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Anti-Hyperlipidemic Activity of Polyphenol-Rich Extract of *Cochlospermum Planchonii* Roots in Triton x-100 Induced Rats

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Abstract

Cochlospermum planchonii is used for treatment of cardiovascular diseases in Nigeria and in some other African countries. This study investigated the anti-hyperlipidemic activity of polyphenol-rich extract of *C. planchonii* root in triton X-induced hyperlipidemic rats. Polyphenols were extracted from roots of *C. planchonii* with 80% aqueous methanol and acetone. Thirty female albino rats were randomized into six groups of five (5) rats each, Group I the non-hyperlipidemic control received saline only, group II the hyperlipidemic group received only saline, group III served as hyperlipidemic rats treated with 10 mg/kg b.w. atorvastatin while group(s) V-VII were hyperlipidemic rats treated with 25, 50 and 100 mg/kg b.w polyphenol-rich extract of *C. Planchonii* respectively. The effect of the administration of the extract on the serum lipid profile and hematological parameters was investigated. *C. planchonii* roots contained 47.7 ± 0.23 mg gallic acid equivalent / g dry extract and 49.14 ± 0.23 mg quercetin acid equivalent / g dry extract. Significant ($p < 0.05$) increase observed in serum total cholesterol, triacylglycerol and low-density lipoprotein with concomitant reduction in high-density lipoprotein concentration were mitigated by the polyphenol-rich extract. No significant changes were observed in the hematological indices of the hyperlipidemic rats at the doses investigated when compared to the control. The results indicated that polyphenol-rich extract of *C. planchonii* root exhibited anti-hyperlipidemic activity. Thus, it could be promoted as a recipe for protection against hyperlipidemia.

Keywords: hyperlipidemia, *Cochlospermum planchonii*, polyphenol, lipid profile

Introduction

The development of cardiovascular disease such as coronary artery disease, atherosclerosis and stroke in human among other diseases is a life threatening disease that has been of global concern. Although high blood pressure, obesity, insulin resistance, impaired lipid metabolism, smoking, positive family history and hyperlipidemia are associated risk factors of cardiovascular diseases

(Huang, 2009). Hyperlipidemia is an elevation of one or more of the plasma lipids, including cholesterol, cholesterol esters, triglycerides and phospholipids. Hyperlipidemia is specifically characterized by elevated serum total cholesterol (TC), low density lipoprotein (LDL-c), very low

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density lipoprotein (HDL) levels (Kaur & Meena, 2013). These elevated plasma lipoproteins (TC, LDL-c, and VLDL-c) which are known characteristics of hyperlipidemia serve as surrogate indicators for the development of atherosclerosis and other related cardiovascular conditions. A conscious healthy life style such as physical exercise and reduction in total calories intake are lifestyle intervention used for managing hyperlipidemia associated with cardiovascular disease (NCEP, 2002; Lichtenstein *et al.*, 2006). However, this intervention option is not sufficient in lowering low-density lipoprotein cholesterol, a primary target of therapy (NCEP, 2002; Grundy, 2004). In addition, the use of fibrate, niacin, omega 3-fatty acids and statin which are pharmacological interventions for the treatment of cardiovascular disease though efficacious but their demand for treatment of the menace cannot be met because of the diversity of hyperlipidemia patients. The possibility of patients becoming dependent on drug and developing the associated side effects such as elevated plasma glucose, eructation, infection, flu syndrome and dyspepsia is high (Alsheikh-Ali *et al.*, 2004; Miller, 2009).

