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Research

Evaluation of anti-diabetic effect of ethanolic leaf extracts *Ceriops decandra* using various in vitro models

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	Abstract
Published on: 04 May 2025	Siddha, one of the most ancient medical systems in India, is believed to have been the main form of treatment employed by the early Tamils and Dravidians in South India. Not only is it the oldest system, but it also boasts numerous specialties that surpass those found in Ayurvedic practices. <i>Ceriops decandra</i> (Griff.) Ding Hou is traditionally utilized for the treatment of various health issues such as diabetes, bleeding, pain, diarrhea, angina, and dysentery. Additionally, <i>Ceriops tagal</i> Linn is employed in folk medicine to address conditions like hemorrhage, acariasis, wound infections, malaria, severe diabetes, and ulcers. It contains a wealth of phytochemicals, including proteins, coumarins, phenolic compounds (such as catechin and procyanidins), triterpenoids (like lupeol, α-amyrin, oleanolic acid, and ursolic acid), flavonoids, saponins, glycosides, alkaloids, diterpenoids (specifically ceriopsin A-G), and tannins. This study aimed to evaluate the antidiabetic effects of the alcoholic extract of <i>Ceriops decandra</i> leaves in rats with streptozotocin-induced diabetes. Preliminary phytochemical screening of the leaves was conducted using different water and alcohol solvents. The resulting extracts underwent various qualitative chemical analyses, revealing the presence of carbohydrates, alkaloids, flavonoids, glycosides, saponins, steroids, tannins, and terpenoids.
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Keywords: Ceriops decandra, Anti-diabetic effects, Ethanolic extract, Streptozotocin-induced diabetes, Phytochemical screening.	

INTRODUCTION

Sustained hyperglycemia is a hallmark of diabetes mellitus, a chronic metabolic disease that has become one of the biggest threats to world health. Diabetes is caused by a complex interaction of lifestyle, environmental, and hereditary variables that, taken together, interfere with the effect of insulin or its secretion. A considerable socioeconomic burden is imposed globally by this chronic hyperglycemic state, which is widely

acknowledged as a prelude to a number of debilitating consequences, such as cardiovascular disease, nephropathy, neuropathy, and retinopathy [1]. Long-term care of diabetes is still difficult despite the wide range of pharmacotherapies that are available, from insulin formulations to oral hypoglycemic medications, because of problems such as drug resistance, undesired side effects, and expensive therapy. These restrictions have compelled scientists to investigate substitute medicinal substances, especially those obtained from natural sources, which frequently have complex modes of action and fewer side effects.

PREVALANCE

Many Indians suffer with Malnutrition Related Diabetes Mellitus (MRDM), which can be controlled or even reversed with a nutritious, balanced diet. This disease already affects more than 180 million people globally, and the World Health Organization (WHO) predicts that number will double by 2030. In 2008, there were an estimated 347 million diabetics worldwide, and the number is rising, mostly in low- and middle-income countries. According to data from 2015, 69.2 million Indians (8.7%) suffer from diabetes. Approximately 36 million of them remained undiagnosed. Diabetic tissues are starved for glucose, despite blood glucose levels being two to three times higher than normal. There is an increase in fat and protein, which can build up, along with higher blood glucose levels. The body may break them down to produce energy. Fasting blood glucose levels in humans normally range from 60 to 100 mg/dl, but in diabetics, they can reach 350 mg/dl. Long-term effects of the high blood glucose levels include impaired organ function and the body's capacity to maintain homeostasis. This has negative effects in several ways on tissues that depend on insulin to transport glucose (adipose, liver, and muscle) as well as those that do not, like the brain, kidney, and red blood cells. Insulin Dependent Diabetes Mellitus has been linked to an autoimmune reaction mediated by T cells to glutamic acid decarboxylase. [2]

SYMPTOMS

The diabetes mellitus symptoms may rely on how much your blood sugar level has been raised. Some patients, particularly those with type 2 diabetes or pre diabetes, may not always exhibit symptoms. The symptoms of type 1 diabetes usually appear more immediately and are more severe. [3]

Diabetes type 1 and type 2 symptoms include the following:

