Section A-Research paper
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Evaluation of *Musa Sapientum* flowers for its antidiabetic potential

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Abstract:

This research aimed to assess the potential of alcoholic extracts from *Musa Sapientum* flowers in reducing blood sugar levels in rats. The study also looked into the effectiveness of these extracts in treating diabetes in rats induced with streptozotocin. The preliminary analysis of the extracts revealed the presence of glycosides, fixed oils, tannins, phytosterols, and phenolic compounds. However, the notable effects of the alcoholic extract were mainly seen at higher doses.

In the case of rats with streptozotocin-induced diabetes, the alcoholic extract of *Musa Sapientum* flowers displayed significant antidiabetic properties, especially at higher doses, surpassing the effects of the standard drug Glibenclamide. When given at higher

doses, both the alcoholic extracts and Glibenclamide showed similar positive effects on the rats' physical characteristics. Moreover, when examining the pancreatic tissue, the study observed that the alcoholic extract led to a noteworthy restoration of damaged cells in the islets of Langerhans, even more so than the effects of glibenclamide.

In conclusion, the study suggests that the alcoholic extract from *Musa Sapientum* flowers holds promise as an antidiabetic agent, affirming its traditional use in diabetes management.

Keywords: *Musa Sapientum,* Hypoglycemic, Antidiabetic, Streptozotocin, Glibenclamide.

1.0 Introduction:

Diabetes mellitus, often referred to as diabetes, is a stealthy health threat that becomes more prevalent as individuals age, impacting both men and women. In the age range of 20 to 49 years, the occurrence of diabetes consistently leans towards being higher in men than in women. This condition is characterized by elevated blood sugar levels, accompanied by increased lipid levels, oxidative stress, excessive urination, heightened appetite, excessive thirst, ketosis, kidney problems, nerve damage, and cardiovascular complications.

Currently, diabetes affects a staggering 30 million individuals globally. Its far-reaching implications for health make it a significant contributor to mortality rates in both advanced and developing nations. In the United States, diabetes ranks as the fourth leading cause of death. Within India, approximately 1-2% of the population is grappling with this condition. (1,2)

A recent publication has brought to light the alarming surge of diabetes on a global scale. Presently, approximately 1.7% of the world's population is believed to be grappling with diabetes mellitus, a statistic projected to escalate to 3.6% by the year 2025. This unsettling trend is particularly evident in regions such as the United States, where instances of diabetes are anticipated to double by the year 2030. In fact, certain assessments propose that the incidence of new diabetes cases might even triple (3)

Drawing from short-term projections, it is estimated that by that time, a significant number of 651,000 individuals afflicted by diabetes will require treatment for end-stage renal disease. These revelations serve as a stark reminder of the pressing need for effective measures to counteract this escalating global health concern (4).

Contemporary medicine still lacks a definitive and successful remedy for diabetes mellitus. While insulin therapy remains a cornerstone in diabetes management, it comes

with a range of limitations. Issues such as insulin resistance, anorexia nervosa, brain atrophy, and fatty liver are some of the setbacks associated with this approach. Additionally, extended usage of medications like sulfonylureas and biguanides, aimed at chronic treatment, also introduces undesirable side effects into the equation (5).

The challenges extend beyond the treatment itself. Necessitating refrigeration for proper storage, demanding skilled personnel for administration, and the considerable cost of these interventions compound the difficulties. This financial burden proves particularly concerning within economically disadvantaged communities, where access to such treatments becomes a formidable challenge. These obstacles underscore the imperative for further innovation in diabetes management to ensure more effective, accessible, and less encumbered solutions (6).

Given the existing limitations within modern medicine, achieving stringent glycemic control without undesirable consequences remains a challenge. In response, herbal remedies have emerged as a prominent avenue for addressing diabetes mellitus and various other ailments. This practice harks back to ancient times, not only in India but across the globe. The allure of herbal medications lies in their tendency to yield fewer adverse effects when compared to their synthetic counterparts. This historical reliance on herbal treatments underscores their potential as a promising and more harmonious approach to healthcare (7,8).

