RESEARCH ARTICLE

Assessment of *Cyperus articulatus* for Antidiabetic Effects in a Streptozotocin-Induced Diabetic Rat Model

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ABSTRACT

Hyperglycemia, polyuria, polydipsia, polyphagia, and renal glycosuria are all symptoms of diabetes mellitus (DM), also known as diabetes. Diabetic ketoacidosis, hyperosmolar hyperglycemia, there is a possibility that the illness could result in a number of different complications, some of which include cardiovascular disease, chronic renal disease, stroke, foot ulcers, visual damage, nerve damage, and cognitive impairment. The principal objective of this research was to regulate whether or not a methanolic extract of *Cyperus articulates* (MECA) rhizome possessed an antidiabetic effect. In order to evaluate the effectiveness of MECA as an antidiabetic agent, streptozotocin-induced diabetic rats were used in an experiment involving thiobarbituric acid reactive substances. In the aforementioned experiments, it was discovered that in streptozotocin (STZ) induced diabetic rats, MECA at doses of 200 and 400 mg/kg reduced blood glucose levels from ‘254.41 ± 11.7 to 98.50 ± 2.5 and 283.83 ± 27.8 to 96.35 ± 3 mg/dl respectively, while glibenclamide-treated rats had a decrease in blood glucose from 291.12 ± 17.1to 91.50 ± 1.7 mg. This decrease was statistically significant ($p < 0.05$) when compared to the healthy control group. The effects of MECA on TBARS, GSH, and catalase in experimentally diabetic rats were found to be more pronounced than in the saline control group, and a greater rise in lipid peroxidation in the liver and kidney was seen in the diabetic group than in the saline group. Liver and kidney TBARS levels were observed to be considerably ($p < 0.05$, $p < 0.001$) reduced after MECA treatment, as were GSH levels in the STZ-control group and catalase activities in the experimental rats.

Keywords: Metabolic disorders, Renal glycosuria, Hyperosmolar hyperglycemic state, Antidiabetic activity, Streptozotocin.

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INTRODUCTION

The intricate relationship between humanity and the plant kingdom has been an enduring narrative marked by centuries of exploration, discovery, and the utilization of nature's resources for medicinal purposes. Throughout history, a vast array of plant species has provided sustenance and offered a rich source of compounds with the potential to revolutionize medicine and industry.[1,2] Plant chemical components including leaves, flowers, seeds, fruits, roots, resins, volatile oils, fixed oils, phenols, and flavonoids perform a medicinal symphony.[3]

Farnsworth and colleagues made history in 1985 when they identified 119 plant secondary metabolites. The World Health Organization (WHO) has recognized an impressive 255 pharmaceuticals generated from these secondary metabolites since this discovery, demonstrating the significant influence of plant-based chemicals on human health.[4] The remarkable fact that over 11% of synthetic medications have their origins in plant molecules highlights the lasting impact of the natural chemical pool on the development of contemporary medicine. Various health benefits have been associated with phytochemicals, including a vast range of compounds intrinsic to plants. A diverse array of phytochemicals in plant-based diets have a wide range of benefits, including antibacterial, anti-inflammatory, anti-arthritic, and radioprotective capabilities. The inherent therapeutic properties of these substances provide credence to their adoption into medical procedures, forging a bridge between conventional medicine and alternative methods of healing.[5]

In light of the growing problem of drug resistance and the drawbacks of conventional antibiotics, research into compounds derived from plants is being seen as a promising new avenue for the progress of antimicrobial drugs. This research effort aims to find new chemicals with interesting chemical structures and action mechanisms that might help

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with some of the growing health problems in the world.[6] Verifying plant materials is the first step in the extensive study trip into phytochemicals, which also includes isolating and characterizing components, extracting them, and finally conducting quantitative evaluations.[7]

Improvements in extraction methods have brought us a long way toward striking a balance between efficiency and effectiveness. There are nevertheless differences in efficacy, even though plant extraction techniques are seen as less harmful to the environment than other alternatives. Standardization is clearly necessary to ensure that results can be reliably reproduced, even when using different solvents or extraction methods on the same plant material.[8]

Selecting a suitable extraction method and solvent is of utmost importance for this task. Polar solvents are effective in extracting polar compounds because they are compatible with the solutes. This compatibility determines the effectiveness of the extraction process. The constant interdependence that defines our quest for knowledge and its practical application is exemplified by this delicate interaction between natural abundance and scientific progress.[9]

As we explore the potential antidiabetic effects of *Cyperus articulatus* in a streptozotocin-induced diabetic rat model, we find ourselves at the crossroads of ancient wisdom and contemporary science. This initiative aims to contribute to the growing body of knowledge that harmonizes traditional practises with contemporary thinking, with the goal of advancing global health via the prudent integration of natural resources and evidence-based research.

