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Total Protein and Cardiovascular Disease Risk Factors of Normal Wistar Rats Exposed to Moderate Dose of Aqueous Extract of Dialium guineense Stem Bark

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Abstract

The health benefits of plant-derived materials are well established. However, the major setback to the use of herbal formulations in disease management is their potential toxic effect at doses administered. The present study investigated the effect of moderate dose of aqueous extract of *Dialium guineense* (AEDG) stem bark on total protein (TP) and cardiovascular disease risk factors of normal rats. Male albino rats (Wistar strain, n = 10) weighing between 150 and 180 g (mean weight = 165 ± 15 g) were divided into two groups (5 rats per group): control and observation groups. Rats in the observation group received 1000 mg/kg body weight, bwt, AEDG stem bark orally for twenty-eight days, and assays were performed on weekly basis. The results showed that there were no significant differences in the concentrations of total protein, total cholesterol (TC) and high-density lipoprotein cholesterol (HDL-C) throughout the period of treatment, when compared with control group ($p > 0.05$). However, there were significant and time-dependent reductions in the concentrations of triacylglycerol (TG), very low-density lipoprotein cholesterol (VLDL-C), low-density lipoprotein cholesterol (LDL-C) and atherogenic index of plasma (AIP), relative to control group ($p < 0.05$). In addition, atherogenic coefficient and cardiovascular disease risk ratio were significantly reduced at weeks 3 and 4 ($p < 0.05$). These results indicate that the medicinal plant stem bark can be used as crude drug to manage diseases resulting from hypercholesterolemia and hypertriglyceridemia.

Keywords: Atherogenic index, Cardiac disease, Lipids, Hypercholesterolemia, Medicinal plant

Introduction

Lipid is the collective name for fats, oils, waxes, and fat-like molecules. The basic unit of lipids is a triglyceride, synthesized from glycerol (propane-1,2,3-triol) and fatty acids. Lipids participate in cellular metabolism and homeostasis. In addition to their numerous functions in cells, they are integral part of plasma and intracellular membranes (Friedman *et al.,* 2003). Besides their protection, waterproofing, insulation and buoyancy functions, lipids serve as energy stores and chemical messengers (steroid hormones). Disruption of lipid metabolism, synthesis and transportation can result in unpleasant consequences in cells (Friedman *et al.,* 2003). Thus, abnormal lipid profile is often seen in severe liver dysfunction. For example, a prominent decline in plasma total cholesterol and triacylglycerol levels is observed in patients with severe hepatitis and hepatic failure (Halsted, 2004).

Traditional medicine makes use of materials derived from plants. These substances are effective in the treatment of diseases (Fabricant and Farnsworth, 2001). Medicinal plants contain compounds with proven/demonstrated biological activities. Their use in disease management is as old as man. These plants serve as cheap alternative to orthodox medicine as they are readily available (Kar, 2007; Abu and Onoagbe, 2021; Abu *et al.,* 2022a).

Dialium guineense is a medicinal plant used in folklore medicine for the treatment of infections such as diarrhea, severe cough, bronchitis, wound, stomachaches, malaria, jaundice, ulcer and hemorrhoids (Bero *et al.,* 2009; Abu *et al.,* 2015; Abu and Onoagbe, 2019). Extracts of the plant are reported to be rich in important phytochemicals (Hostettmann and Marston, 1995; Kar, 2007; Abu *et al.,* 2020a). This study investigated the effect of moderate dose of AEDG stem bark on total protein and cardiovascular disease risk factors in normal rats.

Materials and Methods

Chemicals and Reagents

All chemicals and reagents used in this study were of analytical grade and they were bought from Sigma-Aldrich Ltd. (USA).

Plant Sample Collection and Extract Preparation

The stem barks of *D. guineense* were collected from Auchi area of Edo State, Nigeria and authenticated at the herbarium of the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria (No. UBH_D330). The plant's stem bark was washed and shade-dried for 1 month at room temperature, and then pulverized using a blender. Exactly 500 g of the powdered plant material was steeped in 5 L of absolute ethanol. The resulting extract was filtered through muslin cloth and freeze-dried via lyophilization (Abu *et al.,* 2017a,b; Abu *et al.,* 2019a,b).

Experimental Rats

Male albino rats (Wistar strain, n = 10, mean weight = 165 ± 15 g) were purchased from the Department of Anatomy, University of Benin, Nigeria and housed in wooden cages. They were acclimatized for 14 days just before commencement of the study, and had free access to feed (rat chow) and water.

Experimental Design

The rats were divided into two groups (5 rats per group): control and observation groups. The observation group rats received 1000 mg/kg bwt, AEDG stem bark orally for 28 days.