- Increased thirst
- Frequent urination
- Extreme hunger
- Unexplained weightloss
- Presence of ketone sintheurine
- Fatigue
- Irritability
- Blurre dvision
- Slow healing sores

Frequent infections such as gumsor skin infections and vaginal infections

CLASSIFICATION OF ORAL ANTIDIABETIC DRUGS

1. **Insulin secret agogues**
 - A. SulfonylureasI generation
Eg: Tolbutamide, chlorpropamide, acetohexamide, tolazamideII generation
Eg: Glibenclamide^[16], glipizide, gliclazide, glimepiride
 - B. Meglitinides
Eg: Repaglinide, nateglinide
2. **Biguanides**
Eg: Phenformin, metformin
3. **Thiazolidinediones**
Eg: Troglitazone, pioglitazone, rosiglitazone
4. **Alpha glucosidase inhibitors**
Eg: Acarbose, miglitol
5. **Newer drugs**
 1. Amylin analog
Eg: Pramlintide (subcutaneous)
 2. GLP-1 analog
Eg: Exenatide, liraglutide (subcutaneous)
 3. DPP-4inhibitors
Eg: Sitagliptin, vildagliptin, saxagliptin, linagliptin
 4. SGLT-2inhibitors
Eg: Dapagliflozin, remogliflozin
6. **Thiazolidinediones**

- Eg: Troglitazone, pioglitazone, rosiglitazone
7. **Alpha glucosidase inhibitors**
Eg: Acarbose, miglitol
8. **Newer drugs**
1. Amylinanalog
Eg: Pramlintide (subcutaneous)
 2. GLP-1 analog
Eg: Exenatide, liraglutide (subcutaneous)
 3. DPP-4inhibitors
Eg: Sitagliptin, vildagliptin, saxagliptin, linagliptin
 4. SGLT-2inhibitors
Eg: Dapagliflozin, remogliflozin

IMPORTANCE OF HERBAL DRUGS IN DIABETES MELLITUS

One of the main concerns of the medical community is still finding a diabetes treatment with no adverse effects. Approximately 800 plants, according to the World Ethnobotanical Society, can help prevent diabetes mellitus. Of those plants, 109 have a complete method of action, and only 450 have been clinically demonstrated to have anti-diabetic benefits. Diabetes has traditionally been treated with traditional medicinal plants in China and India. A variety of adverse symptoms, such as nausea, vomiting, diarrhea, alcohol flush, headaches, edema, malignant anemia, and fainting, are associated with synthetic drugs used to treat diabetes. Therefore, it has been demonstrated that herbal medicines are a better choice than synthetic medications because there are less cases of adverse side effects. Serious ailments are commonly treated with these natural remedies.

When chemical drugs don't work to treat a disease, herbal remedies are tried. Herbal medicines have no negative side effects because they are natural and harmless. Herbal medicines can cure a person's ailment permanently, but synthetic pharmaceuticals cannot. Natural extracts of herbs, fruits, and vegetables are used in herbal remedies to cure a range of illnesses, whereas chemical drugs are manufactured artificially and have unfavorable effects. The cost of herbal formulations is lower than that of allopathic drugs. Herbal formulations are made from natural sources and are ecologically friendly, while allopathic medicines are made from chemicals and natural substances that have been chemically altered. Herbal formulations are available over-the-counter, but allopathic treatments need a prescription. The fact that herbal medicines are used so widely these days indicates that herbs are playing a bigger role in high-tech, modern drugs. The antidiabetic action of medicinal plants, which lowers blood glucose levels, is caused by the presence of flavonoids, terpenoids, phenolic compounds, coumarin, and other chemical elements. [4-5]

Aim and objective

The purpose of this study was to assess the antidiabetic effects of *Ceriops decandra* leaf alcoholic extract in rats that had diabetes induced by streptozotocin. In order to perform a preliminary phytochemical screening of the leaves, various water and alcohol solvents were used. The water and alcohol extracts exhibited hypoglycemic effects attributed to the presence of flavonoids, recognized for their efficacy in controlling hypoglycemia while causing few side effects. The extracts from *Ceriops decandra* notably enhanced glucose tolerance and resulted in reduced fasting blood glucose levels in healthy diabetic rats.

