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Hypoglycemic and Antioxidant Capacity of *Curcuma Longa* and *Viscum Album* in Alloxan Induced Diabetic Male Wistar Rats

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Abstract: Plant based therapies may be a potent means of managing and preventing diabetes and currently, combination therapies are employed for the treatment of critical diseases. In view of this, the objectives of the present study was to investigate the hypoglycemic and antioxidant capacity *C. longa*, *V. album* and co-treatment with *C. longa* + *V. album* on diabetes and its related complication. Qualitative phytochemical analysis of *C. longa* and *V. album* were examined using standard procedures and the result revealed the presence of alkaloids, cardiac glycosides, flavonoids, phenols, saponins, tannins, terpenoids and steroids respectively. Thirty six (36) male albino rats with the mean weight between 120-135g were divided into six (6) groups (n=6), group one (1) served as the normal control and there experimental groups were diabetic, induced with 150 mg/kg intraperitoneal alloxan injection. Body weight, blood sugar level, glycated hemoglobin, glucose-6-phosphate dehydrogenase, α-amylase, lipid profile, liver function and antioxidant markers were determined using standard procedures and the results revealed that, co-treatment with *C. longa* + *V. album* demonstrated an excellent weight reduction ability, hypoglycemic capacity, modulation of G6PDH, HBA_1C and lipid profile, inhibition of α-amylase and enhancement of liver function and antioxidant levels. Therefore, co-treatment with *C. longa* + *V. ablum* can be a good therapeutic choice for the management of diabetes and its related conditions.

Keywords: Diabetes Mellitus, *Curcuma Longa*, *Viscum Album*, Lipid Profile, Liver Function and Antioxidant

1. Introduction

Diabetes Mellitus (DM) is a serious, chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Both the number of cases and the prevalence of DM has steadily being on a rise over the past few decades [1] and it is regarded to be a silent killer disease, affecting millions of peoples in the world [2]. The world prevalence of DM is estimated to increase from 425 million people in 2017 to 629 million by 2045 [3] and in Africa, the number of people with diabetes will increase from 14.2 million in 2015 to 34.2 million in 2040 predominantly populated in some of the region's most populous countries: South Africa, the Democratic Republic of Congo, Nigeria and Ethiopia (IDF 2015) [4]. Particularly, Type 2 DM is associated with obesity, there is hyperinsulinemia, high circulating cholesterol, triglyceride, low HDL, and alteration in the sensitivity or reactivity of vascular smooth muscle to neurotransmitters and circulating hormones, which may cause or contribute to diabetic vessel complications [5, 6]. Often, complications associated with DM account for increased morbidity, disability, and mortality and represent a threat to the economies of all countries, especially the developing ones. In the same light, there is increasing evidence that the underlying mechanisms in the pathogenesis of diabetic

complications include certain genetic and epigenetic modifications, nutritional factors, and sedentary lifestyle [7, 8].

Among the many challenges faced by developing countries in the face of rapid urbanization is the need for medications to debilitate the silent killer DM. To address this need, indigenous knowledge is often referred to, including the use of extracts from medicinal plants [9]. Although, insulin and oral hypoglycemic agents like sulphonylureas and biguanides are still the key players in the management of DM. However, various harmful side effects, exorbitant cost and reported weak effectiveness of some conventional treatment regimen has resulted in the search for safer, more effective and viable alternative. It has also being recognized that traditional medicine is an accessible, affordable and culturally acceptable form of healthcare trusted by numerous people, which stands out as a way of coping with the relentless rise of chronic non-communicable diseases in the midst of soaring health-care costs and nearly universal austerity' [10, 11].

