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Liver Function Status of Diabetic Wistar Rats Treated with Ethanol Extract of *Cucumis Sativus* Fruit

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ABSTRACT

Diabetes mellitus is a fast growing metabolic disorder and one of the leading causes of death worldwide. The aim of this study was to evaluate the effect of ethanol extract of *Cucumis sativus* on liver function in diabetic rats. Adult male Wistar albino rats (n = 25) weighing 200 to 230 g (mean weight = 215 ± 15 g) were used for this study. The rats were randomly assigned to five groups of 5 rats each: normal control group, diabetic control group, metformin group, 200 mg/kg bwt extract and 300 mg/kg bwt extract groups. Diabetes mellitus was induced in the rats via intraperitoneal injection of STZ at a dose of 50 mg/kg bwt. The diabetic rats were then treated for 21 days with either metformin (50 mg/kg bwt) or the extract at doses of 200 and 300 mg/kg bwt, respectively, leaving the diabetic control group untreated. Induction of diabetes mellitus with STZ significantly increased the serum activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP), as well as total protein, bilirubin, and Fasting Blood Glucose (FBG) concentrations ($p < 0.05$). However, treatment of diabetic rats with ethanol extract of *C. sativus* markedly reduced the activity of the liver enzymes, and the concentrations of total protein, bilirubin and FBG. The results obtained in this study suggest that ethanol extract of *C. sativus* is effective in ameliorating STZ-induced diabetes mellitus.

Keywords: Aminotransferases; *Cucumis Sativus*; Hepatocytes; Liver Function; Total Protein

Abbreviations: AST: Aspartate Aminotransferase; ALT: Alanine Aminotransferase; FBG: Fasting Blood Glucose; ALP: Alkaline Phosphatase; T1DM: Type 1 Diabetes Mellitus; T2DM: Type 2 Diabetes Mellitus; BDH: British Drug House; LFTs: Liver Function Test; ROS: Reactive Oxygen Species

Introduction

Cucurbits are vegetable crops, belonging to the family Cucurbitaceae, which primarily comprises species consumed as food worldwide. Cucurbits are an excellent fruit in nature, composed of all the essential constituents required for good health in humans [1]. They are consumed as vegetables and salads due to their availability at low cost. Cucumbers are botanically categorized as berries, which are available in many different sizes, shapes and colours. They range from thick, stubby little fruits (10 - 12 cm long) to Dutch greenhouse varieties (of up to 50 cm long) [1]. The most common variety is the long cucumber which has a smooth, dark-green skin. The "gherkin" is a cucumber that was harvested when little and pickled in brine. The true gherkin is a different species (Cucumis anguria), which is primarily grown in the West Indies. Cucumbers may not contain a lot of food value, but they make up for this lack of nutrients with a wide variety of healthy substances [2]. The parts of this medicinal plant which are traditionally used are leaves, flowers, seeds, fruits, and bark. These parts contain bioactive compounds responsible for particular pharmacological activity [3]. *Cucumis sativus* is used in traditional medicine for the treatment of various ailments [3,4]. Diabetes mellitus is a heterogeneous group of syndromes characterized by an increase in fasting blood glucose, caused by a relative or absolute deficiency in insulin [5].

It is one of the most common metabolic disorders affecting millions of people worldwide [6]. It is a major cause of heart disease and stroke [7]. Death rates for heart disease and the risk of stroke are about 2 – 4 times higher among adults with diabetes than in non-diabetics [7]. In diabetic individuals, high blood pressure, high blood cholesterol, and smoking increase the risk of heart disease and stroke [8]. The most common forms of diabetes mellitus are type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), gestational diabetes, and other types [9]. Biochemical and histochemical analysis have shown that some cucurbits are effective in preventing pancreatic β-cell apoptosis induced by noxious chemicals [10].

Materials and Methods

Drugs and Chemicals

The standard antidiabetic drug, metformin, was purchased from Micronova Laboratories (India), and STZ was a product of British Drug House (BDH) Chemicals Ltd. (England). Absolute ethanol, chloroform, syringes, beakers, test tubes, pH meter and other glass wares were obtained from Bell, Sons & Co. (England), and formaldehyde was purchased from Thermo Fisher Scientific Ltd. (USA). All the chemicals and solvents used in this study were of analytical grade.