PLANTPROFILE





Fig 1: Ceriopsdecandra plant

2. Scientific Classification

Kingdom: Plantae
 Subkingdom: Tracheophytes
 Superdivision: Angiosperms
 Division: Eudicots
 Class: Rosids
 Order: Malpighiales
 Family: Rhizophoraceae
 Genus: Ceriops
 Species: C. decandra

3. Synonyms

English: Spurred Mangrove
 Sanskrit: Venuparnika
 Hindi: Sundari
 Tamil: Kandal
 Telugu: Tella Mada
 Malayalam: Kadukukandal
 Kannada: Kettibale
 Bengali: Garan

4. Distribution

Ceriopsdecandra is found in tropical and subtropical regions, primarily in mangrove ecosystems along coastal areas. It is native to South Asia, Southeast Asia, and parts of East Africa. In India, it is commonly found in the Sundarbans, Andaman and Nicobar Islands, and coastal regions of Tamil Nadu and Odisha.

Traditional Uses

Ceriops decandra has been traditionally used in various medicinal practices:

- Ayurveda: Used for treating skin disorders, wounds, and inflammation.
- Traditional Coastal Medicine: Bark extracts are applied for healing cuts and ulcers.
- Mangrove Folk Medicine: Leaves and propagules are used to prepare decoctions for diarrhea and dysentery.
- Dyeing and Tanning: The bark, rich in tannins, is used for dyeing and tanning leather.

MATERIALSAND METHODS

The designing of methodology involves a series of steps taken in a systematic way in order to achieve the set goal(s) under the prescribed guidelines and recommendations. It includes in it all the steps from field trip to the observation including selection and collection of the medicinal plant, selection of dose value, standardization of protocol, usage of instruments, preparation of reagents, selection of specific solvents for extraction, formation of protocols and final execution of the standardized protocol. All this requires good build of mind and a good and soft technical hand to handle the materials and procedure in a true scientific manner.

Drugs and Chemicals

Drugs and Chemicals used in this study were of analytical grade and of highest purity procured from standard commercial sources in India.

Table 1: Drugs and Chemicals

<i>S.No</i>	<i>Materials</i>	<i>Company Name</i>
1.	Alloxan	Quali Kems Fine Chem Pvt, Ltd, Vadodara.
2.	Methanol	Merck, India.
3.	Alcohol	Merck, India.
4.	Glibenclamide	Sanofi India Ltd, Ankleshwar.

Instruments

Following instruments were required for the study:

Table 2: List of Instruments used for study

Name of the instrument	Source
Centrifuge	Dolphin
Digital weighing balance	Horizon
Glucometer	Horizon
Heating mantle	ASGI®
Refrigerator	Videocon
Soxhlet extractor	ASGI®
Condenser	ASGI®
Burette stand	Dolphin
Round bottom flask	ASGI®, Amar
Mixer	Videocon
Oven	ASGI®
Water bath	ASGI®
Stirrer/glass rod	ASGI®
Watch glass	ASGI®
Whatmann filter paper	Manipore microproducts, Ghaizabad.
Butter paper	ASGI®
Spatula	ASGI®
Rubber pipes	ASGI®

Experimental animals

Healthy adult albino wistar rats weighing 200-250grams of either sex were selected for the study. Animals were housed in appropriate cages in uniform hygienic conditions and fed with standard pellet diet (Amrul Laboratory Animal Diet) and water ad libitum. They were fasted overnight before the day of experiment, after 72hours of fasting from the day of Alloxan introduction. Animals were housed within the departmental animal house and the room temperature was maintained at 27° C. Animal studies had approval of IAEC.

Plant Material Collection

The leaves of *Ceriopsdecandra* was collected from the local market in Hyderabad in the month of January and was identified and authenticated from Department of Pharmacognosy. The plant material was cleaned, reduced to small fragments, air dried under shade at room temperature and coarsely powdered in a mixer. The powdered material was stored or taken up for extraction process.

Statistical analysis

The values were expressed as mean $\pm$ SEM data was analyzed using one-way ANOVA followed by T-test. Two sets of comparison had made. i.e.

1. Normal control Vs All treated groups.
2. Diabetic Control Vs All treated groups.

Differences between groups were considered significant at $P < 0.001$ and $P < 0.05$ levels.