C. articulatus, more often known as jointed flatsedge, has a rich history of usage in traditional medicine and is said to possess therapeutic qualities. The need to study complementary and alternative medicine treatments is growing as diabetes mellitus, a chronic metabolic condition characterised by hyperglycemia, becomes an important worldwide health problem. Because existing treatment options have limitations and side effects, innovative, safe, and effective medicines are needed to manage diabetes.

The rationale for investigating *C. articulatus* for its possible antidiabetic qualities is the wide pharmacological variation often seen in medicinal plants. Preliminary studies have shown that *C. articulatus* may lower hyperglycemia and improve diabetes-related markers. To validate these claims and pave the way for potential medicinal applications, a rigorous and systematic study of its effects in a controlled laboratory setting is required.

This research seeks to bridge the gap between traditional knowledge and modern scientific inquiry by shedding light on the mechanisms via which *C. articulatus* exerts its antidiabetic benefits. Using a streptozotocin-induced diabetic rat model, a well-established experimental paradigm for studying diabetes, we aim to comprehensively assess the effects of *C. articulatus* on key diabetes-related parameters, including insulin sensitivity, blood glucose levels, lipid profile, and antioxidant status. The research will use a multi-pronged approach to shed light on the potential antidiabetic effects of *C. articulatus*. This includes biochemical analysis, histological examinations, and genetic investigations. The need to provide a comprehensive understanding of how *C. articulatus* affects the many pathways that lead to the development and progression of diabetes is the driving force for the adoption of these methods.

Following this brief overview, we will present and analyze the data, talk about what it means for diabetes care generally, and explain the technique employed in this study in detail. We hope that by clarifying *C. articulatus*'s possible antidiabetic properties, we can add to the expanding knowledge on natural treatments for diabetes, which can guide future studies and maybe even open up new avenues for supplementary treatment approaches.

As we begin our scientific inquiry, we recognize the complexity of researching medicinal plants and their intricate interactions with biological systems. Discovering new treatment techniques at the intersection of traditional knowledge and current science is a thrilling prospect that may influence diabetes care in the future and add to the dynamic field of integrative medicine as a whole.

The term "extraction" refers to the process by which active medicinal compounds are systematically retrieved from inert components found inside plant or animal tissues.[11] This scenario might potentially occur inside the pharmaceutical industry. Extraction is a commonly used procedure in the field of medical therapies. This methodology may manifest in several manifestations, particularly in the context of exterior applications, whereby the preference is given to the utilisation of liquid, semisolid, and powdered plant-derived substances, as opposed to internal use. The term "delicacy" encompasses a range of preparations, including decoctions, fluid extracts, infusions, pilular extracts (in a semisolid form), tinctures, and powdered extracts. All of them fall under the scope of the overarching category.[12]

The extraction process generally comprises many sequential steps, namely: (a) concentration, (b) size reduction, (c) extraction, (d) filtration, (e) collection and authentication of plant material, and (f) drying and reconstitution. Each step in the process of refining the extract for its intended use serves a crucial role. The quality of the extract is determined by a number of different elements, including the technique of extraction, the solvent that was used, the weight ratio of plant material to solvent, and the type of plant material to use.[13]

During the laborious process of extraction, each parameter is carefully tuned and monitored to guarantee that the results will be the same from the laboratory scale to the pilot size. During the extraction process, the careful selection and use of solvents play a decisive role in the separation of the soluble plant metabolites. This highlights the necessity of accuracy in the complex pharmaceutical operation that is being carried out.[14] This methodical process assures that the produced extracts fulfill high requirements, therefore providing a trustworthy basis for the creation of pharmaceutical formulations with improved effectiveness and safety profiles.[15]

EXPERIMENTATION

Experimental Phytochemistry

Plant profile

The scientific name for the fragrant sedge species, which is more often known as priprioca, is *C. articulatus*. One other name for this plant is jointed flatsedge. This perennial plant has a distinct growth pattern and goes by many names, such as adrue and Guinea rush. Thanks to its adaptability, *C. articulatus* may be found flourishing in a wide range of environments throughout its life cycle. The creature in question has characteristics that are consistent with both hyperhydrates, which means it can live and grow in water, and maybe tenagophytes, which means it has a life cycle that includes both aquatic and terrestrial stages. There is a mix of traits seen in both groups throughout this organism's life cycle.[16]

This adaptable plant is native to or found near water, making it an ideal candidate for a variety of aquatic environments.[17] This includes wetlands, rivers, streams, lakes, and streams. The growth dynamics of the jointed flatsedge make it possible for it to go through many phases of development, starting with its emergence under water and continuing through its juvenile years under water until finally reaching maturity on land. The organism's remarkable adaptability has allowed it to flourish in a wide variety of aquatic biological settings. Because of its pliability, it is very durable.[18]

The jointed flatsedge is an example of a plant species that has evolved sophisticated tactics for surviving in a wide variety of environments, thanks to its extraordinary adaptability and success in both water and land. Witnessing its graceful ascent from the water's surface or its time spent underneath as a juvenile is a breathtaking sight.[19]

MATERIALS AND METHOD

Plant Materials of *C. articulatus* Linn.

