



Synergistic Effect of Aqueous Extracts of *Croton Zabensicus* and *Vernonia amygdalina* Leaves as an Antihyperglycemic Agent in an Alloxan Induced Diabetic Albino Rats

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2019/v29i530092

Editor(s):

(1) Dr. Kate S Collison, Department of Cell Biology, King Faisal Specialist Hospital & Research Centre, Saudi Arabia.

Reviewers:

(1) Muruganandan Shanmugam, Wayne State University, USA.

(2) Dr. Dennis, Amaechi, Veritas University, Abuja-Nigeria.

(3) Veeravan Lekskulchai, Srinakharinwirot University, Bangkok, Thailand.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/46484>

Original Research Article

Received 19 October 2018

Accepted 09 January 2019

Published 06 April 2019

ABSTRACT

Aims: This study was aimed at investigating the antihyperglycemic effect of a combined extract of *Vernonia amygdalina* and *croton zabensicus* compare with a hypoglycemic drug, glibenclamide.

Methodology: Twenty 20 experimental animals were used (albino rats); the rats were divided equally into four groups of five rats each; namely A (control), B (glibenclamide 10 mg/kg body weight), C (synergetic treatment 1000 mg/kg body weight), D (synergetic treatment 500 mg/kg of body weight). Diabetes was induced intraperitoneal using Alloxan Monohydrate to all the animals and their blood glucose rise above 200 mg/dl.

Results: It was observed that group B and group C treated with glibenclamide (10 mg/kg body weight) and synergetic aqueous extract (1000 mg/kg body weight) show significant decrease in the

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blood glucose level from 451.75 mg/dl to 64.50 mg/dl and 339.50 mg/dl to 182.50 mg/dl respectively compared with group D with 278.25 mg/dl to 194.75 mg/dl. However, a change was also observed in the body weight of the groups; Group A (Normal control) showed a continuous increase in the body weight, Group B, C and D were observed to have decreased in body weight from induction period, but a steady increase was observed as treatment commences.

Conclusion: Hence this combined extract can be used as antihyperglycemic; only that it is slower in remediation compared with the glibenclamide; but without side effect, as may be in the case of most standard drug.

Keywords: Synergistic; aqueous extract; *Croton zabensisus*; *Vernonia amygdalina*; hyperglycemia.

1. INTRODUCTION

Diabetes mellitus is a metabolic disorder found in all nations of the world. It is one of the most prevalent endemic diseases of the 21st century. Diabetes Mellitus is a syndrome of impaired carbohydrate, fat and protein metabolism caused by either lack of insulin secretion or decreased the sensitivity of the tissues to insulin characterized by hyperglycemia.

Type 1 diabetes typically occurs in children and young adults, though it can appear at any age. In the past, type 1 diabetes was called juvenile diabetes or insulin-dependent diabetes mellitus. Over time, high blood glucose damages nerves and blood vessels, leading to complications such as heart disease, stroke, kidney disease, blindness, dental disease, and amputations. No one is certain what starts the processes that cause diabetes, but scientists believe genes and environmental factors interact to cause diabetes in most cases. Insulin must be used in Type 1, which must be injected; while diabetes mellitus Type 2 is a disease of insulin resistance by cells. [1] has defined Diabetes mellitus based on laboratory findings as a fasting venous plasma glucose concentration greater than 7.8 mmol/l (140 mg/dl) or greater than 11.1 mmol/l (200 mg/dl) two hours after a carbohydrates meal or two hours after oral ingestion of the equivalent of 75 g glucose. The beginning of diabetes in the rat is judged as blood glucose is higher than the expanded normal upper level. The criteria for rats are close to that for a human. Alloxan is a toxic glucose analogue, which selectively destroys insulin-producing cells in the pancreas when administered to rodents and many other animal species [2]. Diabetes mellitus is further characterized by an inability to reabsorb water resulting in increased urination (polyuria), excessive thirst (polydipsia) and excessive eating (Polyphagia). Herbal products are of interest to many patients and health care practitioners since about 70% of the population worldwide rely on

herbal medicines for part of their primary health care. In different regions and cultures, herbal products are used as a single herb, a combination of herbs, or combination of herb(s) and drug(s) e.g China and India. The most desirable interactions are those which can result in additional therapeutic benefit. This is often the intended or expected outcome when using combination therapy. In African traditional medicine, several plants include *Anacadium occidentale*, *Congronema latifolium*, *Croton zabensisus*, *Vernonia amygdalina* etc; have been used to lower hyperglycemia.