Blood Sample Collection and Preparation

Blood samples were collected on weekly basis via rat tails. At the end of day 28 of treatment, the rats were euthanized under mild chloroform anaesthesia after an overnight fast. Blood samples collected via cardiac puncture in heparin containers were centrifuged at 2000 rpm for 10 min to obtain plasma.

Biochemical Analyses

The concentrations of plasma total protein, total cholesterol, triacylglycerol, VLDL-cholesterol, HDL-cholesterol, LDL-cholesterol, AIP, atherogenic coefficient (AC) and cardiovascular disease risk ratio (CRR) were determined (Henry *et al.,* 1957; Friedewald *et al.,* 1972; Lopes-Virella *et al.,* 1977; Reiser *et al.,* 1985; Tietz *et al.,* 1990; Frohlich and Doblasova, 2003).

Data Analysis

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

Results

Effect of AEDG Stem Bark on Weight Parameters

The weights of rats were significantly and time-dependently increased by extract treatment ($p < 0.05$; Figure 1).

Effect of AEDG Stem Bark on Total Protein and Cardiovascular Disease Risk Ratio

There were no significant differences in the concentrations of total protein, total cholesterol and HDL-cholesterol throughout the period of treatment, when compared with control group ($p > 0.05$). However, there were significant and time-dependent reductions in the concentrations of TG, VLDL-C, LDL-C and atherogenic index of plasma, relative to control group ($p < 0.05$). In addition, atherogenic coefficient and cardiovascular disease risk ratio were significantly reduced at weeks 3 and 4 ($p < 0.05$). These results are shown in Figures 2 – 6).

Discussion

Lipids are heterogeneous group of substances that are hydrophobic (that is, insoluble, or only sparingly soluble in water, but soluble in organic solvents). They are mostly derivatives of fatty acids, their esters, and amides, among others. Among many functions of lipids, they are components of biological membranes. As organized assemblies of lipids and proteins with small amounts of carbohydrates membranes are necessary for the maintenance of cellular integrity. Lipid profile is a panel of blood tests that serves as an initial broad medical screening tool for the assessment of abnormalities in the concentrations of lipids (cholesterol and triacylglycerol). These tests can identify certain genetic diseases and determine approximate risks for cardiovascular diseases (CVDs), certain forms of pancreatitis, and other diseases. Lipid profile typically includes LDL-C, HDL-C, TG, TC, VLDL-C and CRR (Reiser *et al.,* 1985). Atherogenicity index (coefficient) reflects the ratio of atherogenic lipoproteins (LDL) to the content of anti-atherogenic lipoproteins (HDL) in the blood, or more accurately reflects the favourable and unfavourable combination of lipoproteins in terms of the risk of coronary artery disease.

This study investigated the effect of AEDG stem bark on total protein and cardiovascular disease risk ratio of normal rats. The results showed that there were no significant differences in the concentrations of total protein, total cholesterol and high-density lipoprotein cholesterol throughout the period of treatment, when compared with control group. However, there were significant and time-dependent reductions in the concentrations of triacylglycerol, very low-density lipoprotein cholesterol, low-density lipoprotein cholesterol and atherogenic index of plasma, relative to control group. In addition, atherogenic coefficient and cardiovascular disease risk ratio were significantly reduced at weeks 3 and 4.

These results appear to indicate that the plant extract may possess anti-hypertriacylglycerolemic and anti-hypercholesterolemic properties, and are in agreement with results of previous studies (Abu *et al.,* 2022a,b; Abu *et al.,* 2023a,b). The reductions of TG, VLDL-C, and LDL-C in the rats may be beneficial in ameliorating cardiovascular disease risk factors. The lipid lowering capacity of plant extracts has been reported to be due to antioxidant activity of phytochemicals in different parts of plants (Abu *et al.,* 2021a,b,c; Abu *et al.,* 2022c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v; Abu *et al* 2023c,d,e,f,g,h,i,j,k,l,m; Abu *et al.,* 2024a,b,c,d).

Conclusion

The results of this study indicate that the medicinal plant stem bark can be used as crude drug to manage diseases resulting from hypercholesterolemia and hypertriglyceridemia.

Conflict of Interest

The authors declare no conflicts of interest.

