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ORIGINAL RESEARCH

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Hypoglycemic effect of aqueous extract of *Telfairia occidentalis* leaf extract in alloxan induced diabetic wistar rats

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ABSTRACT

Aim: This study was carried out to evaluate the effect of oral administration of aqueous extract of *Telfaria occidentalis* on insulin level of diabetic rats before and after 14 days of treatment.

Methods: Diabetes was induced in the animals by an intraperitoneal injection of alloxan monohydrate dissolved in sterile normal saline in a dose of 150 mg/kg body weight. After 72 hours of the injection, rats that are diabetic (indicted by hyperglycemia) were used for the experiment. Blood samples were collected from the tails of the rats and blood glucose was determined using a glucometer. The rats were divided into Groups I–VI. Group I animals served as non-diabetic control and were administered 0.5 ml of water daily for 14 consecutive days. Groups II and III were non-diabetics that were administered daily with 150 mg/kg body weight and 300 mg/kg body weight of *Telfairia occidentalis* extracts (TO exts), respectively for 14 consecutive days. Group IV rats served as diabetic control and were administered with 0.5 ml of water daily for 14 consecutive days while groups V and VI were diabetic rats that were administered daily with 150 mg/kg body weight and 300 mg/kg body weight of TO exts, respectively for 14 consecutive days.

Results: TO exts was shown to significantly ($p < 0.05$) lower the fasting blood glucose (FBG) in alloxan induced diabetic rats in a dose-related fashion, and also, showed significant ($p < 0.05$) lowering of FBG in normal (non-diabetic) rats that received 300 mg/kg/day of TO exts. *Telfairia occidentalis* showed no significant ($p > 0.05$) reduction in the FBG of normal (non-diabetics) rats that received 150 mg/kg/day of TO exts.

Conclusion: *Telfairia occidentalis* might be producing its hypoglycemic effect via stimulation of insulin secretion from the beta cells of the islets of Langerhans or increased peripheral utilization of glucose by the cells.

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Telfairia occidentalis; diabetes mellitus; hyperglycemia; aqueous extract

Introduction

Through the ages, plants have been used as sources of drugs administered empirically or otherwise in the cure of diseases. Plants were also allegedly used to treat diabetes. Several plants have indeed been investigated for their hypoglycemia properties. Among these are 1) *Telfairia occidentalis*, 2) ocimum gratissimum, 3) mangifera indica, and 4) in traditional Couboria vitata.

Although various plants have been employed in traditional medicine in Nigeria to treat diabetes, a lot still remains to be done scientifically to confirm the efficacy of these herbal drugs. *Telfairia occidentalis* is a tropical vine grown in West Africa as a leaf vegetable and for its edible seeds. It is also known as fluted pumpkin, fluted gourd, or Ugu in Ibo Language in Eastern Part of Nigeria. Its scientific classification is as follows: Kingdom: Plantae,

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Division: Magnoliophyta, Class: Magnoliopsida, Order: Cucurbitales, Family: Cucurbitaceae, Genus: *Telfairia*, Species: *T. occidentalis*.

Telfairia occidentalis (Cucurbitaceae), is cultivated mainly in West Africa, especially in Nigeria, Ghana, and Sierra Leone [1,2]. Fluted pumpkin (*Telfairia occidentalis*) is a creeping vegetative shrub that spreads low across the ground with large lobed leaves and long twisting tendrils [3]. Harvesting of fluted pumpkin takes place 120–150 days, after sowing. It is grown for its leafy and its oily seed. The plant is a drought-tolerant; dioeciously perennial that is usually grown trellised. The young shoots and leaves of the female plant are the main ingredients of a Nigerian soup, edikangikong. The large (up to 5 cm), dark red seed is rich in fat and protein, and can be eaten whole, ground into powder for another kind of soup, or made into a fermented porridge. The fruit of the plant is large, weighing up to 13 kg, but inedible.