Herbal remedies typically exhibit a lower level of toxicity or even minimal toxicity, resulting in fewer adverse effects when contrasted with synthetic pharmaceuticals. This inherent advantage has fostered a sustained global fascination with investigating alternative therapeutic avenues such as Ayurveda, Unani, Homeopathy, Siddha, and other traditional systems of medicine. These alternative approaches are revered for their potential to deliver effective outcomes while maintaining a superior safety profile, all the while offering a more economical option for patients seeking treatment (9).

Within indigenous medical systems, numerous plants have been attributed with potential benefits for addressing diabetes mellitus. Despite their promising attributes, the recognition of plants as a viable source for anti-diabetic treatments has not gained substantial traction within the scientific realm. Various factors contribute to this phenomenon, including skepticism among conventional medical practitioners regarding alternative therapies. Additionally, the less structured nature of alternative medicine and the prevalence of unverified treatments offered by unqualified individuals have

contributed to this hesitation. Furthermore, the inconsistency in content, quality, and safety of natural remedies also adds complexity to the situation (10).

In light of this situation, thorough investigation has revealed some intriguing traditional uses of *Musa sapientum*. The fruit of this plant has been employed in folk medicine to address peptic ulcers, while the pulp of *Musa sapientum*, another variety, has been recognized for its analgesic properties. Moreover, the leaves of *Musa sapientum* have found application as an anti-asthmatic remedy. Of particular interest is the historical usage of *Musa sapientum* flowers in managing diabetes mellitus. Despite this traditional acclaim, the scientific exploration of these claims remains conspicuously absent. Consequently, a concerted effort has been undertaken to scrutinize the potential hypoglycemic and antidiabetic attributes of *Musa sapientum* flowers, employing animal models for this purpose (11-15).

2.0 Materials and Methods

2.1 Collection of plant materials:

Flowers of *Musa sapientum* were procured and authenticated by the renowned botanist and voucher specimen was deposited in herbarium for future reference. The collected plant material was shade dried to retain its vital phytoconstituents and then subjected to size reduction for further extraction process.

2.2 Extraction and isolation methods

The flowers underwent a desiccation process in a shaded environment at room temperature. Subsequently, the dried flowers were ground into a fine powder through the use of a grinder. This powdered material was then meticulously packed into a column designed as per Soxhlet's principle. A 90% ethanol solution was employed as the solvent, and the extraction process was conducted over a span of 24 hours. The resultant mixture was subjected to a solvent removal process, facilitated by a rotary flash evaporator. This step led to the elimination of the solvent, leaving behind a concentrated extract. To achieve further concentration, a hot water bath set at temperatures between 70°C and 80°C was employed. The final dried extract was preserved within an airtight container, securely stored in a refrigerator environment below 10°C. To facilitate its administration, a stock solution of the alcoholic extract was formulated using a 2% aqueous solution of gum acacia (16).

2.3 Experimental animals

Albino rats, encompassing both male and female individuals with a weight range of 150 to 200 grams, were acquired from the central animal house to facilitate experimental endeavors. A duration of 7 days was dedicated to the acclimatization of these animals within the laboratory environment. During this period, the rats were provided with a standardized diet commercially available. Adequate access to water was ensured in a freely available manner, all while maintaining a hygienic environment. The ethical considerations governing animal studies were stringently upheld. The research adhered to the guidelines outlined by the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). Furthermore, all activities involving animals were in full compliance with the directives established by the Institutional Animal Ethical Committee (IAEC) (17, 18).

2.4 Acute toxicity study

The acute toxicity of alcoholic extract of flowers of *Musa sapientum* was determined by using albino mice of either sex (20-25gm); those maintained under standard conditions. The animals were fasted over night prior to experiment. Animals were administered with different doses of the extract, orally by following up and down methods as per OECD guidelines number 425. From LD_{50} dose, $1/10^{th}$, $1/20^{th}$ and $1/5^{th}$ doses are to be selected and were considered as low, medium and high dose respectively for alcoholic extract. (19,20)

3.0 Methodology

3.1 Hypoglycemic activity:

Albino rats either sex weighing between 150-200 gm were categorized into five groups, each group consisting of 6 animals.