Acknowledgement

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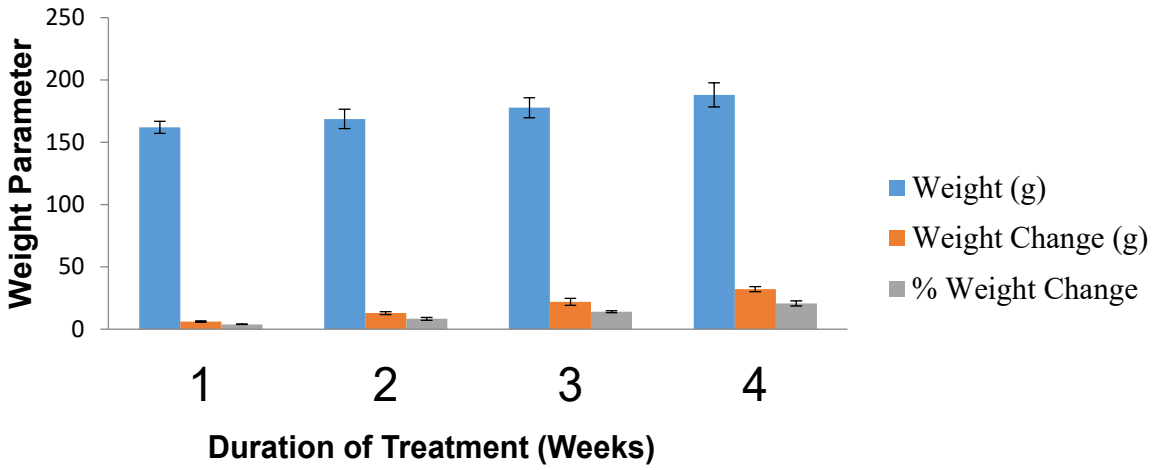

Figure 1: Body Weight of Rat.

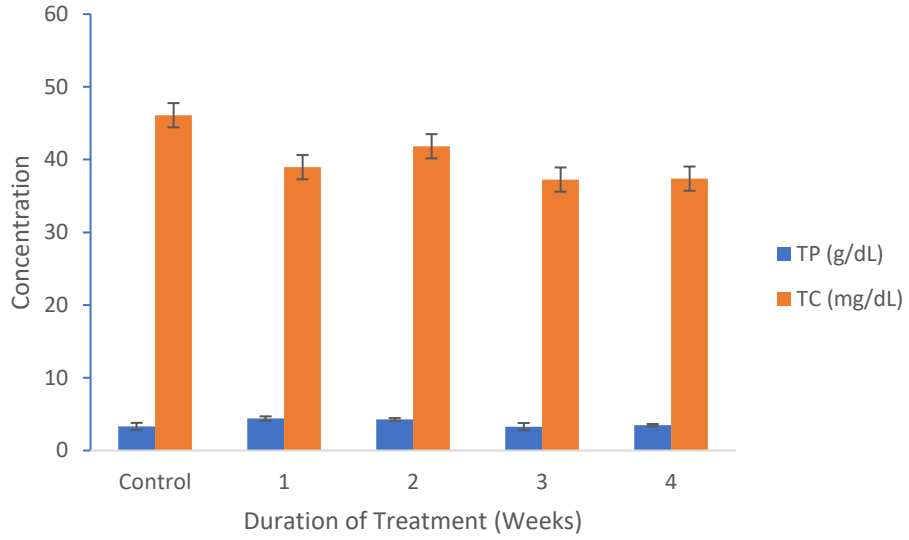

Figure 2: Effect of AEDG Stem Bark on Plasma Total Protein and Cholesterol Concentrations.

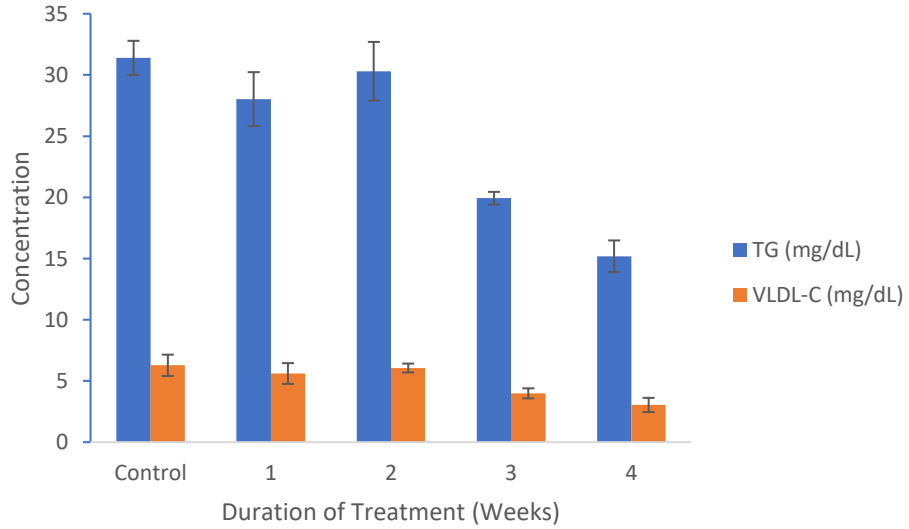

Figure 3: Effect of AEDG Stem Bark on Plasma Triacylglycerol and Very Low-Density Lipoprotein Cholesterol

Concentrations.