Currently, medicinal plants continue to play an important role in the management of DM, especially in developing countries, where many people do not have access to conventional anti-diabetic therapies and Ethno-pharmacological surveys indicate that more than 1,200 plants are used in traditional medicine systems following claims of their hypoglycemic properties [5, 12]. Also, according to ethnobotanical information, about 800 plants possess anti-hyperglycemic effect [13]. *Curcuma longa* (Turmeric), belonging to the family *Zingiberaceae*, it is a tropical plant that is cultivated extensively in Asia, India, China, and other countries with a suitable climate [14,15]. Studies revealed that both the active constituent curcumin and the whole plant have been in use for treatment and management of several disorders. On this premise, curcumin has anti-dyslipidemia [16], anti-inflammatory [17], attenuate diabetes-induced cognitive deficits [18], hypoglycemic [19], anti-oxidant and anti-apoptotic [20] properties and might be a promising functional plant in preventing type 2 diabetes [15]. *Viscum album* is a semi-parasitic plant grown on trees and widely used for the treatment of many diseases in traditional and complementary therapy [21]. It has been used for the treatment of stroke, atherosclerosis, hypertension, and diabetes [15, 22]. In the same light, the plant has many biological activities such as anticancer, antiviral, antioxidant, apoptosis-inducing and immunomodulatory properties [23, 24].

Currently, combination therapies are employed for the treatment of critical diseases, such as cancer, acquired immunodeficiency syndrome (AIDS) and pulmonary tuberculosis, in order to achieve enhanced therapeutic effectiveness. The modern approach of combination therapy is a renewal of what was advocated in Chinese medicine that started thousands of years ago on the use of herb-herb combination for improvement of therapeutic outcome [25]. It is believed that each active component of a plant will be strengthened by the presence of another plant that has such active ingredient (synergism) or can aid its effectiveness in the body [26, 14]. Paucity of reports is available on the ameliorative power of co-treatment of diabetes and its related complication with *C. longa+V. album*. Therefore, it is on this premise, that the present study was investigated.

2. Materials and Methods

2.1. Plant Material

Rhizomes of *Curcuma longa* and fresh leaves of *Viscum album* were purchased from a farm in Jos, Plateau state. The plants were identified and authenticated at the Herbarium, Botany Department University of Ibadan. Rhizomes were washed, chopped into small bits and the fresh leaves were air dried for over two (2) weeks in Nutritional Biochemistry Postgraduate Students' Laboratory and pulverized into coarse powder using Hammer mill in Pharmacognosy Research Laboratory. 400g of each powdered plant material was cold extracted using 2000mls of 70% ethanol for 72 hours and filtered. The filtrate was then concentrated using Buchi rotary evaporator model R-200 at 30°C and further concentrated using a vacuum oven model VF-220 set at 30°C and a pressure of 700 mg/Hg, yielding a brownish residue weighing 112.46g and 102.18g of *C. longa* and *V. album* respectively. The extracts were stored in air tight bottles in the refrigerator.

2.2. Animals

A total of 36 male Wistar rats between the weights of 120-135g were procured from the Central Animal House, Department of Physiology, University of Ibadan, Nigeria for this study and were allowed to acclimatize for two weeks before commencement of experiment. The rats were housed in well kempt, ventilated cages and their beddings changed every three days and they were fed normal rat chow from Ladokun Feed, Ibadan and allowed free access to clean drinking water. All the processes involved in the handling and experiment were carried out according to standard protocols approved by the Animal Ethics Committee of University of Ibadan.

2.3. Phytochemical Screening

Phytochemical screening of *Curcuma longa* and *Viscum album* were performed by standard methods according to [27, 28].

2.4. Induction of Diabetes with Alloxan

The animals were fasted overnight with free access to water prior to induction of diabetes. Diabetes was induced by single intraperitoneal injection of Alloxan monohydrate (Sigma St. Louis, U.S.A.) at a dose of 150mg/kg body weight dissolved in 0.9% cold normal saline solution [29]. Since Alloxan is capable of producing fatal hypoglycemia as a result of massive pancreatic insulin release, the rats were treated with 20% glucose solution orally after 6 h. The rats

were then kept for the next 24 h on 5% glucose solution bottles in their cages to prevent hypoglycemic shock [29,30].

2.5. Experimental Design

Following two weeks of acclimatization, the rats were divided randomly into six groups, administration of the extracts was done by oral intubation using corn oil as vehicle and the treatment duration was for a period of 21 days.

Group 1: Normal control received corn oil.

Group 2: Negative control received 150 mg/kg Alloxan and remained untreated.

Group 3: Positive control received 150 mg/kg Alloxan and treated with 100 mg/kg metformin.

