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Research Article

Antidiabetic Activity and Protective Effect on the Survival of *Raphia Sese* De Wild Fruit Pulp in Diabetic Mice: An In-Vivo Experimental Study

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ABSTRACT

Diabetes mellitus is a serious public health problem, especially in the developing world where access to treatments, particularly conventional treatments, is limited. Consequently, the use of medicinal plants promotes health in this context, where traditional medicine is an attractive alternative in the therapeutic field. The objective of this study is to evaluate the antidiabetic activity and effect on survival of the fruit pulp extract of Raphia sese De Wild in diabetic mice. Diabetes was induced by alloxan monohydrate in Swiss albino mice. The animals were divided into a negative control group using the solvent, a positive control group using glibenclamide (reference drug), and three groups using the fruit pulp extract of Raphia sese De Wild (250 mg/kg, 500 mg/kg, and 1000 mg/kg). The treatment was administered orally for 10 days. Blood glucose levels were recorded in the fasting state (D0, D3, D6, and D10). Animal survival was monitored around the clock and evaluated using the Kaplan-Meier method (E. L. Kaplan & P. Meier, 1958). Differences between groups were compared using the log-rank test. The results showed a statistically significant decrease in blood glucose levels following ingestion of the pulp extract under study, particularly at doses of 500 and 1000 mg/kg, respectively. Survival analysis also reported a significant increase in the probability of survival in these same groups. The glibenclamide group also showed improvement, although to a comparatively lesser extent than those treated with high doses of the extract. In conclusion, the pulp extract studied demonstrated significant antidiabetic activity and a protective effect on the survival of diabetic mice, suggesting

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promising therapeutic potential.

INTRODUCTION

Diabetes mellitus is currently a major global public health problem. According to the International Diabetes Federation, more than 500 million people live with diabetes, and this number is expected to continue to rise significantly in the coming decades. Type 2 diabetes, which accounts for approximately 90% of cases, is characterized by chronic hyperglycemia resulting from insulin resistance and/or insufficient insulin secretion (World Health Organization, 2023).

Despite the availability of effective pharmacological treatments, such as sulfonylureas and insulin, their acceptance remains limited in low- and middle-income countries, particularly in sub-Saharan Africa. Furthermore, the side effects associated with these treatments have led to growing interest in medicinal plants traditionally used in the management of diabetes (E. Adeghate et al., 2006).

Among these plants, the pulp of the fruit of *R. sese* De Wild, widely used in traditional medicine in the Democratic Republic of the Congo, is of particular interest due to its potential nutrional and pharmacological properties. Several studies have shown that plant extract rich in bioactive compounds, such as flavonoids and polyphenols, can exert hypoglycemic effects by improving insulin sensitivity and reducing oxidative stress (M. Bnouham et al., 2006).

In this context, the evaluation of the antidiabetic activity of plant extracts generally relies on animal models, particularly the experimental induction of diabetes using agents such as alloxan or streptozotocin (S. Lenzen, 2008). Furthermore, the analysis of animal survival during the experiment is an important indicator of the toxicity and overall efficacy of the treatment, often assessed using the Kaplan-Meier method (E. L. Kaplan & P. Meier, 1958).

Thus, the present study aims to evaluate the antidiabetic activity of the fruit pulp extract under study in mice induced to become diabetic, as well as to analyze their survival during treatment.

MATERIALS AND METHODS

Study Type and Design

This is an in vivo experimental study conducted on laboratory mice, in accordance with international guidelines for animal experimentation (National Institutes of Health, 2011).

1. Materials

1.1. Animal Subjects

A total of 35 Swiss albino mice, aged 8 to 10 weeks and weighing between 20–30 g, divided equally between males and females, were obtained and used for experimentation at the INRB (National Institute of Biomedical Research in Kinshasa). They were housed in plastic cages lined with wood shavings and topped with a wire mesh cover, which opened to provide access to a water bottle and food. On average, the housing temperature was 22°C, and the photoperiod (day and night/light and darkness) was generally maintained.

