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ORIGINAL RESEARCH

Antidiabetic and Hypolipidemic Effects of *Ipomea batata* Fresh Leaves Extract on Alloxan Induced Diabetic Rats

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Abstract:

Introduction: *Ipomea batata* is one of the herbs used in the alternative treatment of diabetes mellitus

Aims: The present study was designed to investigate the antidiabetic and hypolipidemic effects of aqueous extract of *Ipomea batata* aerial part in normal and alloxan diabetic rats.

Materials and Methods: 20 three-month-old male Wistar albino rats weighing 160-200g were obtained from the animal house of the laboratory of the Department of Biochemistry, Lagos State University, Ojo. All animals were kept in an environmentally controlled room with a 12h light/12h dark cycle. The animals had free access to water and rat chow. 15 out of it were injected alloxan monohydrate dissolved in sterile normal saline at a dose of 150 mg/kg body weight, intraperitoneally. (15 diabetic surviving rats, 5 normal rats) were used. Diabetes was induced in rats 2 weeks before commencement of treatment. The rats were divided into 4 groups as follows after the induction of diabetes and each group consisted of 5 rats. Group A (normal rats), Group B (Diabetic untreated rats) Group C (Diabetic and treated with 150 mg/kg body weight of extract Group D (Diabetic rats given Tolbutamide orally at 80mg/kg body weight daily for 2 weeks) After which the animals were sacrificed and blood drawn for biochemical analysis.

Results: The treatment with *Ipomea batata* caused significant reduction ($P<0.001$) in fasting plasma glucose levels in the diabetic treated rats compared with the diabetic untreated rats. There was a significant ($P<0.05$) lowering of serum total cholesterol, triglycerides, ($P<0.001$) Low Density Lipoprotein cholesterol, Total Cholesterol /High Density Lipoprotein Cholesterol as well as significant ($P<0.001$) elevation of High-Density Lipoprotein Cholesterol in the treated diabetic group.

Conclusion: These results suggest that the *Ipomea batata* leaves extract possess antidiabetic and hypolipidemic effects in alloxan-induced diabetic rats.

To Keywords: *Ipomea batata*, Diabetes mellitus, Antidiabetic, Hypolipidemic, Total Cholesterol

All co-authors agreed to have their names listed as authors.

1. INTRODUCTION

Diabetes mellitus is a disease or disorder of carbohydrate, fats and protein metabolism attributed to insufficient action of the insulin owing either to its absence or to resistance to its action [1]. Chronic hyperglyceamia (i.e. high level of sugar in blood stream) during diabetes causes glycation of the body protein that in turns leads to secondary complications affecting eyes, kidneys, nerves and arteries [2]. It is also associated with microvascular and macrovascular complications which are the major causes of morbidity and death in diabetes subject [3].

The daily rise in the number of people suffering from this disease worldwide is highly alarming and thus given much attention as a result of the 578 million and 700 million people projected to be affected by 2030 and 2045, respectively [4]. However, there is an increased focus on plants in the search for appropriate hypoglycemic or anti hyperglycemic agents. The WHO has recommended and encouraged the use of alternative therapy, especially in countries where access to the conventional treatment of disease is not adequate [5, 6].

Ipomea batata plant is an herbaceous perennial vine with alternate heart-shaped lobed leaves and medium sized flower. The root is edible and is often long and tapered. The skin may be red, purple or brown and white in color. The interior or flesh may be white yellow, orange or purple [7, 8]. The plant has been used medicinally in different parts of the world for the treatment of diabetes and weight loss which is also related to diabetes [9]. The leaves of sweet potato are bitter in taste and possess anti-diabetic activity by lowering blood sugar [10]. Researchers have long been interested in finding safer and more effective natural hypoglycemic drugs given that the Yoruba people in the Western States of Nigeria have traditionally used the leaves of medicinal herbs to lower blood pressure [11]. It is in this light that this study was designed to investigate the anti-diabetic and hypolipidemic efficacy of *Ipomea batata* aerial part extract.

2. MATERIALS AND METHODS

2.1 COLLECTION OF PLANT MATERIALS

The aerial part (leaves and stem) of *ipomea batata* were collected in May and June 2008, in Sabo-Yaba market in Lagos State, and identified at the Lagos State University, Department of Botany where a voucher LSU/1401204 sample had been deposited.

2.2 PREPARATION OF EXTRACT

The fresh plant material was air-dried for 4weeks at room temperature and ground into powder. The plant powder (500g) was decocted in 4Litres of distilled water for 24hours. This was repeated four times, until the resulting extract gave no further coloration. The extract was then filtered using a sieve mesh and evaporated to dryness in water bath (Lambfeild Medical, DK 420) at 40°C, to obtain 100g of crude residue (yield: 20%).