Group 4: Received 150 mg/kg Alloxan and treated with 280 mg/kg ethanol leaf extract of *C. longa*

Group 5: Received 150 mg/kg Alloxan and treated with 500 mg/kg ethanol leaf extract of *V. album*

Group 6: Received 150 mg/kg Alloxan and co-administered with 140 mg/kg *C. longa* and 250 mg/kg *V. album*.

2.6. Sample Collection

Blood was collected in plain bottles, allowed to stand for a period of 10-15minutes for coagulation and centrifuged at 3000 rpm using centrifuge (model R-8C) for 10 minutes. The supernatant was transferred into sample bottles and stored at 4°C. The liver was quickly excised, washed in ice cold 1.15% KC1 solution, blotted with filter paper and weighed. They were chopped into bits and homogenized in four volumes of the homogenizing phosphate buffer (pH 7.4) using a Teflon homogenizer. The resulting homogenate was centrifuged using Labnet cold centrifuge model 2366 at 10,000 rpm for 15 minutes at 4°C. The supernatant was then collected, stored in a plain bottle and used for antioxidant enzyme assays.

2.7. Biochemical Analysis

Blood glucose level was measured using ACCU-CHEK glucometer, glycated hemoglobin (HBA_1C) was determined using high performance liquid chromatography (HPLC), serum levels of glucose-6-phosphate dehydrogenase (G6PD), α-Amylase, α-glutamyl transferase (α-GT), alanine and aspartate aminotransferases (ALT and AST), alkaline phosphatase (ALP), protein, urea, bilirubin, creatinine, albumin, sodium, potassium, cholesterol, high density lipoprotein (HDL), and triglycerides (TRIG) were quantified by spectroscopy using Randox commercial assay kits. Organs homogenates were used for antioxidant activities; Protein concentrations were determined by means of biuret method described by [31]. Superoxide dismutase (SOD) activity was determined by the method of [32], catalase (CAT) activity was determined by the method of [33], reduced glutathione (GSH) concentration estimated using the method described by [34] and Glutathione-S-transferase (GST) activity was determined according to [35].

Statistical analysis

Data were analyzed using ANOVA (analysis of variance) and mean separation was done using Turkey HSD and Duncan. $P<0.05$ were considered significant. Data was expressed as means±standard deviation. All statistical analysis was done using IBM SPSS Version 22 and Microsoft Excel.

3. Results

3.1. Phytochemical

Qualitative Phytochemical analysis of *C. longa* rhizome and *V. album* leaves extract (Table 1) showed presence of alkaloids, cardiac glycosides, flavonoids, phenols, saponins, tannins, terpenoids and steroids respectively.

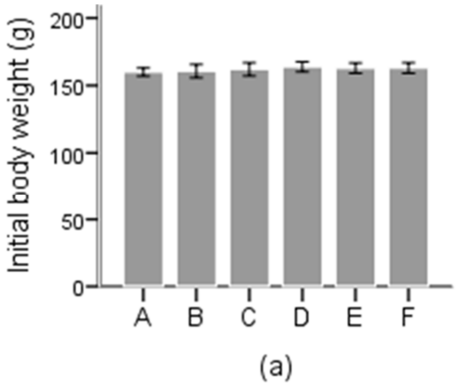
Table 1. *Phytochemical screening of C. longa and V. album ethanol leaves extract.*

Phytochemical	*Curcuma longa*	*Viscum album*
Alkaloids	++	++
Cardiac glycosides	+++	+++
Flavonoids	+++	++
Phenols	++	++
Saponins	++	++
Tannins	++	++
Terpenoids	++	+
Phlobatannins	-	-
Steroids	+	+

(+) indicates presence in trace amount, (++) indicates presence in moderate amount, (+++) indicates presence in strong amount, and (-) indicates not detected.