RESULTS**Phytochemical screening of *Ceriopsdecandra*.**

The present investigation concluded that the isolated compounds from the plant *Ceriopsdecandra* shows

the various Pharmacological effects was determined due to the presence of different phytochemical compounds. Further study is needed for the isolation of the constituents present in the plant and its individual pharmacological activity should need to consider and ultimately it should be implemented for the benefit to human beings.

Table 3: Phytochemical screening of *Ceriopsdecandra*

S.No.	Phytoconstituents	Aqueous	Alcoholic
1.	Alkaloids	-	-
2.	Flavonoids	+	+
3.	Steroids	+	-
4.	Tannins	+	+
5.	Anthraquinones	-	-
6.	Terpenoids	+	+
7.	Cardiac glycoside	+	+
8.	Saponins	+	-

Acute toxicity testing

Acute toxicity studies revealed that the alcoholic extracts of *Ceriopsdecandra* were safe up to 2000 mg/kg of body weight and approximate LD 50 is more than 2000 mg/kg. No lethality or any toxic reactions was observed up to the end of the study period.

HYPOGLYCEMIC ACTIVITY IN NORMAL RATS

Fasting Blood Glucose Levels (FBGL) were within the range of 90-105 mg/dl in all the groups at 0day. Repeated treatment with the doses of aqueous and alcoholic extract (100 and 200 mg/kg) significantly decrease the blood glucose level on 7th, 14th and 21st day, indicating that the extract produce significant hypoglycemic activity after repeated administration. Glibenclamide (10mg/kg) also significantly reduced Fasting Blood Glucose Level (FBGL) after repeated administration as compare to normal control group. Changes in FBGL in different groups after repeated dose administration are summarized in Table 3

Repeated administration of both aqueous and alcoholic extracts had significantly ($p < 0.005$) reduced the FBGL on 7th, 15th and 21st day, indicating these extracts can produce hypoglycemia on repeated administration. However hypoglycemic activity was more significant on 7th, 14th and 21st day for Glibenclamide treated as compare with other groups. The results suggest that the both aqueous and alcoholic extracts possess significant hypoglycemic activity after repeated dose administration. The detailed results are summarized in Table 3.

Effect of extracts of *Ceriopsdecandra* on fasting blood glucose level (FBGL) in normal rats

Table 4: Effect of extracts of *Ceriopsdecandra* on fasting blood glucose level (FBGL) in normal rats.

Treatment	Dose (mg/kg)	Blood glucose level(mg/dl)		
		7 th day	14 th day	21 st day
Normal control	-	89.34±1.66	77.44±2.78	66.13±1.25
Glibenclamide	10	83.65±3.64	76.81±3.23	68.06±2.02
AQCD	20	84.75±1.3	74.61±1.54	71.17±5.27
ALCD	20	80.34±1.35	68.23±1.74	65.15±5.37

Values are expressed as mean± S.E.M. n=4. Significant values were compared with $p < 0.005$, normal control Vs all groups. Parent thesis indicates % reduction in BGL.

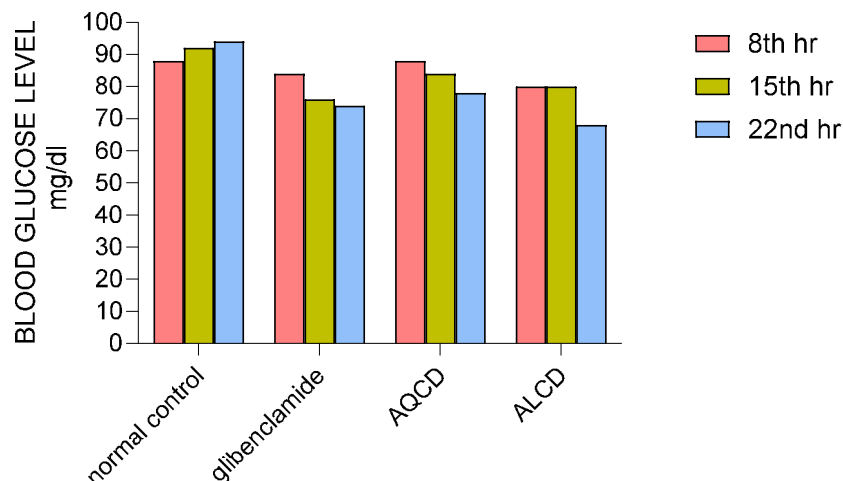
Oral glucose tolerance test (OGTT)

