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Exploring The Antidiabetic Effects Of Murraya Koenigii And Abelmoschus Esculentus Extracts In Diabetic Rat Models

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ABSTRACT
The potential antidiabetic exercises of watery extracts of Murraya koenigii and Abelmoschus esculentus are investigated in this study using alloxan-induced diabetic Wistar rats. Subsequent to collecting, verifying, and cold macerating Murraya koenigii leaves, a fluid concentrate (AEMK) was delivered; the recommended therapeutic portion was 300 mg/kg body weight. The standard treatment was giving the patient 150 milligrams of metformin for each kilogram of body weight. By administering rats alloxan to induce diabetes, intense poisonousness tests determined the protected portion of AEMK. Then, the rats were partitioned into four gatherings: the control bunch, the diabetic gathering, the gathering that got AEMK treatment, and the gathering that got Metformin treatment. The diabetic rats' FBS levels were essentially lower than the diabetic control bunch after treatment with AEMK and Metformin, according to week after week blood glucose monitoring. The consequences of this study recommend that AEMK may be helpful in the treatment of diabetes mellitus due to its antidiabetic properties, which are practically identical to those of Metformin. The way that the examination effectively decreased fasting blood sugar levels demonstrated this.

Keywords: Murraya koenigii, diabetes, dementia, neurodegeneration, oxidative stress, anti-oxidant, nootropic

1. INTRODUCTION

An enormous level of the populace lives with diabetes mellitus (DM), a persistent illness. It causes the body's organs to gradually deteriorate and is linked to both macrovascular and microvascular problems. Cognitive decline and dementia are among the latter problems and are a major issue among the aged population [1]. Research treatments for diabetes individuals' cognitive impairment are urgently needed. Along with microvascular problems including neuropathy, nephropathy, retinopathy, and cardiovascular issues, it should be treated as well [2].

In diabetic research, alloxan is a diabetogenic drug that reduces insulin production. It works by breaking down the pancreatic β-cells using the processes of free radicals and reactive oxygen species (ROS) after aggregating them via the Glut2 glucose transporter [3]. Since oxidative stress prompts a diminishing in antioxidant protections and an increase in free extreme development, it is a huge figure the improvement of diabetic complications, including learning and memory issues. These free extremists cause DNA harm by protein oxidation and film lipid peroxidation, which increases neuronal passing in the hippocampus and other brain districts [4].

For quite a while, individuals have relied upon medicinal plants and the engineered substances they contain to ease up or prevent infection. The flood of medicinal plants in India is remarkable. For instance, notwithstanding the way that Murraya koenigii contains a couple of bioactive parts that have demonstrated to be medicinally huge, this plant has gotten surprisingly little consideration from scientists [5]. Curry Leaf is the English name for Murraya koenigii (L.) Spreng., which is known as Karuveppilei in Tamil, Surabhinimba in Sanskrit, Mitha Neem or Kadi Patta in Hindi, and other Neighborhood Indian names. It is an individual from the Rutaceae family. Notwithstanding its expansive use as a seasoning and sauce in India, research has demonstrated that it has customary medicinal properties [6]. Murraya, Clausena, Glycosmis, Micromelum, and Zanthoxylum are genera in the Rutaceae family that produce phytocarboxazole alkaloids, a surprising class of compounds. It is a lot of seen that carbazole alkaloids are a promising gathering of potential therapeutic compounds because to the various critical natural effects showed by the parent skeleton, which include anticancer, antibacterial, antiviral, antidiabetic, unfriendly to HIV, and neuroprotective characteristics [7].

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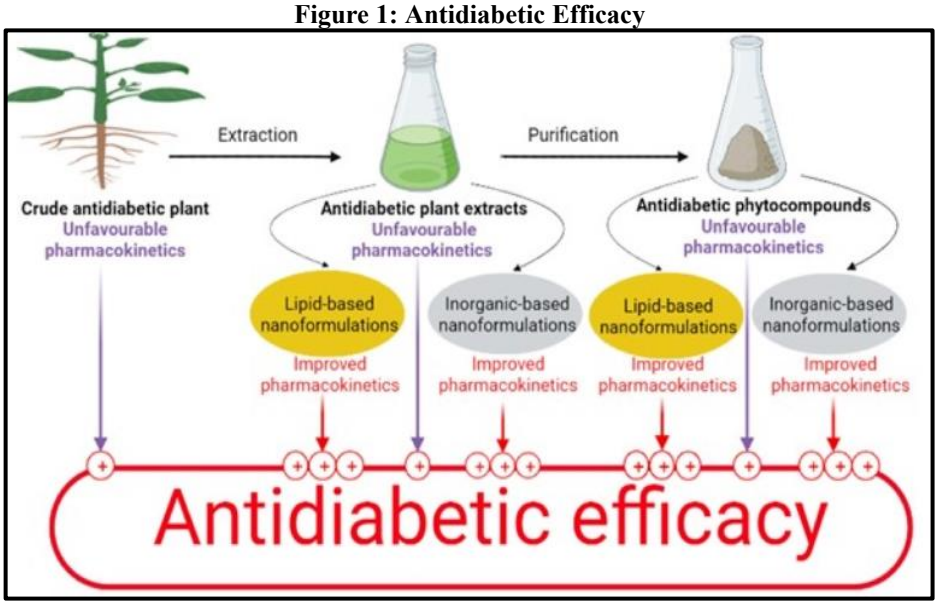
Figure 1: Antidiabetic Efficacy