Group A: Normal control (Saline solution)

Group B: Standard (Glibenclamide)

Group C: Extract of the flowers of *Musa sapientum* (100mg/kg)

Group D: Extract of the flowers of *Musa sapientum* (200mg/kg)

Group E: Extract of the flowers of *Musa sapientum* (400mg/kg)

3.2 Antidiabetic activity:

Albino rats of either sex weighing between 150-200 gms will be categorized into four groups, each group consisting of 6 animals.

Group A: Normal group

Group B : Diabetic group (STZ treated)

Group C : Standard (STZ + Glibenclamide treated)

GroupD : STZ + Extract of the flowers of *Musa sapientum* (high dose 800mg/kg)

3.3 Pharmacological activities

3.3.1 Hypoglycemic activity (21, 22)

For the assessment of hypoglycemic activity, normal animals were selected as participants, a protocol consistently followed for all the proposed extracts in the study. However, the subsequent explanation details the common procedure utilized to evaluate the hypoglycemic effects of any extract, which applies uniformly to all extracts under investigation.

To initiate the experimentation, all animal groups were subjected to a fasting period lasting 16 to 18 hours, a regimen maintained throughout the course of the study. It's important to note that access to water remained unrestricted for the duration of the experiment. The animals were housed within an environment sustaining a 12-hour light and 12-hour dark cycle, with a relative humidity maintained at 45-55%. Throughout the experiment, ambient temperature was upheld.

Prior to the administration of the vehicle, glibenclamide (a reference drug), or the extracts themselves, baseline blood samples were drawn from the animals following their overnight fast to establish initial glucose levels. Subsequently, the animals within their respective groups received the assigned treatment – vehicle, glibenclamide, or extracts. Blood samples were then collected at designated intervals of 0, 1, 2, 4, 8, 12, 18, and 24 hours, and the concentration of blood glucose was measured using the GOD/POD method. This consistent protocol ensures a comprehensive evaluation of the hypoglycemic impact of the extracts, maintaining a rigorous and uniform approach.

3.3.2 Anti-diabetic activity

In the evaluation of antidiabetic activity, diabetic animals with blood glucose levels surpassing 250 mg/dL (induced by streptozotocin treatment) were employed. These diabetic animals, presenting glucose levels exceeding 250 mg/dL, underwent a fasting period of 16 to 18 hours prior to the commencement of the experiment. This fasting protocol persisted throughout the experiment's duration.

The treatment regimen was initiated on the same day, excluding control groups, and spanned duration of 7 days. Throughout this treatment phase, animals across all groups

were provided unrestricted access to a standard diet and water. Parameters such as body weight, food consumption, and water consumption were meticulously monitored from the 1st to the 7th day of the treatment period.

Upon the conclusion of the 7-day treatment, blood samples were collected from the overnight-fasted rats via tail vein methodology at intervals of 0, 1, 2, 4, 8, 12, 18, and 24 hours. These samples were subsequently subjected to blood glucose level analysis.

In the final stage, all animals were humanely euthanized using ether. The pancreas from each animal was promptly extracted and immersed in a 10% formalin solution, preserving them for subsequent histopathological examination. This meticulous process captures the comprehensive nature of the experiment, involving a systematic approach to evaluating the antidiabetic properties of the substances under scrutiny (23,24).

3.4 Estimation of fasting blood glucose level

Pipette out 1 ml of glucose oxidizing reagent into marked test tubes and then mix it with 10µl of serum or plasma into the test tube. Incubate the test tube for 15 mins and then take the absorbance readings.

Calculations:

$$\% \text{ BGL (mg/dl)} = \frac{\text{Initial reading}_{\text{(at '0' time)}} - \text{Test reading}_{\text{(at regular intervals of time)}}}{\text{Initial reading}_{\text{(at '0' time)}}} \times 100$$

3.5 Morphological studies

A. Body weight

Concurrently with the antidiabetic experimentation, a simultaneous assessment of body weight variations was conducted. This evaluation entailed the calculation of the mean body weight for each group. To accomplish this, the mean body weight for every group was determined from the 1st day to the 7th day of the entire experimental period, enabling the tracking of changes in mean body weight. The methodology encompassed a precise weighing of all animals at the initiation of the experiment on the 1st day, prior to any treatments. Subsequently, after duration of 24 hours, another round of weighing was carried out for all animals within each group. This weighing procedure was consistently repeated over the course of the 7-day experiment. The primary objective was to ascertain the alterations in the mean body weight for each group on a daily basis, allowing for a comprehensive comparison against the standard group. This concurrent evaluation of body weight dynamics enhances the understanding of the potential effects

of the tested substances on the animals' physiological condition throughout the experimental period (25).

