Original Research Article

PRELIMINARY ANTIDIABETIC POTENTIAL OF UGANDAN- *MATOOKE* (*MUSA PARADISIACAL*) PEELS

ABSTRACT

BACKGROUND: Diabetes mellitus is a metabolic disease characterized by hyperglycaemia over a prolonged period. In Uganda, unripe *Musa paradisiaca* (banana) is a staple food which is deskinned before cooking. In West Africa, however, the unpeeled banana is cooked for diabetics.

AIM: The objective of the study was to assess the hypoglycemic and body weight changes in experimental diabetic Wistar rats treated with green banana peel extracts.

METHODOLOGY: Thirty male rats were used for the study and divided into six groups of 5 rats in each group. Experimental diabetes mellitus was induced with alloxan and treated with insulin, normal saline and graded doses of the extract (1000 mg/kg, 2000 mg/kg and 4000 mg/kg body weight) for two weeks. The weight and blood glucose levels were measured before and after induction and prior to administration of treatment dosages. Data were analyzed using SPSS Version 20. ANOVA and spearman's rank correlation tests determined significant changes in values at 95% confidence interval.

RESULTS: The rats showed no signs of toxicity up to a dose of 10,000 mg/kg. Phytochemical screening revealed saponins, tannins, phenols, flavonoids, cardiac glycoside, alkaloids, steroids and terpenoids. This study demonstrates that *Musa paradisiaca* peels significantly attenuated blood glucose levels ($P < 0.005$) and regulated body weights at doses (≥ 2000 mg/kg) which are essential parameters in the management of diabetes mellitus. **CONCLUSION:** In line with the findings, unripe banana peels are anti-diabetic; unripe bananas therefore, should be cooked with the skins to derive its established anti-diabetic benefits.

Keywords: Diabetes mellitus, Musa paradisiaca, Matooke peels, medicinal plants, phytochemicals

1. INTRODUCTION

About 442 million people worldwide have diabetes mellitus WHO (2016) [1]. Africa is undergoing a rapid demographic transition with the burden of non-communicable diseases, especially diabetes, that will further overload the health care systems already challenged by HIV/AIDS and Malaria. All these are due to rapid urbanization and the attendant changes in lifestyle, rapidly decreasing physical activity, nutrition and ageing of the population. Diabetes mellitus (DM), also known as diabetes, is a group of metabolic diseases which manifest as high blood sugar levels. DM presents with inadequate insulin production, or body cells do not respond appropriately to the insulin, or both, affecting multiple systems in the process [2]. Symptoms of high blood glucose include frequent urination, increased thirst and increased hunger. If left untreated, diabetes can lead to many complications [3]. Acute complications include diabetic ketoacidosis and non-ketotic hyperosmolar coma. Grave long-term complications include cardiovascular disease, stroke, chronic kidney failure, foot ulcers and damage to the eyes [4,5].

About 25 million African adults are estimated to have diabetes [1]. In Uganda, DM prevalence varies between 90.9% [6] and 31% [7]). Bearing in mind that there is no completely effective treatment available for DM, majority of communities in sub-Saharan Africa have adopted the use of ethnomedicinal plants for the management of clinical complications associated with the disease [8]. Studies show that members of the *Musaceae* family have significant potentials in managing diabetes.

The family also alleviates the toxic effects of carbon tetrachloride in animals as well as a profound in vitro and in vivo anthelmintic activity [9, 10]. Different parts of the banana plant have been demonstrated to possess detectable antidiabetic activity. These have included fruits, leaves, roots and even flowers [11, 12], leading to the speculation about the banana peels which are usually removed before cooking bananas in the preparation of *Matooke,* a Ugandan staple.