Murraya koenigii leaves and roots have been used historically to treat a variety of GIT diseases from ancient times. They have been shown to increase appetite, alleviate nausea, and manage diarrhoea, dysentery, and flatulence. Murraya koenigii is also used as an antidote for animal attacks and to alleviate pain, fever, cancer, and haemorrhoids. Diabetes is treated with leaf extracts from Murraya koenigii. This plant contains minerals, flavonoids, glycosides, carbazole alkaloids, and volatile oil, among other phytoconstituents. Murraya koenigii is useful either straight or in several forms, such as essential oils and extracts [8].

1.1. Abelmoschus Esculentus Extracts

Abelmoschus esculentus, also referred to as lady's finger or okra, has drawn interest due to possible anti-diabetic properties, especially in studies conducted on diabetic rat models. Okra extracts have been found to have strong hypoglycemic effects, which can assist diabetic rats' blood glucose levels stay under control [9]. Okra's bioactive ingredients, which include dietary fibres, polysaccharides, and flavonoids, are hypothesised to have an antidiabetic effect by improving insulin sensitivity, encouraging the absorption of glucose in peripheral tissues, and blocking the enzymes that break down carbohydrates. Okra extracts have been demonstrated to lower hyperglycemia, enhance lipid profiles, and guard against oxidative stress—a major diabetic complication—in experimental conditions [10]. Furthermore, the extract has the ability to shield the insulin-producing pancreatic β-cells from harm. These results imply that Abelmoschus esculentus extracts may provide therapeutic effects for diabetes management that are promising, particularly when investigated further in clinical studies.

2. HISTORICAL USE OF MURRAYA KOENIGII AND ABELMOSCHUS ESCULENTUS IN TRADITIONAL MEDICINE

Curry leaf, or Murraya koenigii, has been utilised in traditional medicine worldwide, notably in India. The Ayurvedic and Siddha traditions venerate Murraya koenigii for its medicinal and culinary purposes. Infections, inflammatory ailments, and gastrointestinal difficulties have long been treated with it. The leaves are consumed fresh or dried in many dishes to boost appetite and digestion. The herb is known to alleviate nausea and vomiting. Murraya koenigii controls blood sugar, making it a classic diabetic treatment. Historical context emphasises the plant's cultural significance and phytotherapy potential [11].

Known as lady's finger or okra, Abelmoschus esculentus has been used in traditional medicine worldwide, notably in Africa, the Middle East, and South Asia. Okra is utilised in traditional African medicine to treat diabetes, obesity, and gastrointestinal disorders due to its nutritional value. Okra may lower blood sugar by slowing intestinal glucose absorption due to its high mucilage content. Traditional Indian medicine uses Abelmoschus esculentus seeds and pods as over-the-counter hyperglycemia remedies and health boosters [12]. These herbs' widespread usage in traditional medicine proves their effectiveness in treating and preventing diabetes.

2.1. Phytochemical Composition of Murraya koenigii and Abelmoschus esculentus

Murraya koenigii's rich phytochemical profile boosts its medicinal value. Bioactive chemicals in leaves include alkaloids, flavonoids, phenolic compounds, and essential oils. Mahanimbine and koenimbine, antidiabetic alkaloids, may alter glucose metabolism. Flavonoids like quercetin and kaempferol reduce diabetes-related oxidative damage. Essential oils

help make it antibacterial and anti-inflammatory [13]. Murraya koenigii's phytochemically rich composition supports common wisdom and provides a sound scientific platform for further research into its therapeutic potential.
Similar phytochemical content in Abelmoschus esculentus benefits health. Okra pods, seeds, and leaves include polysaccharides, flavonoids, phenolic acids, and vitamins including folate and vitamin C [14]. Okra contains mucilage, a polymer that slows intestinal glucose absorption and helps control blood sugar. Flavonoids and phenolic acids counteract inflammation and oxidative damage as antioxidants [15]. These elements demonstrate Abelmoschus esculentus's potential as a functional food in modern diets and its historical use in diabetes control [16].