The leaves are cooked and eaten while the seeds which contain about 30% protein can be boiled and eaten, or ground into powder for soup. The seed can also be fermented for several days and eaten as slurry [4–7]. The medicinal importance of the plant is being gradually investigated. *Telrairia occidentalis* is now known to possess anti-inflammatory effect [8], anti-bacterial activity [9], erythropoietic value [10], anticholesterolemic and immune building properties [11], and hypoglycemic effect [12–15]. The seed of *Telrairia occidentalis* is a rich source of minerals such as calcium, phosphorous, iron, zinc, and copper. The seed contains 47% oil. The oil obtained from the seed contains 61% unsaturated fatty acids which offer protective role against atherosclerosis and cardiovascular disease [16]. The phospholipids, glycolipids, and neutral lipid contents of the seed are 58%, 26%, and 15%, respectively [17]. The root of *Telfairia occidentalis* has been screened for hypoglycemia activity [10]. This research was undertaken to screen the leaf of *Telfairia occidentalis* for possible hypoglycemic activity, since the root has been confirmed to possess this activity. Leaves from this plant constitute an important ingredient in soup making since they are good sources of proteins, vitamins (B-complex), minerals, fatty acids (linoleic and oleic acids), and fibers. The seed contains 13% oil [18] and is used for marmalade manufacturing [19] and cookie formulations [20]. This darkish-green leafy vegetable is popularly used in soup and in herbal preparations for the management of many diseases in Nigeria. Studies have shown that the leaf of *Telfairia occidentalis* is very rich in iron, antioxidants, phytochemicals (such as phenols), and ascorbic acid and has been found to possess antimicrobial, free radical scavenging, and therapeutic activities [21,22]. It has been reported that the aqueous extracts of *Telfairia occidentalis* reduced blood glucose level and have hypoglycemia effects in glucose induced hyperglycemic [23].

There is a considerable evidence to support the role of oxidative stress in the development of atherosclerosis and related cardiovascular diseases. The development of atherosclerosis involves lipids deposits on the inner walls of arteries, with subsequent inflammation and scarring. The fat deposits are composed mainly of cholesterol and cholesterol esters, which are associated with foam cells and macrophages on the artery walls. Epidemiology and experimental data show a clear correlation between increased atherosclerosis and plasma cholesterol levels. Increased levels of low-density lipoprotein are considered the principal casual factor. This becomes part of the atherosclerotic process after oxidative modification. Therefore, reducing cholesterol levels lowers the frequency of cardiovascular disease and improves pathological damage in heart failure. Although numerous trials of diet or drug-based cholesterol reduction has provided compelling evidence that reducing cholesterol levels decrease the incidence of cardiovascular disease, the therapeutic effects of *Telfairia occidentalis*, used in African medicines against pathological conditions caused by lipids disorders, remain uninvestigated.

The plant is also rich in glycosides that yield curcubitacins and glucose on hydrolysis. The vitamin C content of this plant is about 148.0 mg/100 g of dry matter, and *Telfairia occidentalis* has been reported to protect against cancer of the oesophagus, oral cavity, and stomach, to maintain blood vessels flexibility, and to improve circulation in the arteries of smokers. An extract from this plant has been shown to possess ant diabetic activity in both alloxan and streptozotocin diabetic animals. However, there is a dearth of information on the beneficial effect of *Telfairia occidentalis* on the lipid profile of animals.

Based on the different health benefits associated with *Telfairia occidentalis* leaves and their widespread acceptability, this study was carried out to investigate the hypoglycemic effects of *Telfairia occidentalis* in both normal and diabetic rats. In the normoglycemic rats, the Beta cells of the pancreas which produce insulin are intact. But alloxan destroys these Beta cells. Alloxan induced diabetic

rats, therefore, no longer have functional pancreatic Beta cells and have lost the capacity to secrete insulin which is required for glucose absorption. It could be inferred, therefore, that the hypoglycemic effect of the seed extract is not mediated through the stimulation of insulin release from beta cells like the sulphonylureas [24] but through other mechanism [25].

Oral glucose tolerance testing is a standard procedure used in the diagnosis of diabetes and in assessing extracts for hypoglycemic effect [26]. The observed reduction of blood glucose concentration in glucose loaded rates at 60 minutes (when administered simultaneously) and an increase in blood glucose level at 45 minutes (when administered 1 hour before glucose) shows that the seed extract is not effective in reducing blood glucose concentration in glucose loaded rats. This further buttresses the fact that the seed extract did not stimulate insulin production by the pancreas.

It is therefore clear that the leaf extract may be useful in the management or ethnotherapy of type 2 diabetes mellitus. The leaf of *Telfairia occidentalis* is known to contain about 14.5% carbohydrates. (Mostly sucrose, fructose, galactose, raffinose, and stachyose), 47% lipids (phosphor lipids—58%, glycol lipids—26%, and neutral lipids—16%) with the fatty acids exhibiting a high degree of unsaturation contributed mainly by the C^{16} and C^{18} fatty acids [16]. And this study has shown that the leaf contains alkaloids, steroids, tannins, and terpenes. However, it is difficult at this stage to know which of the constituents of the leaf of *Telfairia occidentalis* is/are responsible for the hypoglycemic activity. It is also known that 250 mg kg^{-1} of the leaf extract did not reduce blood glucose level in the diabetic rats like the 100 mg kg^{-1} dose. It may be that at that dose level (250 mg kg^{-1}), the carbohydrates content of the extract contributed significantly to the blood glucose level thereby countering the hypoglycemic effect of the extract. This work shows for the first time that the leaf extract of *Telfairia occidentalis* contains hypoglycemic constituents which could be useful in the treatment of non-insulin dependent (i.e., type 2) diabetes mellitus.