3.2. Body Weight

Figure 1 reveals the weight increment ability of *C. longa* and *V. album* in male Wistar rats. After two (2) weeks of acclimatization, there was no significant difference $p>0.05$ in the body weight of the rats (Figure a). However, following 21days of treatment, body weights were determined and reported as final body weight (Figure b) and a significant increase $p<0.05$ was observed in all the treated groups; metformin (B) 196.67±3.93, *C. longa* (C) 183.67±3.93, *V. album* (D) 173.83±4.88 and *C. longa* + *V. album* (F) 190.00±1.41 relative to the untreated group (B) 144.83±7.14. The same trend was observed for weight variation and % weight variation (Figure c & d), determined as the weight difference of final body weight and initial body weight and the later multiplied by 100.



(a)

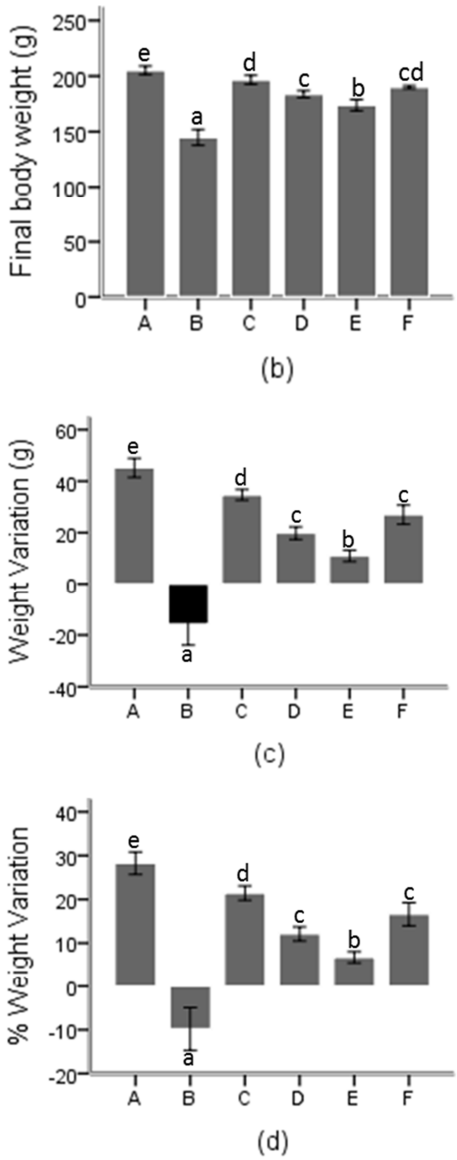


Figure 1. *Effect of Curcuma longa and Viscum album on body weight indices (a,b,c,d). The abbreviations denotes, A: Normal control, B: Negative control, C: Positive control (metformin treated group), D: Curcuma longa treated group, E: Viscum album treated group and F: Curcuma longa+Viscum album treated group.*

3.3. Diabetes

Figure 2 shows the effect of *C. longa* and *V. album* on DM parameters. The experimental groups were exposed to 150 mg/kg intraperitoneal injection of alloxan and after 21days of treatment; investigations were carried out to determine the diabetic status of the rats. blood sugar level, HbA1c and α-Amylase were significantly higher $p<0.05$ in the negative control 19.33±1.51, 11.85±0.43 and 204.00±3.74 respectively, relative to the normal control 6.28±0.43, 5.32±0.29 and 112.50±2.51 whereas, the levels of G6PDH was significantly lower in the negative control 43.00±2.61 relative to the normal control 107.00±3.74. However, blood sugar levels, HbA1c and α-Amylase were significantly decreased and G6PDH significantly increased $p<0.05$ in *V. album*, *C. longa* and pre-eminently *V. album* + *C. longa* treated group vis-à-vis negative control.