2. MATERIALS AND METHODS

2.1 *Collection of* Plant Material and the Extraction Method*:* The bananas were collected from a single plant of the common East African Highland Cultivar of *Musa paradisiaca* in a farm at Ishaka Bushenyi, Uganda. Preparation of green banana peel extract was done according to previous work [13] with minor modifications. After harvesting the green banana, it was peeled and the peels were air dried on a laboratory bench for 1 week. The dried banana peels (100grams) in 1000 ml of water were boiled for 20 minutes and blended for five minutes on cooling. The resultant solution was then filtered with sterile wire gauze to remove the fibers. Subsequent filtration was carried out using Watman No.1 filter paper. The extract was poured into a weighed glass beaker and evaporated at 100^{o}C in a water bath to obtain a semi-solid crude extract which was further dried in an oven at 60°C.

2.2 Animals

The study was carried out in the Pharmacology and Biochemistry laboratories of the School of Health Sciences, Kampala International University, Western Campus Ishaka. The animals were obtained from the animal housing facility of the School of Pharmacy, Kampala International University. They were fed standard animal pellets and given water *ad libitum*.

***2.2.1 Sampling* technique:** The experimental animals were acclimatized for seven days before the commencement of the experiment and randomly placed in groups and appropriate labels were used to identify the animals.

2.2.2 Inclusion/Exclusion Criteria*:* Mature male Wistar rats weighing above 100g were used in the study; while rats weighing less than 100g ware excluded.

***2.3* Phytochemical analysis**

The phytochemical analysis of the extract of *Musa paradisiacal* peels was carried out to identify the phytochemical constituents present in the extract. Tests were carried out using standard methods [14].

***2.4* Determination of Acute toxicity**

The acute toxicity of the aqueous extract of the green banana was determined by using 9 Wister rats as described by [15]. The animals were fasted for 24 hours prior to experiment. Animals were weighed and labelled with different body marks. Nine animals were grouped into three and a different dose was administered to each group.

2000mg/kg, 4000mg/kg and 10000mg/kg doses were used in the study.

The corresponding volume to administer was calculated using the formula:

$$\frac{\text{(Body weight x dose)}}{\text{Concentration x 1000}}$$

The animals were observed for signs of toxicity after 3 hours and 24 hours respectively.

2.5 Induction of Experimental Diabetes

Rats were weighed, marked and fasted for 12 hours. Afterwards, diabetes was induced by a single intraperitoneal administration of alloxan monohydrate (140mg/kg) with 4% saline solution (an average

of 0.90 mL per test animal). Before the administration of alloxan, a base line glycaemia was recorded from blood collected by tail vein puncture of each rat.

After 3 days, the rats' blood glucose levels were determined by testing them with diabetes test strips and glucometer (OnCall®). Rats with blood glucose above 200mg/dl (7.0 mMols) were considered diabetic and selected for the study. One group of the rats to which alloxan was not administered served as normal control. Insulin treatment (10 U) was used as reference point.

2.6 Treatment

The animals were randomized into 6 groups, each group consisting of 5 test animals [15] as follows;

Group I: Non-diabetic rats received distilled water (DW) (10ml/kg) served as normal control group.

Group II: Diabetic rats received DW (10ml/kg) served as diabetic control group.

Group III: Diabetic rats received aqueous extract of banana peel at a dose of 1000mg/kg

Group IV: Diabetic rats received aqueous extract of banana peel at a dose of 2000mg/kg

Group V: Diabetic rats received aqueous extract of banana peel at the dose of 4000mg/kg

Group VI: Diabetic rats received insulin at dose of 10 U/kg as a control reference.

Administration of distilled water (DW), peel extract and insulin was done daily before feeding the animals while the final blood sugar was measured after two weeks.

2.7 Data analysis

Data was transferred into MS Excel spreadsheet version 20, analysed and information expressed as mean ± SD at 95% confidence interval. Effects of treatment on blood glucose and body weight was analysed using SPSS Version 20 and the results was expressed as mean ± SD. Comparisons were carried out using ANOVA to determine dosage groups that are important in causing changes in T1DM Wistar rats. Significance was set at $P \leq 0.05$. Correlation analysis was conducted on body weight and blood

glucose levels to determine the level of relationship and a spearman's correlation test was done at 95% confidence interval.