Croton zabensisus is commonly known in Nigeria as *Kirobalcen maser* in Hausa and *Ajeobale* or *Ajeofole* in Yoruba [3]. The ethanolic extract of the leaf was reported to produce a significant reduction in blood glucose level of diabetic rat [4]. *Vernonia amygdalina* popularly known as the bitter leaf is a shrub of 2 – 5m tall. It is popularly called bitter leaf because of its abundant bitter principles. It is cultivated in Nigeria mainly for its nutritional value.

Diabetes mellitus is a metabolic disorder found in both young and old, rich and poor. It can be very expensive to manage; however, the use of conventional medical approach of simply using insulin and oral drugs to control diabetes Mellitus is not only costly but inadequate, boring and lack compliance and yet they are rarely available. This gives rise to an increase in counterfeit thus the patient's exposure to long term complication remains a risk. Nigeria government has failed to recognize this as a challenge and proffer a lasting solution. This research work intends to encourage the use of a synergistic herbal medicine as a competitive antihyperglycemic for effective management of type 1 diabetes which is readily available, cheap and with no record of toxicity. The specific objectives of this work are to study the synergistic effect of aqueous extract of *croton zabensisus* and *vernonia amygdalina* as an antihyperglycemic agent in alloxan-induced

diabetic rats; the percentage yield of the aqueous extraction of *croton zabensicus* and *vernonia amygdalina*; the phytochemical analysis of aqueous extracts of *croton zabensicus* and *vernonia amygdalina* singly and in combination and investigate the acute toxicity of aqueous extracts of *croton zabensicus* and *vernonia amygdalina*.

2. MATERIALS AND METHODS

2.1 Materials

The fresh leaves of *Vernonia amygdalina* and *Croton zabensicus* were got from Lagos state polytechnic; Ikorodu bush at the early hour of the morning at about 7 a.m and identified by a botanist in the Environmental Biology unit, Biological sciences department of Lagos state polytechnic; Ikorodu With reference number: Ipbh: 016/001, 002.

The animals used for this study include six albino mice of both sex (14 – 22 g) and twenty male albino rats (80 g - 200 g) were bought from Lagos State Teaching Hospital LASUTH in Ikeja. They were acclimatized for two weeks and fed with standard rat feed obtained from ZM veterinary store at Odogunyan, Ikorodu; Lagos and given clean and sterile potable water.

2.2 Phytochemical Screening

The Phytochemical analysis was carried out using the method described by [5]. The plant extracts were screened for the presence of Tannins, Saponin, Flavonoid, Glycosides and Phenol.

Test for Tannin: 5ml of extract with the addition of 0.1% FeCl₃ reagent solution was made. The formation of a greenish black precipitate was observed and regarded as positive for the presence of alkaloids in all the extracts.

Test for Saponin: 2 ml of each of the extracts was added into 5 ml of distilled water and both were vigorously shaken with the application of heat. It was observed that saponin was present in all the extracts.

Test for Flavonoid: 2 ml of sample extract was diluted with sodium hydroxide and hydrochloric acid solutions respectively and filtered. The filtrate, zinc dust and concentrated hydrogen chloride were added together and red colour

formation as observed, showing that flavonoids were present in all the extracts.

Test for Glycoside: 2 ml of extract with the addition of a hydrochloric acid solution (HCl) was neutralized with sodium hydroxide (NaOH) solution, then few drops of ferric chloride solution (FeCl₃) was added as well with 1ml of concentrated H₂SO₄ sulphuric acid underlaid. A reddish brown ring at the interface was observed, indicating the presence of Cardiac Glycosides in all the extracts.

Test for Phenol: 2 ml of the extract was added to 5.0 ml of 95% ethanol; they were boiled in water bath for five minutes and filtered hot. 5.0 ml of distilled water was added and the ethanol was evaporated at a reduced pressure in the water bath. The resultant concentrate with the addition of five drops of 1% of Ferric Chloride and 1% Potassium Ferric cyanide solution was added. A violet, wine, red, purple colour was developed, indicating a positive test for phenolic compounds.

2.3 Preparation of the Extract

The *Croton zabensicus* and *Vernonia amygdalina* leaves were sorted out to obtain only fresh leaves and washed with distilled water without squeezing to remove debris and dust particle. They were air dried separately and ground into powder; 100 g each of the powdered leaves were soaked with distilled water and ethanol respectively. The solutions were stirred at 1-hour interval for 72hours and filtered using a filter paper to obtain an aqueous extract of *Croton zabensicus* (A1), and aqueous extract *Vernonia amygdalina* (B1). The filtrates were centrifuged at 1000 revolution per minute for 5minutes to obtain a pure and clear supernatant; the extract was then concentrated using a rotary evaporator and weighed, the weight was used to calculate the percentage yield of extract. The concentrated extracts were kept in a refrigerator below 4°C for preservation till use.