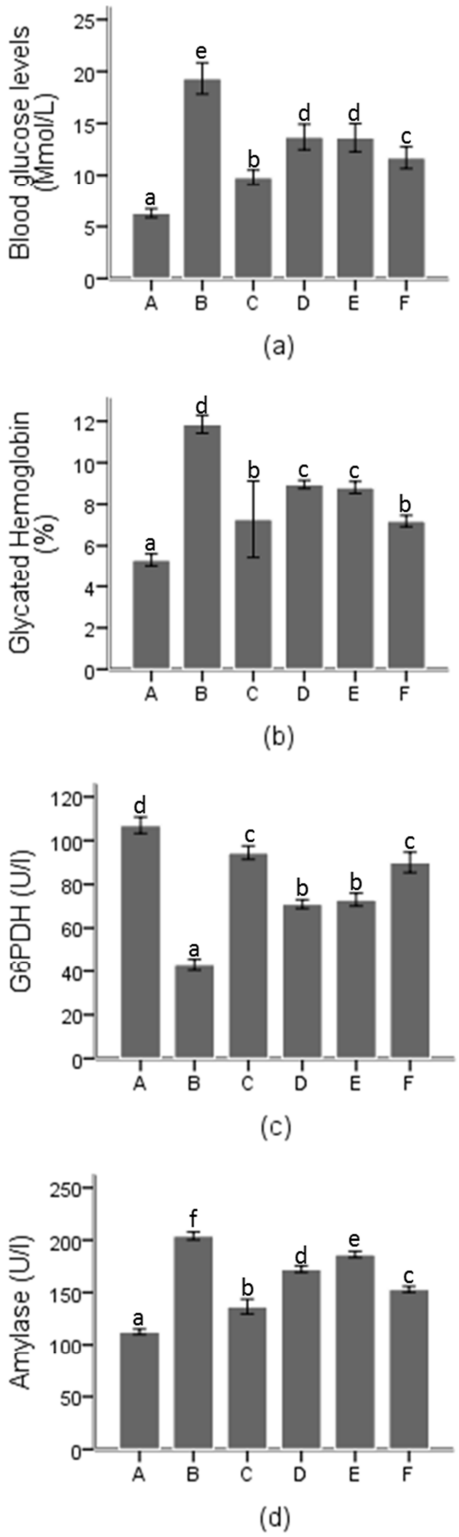


Figure 2. *Effect of C. longa and V. album on blood sugar level (a), Glycated hemoglobin (b), Glucose 6 phosphate dehydrogenase (c) and (d) α-Amylase. The abbreviations denotes, A: Normal control, B: Negative control, C: Positive control (metformin treated group), D: Curcuma longa treated group, E: Viscum album treated group and F: Curcuma longa+Viscum album treated group.*

3.4. Lipid Profile

Figure 3 reveals the effect of *C. longa* and *V. album* on

lipid profile. Following 21days of treatment, the levels of lipid profile parameters were determined. Chol (7.22±0.74) and Trig levels (2.84±0.03) were significantly higher p<0.05 in the untreated group relative to the normal control 2.68±029 and 0.88±0.03, whereas, the level of HDL was significantly lower p<0.05 in the untreated group 0.84±0.08 relative to the normal control 3.18±0.22. However, *C. longa*, *V. ablum* and prominently *C. longa +V. album* showed a significant p<0.05 restoration of the levels of lipid profile parameter.