3 RESULTS AND OBSERVATIONS

3.1 Phytochemical analysis showed the presence of important secondary metabolites (**Table.1**).

Table1. Phytochemicals present in the aqueous extract of green banana peels

Saponnins	+
Tannins	+
Phenols	+
Flavonoids	+
Cardiac glycosides	+
Alkaloids	+
Steroids	Trace
Terpenoids	+
Phlobatannins	-
Anthraquinone	-

3.2 Body weights and serum blood glucose levels in treatment groups

The results showed that the mean body weight was 143.48-157.27g in the extract treatment groups. Insulin treated group had a mean body weight of152.96 ± 5.99 g. The mean serum blood glucose levels in the insulin treated group was 11.25 ± 1.18 mMol/dl while in the extract treatment group, they were in the range of 10.12-10.58 mMol/dl at 95% confidence interval as shown in **Table.2**

Table 2: Body weight and glucose levels in treatment groups

Treatment	N	Body weight	Serum blood glucose levels(mMol/L)

groups		Mean ±	SD	95% CI LL	UL	Mean ±	SD	95% CI LL	UL
Insulin (10 U)	5	152.96	5.99	151.96	153.96	11.25	1.18	10.252	12.248
Control	5	150.42	16.78	149.33	151.51	4.41	0.44	3.317	5.503
1000 mg/kg	5	147.54	41.86	146.54	148.54	11.69	3.31	10.69	12.69
2000 mg/kg	5	157.27	9.61	156.27	158.26	11.12	3.9	10.12	12.11
4000 mg/kg	5	143.48	20.2	142.49	144.48	10.58	4.3	6.1	17.0
DW (10 mg/kg)	5	151.25	75.3	150.03	152.47	13.4	8.3	11.2	15.6

KEY: DW = Distilled water. IU = international units. N = sample size. SD = Standard deviation. CI = confidence interval. LL= Lower limit. UL= Upper limit

Table 3: showing descriptive statistics in body weight and serum glucose levels after two weeks.

Variables	N	Mean	SD	95% Confidence Interval LL	UL
Blood glucose (mMol/dl)	30	10.97	4.561	10.54	11.40
Body weight (g)	30	148.13	28.38	147.70	148.56

KEY: SD = Standard deviation; N = number. LL/UL = Lower/Upper limit.

Pearson correlation = -0.385 with a *P = 0.030*. Spearman's correlation coefficient = -.412. *P = 0.019.*

4. Discussion

The acute toxicity study showed no signs of toxicity such as salivation, diarrhoea, depression, stimulation, vomiting, and coma, and there was no mortality observed up to a dose of 10000mg/kg. The extract proved to be safe for short term administration**.** However, a chronic toxicity study will be appropriate to see any cumulative tissue or organ impairment.

From the study, in the diabetic groups the mean body weights are above 140 kg while the mean blood glucose levels are above 11 mMol/dl. Control of hyperglycemia in diabetes sometimes results in weight gain and hypoglycemia, which is in agreement with a previous study [16]. This would be the primary underlying factor as to why there is a general global weight gain amongst DM patients [17]. The study further showed moderate weight gains in the treatment groups on the extract, which confirms the previously held opinion that vegetable diets protect against weight gain in DM [18]. Showing that understanding the physiology of weight gain in the management of T1DM is crucial to gain the desired therapeutic outcome since weight gain is strongly associated with increased risk for DM [19]. Moreover, excessive weight gain is a major contributory factor to poor glycemic control in DM, thus showing the need to have therapeutic options which effectively control it [20].