2.3 EXPERIMENTAL INDUCTION OF DIABETES IN RATS

Three-month-old male Wistar albino rats weighing 160-200g were obtained from the animal house of the laboratory of the Department of Biochemistry, Lagos State University, Ojo. All animals were kept in an environmentally controlled room with a 12h light/12h dark cycle. The animals had free access to water and rat chow. The rats were injected alloxan monohydrate dissolved in sterile normal saline at a dose of 150 mg/kg body weight, intraperitoneally. Since alloxan is capable of producing fatal hypoglycaemia as a result of massive pancreatic insulin release, rats were treated with 20% glucose solution intraperitoneally after 6h. The rats were then kept for the next 24h on 5% glucose solution bottles in their cages to prevent hypoglycaemia [12]. After a fourth night, rats with marked hyperglycaemia were selected and used for the study.

2.4 EXPERIMENTAL DESIGN

In the experiment a total of 20 rats (15 diabetic surviving rats, 5 normal rats) were used. Diabetes was induced in rats 2 weeks before commencement of treatment. The rats were divided into 4 groups as follows after the induction of diabetes and each group comprised of 5 rats.
Group A (normal rats),
Group B (Diabetic untreated rats)
***Group C (Diabetic and treated with 150 mg/kg body weight* of extract**
***Group D (Diabetic rats given Tolbutamide orally at 80mg/kg body weight* daily for 2 weeks)**.
The animals were carefully monitored every day and weighed every week. Blood samples were drawn at weekly intervals from the animal's tails till the end of study. Fasting blood glucose estimation, body weight, food and water intake measurements were done on day 0, 7 and 14 of the study. On day 14, rats were sacrificed by cervical dislocation under ether anaesthesia. Blood was collected from overnight fasted rats and processed for the estimation of serum glucose and plasma lipids profile.

2.4.1 BIOCHEMICAL ASSESSMENT

Fasting serum glucose was estimated by the glucose oxidase method [13]. Triglycerides (TG), Total Cholesterol (TC), High Density Lipoprotein- Cholesterol (HDL-C) and Low-Density Lipoprotein-Cholesterol (LDL-C) were analyzed by using commercial kits (Pariksha Biotech, Hyderabad, India).

2.5 Statistical analysis.

GraphPad prism 5 was used to analyze data, and expressed as means ± S.E.M. Statistical analysis was made by one-way ANOVA and post hoc Dunnet test, with $P < 0.05$ considered as significantly different.

3. RESULTS AND DISCUSSION

Table 1: Effect of *Ipomea batata* extract on the water intake

Group of rats (n=5)	Average water intake (ml rat^{-1} day^{-1})		
	Day 0	Day 7	Day 14
Normal	16.20±0.42	18.00±0.79	15.00±0.36
Diabetes untreated	77.80±4.16$^{\#}$	87.60±0.76$^{\#}$	79.40±0.28$^{\#}$
Diabetes +Extract	80.80±3.93	74.80±0.42***	48.80±0.65***
Diabetes+Tolbutamide	81.80±0.89	53.20±0.96***	41.20±3.15***

$^{\#}$P<0.001 when compared with Normal rats ***P<0.001 when compared with Diabetic untreated rats

Table 2: Effect of *Ipomea batata* extract treatment on the feed intake of normal and diabetic rats

Group of rats (n=5)	Average feed intake (g rat^{-1} day^{-1})		
	Day 0	Day 7	Day 14
Normal	14.00±0.36	5.60±0.45	15.20±0.23
Diabetes untreated	26.40±1.04$^{\#}$	28.20±0.42$^{\#}$	32.80±0.42$^{\#}$
Diabetes +Extract	27.20±0.42	31.60±0.57	25.20±0.42*
Diabetes+Tolbutamide	28.20±0.74	24.40±0.28	20.90±0.98*

$^{\#}$P<0.001 when compared with Normal rats *P<0.001, when compared with Diabetic untreated rats

Table 3: Effect of *Ipomea batata* extract treatment on the body weight (g) of normal and diabetic rats

Group of rats (n=5)	Average body weight (g)		
	Day 0	Day 7	Day 14
Normal	168.20±3.33	180.00±0.00	186.80±0.36***

Diabetes untreated	176.80±4.29	156.20±0.00	144.40±0.28$^{\#}$
Diabetes +Extract	171.60±4.19	197.00±0.00*	200.40±0.65***
Diabetes+Tolbutamide	169.00±4.47	175.60±0.00	190.80±3.15***

$^{\#}$P<0.05 when compared with Normal rats *P<0.05 ***P<0.001 when compared with Diabetic untreated rats

Table 4: Effect of *ipomea batata* extracts treatment on the serum blood glucose concentration in normal and diabetic rats