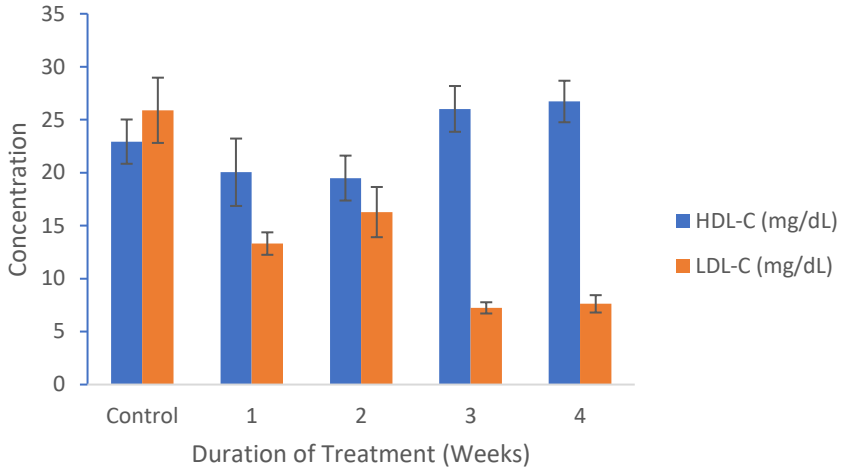

Figure 4: Effect of AEDG Stem Bark on Plasma High-Density Lipoprotein Cholesterol and Low-Density Lipoprotein Cholesterol Concentrations.

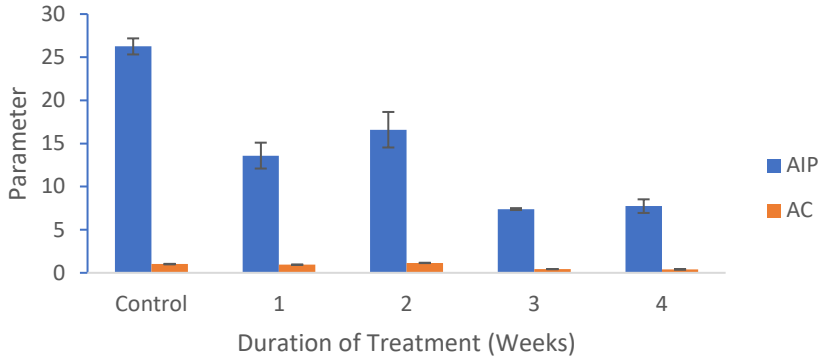

Figure 5: Effect of AEDG Stem Bark on Atherogenic Index of Plasma and Atherogenic Coefficient.

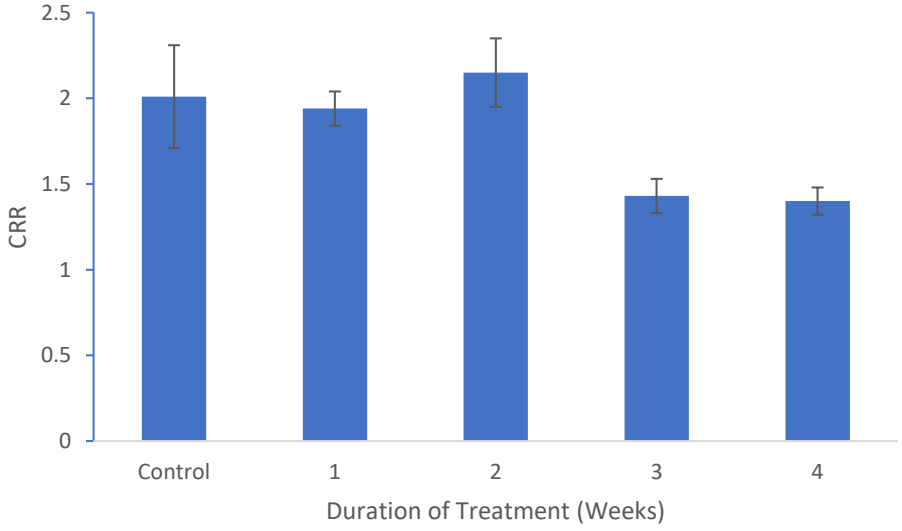

Figure 6: Effect of AEDG Stem Bark on Cardiovascular Disease Risk Ratio in the Rats.

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