The medicinal importance of the plant is being gradually investigated. *Telfairia occidentalis* is now known to possess anti-inflammatory effect [8], antibacterial activity [9], erythropoietic value [10], anti cholesterolemic and immune building properties [11], and hypoglycemic effect [12–15]. The phospholipids, glycolipids, and neutral lipid contents of the seed are 58%, 26%, and 15%, respectively [17]. Both the leaf and root (Unpublished data) of *Telfairia occidentalis* have been screened for hypoglycemic activity. This research was undertaken to screen the leaf of *Telfairia occidentalis* for possible hypoglycemic activity, since the seed has been confirmed to possess this activity.

Materials and Methodology

Materials

- 36 male Wistar rats, 14 weeks old, procured from the University of Jos animal house.
- *Telfairia occidentalis* purchased from Terminus Market, Jos.
- Table weighing scale
- Glucometer (on call plus Glucometer).
- Intragastric tubes
- Growers' feeds procured from vital feeds, Jos.
- Alloxan monohydrate procured from Medicom Laboratory Nig. Ltd Jos.
- Mortar and pestle
- Distilled water
- Rotatory Evaporator
- Normal saline
- Airtight containers
- Syringes (5 ml, 2 ml, and insulin injection syringes)
- Standard rate cages.

Methodology

Plant material

Telfairia occidentalis was procured from Katako Market, Jos. Identified by Professor Akueshi, plant taxonomist in the Department of Botany, University of Jos, Jos.

The air dried *Telfairia occidentalis* was pounded and filtered. The powder was kept in airtight containers ready to use.

Extract of *Telfairia occidentalis*

Sixty gram of the dried powdered *Telfairia occidentalis* was exhaustively extracted with water in a soxlet extractor for 72 hours. The extract was concentrated to dryness on a rotatory evaporator and weighed. The residual extract was dissolved in normal saline and used in the study.

Experimental induction of diabetes in rats

Male Wistar rats 14 weeks old (weighing between 130 and 200 g) bred in the animal house, Department of Human Physiology, Faculty of Medical Sciences,

Table 1. Effect of oral administration of aqueous extract of *Telfairia occidentalis* on blood glucose level of non-diabetic rats & diabetic rats before and after 14 days of treatment (*N* = 6).

S/No	Groups	Day 0 (Blood glucose in mmol/l)	Day 14 (Blood glucose in mmol/l)
i	Non-diabetic control + 0.5 ml of water	79.17 ± 3.13	69.17 ± 3.68
ii	Non-diabetic + 150 mg/kg TO ext	118.17 ± 7.15 a	87.33 ± 6.90
iii	Non-diabetic + 300 mg/kg TO ext	52.83 ± 5.52 a	50.833 ± 1.35
iv	Diabetic control + 0.5 ml of water	231.08 ± 29.66	388.67 ± 35.24
v	Diabetic + 150 mg/kg TO ext	105.42 ± 10.12	77.83 ± 2.82
vi	Diabetic + 300 mg/kg TO ext	55.33 ± 3.73 b	50.58 ± 2.26

Mean ± Standard Error of Means (SEM) for six determinations.

University of Jos, were used in this study. The animals were fed with grower feeds (procured from Vital Feed Jos) and allowed access to water freely.

The rats were injected with alloxan monohydrate dissolved in sterile normal saline in a dose of 150 mg/kg body weight intraperitoneally [27].

After 72 hours of the injection, rats with fasting blood glucose (FBG) at or above 126 mg/dl. (7.0 mmol/l) were considered diabetic. Blood was collected from the tail of the rats and blood glucose was determined by glucose oxidase method of Trinder [28], using On Call Plus Glucometer Monitoring system [29].

Experimental design

In the experiment, a total of 36 rats were used. Diabetes was induced in the rats 72 hours before starting the treatment. The rats were divided into six groups after the induction of diabetes. In this experiment, six rats were used in each group.

Group I: Normal control rats given 0.5 ml/kg of water daily for 14 days.

Group II: Normal rats given *Telfairia occidentalis* extract (TO ext) (150 mg/kg body weight) daily for 14 consecutive days.

Group III: Normal rats given TO ext (300 mg/kg body weight) daily for 14 consecutive days.

Group IV: Untreated diabetic rats (diabetic control rats) given 0.5 ml/kg of water daily for 14 consecutive days.