2.2. Previous Studies on the Antidiabetic Effects of These Plants

Murraya koenigii has been studied for its antidiabetic effects. Extracts from Murraya koenigii leaves have been shown to reduce blood glucose in diabetic animal models. Murraya koenigii extract lowered fasting blood sugar and enhanced glycaemic control in one study. Improving insulin sensitivity and stimulating pancreatic beta-cell regeneration boost the extract's hypoglycemic effects. Cooking with curry leaves improved diabetics' glycaemic indices in clinical studies. These findings corroborate Murraya koenigii's traditional use as an antidiabetic and show its potential as a supplement [17].
Research on Abelmoschus esculentus suggests it has anti-diabetic properties. Experimental rat models of diabetes showed that okra extracts reduced blood sugar and improved insulin sensitivity. Okra lowers postprandial blood glucose because its mucilage regulates carbohydrate absorption. In diabetic clinical trials, okra improved lipid profiles and glycaemic control. These results suggest that Abelmoschus esculentus should be included in diabetic diets and used as a natural diabetes treatment [18].

2.3. Mechanisms of Action of Their Bioactive Compounds

Bioactive compounds in Murraya koenigii support its antidiabetic effects through many routes. Alkaloids, especially mahanimbine, boost pancreatic beta-cell insulin synthesis, enhancing peripheral glucose absorption. Curry leaves contain potent antioxidant flavonoids and phenolic compounds that reduce inflammation and oxidative stress, two key insulin resistance reasons. Some Murraya koenigii components impede alpha-glucosidase activity, slowing carbohydrate digestion and lowering postprandial blood glucose. Murraya koenigii's complex glucose metabolism makes it a possible diabetic therapy [19].
Complex factors underpin Abelmoschus esculentus's antidiabetic properties. Okra's mucilage delays carb absorption in the intestines, creating a gel-like substance that controls blood glucose. This function prevents high blood sugar rises after meals. Okra's flavonoids and phenolics reduce inflammation and improve insulin sensitivity. These compounds may increase glucose metabolic pathways, improving glucose utilisation, according to research. These bioactive compounds show that Abelmoschus esculentus might cure diabetes as a meal [20].

3. RESEARCH METHODOLOGY

3.1. Drug and chemicals : We purchased a blood glucose monitor from Bayer Healthcare in India, metformin from Auro Pharmaceuticals in Mumbai, India, and alloxan monohydrate from Loba Chemie in Mumbai, India. Every chemical and reagent used was analytical grade, and it was kept in a refrigerator at +4ˆC.

3.2. Gathering and verifying plant specimens : Murraya koenigii leaves were accumulated. The leaves were checked and upheld by the Innate science Division at M. S. Shinde Mahavidyalaya in Tisangi, Kolhapur, India. The herbarium as of now contains the voucher for the plant model with the number V03 (Ref: MHST/2016-17/28) attached to it. Following a comprehensive washing with running water, the leaves were allowed to dry in the shade and subsequently beat into a powder using a machine.

3.3. Methods for Making an Aqueous Extract from Murraya Koenigii Leaves : The Karad region in Maharashtra, India, which is situated at 17.2760 degrees North and 74.2003 degrees East, was the wellspring of the new leaves of the Murraya koenigii plant. The Herbal Science Division of M. S. Shinde Mahavidyalaya, which is situated in Tisangi, Kolhapur, led a check cycle on these leaves in request to lay out their identifying qualities. In the herbarium, the example of the plant was recorded with the voucher number V03 in the example list. After the leaves were gathered, they were washed under running water in request to eliminate any contaminants that might have been available. In request to maintain their integrity, they were then permitted to dry normally in the shade once this step was finished. A short time later, the dried leaves were squashed into a fine powder using a machine until they were reasonable for additional use. This cycle was rehashed until the powder was uniform in size and consistency

3.4. Preparation of Metformin : Metformin is to be administered orally, with the dosage carefully calibrated to 150 mg per kilogram of body weight. To prepare the metformin solution, referred to as MET, a precise amount of 150 mg of pure metformin powder was meticulously dissolved in 10 milliliters of distilled water. This process yielded a concentrated solution with a final strength of 15 mg per milliliter, ensuring accurate dosing and consistency for experimental or clinical applications.