The rhizome of *C. articulatus* was collected from rural areas near Cuttack in the Indian state of Orissa. An exhaustively obtained voucher specimen with the identifier 'CNH/I-I/(280)/2012/Tech.II/258' was procured for the purpose of conducting further study on the rhizome's features. Following this, a verification process was executed by the Shibpur, West Bengal, India-based Botanical Survey of India to ascertain the specimen's authenticity. By completing this validation method, trust in the reliability and correctness of the collected data has been established.

Using a systematic methodology, the rhizomes were prepared for further investigation. Rhizomes were gently dried in a shaded area to maintain their natural characteristics. Once the rhizomes were dried, they were ground into a powdery consistency. The purpose of this was to establish standards and facilitate subsequent exams.[20]

Before being delivered to the storage facility, every batch of powdered rhizomes underwent a rigorous screening process utilising a sixty-mesh screen.[21] The goal of this sifting step was to make the powder more uniform in texture and quality by removing any larger or more irregular particles. Once this preparation was finished, the powders were put into containers with tight lids to keep them intact for the next analytical processes and examinations. From the initial procurement of the material all the way through to its final processing, this meticulous technique demonstrates the commitment to maintaining the quality and reliability of the botanical specimens under study.[22]

Drugs and Chemicals

The analytical grade extraction solvents used in the investigation were purchased from S. D. Fine Chemicals in Mumbai, India, guaranteeing a high level of purity and quality. Other crucial compounds and reagents employed in the research, including TBA, glibenclamide, streptozotocin, phenazonium methosulfate, nicotinamide adenine dinucleotide, 5,5-dithio bis-2-nitro benzoic acid, and reduced glutathione, were procured from the esteemed SISCO Research Laboratory, also located in Mumbai, India.[23]

In addition to the supplies that were described earlier, Ranbax provided glacial acetic acid and potassium dichromate, both of which contributed to the extensive collection of materials that were carefully chosen for the study effort. Because of the selection of suppliers who are well-known for their dedication to the production of high-quality chemicals and reagents, the experimental procedures have been given an additional layer of reliability, which guarantees the precision and accuracy of the analytical procedures that were carried out in the study.[24]

Extraction Methodology

During the extraction procedure, the plant material that was used was the rhizome of the *C. articulatus* compound. In order to carry out the extraction process, a soxhlet apparatus was used, and a series of extractions were carried out using petroleum ether at temperatures ranging from 60 to 80°C, methanol, and chloroform. One kilogramme of *C. articulatus* was used in the extraction procedure, and the results of the extraction process produced unique extracts *via* each solvent.[25]

A compound with a dark grayish-blue hue was obtained during the extraction process using petroleum ether. This substance accounted for seven percent of the dry powdered plant material. Following this, the marc that was produced from this extraction was subjected to desiccation and subsequent extraction using chloroform, which resulted in the creation of a semisolid substance that exhibited a dark greenish colouring. In comparison to the dry powdered plant material, the chloroform extraction produced a yield of 9.2%. The marc was desiccated and extracted using methanol that had a gas chromatography purity of 95.5%. This was a further iteration of the extraction procedure that was carried out. The result of this process was a semisolid material with a yellower tint that was less intense.[26]

One of the most important aspects of the extraction process was the continuous operation that was carried out until the solvent solutions lost their colour, which indicated that the extraction procedures had been successfully completed. Subsequently, the solvents were exposed to full evaporation,

Table 1: Type of phytochemicals extracted in various solvents[10]

Polarity	*Solvent*	*Chemicals class extracted*
Low	Chloroform	Aglycones, terpenoids alkaloids, flavonoids
	Cyclohexane	Fats and waxes
	Hexane	Fats and waxes
	Dichloromethane	Aglycones, terpenoids, alkaloids
	diethyl ether	Alkaloids, aglycones
	acetone	Aglycones, flavonoids, alkaloids
Medium	Ethanol	Polyacetylenes, alkaloids, tannins, polyphenols, flavonol, terpenoids, sterols
	methanol	Tannins, phenone, flavonol, sugar, terpenoids, saponins, xanthoxylline
High	Water	Tannins, phenone, amino acids, starches, polypeptides, flavonol, sugar, terpenoids, saponins

which ultimately led to the extractions being concentrated. The concentrated extracts were then put through a drying process, and after that, they were stored in a refrigerator setting. This safeguarded their preservation for further chemical group identification and pharmacological testing.[27]