Plant Preparation and Extraction

Freshly harvested *Cucumis sativus* fruits were purchased from a major fruit/vegetable market in Benin City, Nigeria and identified by Dr. Henry Akinibosun of Plant Biology and Biotechnology Department, University of Benin. They were thereafter washed and air-dried for about 4 weeks at the Department of Biochemistry. The dry plant was ground with a mechanical blender. The pulverized sample was cold macerated in absolute ethanol for three days (72 h) in a bell jar and filtered using Whatmann filter paper No. 42 (125 mm). The ethanol extract was thereafter concentrated using rotary evaporator and freeze-dried using a lyophilizer [11,12].

Experimental Animals

Adult male Wistar albino rats (n = 25) weighing 200 to 230 g (mean weight = 215 ± 15 g) were used for this study. The rats were bought from the Department of Anatomy, University of Benin and housed in wooden cages. They were acclimatized for two weeks before commencement of the study, and had free access to feed and water.

Experimental Design

The rats were randomly assigned to five groups of 5 rats each: normal control group, diabetic control group, metformin group, 200 mg/kg bwt extract and 300 mg/kg bwt extract groups. Diabetes mellitus was induced in the rats via intraperitoneal injection of STZ at a dose of 50 mg/kg bwt. The diabetic rats were then treated with either metformin (50 mg/kg bwt) or the extract at doses of 200 and 300 mg/kg bwt, respectively, for 21 days.

Collection of Blood

At the end of the treatment, the rats were subjected to mild chloroform an aesthesia after an overnight fast. They were euthanized and blood was collected via retro-orbital sinus puncture and centrifuged for 10 min at 3000 rpm to obtain serum which was used for biochemical analysis.

Biochemical Assays

The biochemical parameters studied were liver function tests such as AST, ALT, ALP, bilirubin and total protein [13-16].

Statistical Analysis

Data are presented as mean ± SEM (n = 5). Statistical analysis was performed using SPSS version 21. Statistical differences between means were compared using Duncan multiple range test. Statistical significance was assumed at $p < 0.05$

Results

Effect of Ethanol Extract of *C. sativus* on Weight and Blood Glucose of Rats

As shown in (Table 1), induction of diabetes mellitus using STZ significantly increased the blood glucose concentrations of the rats ($p < 0.05$). However, treatment of the diabetic rats with the extract markedly reduced the FBG concentration and body weights of rats ($p < 0.05$).

Table 1: Effect of Ethanol Extract of *C. sativus* on Weight and Blood Glucose Parameters.

Group	Weight Change (g)	% Weight Change	Glycemic Change (mg/dL)	% Glycemic Change
Normal Control	-	-	-	-
Diabetic Control	-	-	-	-
Metformin	20.35	12.16	399	49.88
200 mg/kg bwt Extract	12.26	7.87	421	52.63
300 mg/kg bwt Extract	29.08	17.02	227	62.36

Note: Data are weight and FBG parameters and are expressed as mean ± SEM (n = 5).

Effect of Ethanol Extract of *C. sativus* on Activities of Liver Enzymes and Total Protein Concentration

Induction of diabetes mellitus with STZ significantly increased the serum activities of AST, ALT and ALP, as well as total protein concentration ($p < 0.05$). However, treatment of diabetic rats with ethanol extract of *C. sativus* markedly reduced the activities of the liver enzymes and total protein concentration ($p < 0.05$). These results are shown in (Tables 2 & 3).

Table 2: Activities of Liver Enzymes in Diabetic Rats Treated with Ethanol Extract of *C. sativus*.