In contrast, plant extracts which are known to contain a variety of active ingredients such as polyphenolic compounds (e.g. flavonoids, anthocyanins, and phenolic acids) have been distinguished to have potential health benefits with negligible side effects and have also been applied extensively in several countries as folklore medicines and traditional remedies for the treatment of hyperlipidemia (Villaseñor *et al.*, 2016). *Cochlospermum planchonii* popularly called False cotton (English); Faux cotonnier (French) and locally called Gbehutu or Feru by the Yoruba tribe of the South-western, Nigeria is a shrub of about 2-4 m tall, with scarbid trilobed leaves (Blench & Dendo, 2007). The root extracts of the plant are the most frequently used part employed in folk medicine in Nigeria and other West Africa countries for the treatment of various kinds of diseases such as malaria and fever, infertility, premenstrual pain, gonorrhoea, diabetes, hyperlipidemia (Benoit-Vical *et al.*, 2001), stomach disorder, typhoid fever and urinary tract infection (Togola *et al.*, 2008). Some studies have also documented the anti-diabetic

(Anaga & Oparah, 2009; Yakubu *et al.*, 2010), anti-malarial (Benoit-Vical *et al.*, 2001; Vonthron-Sénécheau *et al.*, 2003), anti-diarrheal (Ezeja & Anaga, 2010), antibacterial (Isah *et al.*, 2013), anti-inflammatory and analgesic (Anaga & Oparah, 2009) activities of the roots extract of this plant. Nafiu *et al.* (2011) earlier reported the phytochemical constituents of *C. planchonii* root extract, however information on the anti-hyperlipidemic activity of the plant is lacking. This study therefore aimed to investigate the anti-hyperlipidemic properties of polyphenol rich-extract of *C. planchonii* in rats.

Materials and Methods

Plant Collection

Roots of *C. planchonii* were bought at *Oja-Oba* Market in Ilorin, Kwara State, Nigeria in the month of April, 2011 and authenticated at the Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria. A voucher specimen (F.H.I 99093) was deposited at the herbarium of the institute.

Chemical and Reagents

Triton X-100 was a product of Technico Laboratory Chemicals, Coimbatore. Atorvastatin drug was a product of Alembic Pharmaceuticals Ltd., Vadodhara, Gujarat. Assay kits used for low density lipoprotein, high-density lipoprotein, total cholesterol (TC), triglycerides (TG) assay were products of Randox Laboratory Ltd., Ardmore, Co. Antrim, UK. All other chemicals used were commercially obtained and were of analytical grade.

Preparation of plant material and extraction of polyphenol

Roots of *C. planchonii* were rinsed with distilled water to remove dirt and air-dried in the laboratory at room temperature (25°C) for 30 days. The dried roots were crushed to powder using an electric blender (Philip Comfort Blender, model HR1727, Holland). The powdered plant sample (200 g) was soaked in 1 liter of n-hexane to remove lipophilic compounds (defatted). The residue obtained was air-dried and sequentially macerated in 80% cold aqueous methanol and 80% aqueous acetone respectively for 18 hours with intermittent shaking

to extract the polyphenols as described by Bren *et al.* (2016). Both extracts were combined and filtered firstly using a cotton plug followed by Whatman No. 1 filter paper. The filtrate obtained was concentrated at 40°C with a water bath to give a yield of 12.25%. A calculated amount of the concentrated residue was reconstituted in distilled water to give the required doses of 25, 50 and 100 mg/kg body weight. The doses used in this study were arrived at after preliminary trials conducted on the animals by the authors.

Determination of polyphenol

Total phenolic content

Total phenolic content in the root extract was determined by the Folin Ciocalteu method of Deori *et al.* (2014). Briefly, the extract (0.5 ml) was mixed with Folin Ciocalteu reagent (2.5 ml, diluted 10 times) and incubated for 2 min at room temperature followed by addition of sodium carbonate solution (2 ml, 7.5% w/v). The mixture was allowed to stand for 30 min at room temperature and absorbance was measured at 750 nm. The amount of total phenolic content was calculated as a gallic acid equivalent from the calibration curve of gallic acid standard solutions and expressed as mg gallic acid /gm of extract

Flavonoids content

Total flavonoid content in the root extract was determined according to the method of Deori *et al.* (2014). Briefly, 2 ml of extract was mixed with 2 ml of aluminum III chloride (AlCl₃) in methanol (2%). The absorbance was read at 415 nm after 10 min. Quercetin was used as a reference compound and the result expressed as mg quercetin / g dry weight of the extract.