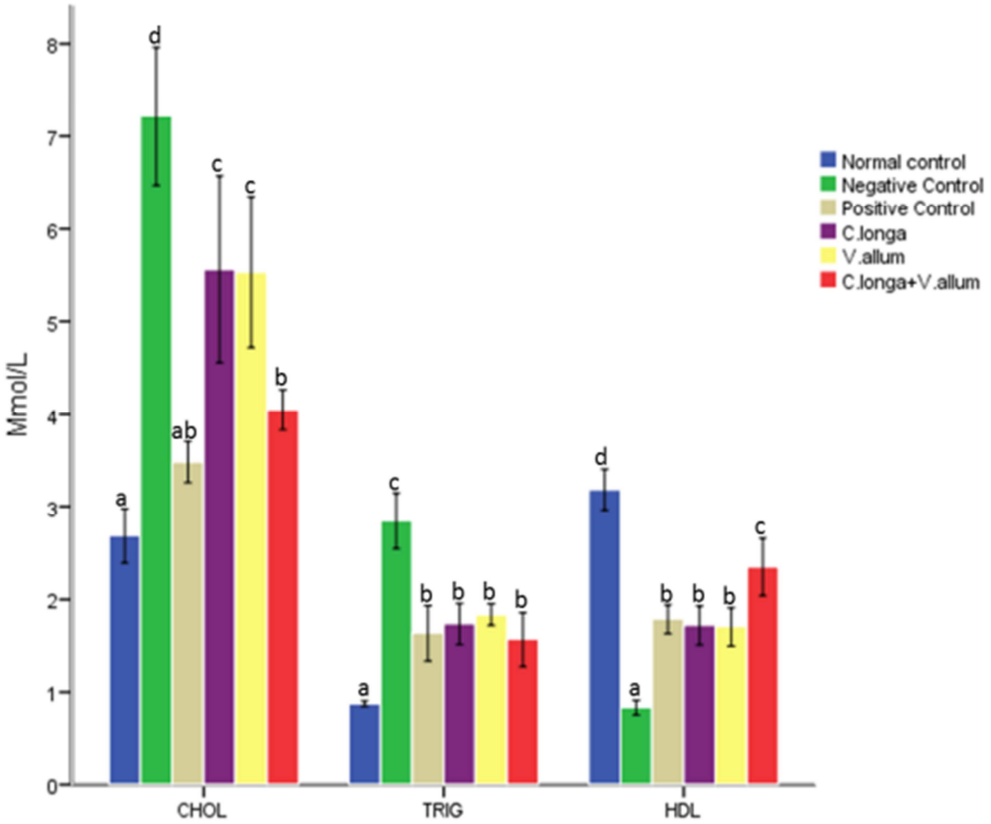


Figure 3. *Effect of C. longa and V. album on lipid profile. The abbreviations denotes, CHOL: cholesterol, TRIG: Triglyceride, and HDL: High density lipoprotein. Bars with same alphabet as superscript are non-significantly (p>0.05).*

3.5. Liver Function

Table 2 demonstrates the effect of *C. longa* and *V. album* on liver function enzymes. At the end of the treatment for the period of 21days, serum liver function enzymes levels were determined and the levels of AST (221.33±6.62), ALT (78.00±3.90), ALP (96.67±3.39) and γ-GT (79.67±3.01) respectively, were significantly increased P<0.05 in the untreated group (Negative control) relative to the normal control (146.33±2.42, 32.33±3.20, 45.67±3.14 and 32.50±3.39). However, *C. longa*, *V. album* and strongly, *C. longa + V. album* treated group significantly P<0.05 reduced the enzymes levels relative to the untreated group (Negative control).

Table 2. *Effect of C. longa and V. album on liver function enzymes.*

Groups	AST	ALT	ALP	γ-GT
Normal Control	146.33±2.42^{a}	32.33±3.20^{a}	45.67±3.14^{a}	32.50±3.39^{a}
Negative Control	221.33±6.62^{e}	78.00±3.90^{d}	96.67±3.39^{d}	79.67±3.01^{d}
Positive Control	186.33±3.08^{cd}	62.67±3.56^{c}	75.17±4.26^{c}	50.00±6.69^{b}
C. longa	183.00±5.48^{d}	64.00±4.10^{c}	75.33±4.97^{c}	55.67±2.42^{c}
V. album	188.67±2.94^{d}	62.83±4.26^{c}	75.00±5.83^{c}	56.33±3.56^{c}
C.longa+V.album	167.00±4.56^{b}	46.83±3.49^{b}	59.83±7.30^{b}	45.83±1.94^{b}

Data are expressed as means±SD: Means with different alphabet as superscript within each column variable are significantly (p<0.05). Abbreviations denote, AST: Aspartate aminotransferases, ALT: Alanine aminotransferase, ALP: Alkaline Phosphatase and γ-GT: Gamma glutamy transferase.

3.6. Antioxidant Enzymes

Table 3 reveals the effect of *C. longa* and *V. album* on antioxidant enzymes. At the end of the experimentation, the rats liver were excised, homogenized and the homogenates were then used for determination of antioxidant enzymes. The levels of antioxidant enzymes assayed for CAT, GST, GSH & SOD respectively, were significantly decreased

$p<0.05$ in the untreated group (Negative control) 4.83±1.47, 3.17±1.17, 44.67±2.25 and 3.67±1.21 relative to the normal control 11.50±1.87, 9.67±1.75, 80.50±5.68 and 10.67±1.63 respectively. However, treatment with *C. longa*, *V. ablum* and *C.longa+V.album* significantly increased the levels of the enzymes relative to the negative control.

