

In Vitro α -Glucosidase Inhibitory and *In Vivo* Glucose Digestion Activities of Ethanol Leaf Extract of *Acalypha Wilkesiana* in Normoglycaemic Rats

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ABSTRACT

We observed the ethanol leaf extract of *Acalypha wilkesiana* to be a rich source of phytochemicals and vitamins of therapeutic benefits. Considering the search for medicinal plants and products with hypoglycemic potentials, we conducted *in vitro* and *in vivo* studies to respectively investigate α -glucosidase inhibitory and glucose digesting activities of *A. wilkesiana* extract. The α -glucosidase inhibitory activity was determined following previously described methods at concentrations of 0.1-0.9 μ g/mL using acarbose as standard drug. Oral glucose tolerance test was determined in 24 normoglycemic adult male Wistar rats of (140-160g) weight, assigned to four groups (n=6). At 0 minute, Group1 (control) and 2 (glucose treated) received 10ml/kg mL distilled water while 3 (standard hypoglycemic treated) and 4 (*A.wilkesiana* extract treated) received glimepiride (0.1mg/kg) and *A. wilkesiana* extract (250mg/kg) respectively. 30 minutes after, group 1 received distilled water (10ml/kg mL) while groups 2, 3 and 4 received 5% glucose water (10ml/kg) and blood glucose level measured at 30 minutes interval for 180 minutes. The results showed a dose dependent % inhibition of α -glucosidase activity from 51.12 \pm 0.14 to 58.01 \pm 0.11 with acarbose and 50.48 \pm 0.29% to 56.14 \pm 0.56% with ethanol leaf extract of *A. wilkesiana*. *A. wilkesiana* (69.50 \pm 4.71mg/dl; p<0.05) and glimepiride (74.33 \pm 5.10mg/dl; p>0.05) administrations concealed the rise in blood glucose following glucose loading (97.67 \pm 3.25mg/dl) and significantly lowered blood glucose levels compared with the glucose treated group at 30 through 180 minutes. These findings suggest that ethanol leaf extract of *A. wilkesiana* possesses hypoglycemic potentials by inhibiting α -glucosidase activity and increasing glucose digestion or inhibiting absorption in normoglycemic rats.

Introduction

Metabolic syndrome is a cluster of several metabolic abnormalities, including central obesity, insulin resistance, hypertension, dyslipidemia, and hyperglycemia, that has become a major public health challenge [1]. Though different types of oral hypoglycemic agents are available along with insulin for the treatment of diabetes, there is an increase demand by patients to use the natural products with anti-diabetic activity

[2]. Interestingly, medicinal plants are now increasingly used in most parts of the world as hypoglycemic [3-7]. The high cost, low availability, uncertainty of use during pregnancy and undesirable side effects of synthetic drugs have been some of the factors leading to a strong preference for hypoglycemic drugs of plant origin, which are believed to be suitable for hyperglycemia treatments [8]. Herbal products can improve glucose metabolism and the overall

condition of individuals with diabetes, not only by hypoglycemic effects, but also by improving lipid metabolism, antioxidant status and capillary function [9]. In our recent investigation, we observed the ethanol leaf extract of *Acalypha wilkesiana* to be a rich source of phytochemicals, macro-elements and vitamins known to have several therapeutic benefits [10]. Though this plant is not edible, it is found to contain alkaloids, tannins, resins [11] as well as plenty of terpenoids and vitamin C and moderate level of flavonoids [10]. The plant has wide uses in the traditional treatment of bacterial and fungal skin infections, neonatal jaundice, gastrointestinal disorders and malaria [12,13], antiparasitic and analgesic [14], possess antimicrobial [15, 16], antihypertension [17,18], anticarcinogenic properties [19]. Its antihyperglycemic, antihyperlipidemic and ameliorative role on electrolytes disturbances have been demonstrated in diabetic mice [20]. According to El-Khateeb et al. [21], not much pharmacological research has been carried out on *A. wilkesiana* despite its importance in traditional medicine. Therefore, this study investigates the in vitro and in vivo α -glucosidase inhibitory and glucose digestion activities of ethanol leaf extract of *A. wilkesiana* using normoglycemic adult male Wistar rats.