Laboratory Animals

Thirty (30) female albino rats (*Rattus norvegicus*) about 4 months of age and average weight 170 ± 2.4 g were used for the experiment. The rats were obtained from the Animal Holding Unit of the Department of Biochemistry, University of Ilorin, Nigeria and were acclimatized for 14 days under standard housing condition (temp 25 ± 2 °C), relative humidity of 40% to 45%, and 12-hour light

/dark cycle. Water and rat pellets were provided *ad libitum*.

Ethical clearance

Ethical clearance on the use of laboratory animals was issued by Ethics Committee of University of Ilorin, Kwara State, Nigeria, with an ethical clearance number UERC/ASN/110 and the researcher adhered strictly to the Principles of Laboratory Animal Care (NIH Publication, No. 85-23).

Animal grouping and treatment

The rats were completely randomized into six groups of five (5) rats each. Group I served as the non-hyperlipidemic control and received normal saline only, group II served as the hyperlipidemic rats and received normal saline only, group III served as hyperlipidemic rats treated with 10 mg/kg body weight Atorvastatin (reference drug) while group(s) V-VII served as the hyperlipidemic rats treated with 25, 50 and 100 mg/kg body weight polyphenol-rich extract of *C. Planchonii* respectively.

Triton-X-100 was used to induce hyperlipidemia after which treatment with the vehicle and extract commenced by oral administration and lasted for 7 days.

Induction of hyperlipidemia

Hyperlipidemia was induced in Wistar albino rats by single intraperitoneal injection of freshly prepared solution of Triton-X-100 (100 mg/kg) in physiological saline solution (0.9% NaCl solution) after fasting the animals overnight for 18 h (Thanga *et al.*, 2013).

Collection and preparation of blood sample

Twenty-four (24) hours after the last treatment, the rats were sacrificed under ether anaesthesia and blood was collected by incising the jugular vein into ethylene diamine tetracetic acid (EDTA) and plain sample bottles. The blood sample (plasma) in the EDTA bottles was used for hematological analysis while the blood sample in the plain bottles was allowed to clot for 30 min, centrifuge at 33.5 g x 15 min using Uniscope Laboratory Centrifuge (Model SM800B, Surgifriend Medicals, Essex, England). The sera were thereafter aspirated into

clean, dry, sample bottles using Pasteur pipette and were kept frozen overnight before being used for the lipid profile assays.

Preparation of tissue homogenates

The organs of interest (liver and heart) were excised, blotted with cotton wool, weighed and immediately stored in ice cold 0.25 M sucrose solution. The liver (1 g) was cut with a clean scalpel and homogenized in ice cold 0.25 M sucrose solution (1:5 w/v). The homogenates were centrifuged at 3000 rpm for 15 min to obtain supernatants which were used for the various biochemical analyses in this study.

Biochemical analysis

Blood samples in the EDTA bottles were analyzed using established procedures and automated Swelab alfa hematology analyzer. Parameters that were recorded included Hemoglobin (Hb), Red blood cells (RBC), White blood cells (WBC), Platelets, Packed cell Volume (PCV), Mean corpuscular hemoglobin (MCH), Lymphocytes. The serum was assayed for cholesterol, triacylglycerol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) using procedure outlined in commercially kits obtained while very low density lipoprotein (VLDL) and atherogenic index (AI) values were calculated using the method described by Friedwald *et al.* (1972).

Statistical analysis

Data are means of five replicates \pm SEM and were subjected to one way Analysis of variance (ANOVA) using graph prism version 8.0. Significant levels were tested at $p < 0.05$.