Both the aqueous and alcoholic extracts of *Ceriopsdecandra* significantly ($P < 0.005$) suppress the rise in FBGL after glucose load (2g/kg) in rats, at first half-an-hour and up to 2hr time period as compare with other groups extract Glibenclamide on 8th, 15th and 22nd day. While aqueous and alcoholic extracts produced significant reduction in FBGL. Glibenclamide (10mg/kg) showed ($P < 0.005$) significant suppression in FBGL rise at first half-an-hour, 1hr and normalized FBGL within 2hr. The detailed results are summarized in Table 7.

Table 5: Effect of extracts of *Ceriops decandra* on 8th, 15th and 22nd day in normal rats.

Treatment	Dose (mg/kg)	Blood glucose level(mg/dl)		
		8 th day	15 th day	22 nd day
Normal control	-	88.05±3.56	92.36±1.74	94.31±2.47
Glibenclamide	10	84.11±2.57	76.17±2.85	74.21±1.68
AQCD	20	88.26±1.82	84.02±0.37	78.17±4.57
ALCD	20	80.57±1.83	80.25±1.85	68.38±3.84

Values are expressed as mean ± S.E.M. n=4. Significant values were compared with P<0.005. Normal control Vs all groups. Paranthesis indicates % reduction in BGL.

**Fig 2: Effect of extracts of *Ceriops decandra* on 8th, 15th and 22nd day in normal rats.**

ANTI-DIABETIC ACTIVITY IN ALLOXAN INDUCED DIABETIC RATS

Fasting blood glucose levels (FBGL) in normal rats were in range of 90-100 mg/dl. Treatment with alloxan (120 mg/kg, I.P.) had increased the FBGL to range of 252-266 mg/dl after 72 hours. These values on subsequent days got stabilized by day seven on an average between 255 mg/dl. Changes in the fasting blood glucose levels in different groups are tabulated in Table No.:. This data shown that blood glucose level of normal control animals has maintained throughout the study period. The diabetic control group has shown significant increase in fasting blood glucose levels during this 21st day study period. Glibenclamide (10mg/kg) treated group has shown (p<0.05) significant decrease in fasting blood glucose level during 7th, 14th and 21st day of study period.

Effect of *Ceriops decandra* extracts on anti diabetic activity in alloxan induced diabetic rats

The animals treated with 100 and 200mg/kg of aqueous and alcoholic of different extracts shown significant decrease (P<0.05) in FBGL on 7th, 14th and 21st day of treatment when compare to other groups of animals. The aqueous extracts have reduced more (%) in FBGL when compared to alcoholic extracts except standard group. The detailed results are summarized in Table.

Table 6: Effect of extracts of *Ceriops decandra* on fasting blood glucose level (FBGL) in Alloxan induced diabetic rats.

Treatment	Dose (mg/kg)	Blood glucose level(mg/dl)		
		7 th day	14 th day	21 st day
Normal control	-	83.19±4.69	88.90±7.46	84.74±4.57
Diabetic control	10	298.10±11.95	278.04±10.05	250.13±12.37
Glibenclamide	10	267.21±10.27	285.18±12.04	260.26±11.74
AQCD	20	374.61±11.28	351.16±19.83	352.57±29.16
ALCD	20	206.43±12.84	169.29±16.84	164.30±20.35

Values are expressed as mean ± S.E.M. n=4. Significant values were compared with P<0.05. Normal control Vs all groups. Paranthesis indicates % reduction in BGL.