B. Water consumption

In tandem with the antidiabetic investigation, a simultaneous analysis of water consumption was conducted. In this process, the mean water intake per group was ascertained, thereby tracking changes in the average water consumption by the rats. This evaluation encompassed the period from the 1st day to the 7th day of the entire experimental timeframe. The baseline water intake for a rat is typically within the range of 10-12 mL per day. To conduct this assessment, a precisely measured quantity of 200 mL of water was dispensed into a marked feeding bottle for each group, consisting of six animals. The timing of water provision was noted. After the passage of 24 hours, any remaining water in the bottle was carefully measured and subtracted from the initial volume of 200 mL. The resultant value, denoting the actual water consumed, was then divided by 6, representing the number of rats in the group. This calculation yielded the mean water intake for that specific group. This procedure was consistently repeated over the course of 7 days for all groups, ensuring a comprehensive understanding of the changes in water consumption patterns exhibited by the rats under the influence of different treatments (26).

C. Food consumption

Concurrently with the antidiabetic investigation, an accompanying assessment of food consumption was undertaken. In this process, the average food intake per group was determined, enabling the monitoring of changes in the rats' mean food intake. This analysis spanned from the 1st day to the 7th day of the entire experimental period. Given that the normal food intake for a rat typically falls within the range of 20-40 grams per day, a precise quantity of 300 grams of food was dispensed for each group, comprised of six animals. The timing of food provision was duly recorded. Following a duration of 24 hours, any remaining food in the container was meticulously measured and subtracted from the initial 300-gram quantity. The resultant value, indicative of the actual food consumed, was then divided by 6, reflecting the number of rats within the group. This calculation yielded the mean food intake for that particular group. Consistently applying this procedure over the course of 7 days and across all groups provided a comprehensive perspective on the shifts in food consumption patterns demonstrated by the rats subjected to various treatments (27).

3.6 Statistical analysis:

The values were expressed as mean ± SEM. The statistical analysis was carried out by one way analysis of variance (ANOVA) followed by Dunnet‟s t‟- test. p values <0.05 were considered significant.

4.0 Results

4.1 Hypoglycemic study

4.1.1 Effect of alcoholic extract of *Musa sapientum* flowers on fasting blood glucose levels in normal and diabetic rats

Alcoholic extract of *Musa sapientum (AEMP)* exhibited a significant dose dependent hypoglycemic activity on single dose treatment. However the hypoglycemic effect of alcoholic extract at 400 mg/kg was found near to the reference standard glibenclamide. The results are depicted in fig 1.

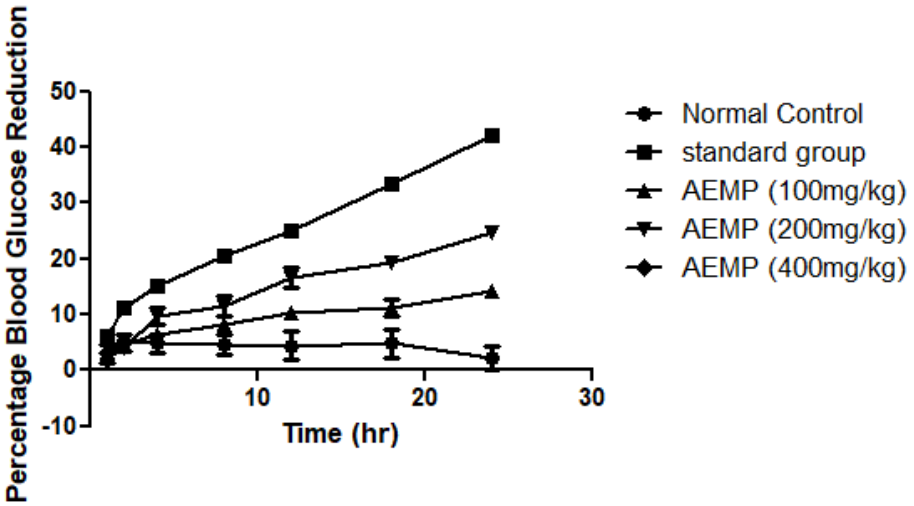

Fig no 01: Effect of alcoholic extract of *Musa sapientum* flowers on fasting blood glucose levels in normal rats