Group	AST (U/L)	ALT (U/L)	AST/ALT
Normal Control	82.25 ± 3.25	13.34 ± 0.38	6.17 ± 0.39
Diabetic Control	156.00 ± 1.00	52.69 ±2.13	2.96 ±0.47
Metformin	85.75 ± 4.75	18.70 ± 0.74	4.59 ±0.64
200 mg/kg bwt Extract	89.00 ± 0.00	16.30 ± 0.00	5.46 ± 0.00
300 mg/kg bwt Extract	85.75 ± 0.25	16.30 ± 2.60	5.26 ± 0.96

Note: Data are activities of liver enzymes and are expressed as mean ± SEM (n = 5).

Table 3: Activities of ALP and Total Protein Concentration.

Group	ALP (U/L)	Total Protein (g/dL)
Normal Control	23.87 ± 0.00	8.59 ±1.16
Diabetic Control	52.88 ± 0.00	16.95 ± 7.20
Metformin	24.14 ± 0.00	8.01 ± 0.58
200 mg/kg bwt Extract	29.83 ± 0.00	9.29 ± 0.00
300 mg/kg bwt Extract	23.60 ± 0.28	7.95 ± 0.53

Note: Data are activities of ALP and total protein concentration, and are expressed as mean ± SEM (n = 5).

Effect of Ethanol Extract of *C. sativus* on Concentrations of Bilirubin

As shown in (Table 4), bilirubin concentration was significantly higher in the diabetic group than in the normal control and extract–treated rats ($p < 0.05$).

Table 4: Concentrations of Bilirubin in the Different Groups.

Group	T. Bilirubin (µmol/L)	D. Bilirubin (µmol/L)	Ind. Bilirubin(µmol/L)
Normal Control	13.00 ± 0.00	4.06 ± 0.37	8.94 ± 0.71
Diabetic Control	20.35 ± 1.85	6.28 ± 0.13	14.07 ± 1.72
Metformin	11.10 ±0.00	4.80 ± 2.09	6.30 ± 0.90
200 mg/kg bwt Extract	3.70 ± 0.00	6.64 ± 0.00	0.00 ± 0.00
300 mg/kg bwt Extract	5.11 ± 1.58	3.12 ± 0.36	1.99 ± 0.22

Note: Data are concentrations of bilirubin and are expressed as mean ± SEM (n = 5).

Discussion

There is presently a growing interest in herbal treatments due to the expansion of medicine. In Africa alone, over 500 plants are known to be used for medicinal purposes, but only a few have been described or studied [17]. A plant is said to be medicinal only when its biological effect has been ethnobotanically or scientifically proven [18]. Plant secondary metabolites are unique resources for pharmaceuticals, food additives, and fine chemicals [19]. An estimated increase in the number of persons with diabetes mellitus is expected over the next decade. Diabetes mellitus is a condition primarily defined by the level of hyperglycemia giving rise to risk of microvascular damage (retinopathy, nephropathy, and neuropathy). It is also associated with increased risk of macrovascular complications (ischemic heart disease, stroke, and peripheral vascular disease), reduced life expectancy, morbidity and reduced quality of life [20,21]. If blood glucose level remains high (hyperglycemia) for a long time, there would be long-term damage to organs such as liver, kidney, eye, nerves, heart and blood vessels [22,23]. Several pathogenic processes are involved in the development of the disease. These range from autoimmune destruction of pancreatic beta cells with consequent insulin deficiency, to abnormalities resulting in resistance to insulin action [20].

The basis of the abnormalities in carbohydrate, fat, and protein metabolism in diabetes mellitus is reduced action of insulin on target tissues. Deficiency in insulin action results from inadequate insulin secretion and/or diminished tissue responses to insulin at one or more points in the pathways of hormone action. Impairment of insulin secretion and defects in insulin action often coexist in the same patient, and it is often unclear which abnormality, if either alone, is the primary cause of hyperglycemia [21]. Liver Function tests (LFTs) can be used to screen for the presence of liver disease, suggest the

underlying cause, estimate the severity, assess prognosis, and monitor effectiveness of therapy. Liver enzymes are released into systemic circulation following cellular necrosis and increased cell membrane permeability and are used as diagnostic measure of liver damage. Most proteins in plasma are synthesized by hepatocytes and secreted into circulation. Bilirubin, a major breakdown product of hemoglobin, rises when there is liver injury or damage, leading to discolouration of the skin; a condition known as jaundice. Elevation of total bilirubin which results from decreased uptake and conjugation of bilirubin by the liver is caused by liver cell dysfunction, while increased levels of direct or conjugated bilirubin is due to decreased secretion from liver or bile ducts obstruction. Increase in albumin, bilirubin and total protein following increase in hemolysis or liver disease or both can lead to jaundice of the skin or kernicterus in the brain [24].