3.5. Acute toxicity study of extract: An intense poisonousness test was done in understanding with the normalized conventions gave by the Association to Ecological Control and Improvement (OECD) in laying out the legitimate portion for AEMK 423 suggestions in request. This widely accepted method is intended to assess a substance's safety

and possible hazardous consequences when given as a single, large dosage. To ensure that the greatest potential effect was seen, 2000 mg of AEMK per kilogramme of body weight (bw) was the first dosage that was given. The drug was given orally to the rats, who served as the test participants. This approach was selected due to its consistency in mimicking normal ingesting pathways.

A fraction of the chemical's lethal dose (LD50), or the dose at which 50% of the test population would be anticipated to die from the substance, was used to establish a therapeutic dosage after careful observation of the animals' reactions to this high dose. A dosage equal to 10% of the estimated LD50 was chosen for therapeutic purposes. This cautious approach struck a compromise between the test participants' safety and efficacy by ensuring that the provided dosage would have positive benefits while lowering the possibility of negative results.

3.6. Inclusion criteria : Wistar albinos of either sex, weighing between 100 and 250 grammes. Normal conduct and activity of albino Wistar rats.

3.7. Exclusion criteria : Rats that are expecting or have given birth before Rats Albino Wistar that has been employed in any other type of experimentation in the past

3.8. Alloxan induced diabetes in rats : Diabetes mellitus was induced using alloxan. Rats starved throughout the entire night. Each rat was given an injection of a newly made 2% solution of alloxan monohydrate in a 0.9% sodium chloride solution after an overnight fast. Intraperitoneally, 130 mg/kg body weight was the injection dosage. For the investigation, rats given an alloxan injection seven days prior were chosen if their FBS was greater than 150 mg/dl. Alloxan-induced diabetic (AID) rats were designated as diabetic rats, while non-diabetic (ND) animals were designated as normal rats.

3.9. Experimental Design : Throughout the course of the trial, six animals from each of four randomly assigned groups of Albino Wistar rats of both sexes were given free access to water and an animal food. For a duration of 28 days, the recommended dosages of Metformin and AEMK were administered orally once daily at a predetermined time.

Group I-NC: A normal control group of rats were maintained by administering ND rats DW-5 ml/kg/day, b w, p. o.
Group II-DC: As a control group, diabetic rats were administered DW-5 ml/kg/day subcutaneously.
Group III-AEMK: The rats in the study were given AEMK at a dosage of 300 mg/kg/day, orally, b.w., and p.o.
Group IV-MET: A control group of AID rats that were given MET-150 mg/kg/day orally served as the gold standard.

3.10. Tracking of glucose levels in the blood throughout therapy : At day 0 and weekly intervals throughout the trial, blood was drawn from rats by snipping the tips of their tails. The FBS was then measured using blood glucose test strips and a glucometer. At the conclusion of the research, all animals were killed by severing their cervical spines.

4. RESULT & DISCUSSION

The mean and SEM are used to express the results. One-way ANOVA and repeated measures were used for data analysis, and Tukey's and Kramer's multiple comparison tests were used for post hoc comparisons. Less than 0.05 was the threshold for statistical significance. Six normal diet (ND) rats that were part of the negative control (NC) group during the research period are shown in Figure 2 with their fasting blood sugar (FBS) levels. Between day 0 and day 28, the ND rats' mean FBS levels varied from 76.33 mg/dl to 85.67 mg/dl. Throughout the investigation, the FBS levels in the ND group did not exhibit any notable variations or oscillations. Instead, they stayed continuously steady. The statistical outcome produced a p-value of 0.0667, as shown in Table 1, suggesting that the observed differences were not statistically significant.

Table 1: ND rats with DW (5 ml/kg, b w, p. o) had higher FBS levels.

FBS Level (mg/dl)	Rats				
	Day 0	Day 7	Day 14	Day 21	Day 28
0	80	70	50	60	30
10	60	50	40	50	40
20	40	90	30	30	60
30	20	30	10	40	50
40	40	20	20	50	40