Materials and Methods

Collection, Processing and Extraction of Plant Materials

Samples of *Acalypha wilkesiana* leaves were collected from Benin City, Nigeria and authenticated at the Herbarium Unit of Forestry Research Institute, Ibadan, Nigeria. The leaves were sorted, air-dried for 7 days and then pulverized and packaged in polyethene air tight bags. 200g of the powder leave was added into a container containing 1.5L of 70% ethanol and used to prepare the ethanolic extract as described in Majekodunmi and Nubani [22] with few modifications.

In Vitro Anti-Diabetic Activity of Ethanolic Leaves Extract of *A. Wilkesiana*

The α -glucosidase inhibitory activity of the ethanol leaf extract of *A. wilkesiana* was determined as described by Shai et al. [23] with slight modifications. Briefly, ethanol leaf extract of *A. wilkesiana* or acarbose at different concentrations (0.1-0.9 μ g/mL) was incubated with 500 μ L of porcine pancreatic amylase (2 U/mL) in phosphate buffer (100 mM, pH 6.8) at 37 °C for 20 minutes. 250 μ L of 1% starch dissolved in 100 mM phosphate buffer (pH 6.8) was added to the reaction mixture and incubated at 37° C for 1 hour. Dinitrosalicylate colour reagent (1 mL) was added and boiled for 10 minutes. The absorbance of the resulting mixture was read at 540 nm and the inhibitory activity was expressed as percentage of a control without the inhibitors. All assays were carried out in triplicate. The inhibitory activities of the fractions on the α -glucosidase were calculated using the following formula:

$$\text{Inhibitory activity \%} = (1 - [\text{AS}/\text{AC}]) \times 100$$

Whereas is the absorbance in the presence of the sample and Ac is the absorbance of the control.

Experimental Animals

Twenty-four (24) adult male Wistar rats with average weight of 140-160g were obtained from the Animal House of the College of Medicine, Ambrose Alli University, Ekpoma. They were housed at room temperature on a 12 hour dark-light cycle and acclimatized for a 14-day period with ad libitum access to clean water and food (rat chow; Vital Feed Nig. Ltd, Jos, Nigeria).

Oral Glucose Tolerance Test in Normoglycemic Rats

The 24 rat which were normoglycemic were used for the study after acclimatizing for two weeks. They were fasted overnight for 12 hours before the experiment. Their fasting blood glucose levels were determined using Accu-check glucometer by Roche Diagnostic and then divided to four groups (n = 6) as follows:

- a. **Group 1:** Negative control group; received 10ml/kg of distilled water and another 10ml/kg mL of distilled water after 30 minutes.
- b. **Group 2:** Positive control group; received 10ml/kg of distilled water and 10ml/kg of 5% glucose water after 30 minutes.
- c. **Group 3:** Standard drug treated group; received 0.1mg/kg of Glimpiride; a standard anti-diabetic drug, and 10ml/kg of 5% glucose water after 30 minutes.
- d. **Group 4:** Extract treated group; received 250mg/kg ethanol leaf extract of *Acalypha wilkesiana* and 10ml/kg of 5% glucose water after 30 minutes.

The blood glucose levels were measured at 0, 30 min, 60 min, 90 min, 120 min, 150 min and 180 min after glucose loading. The mean increment of glycaemia in each group was calculated as the sum of increases in blood glucose divided by the number of animals after each period according to the method of Madar [24]. Data were expressed in means \pm SEM. Paired sample "t"-test and one-way analysis of variance (ANOVA) was used to compare the group means between treatments in the in vitro and in vivo studies respectively. Differences were considered significant when $P \leq 0.05$.

Results

Figure 2 compares the α -glucosidase inhibitory activities of varying concentrations of the ethanol leaf extract of *A. wilkesiana* and acarbose. There was dose dependent % inhibition of α -glucosidase activity from 51.12 \pm 0.14% to 58.01 \pm 0.11% with acarbose and from 50.48 \pm 0.29% to 56.14 \pm 0.56% with the ethanol leaf extract of *A. wilkesiana*. The percentage α -glucosidase inhibitory activities was significantly higher ($p < 0.05$) in the acarbose compared with the ethanol leaf extract at all doses but was similar at doses of 0.01 μ /ml (51.12 \pm 0.14% vs. 50.48 \pm 0.29%; $p > 0.05$) and 0.09 μ /ml (58.01 \pm 0.11% vs. 56.14 \pm 0.56%; $p > 0.05$).