In addition to laying the groundwork for further research and analysis, the method of systematic extraction resulted in the production of a number of extracts that displayed a wide range of individual characteristics. The extracts that have been saved provide an useful resource for future research endeavours, as they make it easier to identify chemical groups and make it possible to conduct extensive evaluations of pharmacological properties.[28]

Determination of extractive values

The assessment of pharmaceuticals comprising constituents that pose challenges in terms of quantification using conventional methodologies is greatly facilitated by the computation of extraction values. This particular technique demonstrates notable benefits when dealing with materials that do not possess verified chemical or biological testing. The determination of the concentration of active constituents in a certain botanical specimen inside a particular solvent is notably impacted by extractive properties.[29]

To conduct this investigation, meticulous extraction techniques were systematically used, using a varied array of solvents. The selected solvents have been carefully chosen according to their compatibility with the particular plant material, hence facilitating the extraction of bioactive compounds. The used extraction technique yields pertinent data on the pharmacologically relevant constituents present in the botanical specimen.[30]

By using extractive value determination, researchers may get a quantitative understanding of the concentration of active constituents found in the botanical matter. The aforementioned data has significant importance in the assessment of the potential therapeutic efficacy of the plant and offers valuable perceptions for guiding future investigate and development initiatives. The use of extractive values offers a valuable approach to evaluate the medicinal properties of plant materials and contributes to the broader field of pharmaceutical research, especially in situations when traditional evaluation methods are insufficient.[31]

Preliminary phytochemical screening

A preliminary examination was conducted to analyse the phytochemical composition of extracts derived from *C. articulatus* Linn. This investigation included the use of several known qualitative chemical tests to confirm the presence of certain compounds. The main aim of this systematic inquiry was to determine and authenticate the presence of certain phytochemical constituents in the plant extracts.[32]

The use of qualitative tests in phytochemical analysis is generally acknowledged and recognised as a standard methodology. These tests use specific reagents to detect the presence of certain classes of chemicals, such as alkaloids, flavonoids, tannins, glycosides, saponins, and other compounds. Various categories of phytochemicals show unique reactions to certain chemical tests, hence providing indications of their existence in plant material.[33]

Through the use of confirmatory tests, researchers are able to get valuable information into the wide range of phytochemicals that are found in *C. articulatus* Linn. This first inquiry establishes the framework for a more extensive comprehension of the botanical specimen's chemical constitution, establishing the groundwork for later meticulous examinations, pharmacological investigations, and the study of prospective therapeutic utilities.[34]

Experimental Pharmacology

Animal used

Male wistar rats, weighing 150 to 175 g and aged 9-12 weeks, were sourced from M/S Agarwal Enterprises in Lucknow, while male and female Swiss albino mice, averaging 22 to 25 g, were also obtained from the same supplier. The Institutional Animal Ethical Committee at Rameshwaram Institute of Technology and Management granted approval for the experimental protocols under reference code 1397/ac/10/CPCSEA, ensuring compliance with ethical standards for the human treatment and use of animals in scientific research. This careful selection of animals and adherence to ethical guidelines underscores the commitment to responsible and ethical research practices.[35]

Assessment of antidiabetic activity of methanolic extract of C. articulates (MECA)

- *Acute toxicity studies*

The acute oral toxicity and LD_{50} of the methanol extract of *C. articulatus* (MECA) were assessed by according to the methods outlined in the guideline 423 published by the OECD. Within the scope of this investigation, the oral administration

of MECA to the animals that were tested, with dosages ranging from 10 to 4000 mg/kg of body weight, did not display any visible signs of toxicity. The absence of adverse effects within this dosage range indicates a favorable safety profile for the methanol extract of *C. articulatus*, emphasizing its potential as a non-toxic substance at these concentrations in the context of acute oral exposure. This adherence to OECD guidelines ensures a standardized and scientifically rigorous approach to assessing the safety of the methanol extract in experimental conditions.[36]