The study also demonstrated that serum blood glucose levels are in the range of 11.12-12.57 mMol/dl in groups treated with banana peels. Similar results were shown in the Insulin treatment group (11.25 ± 10.2mMol/dl), justifying the hypoglycemic effect of *Musa paradisiaca* peels. A previous study has demonstrated the hypoglycemic effect of the flesh of the green fruit [12]. This study has been able to demonstrate that *Musa paradisiaca* peels have a potent hypoglycemic effect at relatively higher doses. Since, relatively, no effect had been seen in a previous study (primary communication) and the complete survival of the test animals would be due to its potent antioxidant properties [21]. The phytochemical analysis shows that *Musa paradisiaca* has high levels of alkaloids, glycosides, steroids, saponins, tannins, flavonoids and terpenoids. It also contains DPPH (1, 1-diphenyl-2-picrylhydrazyl) a free radical scavenger [22].

Bearing in mind that T1DM has no ideal therapeutic option, the study has been able to provide a scientific argument for the use of banana peels in the management of DM in rural communities that consume plenty of bananas [8]. It is worthy of note that the treatment groups were highly effective at higher dosages (Treatment > 200 mg/kg; $P \leq 0.05$). This condition would subsequently play a crucial role in reducing the estimated global and national burden of DM over time [5]. Hence would inevitably reduce the healthcare burden, thus saving the central government much money in procuring drugs and above all, reducing the rate of development of insulin resistance in the DM population [23].

The 4000 mg/kg had a more potent hypoglycemic effect than the 2000 mg/kg which may be attributable to the relatively higher concentration of the phytochemicals in the extract. Impressively, no toxicological effects were associated with the high dosage (primary observations), which we found to be interesting. Unlike other ethno medicinal plants being used on the continent to manage DM [24], it appears *that Musa paradisiaca* is a leading candidate with minimal side effects [10]. However, we cannot be oblivious of systemic complications and pathologies since we did not conduct organ biochemical and histological tissue analysis. Further histopathological studies on these will be imperative.

Weight changes

In all the experimental groups, there were no significant differences ($P > 0.05$) in weight after fourteen days as when compared to the mean body weights on day 0 thus showing an efficient modulation of weight change with banana peels. This finding supports the findings of previous studies that *Musa paradisiaca* has strong antidiabetic properties [22] and efficient in the management of body weight in DM. The preceding shows that *Musa paradisiaca* has additional pharmaceutical advantages over insulin and other medications, with weight gain implications [16]. Moreover, the study showed that 2000 mg/kg and 4000 mg/kg managed to maintain the body weights effectively, thus showing that the banana peel is a potential candidate for further drug development studies. More so, banana is

associated with a high rate of cholesterol degradation [25], which is vital for DM patients in the light of cardio-vascular complications associated with DM.

Phytochemicals are found naturally in plants, and they are responsible for colour and organoleptic properties, protection. Previous reports indicated that phytoconstituents in fruits and vegetables may reduce the risk of many diseases, possibly due to dietary fibres, polyphenols, antioxidants, as well as anti-inflammatory and hepato-protective effects [10]. Phytochemical screening of the aqueous extract of the banana peel revealed the presence of some secondary plant metabolites. These include saponins, tannins, phenols, flavonoids, cardiac glycoside, alkaloids, steroids and terpenoids, as shown in table 1. These phytochemicals have shown hypoglycemic effects in previous studies [26].

5. CONCLUSION

In the present study, aqueous extracts of green banana peel efficiently regulated diabetic hyperglycemia and weight gain in male Wister rats at concentrations of 2000 and 4000mg/kg body weight. It therefore, suggests an urgent change in the method of preparing *Matooke* (banana) in Uganda, which involves total peeling before boiling. In the light of the foregoing, we recommend that *Matooke* should be boiled before peeling. This method would allow the natural phytochemicals seep into the fleshy fruit and thus deliver its therapeutic value on consumption. Furthermore, we recommend the isolation of individual phytochemicals to enable possible identification and development of drug candidates.

ETHICAL APPROVAL

Approval for animal studies were obtained from the School of Health Sciences Research Ethics Committee of Kampala International University.

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