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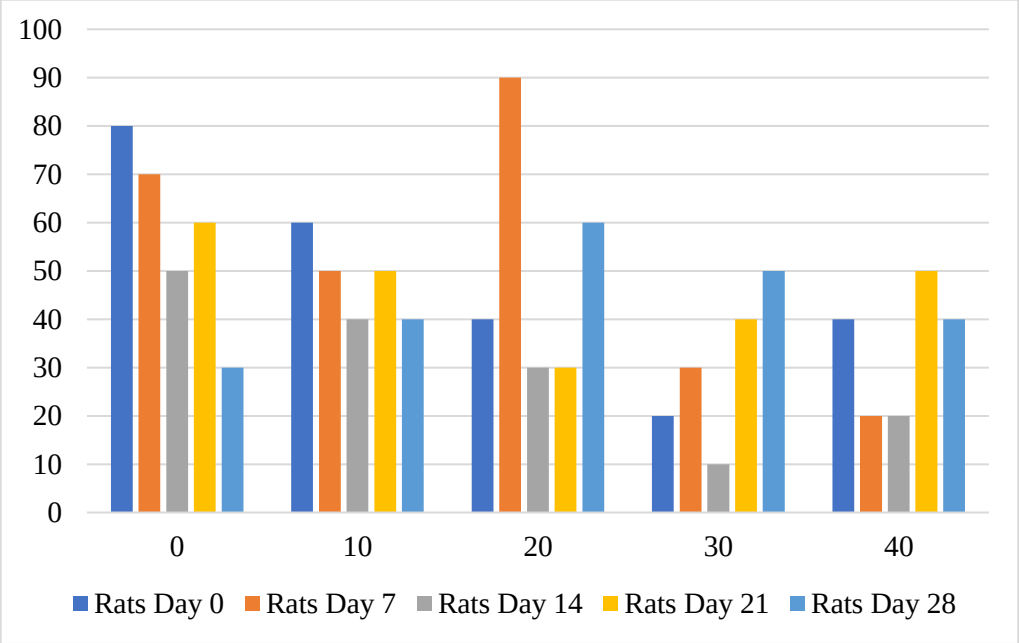
Figure 2: ND rats with DW's FBS levels (5 ml/kg, b w, p. o)



In Figure 3 All of these rats was hyperglycaemic, meaning their fasting blood sugar levels were reliably more than 150 mg/dl. The run of the mill fasting blood sugar levels in this gathering went from 383 to 400.83 mg/dl. According to Table 1, there was no genuinely enormous distinction ($P > 0.05$) in the mean FBS levels among the six diabetic rats in the gathering.

Table 2: AID rats with DW (5 ml/kg, b w, p. o) had higher FBS levels.

FBS Level (mg/dl)	Rats				
	Day 0	Day 7	Day 14	Day 21	Day 28
0	60	20	20	30	30
10	70	10	50	40	20
20	40	60	40	20	60
30	50	70	30	60	50
40	30	80	60	10	40

Figure 3: AID rats with DW (5 ml/kg, b w, p. o) had higher FBS levels.