Figure 3 demonstrates the time course of oral glucose tolerance in normoglycemic rats treated with ethanol leaf extract of *A. wilkesiana* compared with standard drug and controls after glucose loading. Baseline glucose levels were similar in all the groups 30 minutes before glucose loading. Blood glucose level increased in the distilled water + glucose (97.67±3.25mg/dl) treated 30 minutes after glucose loading but the administration of both 250mg/kg ethanol leaf extract of *A. wilkesiana* (69.50±4.71mg/dl; p<0.05) and 0.1mg/kg glimepiride (74.33±5.10mg/dl; p>0.05), concealed

the rise in glucose level. Compared to the control (83.33±2.22mg/dl) treated with only distilled water, blood glucose level was also lower in the extract and standard drug treated groups. Compared with distilled water + glucose treated group, blood glucose levels were significantly lower in the extract and standard drug treated groups by 30 through 180 minute after glucose loading. Although not significant, blood glucose was lower in the extract treated compared with the standard drug by 30 through 180 minutes.

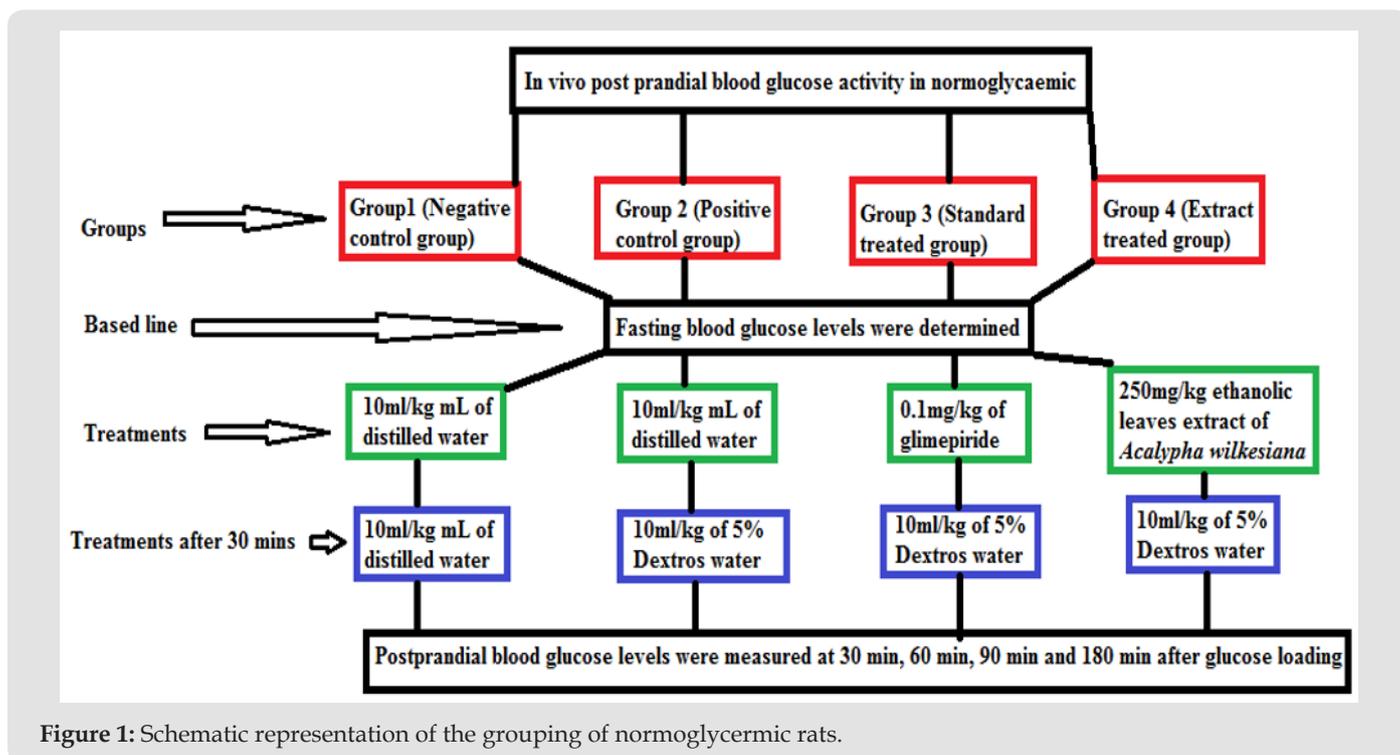


Figure 1: Schematic representation of the grouping of normoglycemic rats.