Group of rats (n=5)	Average serum glucose (mg/dL)		
	Day 0	Day 7	Day 14
Normal	84.20±2.66	64.60±2.75	59.00±3.47
Diabetes untreated	244.20±9.66$^{\#}$	257.00±8.35$^{\#}$	268.00±5.23$^{\#}$
Diabetes +Extract	247.00±10.40	183.80±3.53***	111.40±7.89***
Diabetes+Tolbutamide	245.00±11.18	162.00±2.72***	114.60±7.83***

$^{\#}$P<0.05 when compared with Normal rats ***P<0.001 when compared with Diabetic untreated rats

Table 5: Effect of *ipomea batata* extracts treatment on the serum lipid profile in normal and diabetic rats

Group of rats (n=5)	Lipid profile (mg/dL)				
	Triglycerides	Total-CHL	HDL-CHL	LDL-CHL	T.C/HDL-CHL
Normal	70.35±6.17	70.35±6.17	51.93±6.03	31.87±3.59	1.38±0.09
Diabetes Untreated	132.62±7.59$^{\#}$	122.66±14.78$^{\#}$	38.10 ±6.03	50.26±1.66$^{\#}$	3.21±0.33$^{\#}$
Diabetes+ Extract	90.56±5.07**	91.04±2.89*	47.02±1.67**	21.74±3.10*	1.76±1.95**
Diabetes+ Tolbutamide	87.54±6.32***	82.43±10.90***	54.24±3.91**	17.53±1.33***	1.51±0.26**

$^{\#}$P<0.05 when compared with Normal rats
*P< 0.05; **P<0.01 and ***P<0.001 when compared with Diabetic untreated rats
T.CHL (Total Cholesterol); HDL-CHL (HDL- Cholesterol); LDL-CHL (LDL- Cholesterol); TC/HDL-CHL (Total-Cholesterol /HD L- Cholesterol); HDL (High density lipoprotein); LDL (Low density lipoprotein)

Alloxan induces diabetes by damaging the insulin secreting cells of the pancreas leading to hyperglycaemia [14]. An observation in this study correlates with the previous research finding which indicate the metabolic aberration caused by alloxan on the diabetic rats[14]. The ability of therapeutic compounds including medicinal plants to restore glycemic balance or homeostasis in hyperglycemic condition is an index of their antidiabetic function and relevance, in this study, the blood glucose levels significantly increased (P<0.05) in alloxan untreated diabetic rats, the continuous treatment with aqueous extract of *I. batata* for a period of 2 weeks caused a significant decrease in the blood glucose levels of treated diabetic as indicated in Table 4.

These results have confirmed the earlier results of our preliminary studies (not published). The possible mechanism by which aqueous extract of *I. batata* brings about its hypoglycaemic action may be, by

potentiating the insulin effect, either by increasing the pancreatic secretion of insulin from the cells of islets of Langerhans or its release from bound insulin [15]. A significant reduction ($p<0.05$) in food and water intake and increase in the body weight in treated rats were noticed. This could be the result of improved glycaemic control produced by aqueous extract of *I. batata.*

An elevated serum lipid in alloxan-diabetic rats was observed which could be due to high glucose level in the blood of such rats. Lipids play an important role in the pathogenesis of diabetes mellitus. The level of serum lipids is usually raised in diabetes and such an elevation represents a risk factor for coronary heart disease [16]. Lowering of serum lipids levels through dietary or drugs therapy seems to be associated with a decrease in the risk of vascular disease [17]. Diabetes-induced hyperlipidaemia is attributable to excess mobilization of fat from the adipose due to the underutilization of glucose since insulin inhibits the hormone sensitive lipase [18]. On the other hand, glucagon, catecholamines and other hormones enhance lipolysis. The marked hyperlipidaemia that characterizes the diabetic state may therefore be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots [19]. In our study, we have also observed an increase in the concentration of total cholesterol, triglycerides, LDL cholesterol and T.C/HDL.C in untreated diabetic rats. Hyperlipidaemia is a recognized consequence of diabetes mellitus [20]. Administration of aqueous extract of *I. batata* normalized serum lipids, secondary to the diabetic state. The ability of aqueous extract of *I. batata* to reduce the levels of plasma lipids in diabetic rats, to our knowledge has never been reported before. The regression of the diabetic state due to aqueous extract of *I. batata* administration increased the utilization of glucose, thereby depressing the mobilization of fat.

4. CONCLUSION

Our findings indicate that an aqueous extract of *I. batata* can lower the blood glucose and serum lipids in alloxan diabetics' rats. This is of interest, since elevated concentrations of both are risk factors in the development of arteriosclerosis in diabetes mellitus.

5. ACKNOWLEDGEMENTS

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6. COMPETING INTERESTS

The authors declared that no competing interests exist

7. AUTHORS CONTRIBUTIONS

FOO conceptualize**,** designed and executed the experiment, AOK carried out the statistical analysis, AAG and IJO drafted the manuscript and the final copy was proofread by all authors.

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