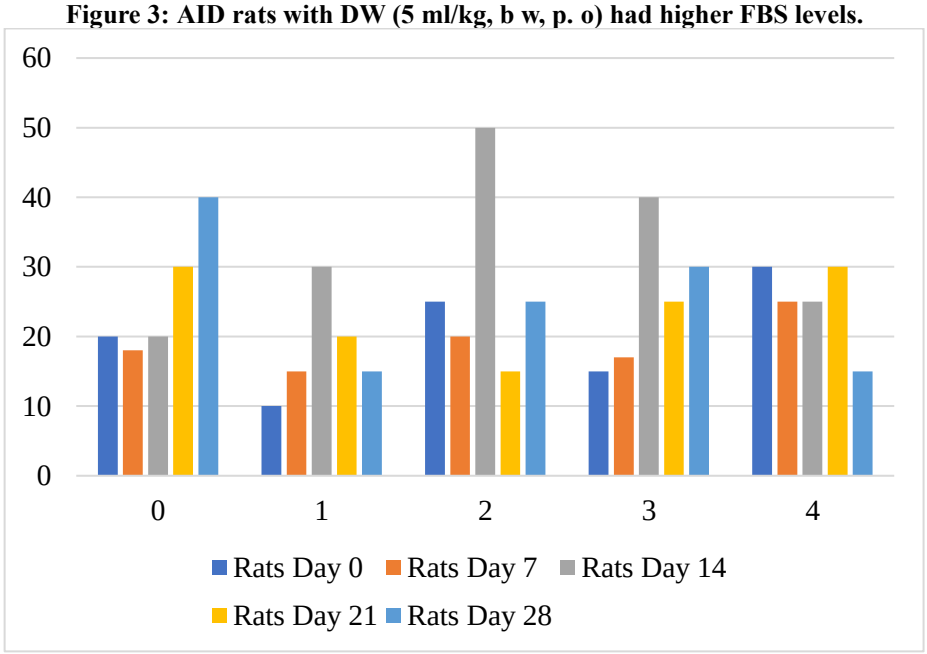


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Figure 4 shows the prospective increases in fasting blood sugar (FBS) in Aide rats given AEMK (300 mg/kg, p.o.) during the research. There was no FBS detected in the Aide rats on the first day of AEMK therapy. Using the same dose of AEMK (300 mg/kg, p.o.) for 7, 14, 21, and 28 days, the FBS levels on those days show the possible increases in FBS in the Help rats. The average FBS level was 333.5 mg/dl before therapy was started (Day 0). The mean FBS levels varied between 98.83 mg/dl and 102.16 mg/dl during the research period, which began on day 7, and ended on day 28, following therapy. These results prove without a reasonable doubt that the Help rats' FBS levels were successfully and persistently decreased by AEMK (300 mg/kg, p.o.). In addition, the data from Table 1 demonstrate a notable difference in the average FBS levels among this group, which is supported by the highly significant ($P<0.0001$) ANOVA results, indicating a steady and noticeable decrease in blood sugar levels during the course of the treatment.

Table 3: FBS levels in AID rats given 300 mg/kg of AEMK (b w, p. o.)

FBS Level (mg/dl)	Rats				
	Day 0	Day 7	Day 14	Day 21	Day 28
0	30	20	25	20	40
100	20	15	35	10	35
200	30	25	20	20	25
300	20	20	25	30	20
400	35	20	30	15	15

Figure 4: FBS levels in AID rats given 300 mg/kg of AEMK (b w, p. o.)

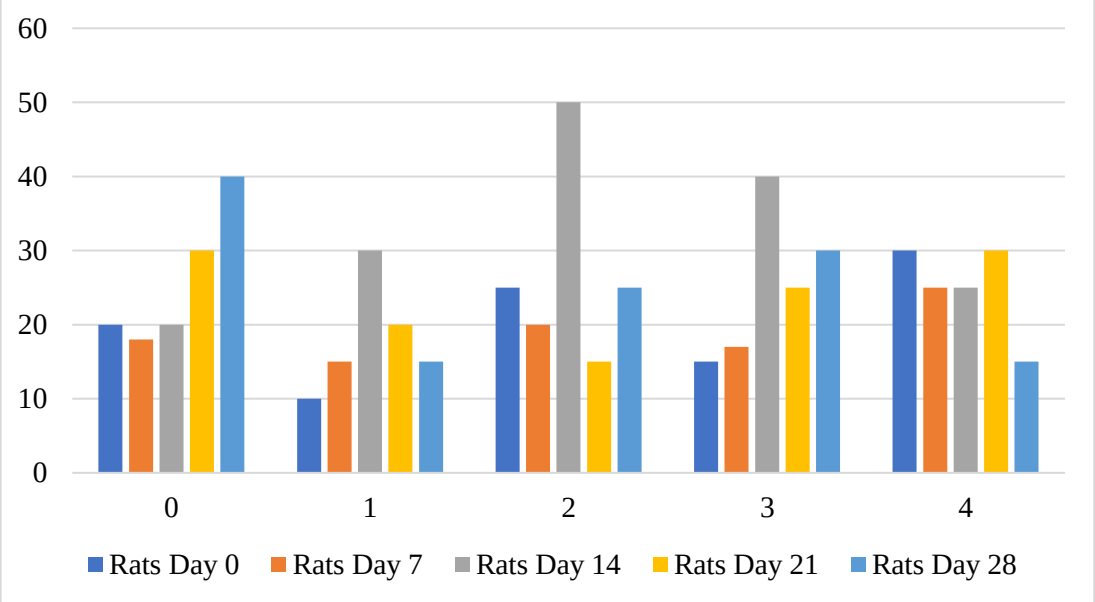

Figure 5 shows the FBS values of the diabetic rats in the control group that were given 150 mg/kg of metformin (MET) orally. On the first day of MET therapy, the reported FBS values are reflective of the diabetic rats' baseline levels. The FBS levels were checked again on days 7, 14, 21, and 28 after therapy started. Prior to therapy, the average FBS level was 350.5 mg/dl, as tested on Day 0. From Day 7 to Day 28, following MET administration, the FBS levels dropped significantly, falling between 77.83 mg/dl and 148 mg/dl. With a p-value of less than 0.0001, the repeated measures ANOVA analysis in Table 1 revealed highly significant reductions in the mean FBS levels, suggesting that MET had a large effect on reducing blood sugar levels in the diabetic rats.

Table 4: FBS levels in AID rats given 150 mg/kg of MET (b w, p.o.)