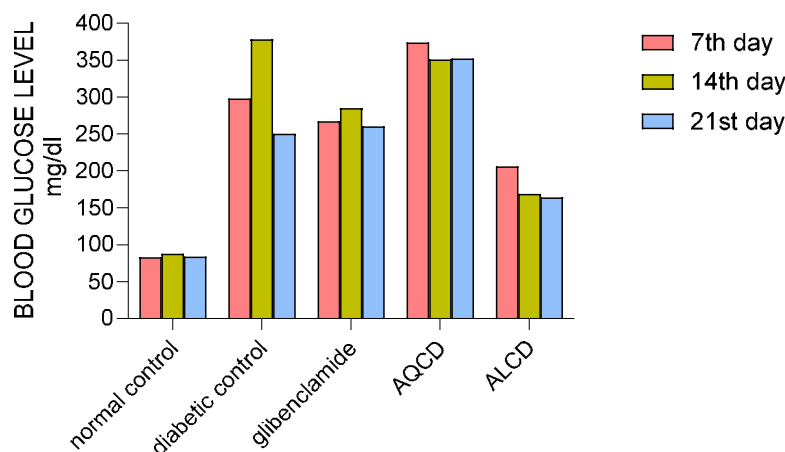


Fig 3: Effect of extracts of *Ceriops decandra* on fasting blood glucose level (FBGL) in Alloxan induced diabetic rats.

Oral glucose tolerance test (OGTT) on 8th, 15th and 22nd day-

Both the aqueous and alcoholic extracts of *Ceriops decandra* are significantly ($P < 0.05$) suppress the rise in FBGL after glucose load (2g/kg) in rats, at first half-an-hour and upto 2hr time period as compare with other groups extract Glibenclamide on 8th, 15th and 22nd day. While aqueous and alcoholic extracts produced significant reduction in FBGL. Glibenclamide (10mg/kg) showed ($P < 0.05$) significant suppression in FBGL rise at first half-an-hour, 1hr and normalized FBGL within 2hr. The detailed results are summarized in Table No.

Table 7: Effect of extracts of *Ceriops decandra* on 8th, 15th and 22nd day in Diabetic rats.

Treatment	Dose (mg/kg)	Blood glucose level(mg/dl)		
		8 th day	15 th day	22 nd day
Normal control	-	84.75±3.65	86.59±2.87	95.99±1.56
Diabetic control	10	264.01±02.39	237.00±19.55	326.57±14.99
Glibenclamide	10	366.38±21.46	374.88±11.73	284.41±18.53
AQCD	20	262.26±10.36	237.70±16.40	205.36±11.63
ALCD	20	357.55±14.73	347.76±15.28	268.66±10.83

Values are expressed as mean $\pm$ S.E.M. n=4. Significant values were compared with $P < 0.05$. Normal control Vs all groups. Paranthesis indicates % reduction in BGL.

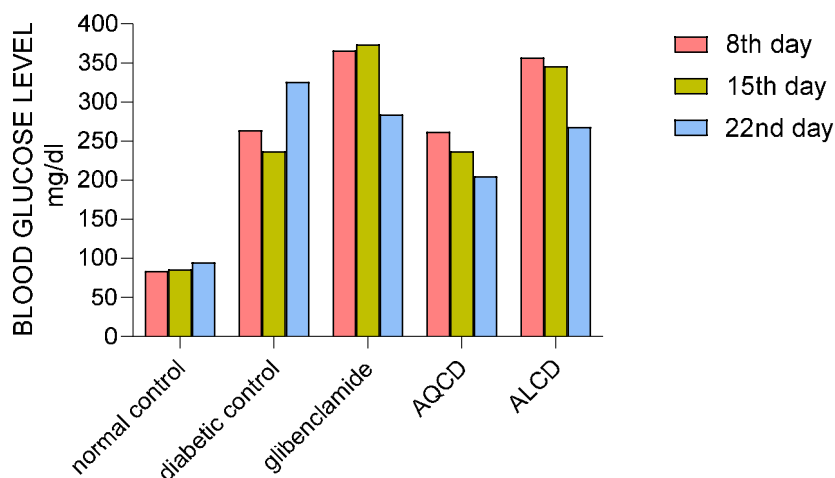


Fig 4: Effect of extracts of *Ceriops decandra* on 8th, 15th and 22nd day in Diabetic rats.