4.1.2 Effect of *Musa sapientum* flower on fasting blood glucose levels in diabetic rats

Ethanolic extract of *Musa sapientum* does not exhibited a significant dose dependent antidiabetic activity on single dose treatment; hence rats were treated with the extracts for 7 days. Since the hypoglycemic effect of alcoholic extract at 400 mg/kg was found nearer to the reference standard glibenclamide. So we selected this dose for

its antidiabetic assessment. Ethanolic extract was subjected for anti-diabetic activity in streptozotocin (STZ) used induced diabetic rats. The results are shown graphically represented in Fig. No. 02

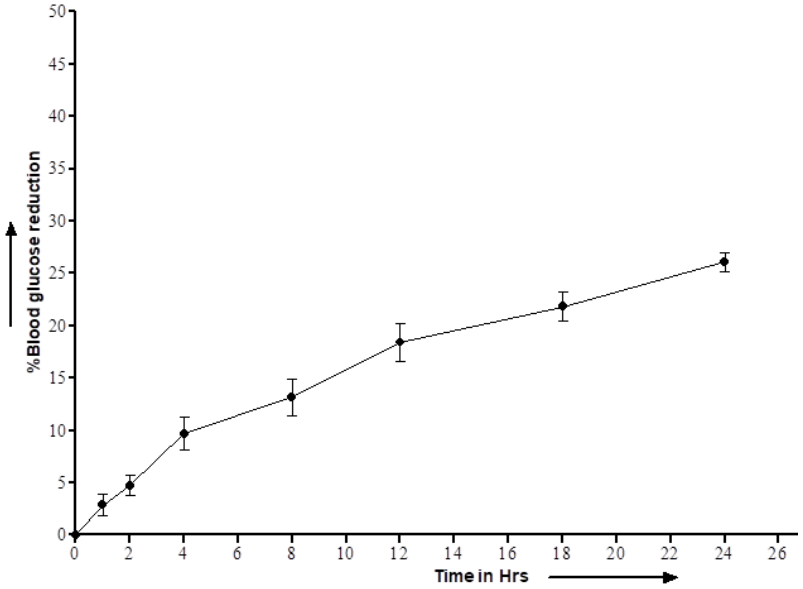

Fig no 2: Effect of *Musa sapientum* flower on fasting blood glucose levels in diabetic rats

4.2 Morphological study

4.2.1 Effect of different extracts of *Musa sapientum* flower on body weight in diabetic rats

Diabetic rats showed significant reduction in their body weight. STZ caused body weight reduction, which was significantly reversed by the both alcoholic extract at the dose of 400 mg/kg. Results are shown in table no 01.

4.2.2 Effect of different extracts of *Musa sapientum* flower on water consumption in diabetic rats

Diabetic rats showed significant increase in their water consumption. Reduction in water consumption was significantly reversed by the alcoholic extract at the dose of 400 mg/kg. Results are shown in Table No. 02

4.2.3 Effect of different extracts of *Musa sapientum* flower on food consumption in diabetic rats

Diabetic rats showed significant increase in their food consumption. Increase in food intake was significantly reversed by the both alcoholic and aqueous extract at the dose of 400 mg/kg. Results are shown in table no. 03

Table No 01: Effect of different extracts of *Musa sapientum* flower on body weight in diabetic rats

S. No	Group (n=6)	Body weight	
		Initial (At start of treatment)	Final (After treatment)
1.	Normal	143.27±0.56	170.23±0.80
2.	Diabetic (STZ)	144.24±0.40	128.10±0.72
3.	STZ + Glibenclamide	133.01±0.63	155.23±1.33*
4.	STZ + Alcoholic extract	145.33±4.01	133.27±1.33*

Table no 02: Effect of different extracts of *Musa sapientum* flower on water consumption in diabetic rats