Results

The quantitative determination of polyphenol content in roots extract of *C. planchonii* showed that *C. planchonii* roots is rich in phenolic and flavonoid; the phenolic and flavonoids content were 47.7 ± 0.23 mg gallic acid equivalent / g dry extract and 49.14 ± 0.23 mg quercetin equivalent/g dry extract respectively (Table 1).

The intraperitoneal injection of triton X caused a marked increase in serum lipid concentration.

Total cholesterol, triglycerides, low density lipoprotein and very low density lipoprotein concentrations significantly ($p < 0.05$) increased (Figures 1-4) whereas high density lipoprotein concentration significantly ($p < 0.05$) decreased (Figure 5) in untreated rats induced with hyperlipidemia using triton X when compared with the control. These changes observed in the serum lipid profile were ameliorated upon the administration of artovastatin and polyphenol-rich extract of *C. planchonii* roots. Artovastatin (5 mg/kg b.w) and the polyphenol-rich extract of *C. planchonii* roots at 25, 50 and 100 mg/kg b.w significantly ($p < 0.05$) lowered TC, TAG, LDL and VLDL concentrations but significantly ($p < 0.05$) increased the concentration of high density lipoprotein (HDL) in hyperlipidemic rats to values close to the control (non-hyperlipidemic rats).

Similar to what was observed in the TC, TAG, LDL and VLDL concentrations of hyperlipidemic rats, the atherogenic value decreased significantly ($p < 0.05$) in hyperlipidemic rats without medical intervention. Administration of the extract at 25, 50 and 100 mg/kg caused a significant reduction in atherogenic value when compared with the hyperlipidemic rats. The polyphenol-rich extract compete favourably with the standard drug (atorvastatin) in reducing the atherogenic value as it was not significantly different to what was observed in the atorvastatin treated group as well as the control.

There were no significant changes observed in RBC, Hb, MCH, MCHC, MCV, HCT, LYM in triton X-induced hyperlipidemic rats compared with the standard drug and polyphenol-rich extract treated groups. Conversely, white blood cell (WBC) level significantly ($p < 0.05$) increased while the platelet (PLT) level reduced significantly ($p < 0.05$) in hyperlipidemic rats when compared with the control. Administration of the polyphenol-rich extract of *C. planchonii* roots at 25, 50, 100 mg/kg b.w and 10 mg/kg b.w administration of atorvastatin to the hyperlipidemic rats significantly ($p < 0.05$) reversed the changes in WBC and PLT to a value that was similar to the control group (Table 2).

Table 1: Phenolic and Flavonoid contents in *Cochlospermum planchonii* roots extract

Concentration per g dry	
Phenolics	47.7 ± 0.23 mg gallic acid equivalent
Flavonoids	49.14 ± 0.23 mg quercetin equivalent

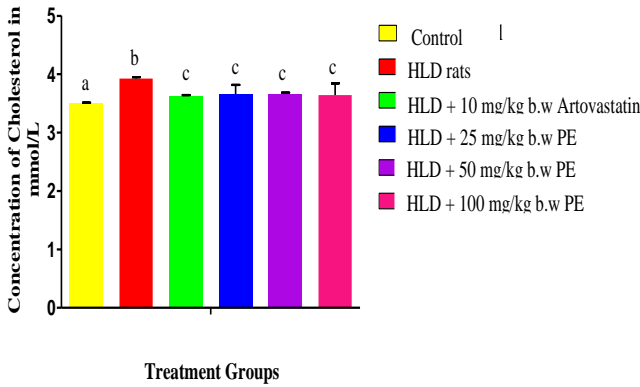


Figure 1: Polyphenol-rich extract of *Cochlospermum planchonii* roots on serum cholesterol concentration of triton X-induced hyperlipidemic rats