Ethical Considerations

The experimental procedures comply with international ethical standards for the use of laboratory animals (National Institutes of Health, 2011). Ethical approval, numbered 87/CBE/ISTM/KIN/RDC/PMBBL/2025, was obtained from the Bioethics Committee of the Institut Supérieur des Techniques Médicales de

Kinshasa (ISTM/Kin), the institution supporting our training.

1.2. Plant Material

The samples of *Raphia sese* De Wild fruit pulp from the town of Gungu (Kwilu Province) used in this study were purchased at the NGABA market in the commune of the same name in the city-province of Kinshasa, DRC. *Raphia sese* De Wild has the nomenclatural number 33138 in the eFlore/ Tela Botanica database published by Emile Laurent in 1905.

The fruit pulp was air-dried at room temperature, then ground into a fine powder using an electric grinder.

Preparation of the plant extract

The fruit pulp of *Raphia sese* De Wild is harvested, dried, and pulverized. Extraction is performed by maceration in a hydroalcoholic solvent (80% ethanol), followed by filtration and evaporation under reduced pressure (J. B. Harborne, 1998).

2. Methods

2.1. Induction of diabetes

Diabetes is induced by intraperitoneal injection of alloxan monohydrate at a dose of 150 mg/kg body weight, followed by administration of 10% sugar water. This is done after subjecting the animals to a 16-hour fast (S. Lenzen, 2008).

After 72 hours, mice with blood glucose levels ≥ 140 mg/dl are considered diabetic and selected for the study.

2.2. Distribution of Experimental Groups

The animals were divided into 5 cages of 7 animals each with the following classification:

- Cage I: *Raphia sese* De Wild extracts at a dose of 250 mg/kg body weight
- Cage II: Positive controls, receiving Glibenclamide (reference drug)
- Cage III: *Raphia sese* De Wild extracts at a dose of 500 mg/kg body weight
- Cage IV: *Raphia sese* De Wild extract at a dose of 1000 mg/kg body weight
- Cage V: Negative controls, receiving the solvent (20% methanol)

2.3. Administration of Treatments

Treatments were administered orally for 7 days.

2.4. Monitoring of study parameters

1. Blood glucose

Blood glucose is measured at regular intervals (D0, D3, D7, and D10) using the “CodeFree” glucometer (American Diabetes Association, 2022).

2. Survival test

Animal survival is monitored daily throughout the experiment. Analysis is performed using the Kaplan-Meier method (E. L. Kaplan & P. Meier, 1958), which estimates the probability of survival as a function of time. Differences between groups are compared using the log-rank test.

Statistical Analysis

Data are expressed as mean ± standard deviation. Statistical analysis is performed using SPSS software

- ANOVA test

- Significance threshold: $p < 0.05$

RESULTS

1. Blood glucose results

Table I: Mean changes in blood glucose levels

Cages	Day 0 (fasting)	Day 3	D6	D10
250 mg/kg	83.3 ± 34.0	179.7 ± 181.0	311 ± 181	120 ± 0
Glibenclamide (Controls +)	83.4 ± 25.0	306 ± 142	132±45	152 ± 28
500 mg/kg	106.0 ± 38.0	267.0 ± 140	249 ± 140	120 ± 21
1000 mg/kg	103.7 ± 34.0	147.7 ± 28	134.4 ± 9	110.0 ± 7
Solvent (Controls -)	117.1 ± 45.0	192.6 ± 138	241 ± 204	167± 139

In this table, we can observe the following:

- at a dose of 1000 mg/kg, blood glucose levels decrease steadily and consistently, reaching near-normal values by day 10. This observation indicates a dose-dependent effect.
- The group treated with glibenclamide (standard reference) also showed a decrease in blood glucose levels.
- significant variability in blood glucose levels in certain groups, particularly at the low dose (250 mg/kg) and in the negative control group.
- The negative control group showed persistently elevated blood glucose levels.

The pulp extract under study demonstrated remarkable antidiabetic activity, characterized by a gradual reduction in blood glucose levels, particularly at doses of 500 and 1000 mg/kg. The hypoglycemic effect becomes significant starting on the 6th day and is comparable to that of the glibenclamide- . These results suggest that the extract has promising therapeutic potential in the management of diabetes.