- *Impact on rats' glucose tolerance*

The study comprised five distinct groups of animals. Group I worked as the control group, receiving no treatment. Diabetic individuals were distributed across four groups: Group II served as a diabetic control, group III was administered the methanol extract of *C. articulatus* (MECA) at 200 mg/kg b.w. p. o., group IV was receive MECA at 400 mg/kg b.w. p. o., and individuals in group V were treated with an oral glibenclamide dose of 0.5 mg/kg. Following an 18-hour fasting period, blood sugar levels were measured at zero hours. Subsequently, the administered drug or extract was given to the animals, followed by the administration of glucose (5 g/kg) 30 minutes later. Blood sugar levels were then measured at 0, 1, and 3 hours post-glucose administration using an Accu-chek active test strip and meter, providing a comprehensive assessment of the impact of the interventions on blood glucose levels over the specified time points.[37]

- *Hypoglycemic activity of extract of C. articulatus in induced diabetic rats*

Streptozocin (STZ) for intravenous administration was prepared by diluting it in 0.9% saline (v/v) and stored in the freezer. To induce diabetes in rats, an intraperitoneal injection of streptozocin at a dosage of 50 mg/kg, dissolved in saline, was administered. The diagnosis of diabetes was confirmed by measuring glucose levels in blood samples collected from the tail 72 hours after streptozocin treatment. Experimental animals exhibited blood glucose levels exceeding 225 mg/dl, a threshold commonly used to diagnose diabetes in humans. This method ensured a standardized and validated approach to inducing diabetes in the rat model for subsequent experimental investigations.[38]

- *Scheduling of treatments and prediction of glucose levels*

The study encompassed seven groups, each comprising six rodents. All groups, with the exception of group I, were comprised of diabetic rats. Group I was serve as a non-diabetic control, while group II consisted of healthy individuals, serving as a comparative group for those with type 2 diabetes induced by STZ. Groups III and IV were administered MECA at doses of 200 and 400 mg/kg b.w., p.o., respectively, while group V received the reference drug glibenclamide at a dose of 0.5 mg/kg b.w., p.o., fasting blood sugar levels were measured on days 0, 5, 10, and 15 using an Accucheck® one-touch glucometer. 24 hours after the last dose, blood was collected via cardiac puncture from fasting animals in each group to assess serum biochemical parameters. After that, the biochemical characteristics of the liver and kidneys were evaluated, and then the rats were terminated in a kind and compassionate way by having their cervical vertebrae dislocated. This comprehensive experimental design facilitated the assessment of the effects of MECA and glibenclamide on blood sugar levels and serum biochemical parameters in diabetic and non-diabetic rat models.[39]

- *Biochemical and antioxidant estimation*

After a 24-hour period, euthanasia of all animals was carried out through intravenous injection of thiopentone sodium at a dosage of 40 mg/kg. Tissues from both the liver and kidneys were harvested, chilled in phosphate-buffered saline, washed, blotted, and then weighed. Subsequently, the liver and kidneys were homogenized at 10% w/v in 0.15 M tris-HCl buffers (pH 7.4). The homogenate was subjected to centrifugation at a force of 2000 times the acceleration due to gravity (2000 g) for a duration of 20 minutes at a temperature of 4°C in order to eliminate cellular debris. Subsequently, the resulting liquid (supernatant) was further centrifuged using a REMI C-24 centrifuge with a force of 12,000 times the acceleration due to gravity (12,000 g) for a duration of 1-hour at a temperature of 4°C.

The assessment of lipid peroxidation was conducted,[40] and the supernatant analysis yielded amounts of glutathione (GSH) and catalase.[41] Furthermore, commercially available kits were used to identify and analyse the blood levels of serum glutamate pyruvate transaminase (SGOT), serum alkaline phosphatase. The use of this particular methodological technique enabled a full assessment of oxidative stress indicators and biochemical parameters in the liver and kidney tissues, so contributing to a comprehensive comprehension of the impacts of the supplied drugs on the experimental individuals.[42]

RESULTS

Pharmacognostical and Phytochemical Screening

Tables 1 to 5 shows the result of Pharmacognostical and phytochemical screening.

Pharmacological Screening

Tables 6 to 10 shows the result of Pharmacological screening.

DISCUSSION

Experimental Phytochemistry

For the purpose of getting a knowledge of the complex composition of plant materials, it is very important to evaluate the extractive value of plant materials. This is particularly true in circumstances when traditional approaches are ineffective. In circumstances in which proper biological or chemical research are not available, this evaluation ends up being of utmost significance. The majority of the time, the identification of *C. articulatus* has been performed by the use of extractive qualities, such as ash values and loss on drying.

A broad variety of phytoconstituents have been found by the use of methanol extracts of *C. articulatus*, which has

Table 2: Determination of extractive values of extracts of *C. articulates*

Reading	*I*	*II*	*III*
Wgt. of crucible in gm	14.126	17.140	23.312
Wgt. of crucible + air dried drug in gm	16.126	19.140	25.312
Wgt. of crucible + ash in gm	14.390	17.384	23.462
Total ash in gm	0.264	0.244	0.150
% of total ash [% w/w]	13.2	12.2	7.5
The total % of ash was found to be 10.96% w/w.			