Calculations:

$$\% \text{ yield of extract} = \frac{\text{weight of concentrated extracts} \times 100}{\text{Weight of powdered extract}}$$

1g each of the extracts A1 and B1 was weight and mixed together with 0.5ml of tween 80 and stirred with a glass rod until they dissolved. The mixture was made up to 10ml with normal saline.

2.4 Acute Toxicity Studies

The median lethal dose (LD50) of the aqueous extract was estimated using Lorke's modified method. Six albino mice were weighed and divided into two groups H and L of three mice each and followed by administration of different doses of the extracts to two groups of three albino mice each; H and L. In this phase, each mouse in group L was administered with a different low dose (500, 1000 and 2000) mg/kg of the combined extracts respectively; whereas group H was administered with a high dose of 3000, 4000 and 5000 mg/kg of the combined extracts respectively. The animals were observed for signs of toxicity; such as respiration, activeness and death within 21 days.

Calculation:

i. volume of extracts administered =
weight of mice (g) x dosage (mg/kg)/ 1000 x
concentration of extracts (mg/ml)

2.5 Induction of Alloxan (Diabetes)

Twenty (20) albino rats were used. The rats were divided into four groups of five rats each; A – D. On the first day before induction; all the rats in the groups were tested for diabetes and they were all negative. A (control), B – D groups were induced with diabetes intraperitoneally using Alloxan Monohydrate sigma Uk with a standard dose of 150 mg/kg body weight and a concentration of 50 mg/ml. 1g of alloxan monohydrate was suspended in 20 ml of 0.9% normal saline every day for four days; however; 48 hours later; At the sixth-day Diabetes was confirmed using a digital glucometer. Animals with blood glucose level ≥ 200 mg/dl were considered diabetic and included in the study. Body weights of all animals in each group were monitored using a digital weighing balance throughout the period of the experiment; so as to calculate the volume of extracts to be administered each day.

2.6 Combined Extract and Drug Administration

At the end of the nine days, the animals that tested positive for diabetes fasted for 12 hours, and then the blood glucose level was checked and recorded and administered the following drug and extracts orally as treatment once daily in a 24 hour cycle at 8: am for nine days; B received (glibenclamide 10 mg/kg body weight); C received (combined extract 1000 mg/kg) and D

receives (combined extract 500 mg/kg of body weight).

2.7 Statistical Analysis

Data collected were expressed as mean, standard error of the mean (SEM). Statistical significance was evaluated by one-way analysis of variance (ANOVA) using SPSS version 17.0 with Duncan's Multiple Range Test (DMRT) option. A value of $P < .05$ was considered to indicate a significant difference between groups.

3. RESULTS

The plant extracts were screened for the presence of Tannin, Saponin, Flavonoid, Glycoside, Alkaloid and Phenol. The table 2 below shows the result of the analysis.

4. DISCUSSION

The result confirms that synergistic treatment of *C. zabensicus* and *V. amygdalina* produced more antihyperglycemic properties with the high dose of 1000 mg/kg of body weight when compared with a lower dose of 500 mg/kg of body weight while the conventional antihyperglycemic drug like glibenclamide produced a hypoglycemic condition after the ninth day of treatment. The rats were considered treated when their fasting blood glucose level returned to almost their basal blood glucose levels. The increase in blood glucose level of diabetic rats was found to have reduced after oral administration of synergistic aqueous leaf extract of *C. zabensicus* and *V. amygdalina* and glibenclamide respectively and shows significant ($p < .05$) decrease in the blood glucose level. It was also observed that the rats in group B and C got treated quickly as compared to group D probably because the rats in group B and C were administered with an antidiabetic drug of a higher dose of the combined extract (1000 mg/kg) respectively as compared with the rats in group D with a low dose of 500 mg/kg. The efficacy of the extract on hyperglycemic rats corroborates the result of other researchers who had systematically demonstrated that the extract from the plant *C. zabensicus* and *V. amygdalina* have antidiabetic properties [4]. Polyphenolics such as tannins and Saponins from several plant extracts had been shown to reduce blood glucose levels through inhibition of α - amylase and sucrose from the intestine. Flavonoids were reported to regenerate the damaged pancreatic β -cells in diabetic animal [6]. Diabetes is also

characterized by weight loss, alloxan administration brought about marked a reduction in body weights of experimental rats. These reduced body weights were found to have increased significantly after the nine days treatment in group B, C and D. The percentage weight gain in group C (13.65%) seems to be prominent when compared with group A, group B

(8.22) and D (6.77). After nine days of treatment, this is an indication that the healing process was slow in the plant extracts and faster in the glibenclamide (standard drug). The facts that hypoglycemic drugs have side effects which can further complicate the health of patients; however, the natural herbs can serve as complements to hypoglycemic drugs [7].