Diabetes mellitus is generally induced in laboratory animals using streptozotocin or alloxan. Streptozotocin (STZ) is a permanent diabetes-inducing drug that is synthesized by a strain of the soil microbe Streptomyces achromogenes (gram positive bacterium) [25]. The most frequently occurring disorder of carbohydrate metabolism is hyperglycemia [26]. Many of the drugs currently used for the treatment of diabetes mellitus produce adverse effects: sulfonylureas usually stimulate pancreatic islet cells to secrete insulin, while metformin slows down hepatic glucose production [27]. The effectiveness of all these therapies are limited, thereby necessitating the search for novel plant-based compounds that can be used to effectively control hyperglycemia. The antidiabetic effect of plant-derived compounds is due to their ability to alter carbohydrate digestion/absorption, stimulate beta cell function, mimic insulin action, and mop up Reactive Oxygen Species (ROS) [28]. In this study, the intraperitoneal administration of STZ caused a significant elevation in Fasting Blood Glucose (FBG) level. This elevated blood glucose level was significantly reduced after daily treatment with ethanol extract of *C. sativus*. Similarly, STZ significantly increased the serum activities of AST and ALT, as well as total protein concentration. However, treatment of diabetic rats with ethanol extract of *C. sativus* markedly reduced the activities of the liver enzymes and total protein concentration. Bilirubin concentration was significantly higher in the diabetic group than in the normal control and extract–treated rats.

The effect of the extract was similar to that of metformin. The evaluation of plasma total protein alone may not tell the actual picture of the metabolic state of an individual, since the concentration of the various proteins are not affected by each other. An elevated level of total protein may be due to dehydration or infection. Plasma concentration may decrease due to impaired synthesis that can result from malnutrition, malabsorption, over-hydration and some forms of liver diseases [29]. It appears that STZ adversely reduced liver functions. It is likely that the extract possesses anti-hyperglycemic effect. It has been reported that ethanol extracts of Cucurbitaceae family fruits like cucumber, white pumpkin, and ridge gourd possess significant anti-hyperglycemic effects [30]. The results of this study are in agreement with previous findings [31-35]. Recent studies validated the presence of antidiabetic agents in *Cucumis sativus* L. [33]. The antidiabetic agent in *Cucumis sativus* L. has been identified as a flavonoid called kaempferol [33]. Studies have shown that plant rich in phytochemicals possess important biological and pharmacological activities [36-44].

Conclusion

The results obtained in this study suggest that ethanol extract of *C. sativus* is effective in ameliorating STZ-induced liver dysfunction.