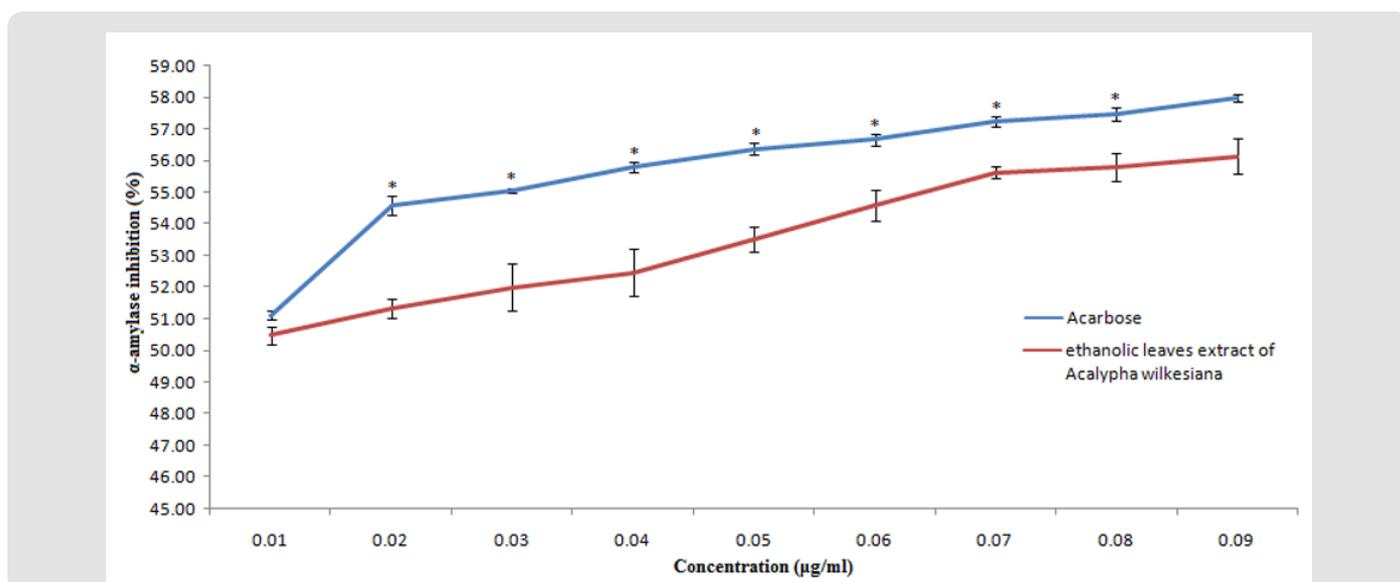


Figure 2: In vitro α- glucosidase inhibitory activities of acarbose compared with ethanolic leaves extract of *A. wilkesiana*. Values are Mean ± SEM in triplicate.

* Indicates significant difference at p<0.05 (paired sample “t”-test).