Table 1. Percentage yield of extracts

Plant	Weight of powdered plant	Weight of concentrated extracts	% yield of extracts
A1	100 g	9.26 g	9.26%
B1	100 g	9.99 g	9.99%

Table 2. Phytochemical analysis

Sample	Tannin	Phenol	Saponin	Flavonoid	Glycoside
A1	+	++	++	++	+
B1	+	+	+++	+	+
A1+B1	++	++	+++	++	+

Table 3. Acute toxicity studies

Mice	Body weight (g)	Dosage (mg/kg)	Volume (ml)	Respiration	Activeness	Death
L1	14.05	500	0.035	Normal	Very active	No death
L2	16.02	1000	0.080	Normal	Very active	No death
L3	20.04	2000	0.200	Normal	Very active	No death
H1	21.70	3000	0.326	Fast	Active	No death
H2	15.49	4000	0.309	Very fast	Weak	No death
H3	18.89	5000	0.472	Rapid pulse	Very weak	No death

Key: L1 : low dose (500 mg/kg); H1: high dose (3000 mg/kg); H2: high dose (4000 mg/kg); L2; low dose (1000 mg/kg); H3: high dose (5000 mg/kg); L3: low dose (2000 mg/kg)

Table 4. Effect of treatment blood glucose

Group	FBG0 (mg/dl)	FBG1 (mg/dl)	FBGL5 (mg/dl)	FBGL7 (mg/dl)	FBGL9 (mg/dl)
A	118.00±19.79 ^a	120.50±19.33 ^a	119.50±2.24 ^a	117.00±19.44 ^a	117.00±20.28 ^a
B	128±5.88 ^a	451.75±54.43 ^c	191.25±8.95 ^a	106.00±16.63 ^a	64.50±11.90 ^a
C	124.75±13.53 ^a	339.50±124.73 ^{bc}	204.25±131.77 ^a	194.00±134.95 ^a	182.50±139.72 ^a
D	122.75±16.35 ^a	278.25±136.80 ^d	214.5±139.23 ^a	204.25±139.39 ^a	194.75±141.89 ^a

Significant difference ($p < .05$) appears between groups with different superscript while significant difference ($p < .05$) does not appear between groups with the same superscript; $n = 4$;

Key: FBG0; Blood Glucose before alloxan induction; FBG1; Blood Glucose 48 hours after alloxan induction; FBG5; Blood Glucose after 5days Treatment; FBG7; Blood Glucose after 7days Treatment; FBG9; Blood Glucose after 9days Treatment

Table 5. Effect of treatment on body weight

Groups	BW0 (g)	BW1(g)	BW9 (g)	CBW(g)	%WG
A	109.50±12.81 ^a	112.00±12.67 ^b	135.25±12.20 ^d	25.75±1.25 ^d	23.80±3.21
B	147.75±19.98 ^b	144.00±5.35 ^c	159.50±6.24 ^c	12.25±0.95 ^{ab}	8.22±0.40
C	103.75±5.56 ^a	101.75±5.73 ^{ab}	118.00±16.91 ^{ab}	14.25±15.90 ^{ab}	13.65±15.15
D	97.75±5.73 ^a	95.25±6.55 ^a	104.50±14.27 ^a	6.75±13.76 ^a	6.97±14.39

A significant difference ($p < .05$) appear between groups with different superscript while significant difference ($p < .05$) does not appear between groups with the same superscript, $n = 4$.

Key: BW0: body weight before induction; BW1: body weight after 48hour of induction; BW9: body weight after nine days treatment; CBW: change in body weight (BW9-BW0); %WG: percentage weight gain

5. CONCLUSION

It can be concluded that synergetic treatment of aqueous extracts of *croton zabensicus* and *vernonia amygdalina* leaves as an antihyperglycemic agent in alloxan induced diabetic albino rats produced a more competitive result with a dose of 1000 mg/kg body weight.

This investigation has demonstrated that the use of a combination of aqueous extract of the two leaves of *C. zabensicus* and *V. amygdalina* is safe, effective, cheap and more comfortable for the management of diabetes mellitus. Further research needs to be carried out to ascertain the appropriate dosage in relation with the duration of the extracts administration for treatment of hyperglycemia in order to prevent hypoglycemia; which is also a concern. Considering the efficacy of the synergistic treatment of combined extracts; awareness should be created to promote the medicinal advantage of the plants over standard drugs and a careful selection should be made following a thorough toxicity investigation; when combining two or more medicinal plants for treatment; so as to prevent complications; bearing in mind that some could be contradicting or antagonizing each other.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

ACKNOWLEDGEMENTS

The authors acknowledge the staff and management of Nigeria Institute of Medical

Research Organisation (NIMER) Lagos laboratory for their approval to use their facilities to carry out this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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