Table 3: Determination of ash value of *C. articulates*

Reading	*Pet ether soluble extractive values*	*Chloroform soluble extractive values*	*Alcohol soluble extractive values*
Wgt. of empty dish (gm)	9 .000	9 .000	9 .000
Wgt. of dish + extract (gm)	9.049	9.052	9.135
Wgt. of solvent soluble extract (gm)	0.049	0.052	0.135
The percentage of soluble extract (% w/w)	3.96	4.20	10.80

Table 4: Determination of loss on drying of *C. articulatus*

Reading	*I*	*II*	*III*
Wgt. of weighing 'bottle' in gm	17.574	17.406	17.250
Wgt. of 'air dried material'	2	2	2.
Wgt. of 'weighing bottle + air dried material' in gm	19.574	19.406	19.250
Wgt. after drying of 'weighing bottle+air dried material' in gm	19.340	19.121	18.897
% of loss of drying (% w/w)	11.7	14.25	17.65
The % of loss on drying was found to be 14.53% w/w.			

enabled the field of preliminary phytochemistry to make significant advancements. Among the many components that have been discovered are reduced sugars, alkaloids, triterpenoids, steroids, tannins, and flavonoids. Also, a large number of components have been identified. By providing a thorough analysis of the plant's phytochemical profile, this study does double duty: it establishes the framework for future research into the plant's medicinal uses and understands the plant's chemical profile inside and out.

Experimental Pharmacology

Acute toxicity studies

One of the most crucial aspects of evaluating the safety profile of potential therapeutic drugs is looking at acute toxicity. The methanol extract of *C. articulatus* has shown a promising absence of toxicity when administered orally at doses ranging from 10 to 4000 mg/kg of body weight. The results are encouraging. Collecting this crucial data is necessary for future study and to establish a safe dosage range for potential medicinal applications.

Effect of body weight

A loss of body weight is a typical complication of diabetes, which is caused by the medication streptozotocin. The control group of people with diabetes showed this. There was a statistically significant decrease in body weight among the diabetic rats compared to the healthy control group. All things considered, this proves that diabetes is bad for the rats' health. It is worth noting that the administration of methanol extract of *C. articulatus* caused diabetic rats to exhibit a significant increase in their body weight levels. This was in contrast to the control group of rats that had diabetes. This study adds to the growing body of research suggesting *C. articulatus* may help diabetics avoid the weight loss that often accompanies the disease.

Antihyperglycemic activity

Research on the effects of *C. articulatus* species' methanol extract (MECA) on diabetic rats' blood glucose levels is necessary to fully understand the potential antidiabetic properties of this extract. For this comprehension to materialise, these examinations are fundamental. Blood

Table 5: Presence of phytochemical constituents in plants extracts of *C. articulates*

Name of extracts	*Name of tests*								
	Alkaloid	*Amino acid*	*Flavonoid*	*Steroid and triterpenoid*	*Reducing sugar*	*Gum*	*Tannin*	*Saponin*	*Glycoside*
petroleum ether extracts									
C. articulates rhizome	-	-	+	+	+	-	-	-	-
Chloroform extracts									
C. articulates rhizome	-	-	+	+	+	-	-	-	-
Methanol extracts									
C. articulates rhizome	+	-	+	+	+	-	+	+	-

'+' Indicates present; '–' indicates absent

Table 6: LD_{50} value of MECA in orally

Determination of LD_{50} of methanol extracts of C. articulatus orally					
Treatment	*Dose (mg/kg)*	*No. of animals*	*No. of survival*	*No. of deaths*	*% of Animals died*
Control 0.1% CMC	---	4	4	00	00
Methanol extracts	10	4	4	00	00
	50	4	4	00	00
	100	4	4	00	00
	400	4	4	00	00
	800	4	4	00	00
	1200	4	4	00	00
	2000	4	4	00	00
	4000	4	4	00	00

Table 7: Normal, MECA, and diabetic rats' weights were measured

Groups	*Initial BW (gm)*	*Final BW (gm)*
Saline control (0.9% NaCl w/v) (I)	175.12 ± 5.5	182.00 ± 4.5
Diabetic control (II)	173.3 ± 6.5	148.31 ± 4.8*
MECA 200 mg/kg (III)	177.50 ± 5.1	165.16 ± 5.3
MECA 400 mg/kg (IV)	179.16 ± 8.8	173.83 ± 6.3
Glibenclamide 0.5 mg/kg (V)	167.33 ± 9.5	175.50 ± 6.4**

Values presented as mean ± SEM (n = 6), * $p < 0.001$ *vs*. saline control, ** $p < 0.05$ *vs*. STZ-control, indicating significant differences in the experimental groups.

glucose levels increased significantly in streptozotocin-induced diabetic rats, which exhibited the hyperglycemia characteristic of diabetes. The antihyperglycemic benefits of MECA were more noticeable at dosages of 200 and 400 mg/kg, although it was equally helpful in bringing blood glucose levels back to normal before and after meals. Further evidence that MECA may be useful as a therapeutic agent in the treatment of diabetes is provided by the substantial decrease in blood glucose levels and the positive control, glibenclamide.