2. Survival test results

Table II: Distribution of mice, taking into account numbers and deaths

Groups	Total number	Deaths	Survival (%)
250 mg/kg	7	6	14.3%
Glibenclamide (Controls +)	7	4	42.9%
500 mg/kg	7	2	71.4%
1000 mg/kg	7	2	71.4%
Solvent (Controls -)	7	3	57.1%

Survival analysis using the Kaplan-Meier method (E. L. Kaplan & P. Meier, 1958) showed a significant improvement in survival among mice treated with the pulp extract under study compared to the negative control group.

The groups receiving doses of 500 mg/kg and 1000 mg/kg had the highest survival probabilities, suggesting a dose-dependent protective effect. The group treated with glibenclamide also showed improved survival, but to a lesser extent than that observed with the high doses of the extract.

In contrast, the negative control group showed a rapid decline in survival, confirming the severity of untreated diabetes.

Survival analysis shows a significant improvement in survival rates in mice treated with the fruit pulp extract under study, particularly at doses of 500

and 1000 mg/kg. This observation suggests a protective effect of the extract against diabetic complications.

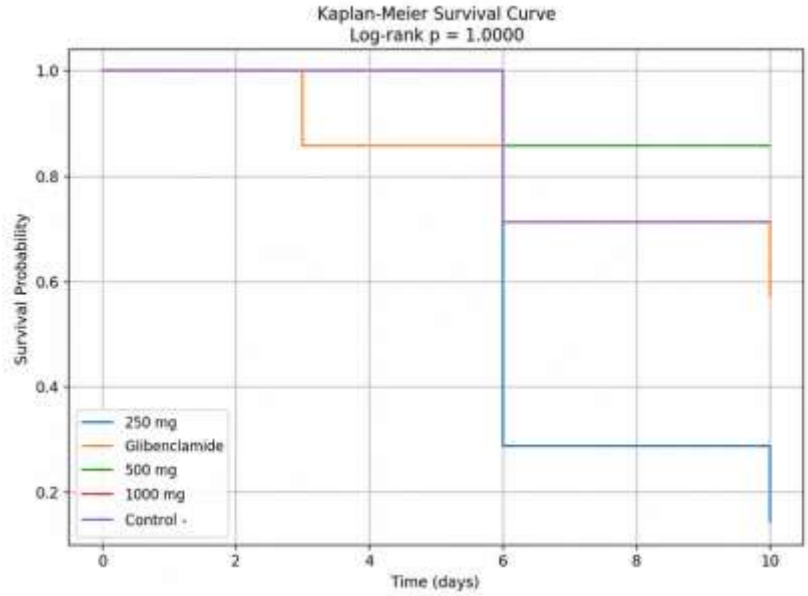


Figure I: Kaplan-Meier survival curves for diabetic mice treated with different doses of the pulp extract from the fruit of *R. sese* De Wild, compared to glibenclamide and solvent.

The use of the Log-rank test on the Kaplan-Meier curves allowed for a comparison of survival rates among different groups in the experiment. These results indicate a statistically significant difference between the groups ($p < 0.005$), with better survival observed when the treatment dose was 500 mg/kg and when a dose of 1000 mg/kg was administered.

Furthermore, overall survival differed between the groups, and a statistically significant difference was observed in the groups that received the pulp extract under study (particularly at doses of 500 mg/kg and 1000 mg/kg). On the other hand, the negative control group showed a rapid decline in survival.

These results indicate that there is a dose-dependent protective effect of the extract on the survival of diabetic mice.

- 1000 mg → better survival.
- 500 mg → very good survival.
- Glibenclamide → intermediate.
- 250 mg → low survival.
- Negative control → high mortality.

DISCUSSION

The objective of the study was to evaluate the antidiabetic activity and survival of the fruit pulp extract of R. *sese* De Wild in mice made diabetic by alloxan. The results showed a significant improvement in blood glucose levels with prolonged survival, particularly at 500 mg/kg and 1000 mg/kg.

1. The extract's effect on blood glucose levels.

The results also reveal a gradual decrease in blood glucose levels in treated mice, particularly at high doses. Bioactive compounds such as flavonoids,

tannins, and polyphenols possess antidiabetic activity that may explain these results.