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

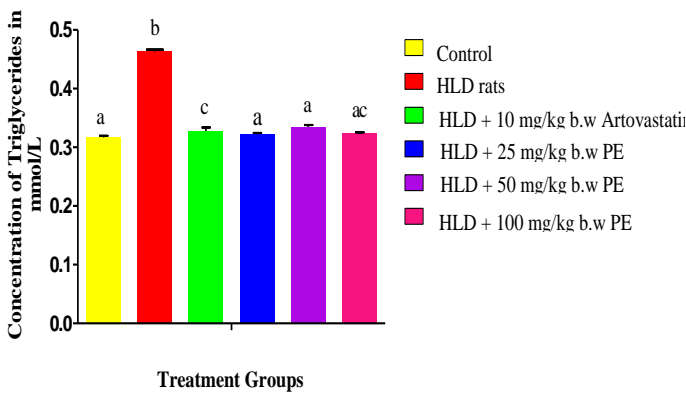


Figure 2: Polyphenol-rich extract of *Cochlospermum planchonii* roots on serum triglycerides concentration of triton X-induced hyperlipidemic rats

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

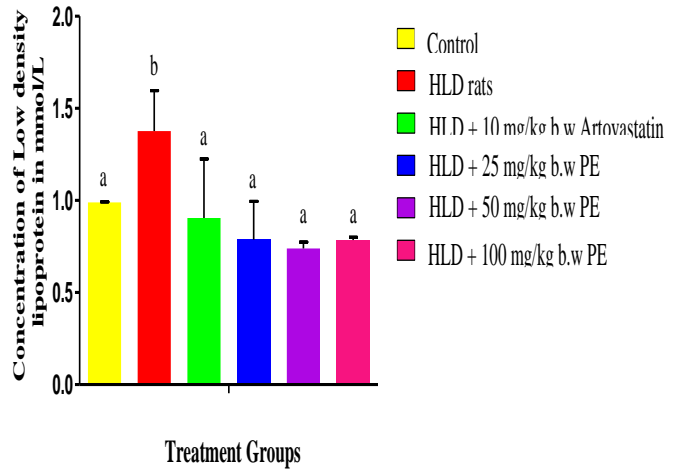


Figure 3: Polyphenol-rich extract of *Cochlospermum planchonii* roots on serum low density lipoprotein (LDL) concentration of triton X-induced hyperlipidemic rats

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

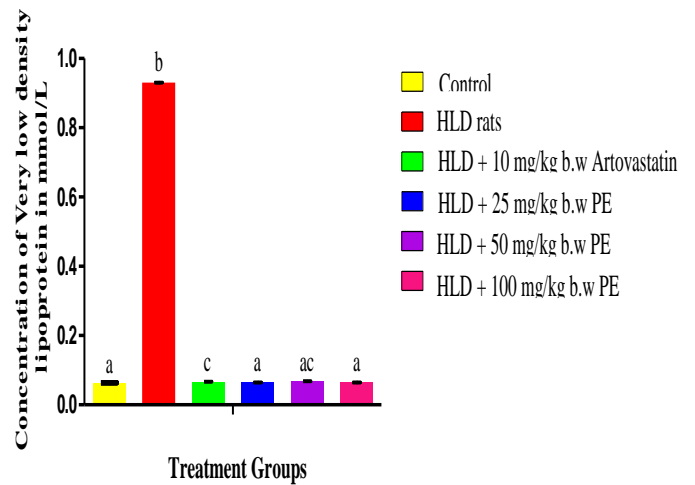


Figure 4: Polyphenol-rich extract of *Cochlospermum planchonii* roots on serum very low density lipoprotein (VLDL) concentration of triton X-induced hyperlipidemic rats

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

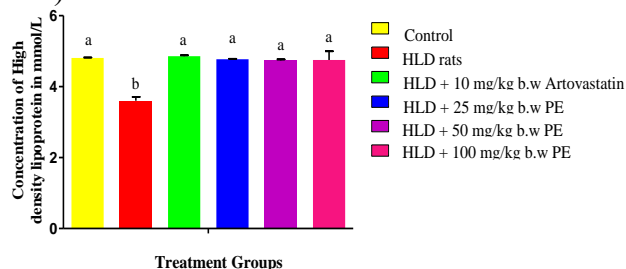


Figure 5: Polyphenol-rich extract of *Cochlospermum planchonii* roots on serum high density lipoprotein (HDL) concentration of triton X-induced hyperlipidemic rats