Effect of TBARS, GSH, and catalase

The development of lipid peroxidation, a hallmark of diabetes, was mostly caused by oxidative stress. The increased concentrations of thiobarbituric acid reactive substances (TBARS) in the liver and kidneys of diabetic rats provide evidence of the oxidative stress these animals are experiencing. A fascinating finding is that TBARS levels were substantially reduced after MECA delivery, indicating that it could have antioxidant properties that inhibit lipid peroxidation. It is suggested by this research that MECA could have these traits.

After receiving MECA therapy, diabetic control rats had their glutathione (GSH) levels normalised and even restored. What this means is that the medication protected the cells' antioxidant defences. Because the administration of MECA therapy was able to halt the sharp drop in catalase levels seen in diabetic rats, it is evident that the extract may boost antioxidant enzyme activity and help reduce oxidative stress in general.

Effect of SGOT, SGPT, and alkaline phosphatase

The elevated levels of liver damage indicators seen in the diabetic control group were significantly reduced after MECA treatment. The research used serum glutamic oxidaloacetic transaminase (SGOT), salivary phosphatase, and serum glutamic pyruvic transaminase (SGPT) as indicators. Consequently, this adds to the mounting evidence that *C. articulatus* may include a number of phytoconstituents that have hepatoprotective effects.

The experimental pharmacological group has finally concluded that *C. articulatus* has shown antidiabetic and antioxidant properties in their investigation. This plant extract improves a number of important metrics, including weight, glucose levels in the blood, markers of oxidative stress, and enzymes in the liver. These beneficial outcomes demonstrate the wide range of therapeutic properties held by this plant extract. Additional study is required to identify the specific active ingredients responsible for these benefits and to comprehend how they work. These findings provide the groundwork for exciting new ways of treating diabetes, such developing drugs based on *C. articulatus*, which are expected to be used soon.

Table 8: MECA's effect on FBS

Groups	*Blood glucose level mg/dl*			
	0 Day	*5th Day*	*10thDay*	*15th Day*
Diabetic control	262.21 ± 11.3*	261.51 ± 10.2*	270.83 ± 10.8*	283.50 ± 10.7*
Saline control	91.56 ± 2.12	92.33 ± 2.36	94.16 ± 1.3	92.12 ± 1.3
MECA 200 mg/kg	254.41 ± 11.7	176.12 ± 1.6**	126.16 ± 3.7**	98.50 ± 2.5**
MECA 400 mg/kg	283.83 ± 27.8	152.50 ± 9.1**	115.16 ± 2.2**	96.35 ± 3.1**
Glibenclamide 0.5 mg/kg	291.12 ± 17.1	137.13 ± 4.9**	105.66 ± 3.4**	91.50 ± 1.7**

Results are shown as mean ± SEM (n = 6), * $p < 0.001$ *vs.* saline control, ** $p < 0.001$ *vs.* STZ-control, highlighting significant differences in the experimental groups.

Table 9: Normal and diabetic rats' TBARS, GSH, and catalase levels

Groups	*TBARS (mM/100 g tissue)*		*Glutathione (mg/100 g tissue)*		*Catalase (U/mg protein)*	
	Liver	*Kidney*	*Liver*	*Kidney*	*Liver*	*Kidney*
Diabetic control	1.62 ± 0.06*	2.56 ± 0.3**	22.38 ± 1.8*	6.76 ± 2.2*	42.15 ± 2.4*	21.22 ± 1.59**
Saline control	1.00 ± 0.05	1.53 ± 1.1	44.55 ± 2.2	21.44 ± 1.8	83.23 ± 2.2	37.21 ± 3.3
MECA 200 mg/kg	1.12 ± 0.08#	1.45 ± 0.11***	43.31 ± 2.3	16.73 ± 1.3	72.34 ± 2.5***	30.9 4 ± 2.6
MECA 400 mg/kg	1.32 ± 0.07	1.57 ± 03***	35.44 ± 2.2**	14.73 ± 1.2	65.12 ± 2.2***	33.15 ± 2.4
Glibenclamide 0.5 mg/kg	1.06 ± 0.09##	1.56 ± 0.07***	38.58 ± 1.6#	14.51 ± 1.8	72.58 ± 2.4***	35.58 ± 1.7#

Data presented as mean ± SEM (n = 6), $^{*}p < 0.01$, $^{**}p < 0.001$ *vs.* saline control group. $^{\#}p < 0.05$, $^{***}p < 0.001$ *vs.* STZ-control group. $^{\#\#}p < 0.01$ vs. STZ-control group, indicating significant differences in the respective comparisons.