FBS Level (mg/dl)	Rats				
	Day 0	Day 7	Day 14	Day 21	Day 28
0	30	20	35	45	30
1	30	50	25	50	45
2	10	30	35	15	25
3	20	20	15	20	35
4	30	20	30	25	40

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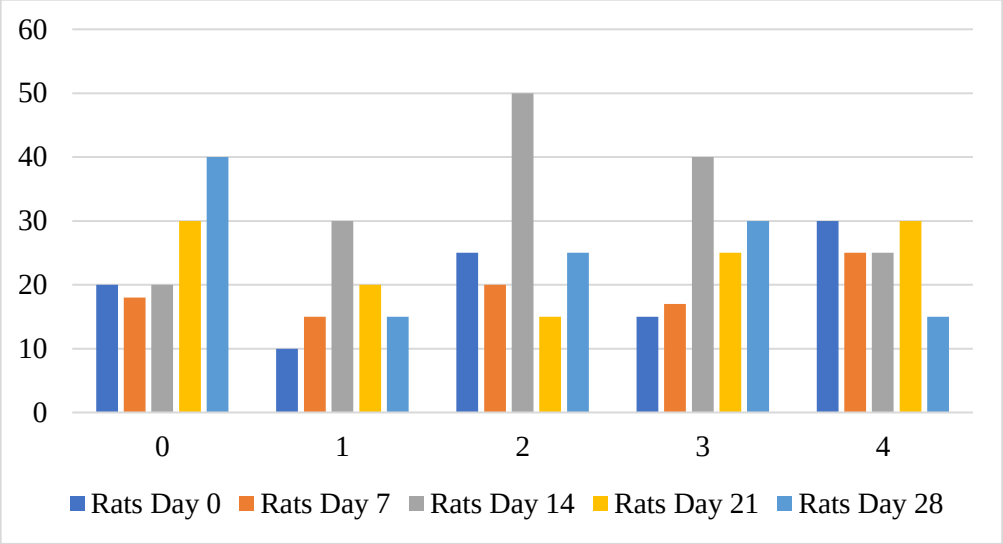
Figure 5: FBS levels in AID rats given 150 mg/kg of MET (b w, p.o.)



The mean FBS values for each gathering were shown in Figure 6. Day 0 is the FBS levels of the diabetic rats before the medicines were started. The FBS levels of diabetic rats are shown on days 7, 14, 21, and 28 following 7, 14, 21 and 28 days of treatment, individually. Every posttreatment mean FBS regard (from Day 7 to Day 28) was not equivalent to the pretreatment mean FBS regard (Day 0). Repeated exercises Table 1's ANOVA indicates that this gathering's mean FBS regard fluctuation was profoundly basic (P<0.0001).

Table 5: Groups NC, DC, AEMK, and MET imply FBS levels

FBS Level (mg/dl)	Rats				
	Day 0	Day 7	Day 14	Day 21	Day 28
0	20	18	20	30	40
1	10	15	30	20	15
2	25	20	50	15	25
3	15	17	40	25	30
4	30	25	25	30	15