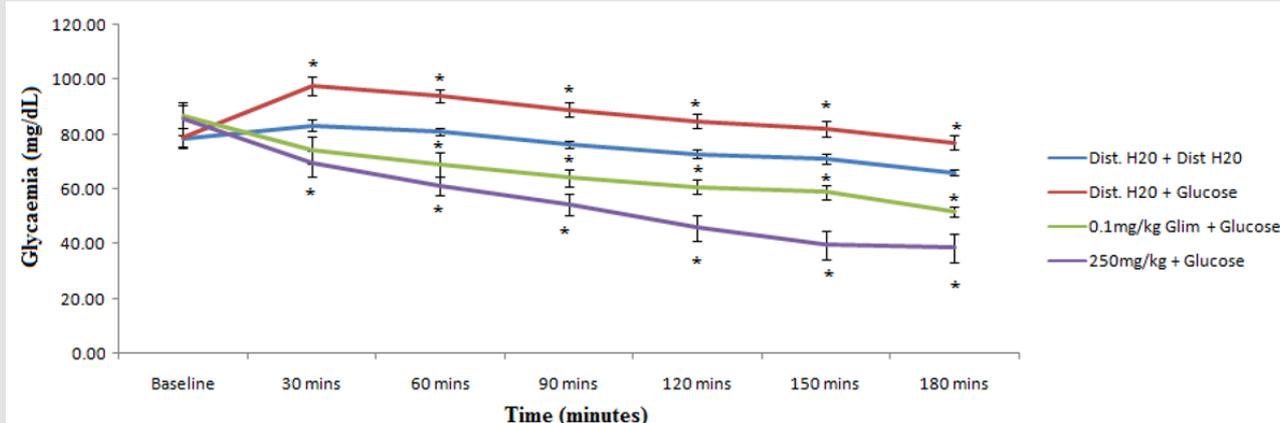


Figure 3: Time course of oral glucose tolerance in the controls, standard drug and ethanolic leaves extract of *A. wilkesiana* treatments in normoglycaemic rats.

Values are Mean±SEM, (n = 6 rats),

* indicates significant difference at $p < 0.05$ compared with untreated control (water treated). H2O = water, Dist = distilled, Glim = Glimperide treated, 250mg/kg = *Acalypha wilkesiana* treated.

Discussion

The major goal in diabetes management is the near normal maintenance of fasting and postprandial blood glucose levels [25]. In fact, Matsui et al. [26] and Wassmann and Nickenig [27], suggested suppression of glucose absorption via inhibition α -amylase or α -glucosidase enzymes inhibition as therapeutic approach to postprandial hyperglycaemia. In the present study, varying concentrations of ethanol extract of *A. wilkesiana* leaves presented similar promising impact in in vitro inhibition of α -glucosidase with acarbose; a standard diabetic drug (Figure 2). This finding suggests the ethanol leaf extract of *A. wilkesiana* to have digestibility action on glucose similar to acarbose. This assertion is based on the fact that α -glucosidase is involved in the digestion of starch into various oligosaccharides, and disaccharides to produce glucose and other monosaccharides [28]. In support of this finding, Fonkoua et al. [29] has reported similar findings with hydroethanolic extract of *A. wilkesiana* but reported no effect with aqueous extract. Both murine model [30] and clinical [31] studies have shown inhibitors of α -amylase and α -glucosidase suppress the production and absorption of glucose in the small intestine. Acarbose is a complex oligosaccharide that binds competitively to the α -glucosidases at the brush border of the small intestine to delay sucrose and starch breakdown and the absorption of glucose and fructose [32]. This drug has proven efficacious in reducing post-prandial increases in glucose and insulin [33]. Thus, the observed finding from the present study indicates the ethanolic leaves extract of *A. wilkesiana* can be a promising drug for postprandial glucose suppression through delaying sucrose and starch breakdown or inhibiting absorption of glucose. In the in vivo study, 250mg/kg ethanolic leaf extract of *A. wilkesiana* cause a decrease in postprandial blood glucose level after glucose loading in normoglycaemic rats. The observed suppression of glucose level

after glucose loading by 250mg/kg ethanolic leaf extract of *A. wilkesiana* in normoglycaemic indicates the extract to have glucose reducing properties. Martin et al. [29] has reported hypoglycaemic effect of 400mg/kg hydroethanolic extract of *A. wilkesiana* in streptozotocin diabetic rats. However, Al-Attar [20] reported orally aqueous *A. wilkesiana* leaves extract to cause a duration dependent decrease in blood glucose in streptozotocin induced diabetic rats.

Conclusion

Overall, this study showed that ethanolic leaf extract of *A. wilkesiana* possesses hypoglycemic activity in normoglycaemic state. Since a similar dose dependent difference was observed between *A. wilkesiana* leaves extract and acarbose in suppressing α -glucosidase, *A. wilkesiana* leaves extract therefore showed hypoglycemic potential via the inhibition of α -glucosidase and stimulation of glucose digestion mechanisms.

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