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

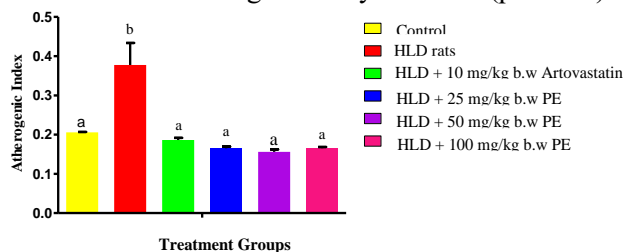


Figure 6: Atherogenic index of triton X-induced hyperlipidemic rats administered polyphenol-rich extract of *Cochlospermum planchonii* roots

*HLD = Hyperlipidemic, PE = Polyphenol Extract

Values are mean of 5 replicates ± SEM. Bars with different letters are significantly different (p < 0.05).

Table 2: Effect of polyphenol-rich extract of *Cochlospermum planchonii* roots on hematological parameters of triton X-induced hyperlipidemic rats

Treatment Groups	Control	HLD rats	HLD + 10 mg/kg b.w Artovastatin	HLD + 25 mg/kg b.w polyphenol extract	HLD + 50 mg/kg b.w polyphenol extract	HLD + 100 mg/kg b.w polyphenol extract
WBC × (10 ³ μL)	10.80 ± 0.18 ^a	16.80 ± 0.29 ^b	10.60 ± 0.22 ^a	12.00 ± 0.18 ^c	11.90 ± 0.37 ^c	10.80 ± 0.17 ^a
RBC × (10 ⁶ μL)	6.60 ± 0.20 ^a	6.30 ± 0.13 ^a	6.60 ± 0.23 ^a	6.70 ± 0.19 ^a	6.20 ± 0.19 ^a	6.60 ± 0.18 ^a
HGB (g/dl)	11.90 ± 0.13 ^a	12.20 ± 0.18 ^a	11.70 ± 0.13 ^a	12.30 ± 0.33 ^a	12.20 ± 0.08 ^a	12.10 ± 0.11 ^a
HCT (%)	49.60 ± 0.16 ^a	50.50 ± 0.23 ^a	48.20 ± 0.20 ^a	47.00 ± 0.22 ^a	48.50 ± 0.21 ^a	49.10 ± 0.22 ^a
MCH (pg)	16.70 ± 0.35 ^a	17.20 ± 0.37 ^a	16.80 ± 0.34 ^a	17.20 ± 0.35 ^a	17.40 ± 0.36 ^a	17.30 ± 0.35 ^a
MCHC (g/dl)	24.20 ± 0.23 ^a	25.50 ± 0.24 ^a	23.20 ± 0.22 ^a	24.10 ± 0.23 ^a	24.70 ± 0.24 ^a	24.20 ± 0.23 ^a
PLT (×10 ³ /μ)	972.55 ± 11.53 ^a	1151.80 ± 6.54 ^b	882.00 ± 3.65 ^c	998.80 ± 2.14 ^d	984.50 ± 2.12 ^d	903.00 ± 5.37 ^c
LYM (%)	72.27 ± 3.19 ^a	70.67 ± 3.60 ^a	68.40 ± 2.60 ^a	74.87 ± 2.37 ^a	71.67 ± 2.27 ^a	69.80 ± 2.09 ^a
PDW (fl)	9.90 ± 0.35 ^a	12.70 ± 1.23 ^b	9.60 ± 0.75 ^a	10.70 ± 0.44 ^c	10.57 ± 0.03 ^c	9.90 ± 0.75 ^a
MCV (fl)	68.73 ± 3.23 ^a	70.90 ± 3.20 ^a	68.77 ± 3.12 ^a	66.67 ± 2.66 ^a	67.60 ± 2.75 ^a	70.10 ± 1.92 ^a
MPV (FL)	7.93 ± 0.23 ^a	9.40 ± 0.67 ^b	8.30 ± 0.10 ^c	8.13 ± 0.03 ^c	7.93 ± 0.47 ^a	7.57 ± 0.32 ^a