Figure 6: Groups NC, DC, AEMK, and MET imply FBS levels

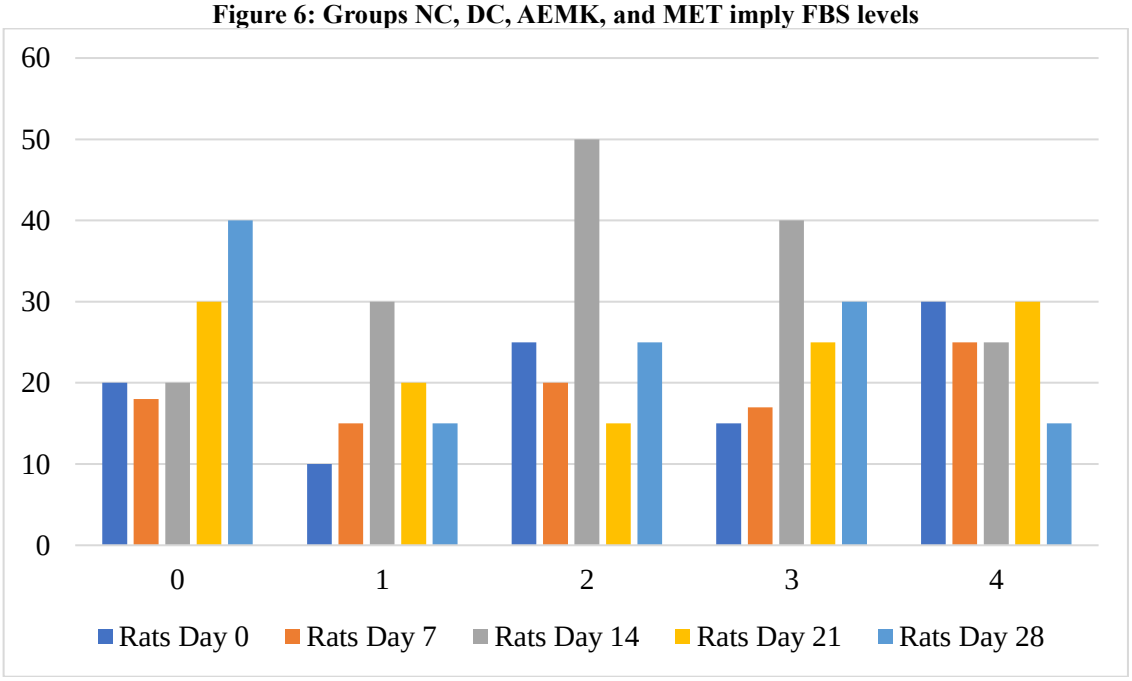


Table 1 shows the mean FBS values for the NC, DC, AEMK, and MET bundles from Day 0 to Day 28.A one-way ANOVA examination uncovered a significant (P<0.001) variety in mean FBS levels between bunches on Days 7, 14, 21, and 28. An intergroup examination of Days 0, 7, 14, 21, and 28 was performed using Tukey-Kramer's various correlation test since a one-way ANOVA showed huge variety. Bunch III and IV's intergroup correlation was insignificant. This indicated that metformin and AEMK diminished FBS similarly at all trials.

Diabetes is a leading reason for infection and mortality. Long haul metabolic confusion affecting fat, protein, and carbs. Current oral diabetes medicines include biguanides, thiazolidinediones, alphaglucosidase inhibitors, effective insulin secretagogues, and DPP-4 inhibitors. These medications enjoy demonstrated benefits yet drawbacks. Despite the fact that specialists have a few medications, diabetes treatment is at this point unclear. Sedates alone can't fix diabetes; in this manner, great food is expected to reestablish and maintain a typical metabolic state.

Just FBS has shown Murraya koenigii leaves' antihyperglycemic properties. Using ethanol, ethyl acetic acid derivation, chloroform, and fluid concentrate, it makes a comparable hypoglycemic difference. Roots and organic product juice of Murraya koenigii have been displayed to decrease blood sugar as well as leaves. Murraya koenigii concentrate might work like metformin, in spite of the ongoing review. This plant extricate was undeniably less hypoglycemic than chlorpropamide, another antidiabetic. This might be on the grounds that chlorpropamide causes hypoglycemia though metformin doesn't. Interestingly, Arulselvan et al. (2006) found that Murraya koenigii ethanolic separate was more compelling than glibenclamide. Adebayo et al. (2004) invalidated Murraya koenigii's antidiabetic ethno-clinical case. Our information affirm that AEMK is unequivocally hostile to diabetic. The antihyperglycemic system of Murraya koenigii fluid concentrate couldn't be explained by perception or this review. We recommend Murraya koenigii's higher BRC content might deliver this Metformin-like outcome. In view of verifiable and contemporary investigations, numerous methods are offered. Our 2018 examination found that Murraya koenigii advances hepatic glycogenesis or inhibits glycogenolysis/gluconeogenesis to support glucose use. It animates pancreatic â cells to generate insulin. Insulin secretagouge's hypoglycaemic activity lessens oxidative stress, restores pancreatic cells, and inhibits pancreatic amylase's ability to lyse dietary starch into glucose, decreasing glucose ingestion from the stomach. Hence, Murraya koenigii leaf watery concentrate's antihyperglycemic properties might supplement the above systems.

5. CONCLUSION

The investigation found that following 28 days of treatment, the fasting blood sugar (FBS) levels in rats with alloxan-induced diabetes were broadly diminished by the watery concentrate of Murraya koenigii (AEMK). Fasting blood sugar (FBS) readings in the diabetic control pack were dependably high from the beginning, indicating consistent hyperglycemia. On the other hand, directly following receiving AEMK, the FBS levels in the treated gathering dropped determinedly, dropping from an initial mean of 333.5 mg/dl to values some place in the scope of 98.83 and 102.16 mg/dl, which shows feasible control of blood sugar. Moreover, the standard treatment gathering's FBS levels dropped extensively from 350.5 mg/dl to values ranging from 77.83 mg/dl to 148 mg/dl ensuing to receiving Metformin (150 mg/kg). Murraya koenigii shows ensure as a trademark treatment for diabetes that can be basically pretty much as compelling as normal drugs like Metformin, according to the results, which require extra survey and its incorporation into diabetes care strategies.

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