References

1. Yawalkar KS (1985) Cucurbitaceous or vine crops. In: Vegetable crops of India Agric. Horticultural Publishing House Nagpur India, pp. 150-158.
2. Sood A, Kaur P, Gupta R (2012) Phytochemical Screening and Antimicrobial Assay of Various Seeds Extract of Cucurbitaceae Family. International Journal of Applied Biology and Pharmaceutical Technology 3(3): 401-409.
3. Patil MVK, Kandhare AD, Bhise SD (2012) Effect of aqueous extract of *Cucumis sativus* Linn. fruit in ulcerative colitis in laboratory animals. Asian Pacific Journal of Tropical Biomedicine 2(2): S962- S969.
4. Heidari H, Kamalinejad M, Eskandari M (2012) Hepatoprotective activity of *Cucumis sativus* against cumene hydroperoxide induced-oxidative stress. Research in Pharmaceutical Sciences 7(5): S936- S939.
5. (2011) Center for Disease Control. National diabetes fact sheet: National estimates and general information on diabetes and prediabetes in the United States.
6. Onoagbe IO, Esekheigbe A (1999) Studies on the anti-diabetic properties of Uvaria chamae in streptozotocin-induced diabetic rabbits Biokemistri 9(2): 79-84.
7. (2012) Center for Disease Control and Prevention. Diabetes Report Card 2012. Atlanta, GA: Centers for Disease Control and Prevention, U.S Department of Health and Human Services.
8. Imperatore G, Cadwell BL, Geiss L, Saaddine JB, Williams DE, et al. (2004) Thirty-year trends in cardiovascular risk factor levels among U.S adults with diabetes: National Health and Nutrition Examination Surveys 1971-2000. Am J Epidemiol 160: 531- 539.
9. (2009) World Health Organization. Medicines: Safety of medicines-adverse drug reactions.
10. Jiyun A, Wonhee C, Suna K, Taeyoul H (2011) Antidiabetic effect of watermelon (Citrullus vulgaris Schrad) on streptozotocin-induced diabetic mice. Food Sci Biotechnol 20: 251-254.
11. Abu OD, Imafidon KE, Obayuwana HO, Okuofu ED (2018) Phytochemical, proximate, and metal content analysis of citrullus lanatus (watermelon) seeds. FUDMA Journal of Sciences 2(2): 153 -156.
12. Abu OD, Onoagbe IO (2019a) Biochemical effect of aqueous extract of Dialium Guineense stem bark on oxidative status of normal Wistar rats. International Journal of Clinical Biology and Biochemistry 1(2): 15-18.
13. Reitman S, Frankel S (1957) A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases Am J Clin Pathol 28(1): 56-63.