WBC: White blood cell, RBC: Red blood cell, Hgb: Hemoglobin, HCT: Hematocrit MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, PLT: Platelet, Lymphocytes percentage, PDW: Platelet distribution width, MCV: Mean corpuscular volume, MPV: Mean platelet volume, HLD: Hyperlipidemic Values are mean of three replicates ± SEM. Values with different alphabets are statistically different (p < 0.05).

Discussion

Medicinal activities exhibited by plants are due to the presence of polyphenols and some other phytoconstituents. In this study, roots extract of *Cochlospermum planchonii* showed to be rich in phenolics and flavonoids. Phenolic and flavonoids are the major groups of polyphenols found in plants such as fruits and vegetables. Polyphenols have disease preventing and healing properties because of their ability to terminate free radical chain reactions in biological system hence, they act as nutraceuticals for a range of oxidative stress implicated diseases like diabetes mellitus, cancer (Espín *et al.*, 2007). They are also known to improve plasma LDL, TAG and total cholesterol (Arranz *et al.*, 2012), scavenge free radicals that induce oxidative stress associated with cardiovascular diseases (Tsao, 2010), reduce abnormal platelet aggregation (Tangney & Rasmussen, 2013) and as well reduce the incidence of coronary heart disease (Tresserra-Rimbau *et al.*, 2014).

In this study, triton X-100 used to induce hyperlipidemia in rats is widely been employed in other experimental studies to induce acute hyperlipidemia (Keshetty *et al.*, 2009). Triton X is a non ionic surfactant which acts to inhibit the enzymatic activity of lipoprotein lipase by blocking the clearance of triglycerides-rich lipoproteins thereby resulting in increased blood lipid concentrations (Kumar *et al.*, 2010). Administration of the polyphenol extract of *C. planchonii* roots at doses 25, 50 and 100 mg/kg b.w to hyperlipidemic rats lowered the concentrations of total cholesterol, triglycerides, LDL and VLDL. This cholesterol lowering activity expressed by the extract may be due to the modulation of 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase, a rate limiting enzyme in cholesterol metabolism probably facilitated by polyphenols (Jung *et al.*, 2006). Polyphenols like flavonoids have been reported to inhibit HMGCoA reductase via two mechanisms firstly by inhibiting cyclic adenosine phosphate phosphodiesterase (cAMP PDE), which cleaves the coenzyme cAMP, causing it to increase and enhance HMG-CoA reductase phosphorylation to the inactive form, thus reducing endogenous cholesterol production and secondly