Water intake by rat(ml)							
GROUP	**1st day**	**2nd day**	**3rd day**	**4th day**	**5th day**	**6th day**	**7th day**
Normal	15.57	17.67	16.00	18.67	19.33	18.05	19.33
Diabetic (STZ)	15.20	19.83	26.00	31.17	32.67	36.00	39.23
STZ +Glibenclamide	14.52	17.67	17.67	19.33	20.33	20.67	20.27
STZ+Alcoholic ext.	15.27	18.32	20.17	21.00	23.54	22.67	26.00

Table no 03: Effect of different extracts of *Musa sapientum* flower on food consumption in diabetic rats

Food intake by rat (gm)							
GROUP	**1st day**	**2nd day**	**3rd day**	**4th day**	**5th day**	**6th day**	**7th day**
Normal	31.02	31.33	31.00	30.16	31.16	29.31	24.33
Diabetic (STZ)	33.32	37.31	41.00	42.66	42.83	45.67	49.33
STZ + Glibenclamide	35.22	35.82	36.00	34.20	35.20	32.23	35.33
STZ + Alcoholic extract	32.62	31.82	32.67	32.47	30.15	31.40	36.33

5.0 Discussion

In this research, the focus was on exploring the potential antidiabetic effects of the *Musa sapientum* flower, commonly known as the banana flower. The study specifically examined its impact on diabetes induced by streptozotocin, a compound widely used to induce diabetes in animal models due to its ability to specifically target and impair pancreatic beta cells. These cells are responsible for insulin production, leading to a condition characterized by insulin deficiency and elevated blood glucose levels akin to type 1 diabetes in humans (28)

The study's outcomes unveiled noteworthy antidiabetic attributes linked to the *Musa sapientum* flower. The group of subjects treated with the extract from the banana flower displayed a significant reduction in their blood glucose levels when compared to the untreated group of diabetic animals. This decline in blood glucose levels hints at the potential of the extract to enhance glucose utilization or stimulate insulin secretion, both of which are vital factors in managing diabetes (29).

Furthermore, the positive shift in glycemic control was underscored by the notable rise in insulin levels within the treated cohort. This finding hints at the potential of the *Musa sapientum* flower extract to positively influence the function of pancreatic beta cells, responsible for insulin production. This could hold promising implications for managing diabetes mellitus (30).

Beyond its antidiabetic attributes, the flower extract has also demonstrated potential antioxidant properties, evident from the reduction in malondialdehyde (MDA) levels. Given the pivotal role of oxidative stress in diabetes development, the extract's capacity to neutralize free radicals and mitigate oxidative damage is likely contributing to its antidiabetic efficacy (31).

Additionally, the treated group exhibited a marked improvement in body weight compared to the untreated diabetic group. It's worth noting that diabetes often leads to weight loss due to increased degradation of fats and proteins. The observed enhancement in body weight suggests that the *Musa sapientum* flower extract might exert a safeguarding effect against tissue wasting, potentially achieved by enhancing nutrient utilization (32).

Furthermore, the study delved into the safety aspect of the banana flower extract. Notably, no adverse effects or toxicities were detected at the doses administered, signifying a favorable safety profile. This critical information holds

significance in evaluating the extract's potential for therapeutic application in individuals with diabetes.

In summary, the study's outcomes provide substantial backing for the traditional utilization of Musa sapientum flowers in the management of diabetes mellitus. However, a deeper exploration is required to unravel the precise mechanisms underpinning its antidiabetic effects. Moreover, extended investigations involving prolonged animal studies and clinical trials with human participants are imperative to establish both its effectiveness and safety for use in individuals with diabetes.

6.0 Conclusion

The current study offers compelling indications of the antidiabetic potential inherent in the *Musa sapientum* flower extract within the context of streptozotocin-induced diabetes mellitus. Its demonstrated capabilities in reducing blood glucose levels, augmenting insulin secretion, and displaying antioxidant attributes position it as a promising contender for the advancement of complementary and alternative medicinal approaches in diabetes management. However, it is imperative to underscore that further in-depth investigations are essential to substantiate these findings and delve into the extract's viability as a therapeutic agent for individuals dealing with diabetes.

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