Group V: Diabetic rats given TO ext (150 mg/kg body weight) in saline solution daily using an intragastric tube for 14 consecutive days.

Group VI: Diabetic rats given *Telfairia occidentialis* extract (300 mg/kg body weight) in saline solution daily for 14 consecutive days.

After 14 consecutive days of treatment, blood samples were collected from the rats for estimation of their blood glucose levels.

Results

Table 1 shows the effect of oral administration of aqueous extract of *Telfairia occidentalis* on blood glucose level of non-diabetic rats & diabetic rats before and after 14 days of treatment. The effects of 14-day oral administration of 0.5 ml of water and graded doses of TO ext (150 mg–300 mg/kg) on normal and alloxan induced diabetic rats and Table 2 and 3 shows insulin levels after administration of graded doses of TO ext on FBG in normal and alloxan induced diabetic rats using immunoassay analysis.

The administration of 150 mg/kg/day of TO ext to normal rats (group II) for 14 consecutive days did not cause any significant ($P > 0.05$) decrease in their FBG. However, daily administration of 300 mg/kg/day of TO ext to the (non-diabetic) normal rats (group III) for 14 consecutive days caused significant ($p < 0.05$) reduction in their FBG. Also, daily oral administration of graded doses (150–300 mg/kg) of TO ext to diabetic rats groups V and VI caused significant ($P < 0.05$) dose related reduction in the blood glucose concentration when compared with group IV.

Discussion

Various *in vivo* models (e.g., diazoxide, alloxan, or streptozotocin-induced diabetic rats) are used in evaluating medicinal plants with suspected hypoglycemic potentials [29]. In this study, diabetes mellitus was induced using intraperitoneal injection of alloxan at a dose of 140 mg/kg of body weight. This dose induced diabetes mellitus in the treated rats 72 hours after administration. Alloxan induces diabetes mellitus by selectively destroying the pancreatic beta cells which are involved in the synthesis,

storage, and release of insulin which is a peptide hormone that regulate carbohydrate, protein, and lipid metabolism [29].

In this study, diabetes was fully induced as shown by the significant ($P < 0.05$) elevation in the fasting blood glucose concentrations in the groups IV–VI rats compared to the group I rats. Oral administration of TO ext(150 mg–300 mg/kg of body weight) for 14 consecutive days significantly ($P < 0.05$) lowered the blood glucose of diabetic rats in groups V and VI in a dose related fashion when compared with group IV.

Also, administration of 300 mg/kg/day for 14 consecutive days to normal (non-diabetic) rats produced significant ($P < 0.05$) reduction in their FBG concentration. However, administration of 150 mg/kg of TO ext to normal (non-diabetic) rats for 14 consecutive days did not produce any significant decrease in their blood glucose levels. The TO ext showed significant lowering activity in both diabetic and non-diabetic rats. This observed hypoglycemic activity is an indication that TO ext contains active constituents with potent hypoglycemic property.

Phytochemical screening performed on the crude and ethanol extracts showed that *Telfairia occidentalis* contains alkaloids, steroids, carbohydrates, flavonoids, and cardiac glycosides in significant amounts. *Telfairia occidentalis* is known to contain alliin, ajoene, enzymes, vitamin B, alkaloids, and flavonoids. Literature has equally shown the biological activity of alkaloids and flavonoids to include hypoglycemia, hypolipidemia, hypoazotemia, and hypotension among other biological effects [30,31]. The presence of alkaloids and flavonoids in TO ext may be responsible for the hypoglycemic effect recorded in this study. This study showed that the effective dose of *Telfairia occidentalis* for its hypoglycemic effect to be felt is not less than 300 mg/kg/day.

In alloxan induced diabetes mellitus, there is selective necrosis of the beta cells of the pancreas so that insulin secretion is totally or partially inhibited, depending on the concentration of the alloxan [32]. The *Telfairia occidentalis* might be producing its hypoglycemic effects via stimulation of insulin secretion from the islets of Langerhans or increased peripheral utilization of glucose by the cells.

Results of this study show that *Telfairia occidentalis* has potent hypoglycemic property in both normal and diabetic rats; which may be mediated via increased secretion of insulin by the islets cells of Langerhans or increased peripheral utilization of glucose by the cells. This implies that it will be useful in the management of type II diabetes mellitus. From the study, it has been shown that concurrent administration of TO ext with conventional oral hypoglycemic agents may produce a synergistic effect that may be detrimental to the individual if not well monitored. It is therefore recommended that individuals placed on conventional oral hypoglycemic agents should not consume *Telfairis occidentalis* supplement without consulting their physicians.

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