Table 3. *Effect of Curcuma longa and Viscum album on Antioxidant enzyme levels.*

Groups	Protein (mg/dl)	CAT (µmol/ H_2O_2/min/mg protein)	GST (µmol/min/mg protein)	GSH (µg/mg protein)	SOD (µMol epinephrine oxidized/min/mg protein)
Normal Control	53.00±2.83^{c}	11.50±1.87^{c}	9.67±1.75^{d}	80.50±5.68^{d}	10.67±1.63^{a}
Negative Control	33.00±2.61^{a}	4.83±1.47^{a}	3.17±1.17^{a}	44.67±2.25^{a}	3.67±1.21^{a}
Positive Control	44.50±2.34^{b}	6.67±1.37^{ab}	6.33±1.21^{bc}	52.67±2.42^{b}	5.00±0.89^{ab}
C. longa	43.17±3.31^{b}	7.67±1.21^{b}	5.00±0.89^{b}	53.83±2.79^{b}	5.50±2.17^{ab}
V .album	41.67±5.12^{b}	7.17±1.17^{ab}	5.50±1.04^{ab}	55.00±2.76^{b}	7.17±1.60^{b}
C.longa+V.album	44.67±3.01^{b}	8.83±1.63^{b}	6.83±1.72^{c}	62.50±2.59^{c}	7.83±2.71^{ab}

Data are expressed as means±SD: Means different alphabets as superscript within each column variable are significantly ($p<0.05$). Abbreviations denote, CAT: Catalase, SOD: Superoxide dismutase, GSH: reduced glutathione, GST: Glutathione-S-transfer.

4. Discussion

Currently, there is a renewed interest in plant-based medicines and functional foods modulating physiological effects in the prevention and management of DM [36]. DM is characterized by hyperglycemia and it is accompanied with loss of body weight [37, 38]. In this respect, our study demonstrated that the diabetic condition was accompanied with body weight loss, as there was a significant $p<0.05$ body weight reduction in alloxan exposed untreated group (Figure 1) which corresponds with the finding that, Alloxan induced diabetes causes a significant loss in body weight as a result of degradation or loss of structural proteins that are obviously known to contribute to the body weight [39, 40]. Apparently, treatment with *C. longa*, *V. album* and pre-eminently co-treatment with *C. longa* + *V. album* led to the restoration of the rats body weights, which of course may have contributed to attenuating the diabetic conditions. In the same light, Alloxan causes diabetes in rat by damaging the insulin-secreting cells of the pancreas leading to hyperglycemia [41] and as such, the present study observed that, the alloxan exposed untreated group showed an increased blood sugar level (Figure 2a). Although, treatment with either *C. longa* or *V. album* showed promising ability in debilitating the blood sugar levels, co-treatment with *C. longa* + *V. album* however demonstrated a better ability similar to that of the diabetic standard drug metformin treated group. They hypoglycemic potency and weight increasing ability of *C. longa* and *V. album* can be attributed to the presence of several phyto-constituents as revealed in Table 1. A number of the phytochemical present in the plants has been demonstrated to possess positive effect on diabetes. Alkaloids inhibit α-glucosidase and reduce the glucose transport to the intestinal epithelium [42], flavonoids increase hepatic glucokinase activity, perhaps by enhancing insulin release from pancreatic islets and significantly reduce the level of glucose [43] and [44]. Saponins, triterpenoid and steroidal glycoside have been reported to stimulate the release of insulin and block the formation of glucose in the blood stream [14]. Clearly, the result of the present study corroborates the findings on the hypoglycemic and body weight improvement ability of *C. longa* [45,19] and *V. album* [46,47]. However, the finding on the marked effect of co-treatment with *C. longa* + *V. album* has not been reported.