14. Babson LA (1965) Phenolpthalein monophosphate, a new substrate for alkaline phosphatase. In: Abstracts of papers from scientifi c sessions: 17th National Meeting of the American Association of Clinical Chemists Chicago III.
15. Jendrassik L, Grof P (1983) Colourimetric method for the determination of serum bilirubin. Biochemische Zeitschrift 297: 81.
16. Henry RJ, Sobel C, Beckman S (1957) Determination of serum protein by the biuret reaction. Anal Chem 92(149): 1-5.
17. Taylor JLS, Rabe T, Mcgaw LJ, Jager AK, van Staden J (2001) Towards the scientific validation of traditional medicinal plants. Plant Growth Regul 34: 23-37.
18. Elujoba AA (1998) The role of pharmacognosy in phytotherapy, the challenges of our time. Nigerian Journal of Natural Products and Medicine 2: 5-8.
19. Müller JL (1998) Love potions and the ointment of witches: Historical aspects of the nightshade alkaloids. J Toxicol Clin Toxicol 36(6): 617- 627.
20. Abbott RD, Brand FN, Kannel WB (1990) Epidemiology of some Peripheral Arterial Findings in Diabetic Men and Women: Experiences from the Framingham Study.
21. Barceló A, Rajpathak S (2001) Incidence and prevalence of diabetes mellitus in the Americas. Rev Panam Salud Publica 10(5): 300-308.
22. Abu OD, Imafidon KE, Obayuwana O (2020a) Effect of aqueous extract of Anacardium occidentale leaves on blood glucose level and lipid profile of diabetic rats. Global Scientific Journal 8(10): 977-987.
23. Abu OD, Imafidon KE, Obayuwana O (2020b) Ethanol leaf extract of Anacardium occidentale ameliorates alloxan-induced changes on blood glucose level and lipid profile of Wistar rats. IAR Journal of Medical Sciences 1(5): 257-262.
24. Majekodunmi SO, Oyagbami AA, Umukoro S, Odeku OA (2011) Evaluation of the antidiabetic properties of Mucuna pruriens seed extract. Asian Pacific Journal of Tropical Medicine 2011: 632-636.
25. Dolan ME (1997) Inhibition of DNA repair as a means of increasing the antitumor activity of DNA active agents. Advanced Drug Delivery Reviews 26(2-3): 105-118.
26. Tietz NW (1999) Fundamentals of Clinical Chemistry (3rd Edn.)., WB Saunders Company.
27. Moller DE (2001) New drug targets for type 2 diabetes and the metabolic syndrome. Nature 414(6865): 821-827.
28. Tiwari AK, Rao JM (2002) Diabetes mellitus and Multiple Therapeutic Approaches of Phytochemicals: Present Status and Future Prospects. Current Science Association 83: 30-38.
29. Tietz NW, Finley PR, Pruden EL (1990) Clinical Guide to Laboratory Tests, (2nd Edn.)., WB Saunders, Philadelphia. Scientific Research, pp. 304-306.
30. Sharmin R, Khan MRI, Akhter MA, Alim A, Islam A, et al. (2012) Hypoglycemic and Hypolipidemic Effects of Cucumber, White Pumpkin and Ridge Gourd in Alloxan Induced Diabetic Rats. Journal of Scientific Research 5(1): 161-170.
31. McNally DJ, Wurms KV, Labbé C, Quideau S, Bélanger RR (2003) Complex C-glycosyl flavonoid phytoalexins from *Cucumis sativus*. Journal of Natural Products 66(9): 1280-1283.
32. Kai H, Baba M, Okuyama T (2007) Two new megastigmanes from the leaves of *Cucumis sativus*. Chemical and Pharmaceutical Bulletin 55(1): 133-136.
33. Ibitoye OB, Uwazie JN, Ajiboye TO (2018) Bioactivity-guided isolation of kaempferol as the antidiabetic principle from *Cucumis sativus L*. fruits. Journal of Food Biochemistry 42(4): 1-7.
34. Abu OD, Onoagbe IO, Obahiagbon O (2020c) Alpha amylase and alpha glucosidase inhibitory activities of extracts of Dialium guineense stem bark. International Journal of Clinical Biology and Biochemistry 2(1): 7-10.
35. Abu OD, Onoagbe I O, Osemwenoyenmwen O (2020d) Alpha amylase and alpha glucosidase inhibitory activities of isolated total saponins and tannins of Dialium guineense stem bark. Journal of Cellular and Molecular Biology Research 1(2): 1-3.
36. Abu OD, Onoagbe IO, Obahiagbon O (2020e) *In Vitro* Antioxidant Activities of Isolated Total Saponins and Tannins of Dialium Guineense Stem Bark. IAR Journal of Medical Sciences 1(4): 193-199.
37. Abu OD, Onoagbe IO, Obahiagbon O (2020f) Vitamin contents of extracts of Dialium guineense stem bark. Biomed J Sci and Tech Res 30(2): 23263 -23267.
38. Abu OD, Onoagbe IO, Obahiagbon O (2020g) Analyses of metal and amino acid compositions of aqueous and ethanol stem bark extracts of Dialium guineense. Journal of Biogeneric Science and Research 6(4): 1-3.
39. Abu OD, Onoagbe IO, Obahiagbon O (2020h) Phenolic contents of extracts of Dialium guineense stem bark. American Journal of Sciences and Engineering Research 3(4): 92-96.
40. Abu OD, Onoagbe IO (2021) Acute toxicity of aqueous and ethanol extracts of Dialium guineense stem bark. Journal of Bioinnovation10(2): 427-432.
41. Abu OD, Adeogun EF, Ebhohon SO (2019b) Oral LD50 of total saponins and tannins isolated from Dialium guineense stem bark. European Journal of Experimental Biology 9(2): 11-13.
42. Abu OD, Iyare HE, Ogboi KU (2022a) Cardiac Oxidative Status in CCl4-Exposed Rats Treated with Extracts of Dialium guineense Stem Bark. Global Journal of Scientific Frontier Research 22(01): 1-6.
43. Abu OD, Umar AB, Eiremiokhae CO (2022b) Investigation of the Cardioprotective Capacity of Aqueous Extract of Icacina trichanta Leaves in Rats Exposed to CCl4. Journal of Genetics and Cell Biology 6(1): 322-328.
44. Abu OD, Onoagbe IO, Ohikhuare F (2022c) Nephrotoxic Evaluation of Ethanol Stem Bark Extract of Dialium guineense in Normal Wistar Rats. International Journal of Forensic Medicine 4(2): 19-22.

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