by retarding the liberation of the aliphatic phosphoesters from HMG-CoA reductase by attaching to the Zn^{2+} in the protein phosphatase active site, to retain its inactivity (Stein & McDonnell, 2006). Triacylglycerol play a central role in regulating lipoprotein interactions to maintain lipid metabolism. Cholesterol and triacylglycerol are not directly atherogenic but represent important markers of atherosclerosis risk (Talayero & Sacks, 2011). The extract also significantly ($p < 0.05$) lowered triacylglycerol concentrations at all doses in a similar manner to the atorvastatin treated group. The triacylglycerol lowering activity of the extract indicate that the polyphenol-rich extract either inhibit lipolysis so that fatty acids do not get converted to triacylglycerol or enhance the plasma lipoprotein lipase and hepatic lipase activities thereby degrading triacylglycerol (Rajput *et al.*, 2014). LDL is regarded as bad cholesterol because it is responsible for transporting cholesterol to the peripheral tissues of the body thereby increasing the risk for developing cardiovascular disease. The polyphenol-rich extract of *C. planchonii* roots reduced the LDL in the treated groups to values within the range of the control. This reduction in LDL expressed by the extract could mean that the polyphenols in the extract enhanced the binding of apolipoprotein B to LDL receptors in the liver making the hepatocytes more efficient to remove LDL from the blood (Venkatesan *et al.*, 2003). The significant increase in HDL concentration obtained in rats treated with polyphenol-rich extract of *C. planchonii* root may be interpreted to be due to the increased activity of lecithin-cholesterol acyl transferase, an enzyme responsible for incorporating free cholesterol with HDL which subsequently promote reverse cholesterol transport and competitively inhibiting the uptake of LDL by endothelial cells (Yokozawa *et al.*, 2006; Geetha *et al.*, 2011). HDL is often referred to good cholesterol known to transports excess cholesterol and cholesterol esters from the blood and peripheral tissues to the liver where it is broken down to bile acids. An increase in HDL is related with a reduction in coronary risk.

Atherogenic index is a strong indicator of cardiovascular, coronary and ischemic diseases.

The higher the AI, the more is the risk of the cardiovascular disease and *vice versa* (Mehta *et al.*, 2003). The increase in AI in hyperlipidemic rats enhances endothelial dysfunction and the probability of cardiovascular pathogenesis. The reversal in AI of rats treated with polyphenol-rich extract of *C. planchonii* roots suggests the protective potential of polyphenol against atherosclerosis and coronary artery disease. Flavonoids are major polyphenol that show protection and prevention from atherosclerosis and cardiovascular diseases mainly by reducing oxidative stress and increasing the availability of nitric oxide in the living system. They are able to modulate genes associated with metabolism, stress defense, drug metabolizing enzymes, detoxification and transporter proteins (Grassi *et al.*, 2008; Grassi *et al.*, 2009a; Grassi *et al.*, 2009b).

Haematological analysis can also be used to determine the toxic effect of foreign compounds including plant extracts on the blood constituents of animal (Ashafa & Yakubu, 2001). The result indicate that there was no significant effect in red blood cell (RBC), haemoglobin (HGB), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV) haematocrit (HCT) and lymphocytes percentage (LYM%) of rats treated with triton X and polyphenol-rich extract of *C. planchonii* roots. These findings are in agreement with Lee *et al.* (2004) who reported that erythrocyte indices (RBC, HGB, MCH, MCHC, MCV, and HCT) do not alter significantly between the subjects with and without hyperlipidaemia. The observed elevated level of WBC in triton X hyperlipidemic rats is in consonance with Abdulrahman *et al.* (2004) and Jamuna *et al.* (2014) who also reported increased WBC count in hyperlipidemic rats. This increase in WBC production may indicate increased stress leading to stimulation of the immune defence system in combating the stress. The present study indicate that there was a significant decrease in platelet (PLT) and platelet distribution width (PDW) in the polyphenol-rich extract and standard drug treated groups. The primary physiological function of platelets is to mediate the haemostatic response. An elevation in platelet count is considered as an

indicator of vascular disease like microangiopathy and macro angiopathy (Kwaan, 1992). It is therefore observed in this study that the administration of polyphenol-rich extract of *C. planchonii* root ameliorated lipid profile alterations in hyperlipidemic rats and thus reduce the risk of cardiovascular disease.

Conclusion

The study revealed that *Cochlospermum planchonii* roots is rich in polyphenol and the administration of polyphenol-rich extract of *C. planchonii* roots led to a reduction in TC, TG, LDL, and VLDL level. Therefore, the study provides validation on the use of *C. planchonii* in traditional medicine of Nigeria to treat CVDs. However a further study is required to identify the polyphenols in the *C. planchonii* roots extract responsible for antihyperlipidemic activity of the plant.

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