These observations are consistent with those of M. Bnouham et al. (2006), who found that several medicinal plants improve insulin sensitivity and stimulate insulin secretion, demonstrating hypoglycemic activity.

Furthermore, E. Adeghate et al. (2006) reported that certain plant extracts can affect hepatic glucose production and its peripheral utilization.

The results of the present study showed that a dose of 1000 mg/kg of the pulp extract under study leads to a greater reduction in blood glucose levels, indicating a dose-dependent effect, supporting F. Mushagalusa Kasali et al. (2021), who confirmed the efficacy of several antidiabetic plants in the Democratic Republic of the Congo.

2. Experimental diabetes model.

The use of alloxan to induce diabetes is based on its ability to selectively target β-cells of the islets of Langerhans, leading to insulin deficiency.

Alloxan causes severe oxidative stress and necrosis of pancreatic cells, S. Lenzen (2008). Consequently, the results observed in treated animals can be attributed in part to an antioxidant effect of the plant extract.

The aforementioned processes have also been reported by Wang-Fischer and Garyantes (2018), highlighting the relevance of animal models for the development of antidiabetic therapeutic approaches.

3. Survival analysis.

Survival analysis using the methods of E. L. Kaplan and P. Meier (1958) showed significant increases in survival in the groups that received the studied pulp extract, especially at higher doses.

The high mortality rate in the negative control group further confirms the severity of untreated diabetes, which is consistent with the observations of D. G. Altman (1991), who stated that uncontrolled chronic diseases lead to a sharp decline in survival.

The results also indicate that survival is better in the groups receiving the extract than in those receiving glibenclamide, suggesting a general protective effect, possibly associated with a combined hypoglycemic and antioxidant effect.

4. Comparison with glibenclamide.

Glibenclamide, the reference drug, acts by stimulating insulin secretion from pancreatic β-cells.

Thus, in this study, there were moderate benefits related to blood glucose levels and survival. However, high doses of the pulp extract studied appear to offer similar, if not superior, efficacy, confirming the conclusion of various studies that have found that certain medicinal plants can rival conventional drugs (M. Bnouham et al., 2010).

5. The Importance of Medicinal Plants in Diabetes Management.

In developing countries, particularly in Africa, the use of medicinal plants remains widespread. According to Heinrich et al. (2020), more than 80% of the population relies on traditional medicine for their primary healthcare.

Overall, these results reveal that the pulp extract under study has a high level of antidiabetic activity and increases the survival rate of diabetic mice. This effect appears to be dose-dependent and comparable to, or even better than, that observed

with glibenclamide. These results suggest the potential for utilizing local resources, including the pulp extracted from the *R. sese* De Wild fruit, in diabetes management.

CONCLUSION

The objective of this study was to evaluate the antidiabetic activity and survival effects of the pulp extract from the fruit of *R. sese* De Wild in mice rendered diabetic by alloxan.

The test results indicate a reduction in blood glucose levels and a survival benefit for the treated animals, particularly at doses of 500 mg/kg and 1000 mg/kg.

The Log-rank test was performed on the Kaplan-Meier curves, allowing for a comparison of survival rates among the different experimental groups. The test results indicated a statistically significant difference in treatment outcomes across the groups ($p < 0,05$) and improved survival with the 500 mg/kg doses. These results support an overall favorable effect, likely associated with the hypoglycemic and antioxydant actions of the plant-derived bioactive compounds.

Furthermore, the effect appears to be dose-dependent in that higher doses (500 mg/kg and 1000 mg/kg) are more effective, comparable, or even superior to glibenclamide as a therapeutic reference.

Consequently, the pulp studied is a viable medicinal or phytotherapeutic substance for diabetes, especially in settings where conventional medications are scarce.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

Data are available upon request.

AUTHOR CONTRIBUTIONS :

- KODONDI KULE-KOTO FRIDOLIN : Study conception and general superviion.
- BALOWA TSHIBUABUA CLEMENCE : Data collection and final drafting.
- BALOW'A KALONJI KAMUNA IGNACE : Statistical analysis and structural organization of the work.
- MUSUYU MUGANZA DESIRE : Methodology

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