, and pterostilbene, which have antioxidant and insulin-mimetic properties. Tripathi and Tiwari (2021) found that diabetic animals can have their fasting blood glucose levels reduced, β-cell activity restored, and glycogen storage improved by using extracts from the heartwood of *Pterocarpus marsupium*. To fully comprehend the hypoglycemic effects of *Murraya koenigii* and *Pterocarpus marsupium*, it is essential to study their effects on albino rats' blood glucose levels. Due to their physiological and metabolic parallels to humans, albino rats, particularly those produced diabetic using streptozotocin (STZ) induction, are ideal models for diabetes research. The chemical streptozotocin (STZ) causes hyperglycemia by destroying pancreatic β-cells. Fukudome *et al*. (2008) found that this model successfully mimics human type 1 diabetes and offers a controlled environment to evaluate the efficacy of antidiabetic medications. Research into the potential antidiabetic benefits of *Murraya koenigii* and *Pterocarpus*

marsupium in rats with STZ-induced diabetes may lead to the development of novel herbal treatments for the control of diabetes. In order to address global health challenges, this research emphasizes the importance of integrating traditional medicinal practices with modern scientific methodologies.

Review of Important Research Work

Experimental diabetes mellitus is defined by a high level of, poor bone deposition, renal thiazide-sensitive NaCl cotransporter overexpression, and calcium/polyvalent cation-sensing receptor downregulation, according to research by Ward *et al*. (2001) on functional, genetic, and enzymatic assessment of streptozotocin-induced diabetes. Narendhirakannan *et al*. (2006) looked into biochemical assessment for their study. Researchers tested the antidiabetogenic effects of numerous common Indian herbs on rats that had been streptozotocin-induced diabetics. The ethanolic extracts of these plant leaves showed hypoglycemic activity, which suggests they can enhance insulin synthesis, according to the study. Researchers Fukudome *et al*. (2008) observed that the radical scavenge edaravone helped fight diabetes in mice that were given low doses of streptozotocin. Excessive production of antioxidants such catalase, thioredoxin, metallothionein, and Cu/Zn superoxide dismutase in cells has been found to prevent type 1 diabetes in previous research. Following a streptozocin injection, edaravone treatment lessens the severity of hyperglycemia and insulitis. The findings reported by Dyke *et al*. (2010) The oxidative and nitrosative stresses that cause type I diabetes can be prevented in rats by using streptozotocin, and this effect can also be observed in humans. In both the pre- and post-diabetic states, harm can be prevented once the disease is identified. The real damage status generated by disease can be changed by creating a diet regimen that includes enough amounts of continuously acting antioxidants and PARP substrates and inhibitors. The effects of a water-based white tea (*Camellia sinensis*) extract were investigated by Islam (2011) using a rat model of streptozotocin-induced diabetes. The results show that this extract greatly improves a variety of diabetic problems in the rats that were tested. Thus, diabetic individuals can cure the abnormalities caused by diabetes using white tea as an adjuvant medication. In 2011, Malini *et al*. assessed Research on ellagic acid's antidiabetic effects was conducted on albino Wistar rats that had developed diabetes mellitus due to streptozotocin. These diabetic rats benefited from ellagic acid's ability to control glucose levels and enzymes involved in carbohydrate metabolism, according to the results. This suggests that ellagic acid has potential as a treatment for diabetes mellitus due to its ability to maintain glucose homeostasis. Research on the chemical diversity of curry leaf (*Murraya koenigii*) essential oils was conducted by Rao *et al*. (2011). A lot of β-carotene is present in the fresh leaves. Curry leaf has antioxidant, antifungal, antibacterial, and pesticidal effects, according to certain investigations. What Cheng *et al*. (2013) found out *Ginkgo biloba* extract was tested for its potential to reduce blood sugar levels in rats that had developed diabetes due to streptozotocin. This study provides more evidence that *Ginkgo biloba* extract may be useful as a dietary supplement or supplemental treatment for people with diabetes due to its antihyperlipidemic, antioxidant, and antihyperglycemic effects in rats with chronic diabetes. Research by El-Amin *et al*. (2013) this work employs streptozotocin-induced diabetic mice to examine the potential anti-diabetic effects of *Murraya koenigii* (L.) and *Olea europaea* (L.) leaf extracts. Phytotherapy is seen as a promising alternative to synthetic drugs for diabetes management due to its lack of side effects and perceived safety. The current analysis shown that both Murraya koeinigii and *Olea europaea* leaves had beneficial effects on blood sugar and cholesterol levels. Medicinal or nutritional supplements derived from these plants may help in the management of type 2 diabetes and dyslipidemia. An investigation of the phytoconstituents found in the heartwood of *Pterocarpus marsupium* Roxb. And its antidiabetic activities were reviewed by Mishra *et al*. (2013). The hypoglycemic effects of a mixture of *Pterocarpus marsupium* heart wood and an ethanolic extract are well-known. The regeneration of pancreatic β-cells can be aided by *Pterocarpus marsupium*, which is an additional benefit. Researchers Yassaa and Tohamy (2014) found that adult rats with streptozotocin-induced diabetes mellitus fared better after consuming an extract from *Moringa oleifera* leaves. Researchers found that diabetic rats treated with an aqueous *Moringa oleifera* leaf extract had a reduction in hyperglycemia and an improvement in antioxidant defenses against ROS-induced cell damage. In 2015, Al-Malki and El-Rabey This study used male rats with diabetes and streptozotocin-induced diabetic nephropathy to examine the antidiabetic effects of modest dosages of *Moringa oleifera* lam Seeds. Researchers observed that in streptozotocin-induced diabetes, an aqueous leaf extract of *Moringa oleifera* reduced hyperglycemia and increased cellular antioxidant defenses, protecting cells from ROS-mediated damage. In their 2015 study, Rosario and Josephine looked at traditional medicinal plants' potential to fight cancer. The World Health Organization reports that medicinal plants represent the primary means of healthcare for 80% of rural residents. Herbal medicines are affordable, readily available, and highly effective in the prevention and treatment of cancer. In 2016, Goyal *et al*. investigated In order to understand the pathophysiology of diabetes and to evaluate treatments, it is essential to examine the difficulties and concerns related to streptozotocin-induced diabetes in a variety of animal models that are relevant to clinical practice. It was determined that streptozotocin induction of diabetes requires careful consideration of cell specificity, organ toxicity, and animal mortality rates to guarantee efficacy and reproducibility.

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