To further confirm the hypoglycemic ability of *C. longa* and *V. album,* glucose-6-phosphate dehydrogenase, glycated hemoglobin and α-Amylase levels were investigated (Figure 2 b, c & d). Glucose-6-phosphate dehydrogenase (G6PDH) catalyzes the first step in the hexose monophosphate (HMP) shunt an alternative pathway for the catabolism of glucose to yield pentose sugar [48], Glycated hemoglobin (HbA_1C) is formed in a non-enzymatic pathway by hemoglobin's normal exposure to high plasma glucose levels [49] and alpha-amylase, is an enzymes involved in the digestion of carbohydrates [36]. G6PDH, HbA_1C and α-Amylase are good markers of DM and in this light, of course, the present study revealed that, treatment with *C. longa*, *V. album* and markedly co-treatment with *C. longa* + *V. album* demonstrated a reduced level of HbA_1C, inhibited α-Amylase and enhanced G6PDH. Thus this ability offers an attractive strategy for the management of DM.

During diabetes, low density lipoprotein (LDL) low triglyceride (TRIG), and high density lipoprotein (HDL) are produced due to oxidation of lipoproteins by free radicals [14] and of course, the diabetic untreated group Figure 3 showed an altered lipid profile levels which is as a result of oxidative damage associated with alloxan and oxidative stress in diabetic conditions enhances lipid peroxidation [50]. Also, among the established risk factors for coronary heart disease (CHD), the lipid triad (elevated triglyceride, LDL-cholesterol levels and decreased HDL-cholesterol concentrations) are there major predisposing factor for atherosclerosis in DM [51]. Thus, the result of this present study Figure 3 also revealed that treatment with *C. longa*, *V. album* and prominently, co-treatment with *C. longa* + *V. album*, lowered the levels of CHOL, TRIG and improved level HDL and this finding is in consistent with report of [19, 45] on *C. longa* and [46] on *V. album*.

Enzyme activities in the tissues are often used as 'marker' to ascertain early toxic effects of administered foreign compounds to experimental animals [5, 52]. ALP is a membrane bound enzyme while ALT and AST are cytosolic

enzymes and high levels of ALP, ALT and AST respectively in the serum are indicators of cell membrane permeability and consequent degree of damage to the liver [5, 52]. Alloxan exerts a toxic effect on pancreatic beta cells, which causes T1DM, but this effect extends to the livers [53]. In this regards, alloxan induced diabetes in the present study, caused damage to the liver of the rats as there were marked elevation in the levels liver function biomarkers (AST, ALT, ALP and γ-GT) relative to the normal control table 2. However, treatment with *C. longa*, *V. album* and co-treatment with *C. longa* + *V. album* enervated levels of liver function biomarkers vis-à-vis the diabetic untreated group and as such improved the liver integrity and function. Also, the result is consistent with the report of [54] on *C. longa* and [55] on *V. album*

Experimental evidence has revealed the involvement of free radicals in the pathogenesis and complications of diabetes and these radicals are able to damage cell proteins, lipids and DNA which alter the cell function [14]. Antioxidants neutralize free radicals and are effective in preventing experimentally induced diabetes in animal models [56], it has been described decreased and free radicals increased in diabetics [57]. In this light, of course, result of the present study table 3, corroborates this finding. In that, the levels of antioxidant enzymes catalase, GST, GSH and SOD respectively were found to be decreased in diabetic untreated rats (negative control) vis-à-vis normal control and this can be attributed to the oxidative damage of the pancreas by alloxan injection. However, treatment with *C. longa*, *V. album* and pre-eminently co-treatment with *C. longa* + *V. album* showed a potent ability in increasing the antioxidant levels and scavenging free radicals which perhaps aggravated diabetic conditions. Plant source bioflavonoids have been reported to be an excellent candidate for free radical scavenging [58] therefore, curcumin from *C. longa* and lectin from *V. album* are excellent antioxidant and has also been demonstrated to be potent in the management of diabetes [59,60].

5. Conclusion

Plants based therapies may be a potent means of managing and preventing diabetes and its related complications. Also, currently, combination therapies are employed for the treatment of critical diseases. In view of this, the result of the present study revealed that *C. longa*, *V. album* and prominently, co-treatment with *C. longa* + *V. album* significantly improved the diabetic condition of the rats, attenuated lipid profile, ameliorated key liver function enzymes and enhanced the antioxidant status. Therefore, we recommend that *C. longa* and *V. album* may be used as nutritional supplements or as an addition to the current medication regimen to prevent or manage DM.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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