DISCUSSIONS

Diabetes is thought to be a controlled rather than a curable condition, despite the fact that it is extremely common and linked to substantial morbidity and mortality globally. The discomfort caused by the illness has been successfully reduced by a variety of synthetic drugs, herbal cures, and dietary adjustments. The potential of medicinal plants as antidiabetic medicines has been the subject of numerous investigations. Numerous plant species have been evaluated in vivo using animal models, including rats, to determine their effectiveness against problems brought on by diabetes in order to discover those having antidiabetic benefits. Numerous of these plants have been found to effectively lower fasting blood glucose levels and alleviate various diabetes-related problems. The chance of developing severe complications from diabetes is greatly decreased by maintaining lower levels of hyperglycemia.[6] For people with diabetes, preventing or correcting these problems and improving their quality of life depend on achieving excellent glucose control.

Several plant species have yielded a large number of naturally occurring active chemicals. Complex alkaloids, flavonoids, steroids, tannins, anthraquinones, terpenoids, and cardiac glycosides are a few examples of these active ingredients. These substances have been shown to have potent hypoglycemic, anti-hyperglycemic, and glucose-suppressive effects. Mechanisms include encouraging insulin secretion from pancreatic beta cells, decreasing intestinal absorption of glucose, inducing hepatic glycogenesis, and improving the body's overall utilization of glucose may be responsible for their effects.[7,8] These substances may also have cardioprotective, anti-inflammatory, antibacterial, and antifungal qualities. They may also help restore enzymatic activities, repair and regenerate pancreatic islets, and lessen damage to the liver and kidneys.

Rats' ability to tolerate glucose was significantly impacted by aqueous and alcoholic extracts of *Ceriops decandra* leaves given at a dose of 20 mg/kg. Additionally, these extracts demonstrated their hypoglycemic potential by lowering fasting blood glucose levels in normoglycemic rats. For both kinds of extracts, the effects were noticeably more potent. These findings imply that the extracts' hypoglycemic effects might be caused by mechanisms other than insulin secretion, like lowering intestinal glucose absorption or blocking endogenous glucose synthesis.[9]

A chemical substance called alloxan monohydrate is frequently used to cause diabetes mellitus in animal models. It causes diabetes by destroying the β -cells in the islets of Langerhans in a dose-dependent manner. Reactive oxygen species produced by this substance cause significant damage to DNA. Studies have demonstrated that a single intravenous dose of alloxan causes noticeable hyperglycemia. The main cause of this hyperglycemia in diabetics is associated with increased hepatic gluconeogenesis and glycogenolysis as well as decreased tissue absorption of glucose. The hypoglycemic effects of a plant extract were examined in hyperglycemic rats throughout a 22-day treatment period because the hyperglycemia brought on by alloxan is categorized as mild and may go away in a few weeks. Throughout the trial, *Ceriops decandra* leaves showed a strong antihyperglycemic effect, as seen by the comparison of the extract-treated hyperglycemic rats' starting and final fasting serum glucose levels. Comparing the extracts' effectiveness to that of the reference medication Glibenclamide revealed some noteworthy differences.[10,11]

Secondary metabolites with antidiabetic qualities have been found in different plant species by phytochemical investigation of *Ceriops decandra* leaf extracts. The flavonoids, alkaloids, and steroids included in the extracts are known to have antidiabetic properties in a variety of plants. The presence of phenolic compounds may also contribute to these effects by inhibiting peroxidation chain reactions, which may limit the destruction of β -cells and provide protection against the development of diabetes. Thus, leaf extracts from *Ceriops decandra* offer encouraging prospects for additional study focused on diabetic medication development. In general, developing phytomedicines is less expensive and time-consuming than developing allopathic drugs, which makes it a more practical choice in light of the current economic climate.[12]

CONCLUSION

This study aimed to evaluate the antidiabetic properties of the alcoholic extract from *Ceriops decandra* leaves in rats with streptozotocin-induced diabetes. To conduct an initial phytochemical analysis of the leaves, a range of water and alcohol solvents were utilized. Qualitative chemical analyses of the resulting extracts revealed the presence of terpenoids, saponins, steroids, alkaloids, flavonoids, glycosides, and carbohydrates. Both the water and alcohol extracts demonstrated hypoglycemic effects, which can be attributed to the flavonoids known for their effectiveness in managing hypoglycemia with minimal side effects. The extracts from *Ceriops decandra* significantly improved glucose tolerance and lowered fasting blood glucose levels in diabetic rats.

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