Table 10: Effect of SGOT, SGPT and Normal and diabetic rats' ALP serum

Groups	*SGOT*	*SGPT*	*ALP*
Diabetic control	39.3 ± 2.55	43.0 ± 2.54	258.50 ± 6.0
Saline control	27.8 ± 2.96	26.2 ± 2.53	118.16 ± 1.9
MECA 200 mg/kg	35.00 ± 2.510	33.50 ± 2.270	142.160 ± 5.10
MECA 400 mg/kg	29.890 ± 1.560	23.50 ± 2.110	154.120 ± 11.80
Glibenclamide 0.5 mg/kg	27.20 ± 1.760	21.50 ± 2.170	132.660 ± 5.50

Data are presented as means ± SEM from n = 6, with arithmetical significance denoted as $p < 0.01$

CONCLUSION

After ingesting rhizome extract from *C. articulatus*, streptozotocin-induced diabetic mice demonstrated a significant increase in their ability to regulate blood glucose levels. The conclusion that was stated here is based on the study results (MECA). Both the weight and the levels of blood enzymes in the diabetic rats increased after this intervention. It is possible that this development indicates that the intervention has enhanced the rats' metabolic function. Furthermore, there is encouraging evidence that the extract might be used as a pharmaceutical treatment to reduce oxidative stress in individuals with diabetes. For the simple reason that it prevented lipid peroxidation, which is the root cause of the problem. This was presented as evidence since it showed that it could work.

Following these promising results, it is critical to conduct more studies to determine the exact active ingredients that caused the antidiabetic benefits and to learn more about how the drugs work. This is due to the fact that the results may considerably alter diabetic care. This is because the findings may significantly impact how diabetes is treated, particularly in the future. Currently, studies are being conducted in the fields of medicine and biology to investigate the potential medicinal applications of MECA. It is encouraging to see these initiatives showing promise for the future of diabetes therapy since they may provide the groundwork for future innovations in the treatment of the disease.

The amount and length of research associated with MECA must be substantial and ongoing; this is of the highest significance. This is because MECA has the ability to be used in a broad variety of therapeutic settings, which is the reason for this circumstance. A broad array of complex systems are responsible for the transmission of the antidiabetic effects of *C. articulatus*. These several procedures are the ones that are accountable for the transmission of these effects. This study makes an effort to identify these routes, as well as the key active components that are responsible for these benefits. Additionally, an attempt is made to determine the pathways themselves. Assuming that we are ever going to uncover how this medicinal plant may ease the symptoms of diabetes and put our findings into practise, it is impossible to emphasise the significance of each and every one of these elements.

Several additional research endeavours may be able to establish themselves on top of the strong footing that was produced by the results of this study. The possibility that this base may serve as a foundation for development is not as far-fetched as one would think. MECA has the potential to be a weapon in the fight against this metabolic disorder since it offers a variety of health advantages that are associated with the treatment of diabetes. This makes it a potential weapon. Particularly connected to the management of diabetes is the provision of these advantages. This is because MECA is able to provide an effective therapy for diabetes, which is the reason behind this. Because the findings of this study not only contribute to the existing body of knowledge regarding natural treatments for diabetes, but they also bring to light the necessity of conducting additional research into this plant, there is a need for additional research to be conducted on *C. articulatus* and the potential medical applications of this plant in the treatment of diabetes.

Researchers are drawn to the potential of medicinal plants like *C. articulatus* to uncover the mysteries of medicinal plants like *C. articulatus* and to make use of the therapeutic potential that these plants hold. When researchers anticipate the challenges and opportunities that come with studying medicinal plants like *C. articulatus*, they are drawn to the potential of these plants. The junction between conventional ways of thinking and modern scientific research has to be regarded as the most important factor in determining the

success of innovations that have the potential to bring about a substantial shift in the way things are done in the field of diabetes treatment. If further study is conducted, it is possible that it may lead to the development of diabetic medications that are more effective than those that are now on the market. In the event that we were to carry out this action, we would be one step closer to gaining an understanding of the complex interaction that exists between natural drugs and metabolic illnesses. There is little doubt that the findings of this investigation provide grounds for hope.

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