FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 10 No. 3, February, 2026, pp 83 – 93
DOI: https://doi.org/10.33003/fjs-2026-1003-4616

EVALUATION OF SERUM ELECTROLYTE AND LIPID PROFILE ALTERATIONS IN MALE WISTAR RATS ADMINISTERED ALMOND (*Terminalia catappa*) AND CASHEW NUT (*Anacardium occidentale*) OILS

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ABSTRACT

Natural plant oils rich in unsaturated fatty acids and bioactive compounds are increasingly explored as safer alternatives to conventional dietary lipids due to their cardiometabolic benefits. This study evaluated the effects of almond *(Terminalia catappa)* and cashew nut (*Anacardium occidentale*) oils on serum electrolyte balance and lipid profiles in healthy male Wistar rats. Twenty rats (135–160 g) were randomly assigned into five groups (n = 4): control, *T. catappa* (200 and 400 mg/kg), and *A. occidentale* (200 and 400 mg/kg). Oils were administered orally for 28 days, after which serum samples were analyzed for lipid parameters and electrolytes using spectrophotometric methods.Results showed no significant changes ($p > 0.05$) in total cholesterol, HDL-C, triglycerides, and VLDL-C across treated groups compared with control. Notably, *T. catappa* at both doses and *A. occidentale* at 400 mg/kg significantly reduced serum LDL-C ($p < 0.05$), suggesting potential cardioprotective properties. Serum sodium, chloride, phosphorus, and bicarbonate levels remained within normal physiological ranges, indicating preserved electrolyte and acid–base homeostasis. However, significant potassium elevation was observed with *A. occidentale* at 400 mg/kg ($p < 0.05$).In conclusion, short-term administration of *T. catappa* and *A. occidentale* oils is largely metabolically safe in healthy rats, with minimal impact on serum lipids and electrolytes. The LDL-C reduction, particularly with *T. catappa*, highlights cardioprotective potential, while potassium elevation with high-dose cashew oil warrants further investigation. These findings support both oils as safe dietary or therapeutic lipid sources.

Keywords: Lipid profile, Electrolyte balance, *Terminalia catappa oil, Anacardium occidentale oil*

INTRODUCTION

Cell homeostasis and function rely on well-orchestrated communication between different organelles. This communication is ensured by signaling pathways and membrane contact sites between organelles (Domingues *et al*, 2025). Fatty acids constitute 80% of the dry mass of the brain and are vital for life (Bathina & Das, 2023). However, excessive intake of certain fats can predispose to metabolic disorders such as hyperlipidemia, obesity, and cardiovascular diseases (Swarup *et al* 2025) In recent years, attention has shifted toward the use of natural plant oils rich in unsaturated fatty acids and bioactive compounds as healthier lipid alternatives. Among such sources are almond (*Terminalia catappa*) and cashew nut (*Anacardium occidentale*) oils, both of which possess promising nutritional and therapeutic potential.

Almond oil is a rich source of monounsaturated fatty acids (oleic and linoleic acids), tocopherols, phytosterols, and phenolic compounds known for their antioxidant, hypocholesterolemic, and anti-inflammatory activities (Souleymane *et al* 2025: Özcan, 2022). Similarly, cashew nut oil contains abundant unsaturated fatty acids and bioactive phenolics such as anacardic acid and cardanol, which have been associated with cardioprotective and lipid-lowering properties (Meneguelli *et al* 2024).

Electrolytes are essential for basic life functioning, such as maintaining electrical neutrality in cells and generating and conducting action potentials in the nerves and muscles. Significant electrolytes include sodium, potassium, chloride, magnesium, calcium, phosphate, and bicarbonates. Electrolytes come from our food and fluids. Serum electrolytes—mainly sodium (Na^+), potassium (K^+), chloride (Cl^-), and bicarbonate (HCO_3^-)—play essential roles in maintaining osmotic balance, nerve transmission, muscle contraction, and acid-base homeostasis. Alterations in these ions may indicate renal dysfunction, dehydration, or metabolic imbalance (Shrimanker & Bhattarai, 2023).

On the other hand, serum lipid parameters such as total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) serve as key indicators of cardiovascular health and lipid metabolism. Nutritional interventions capable of maintaining normal electrolyte balance and improving lipid profiles are therefore of great biomedical interest.

This study evaluates the impact of almond (*Terminalia catappa*) and cashew nut (*Anacardium occidentale*) oils on serum electrolyte balance and lipid profile in male Wistar rats.

MATERIALS AND METHODS

Plant Collection and Preparation

Terminalia catappa and *Anacardium occidentale* was purchased from the local market, in delta state university Abraka, The plant was identified with voucher number (DELSUH-025 and DELSUH-081) at the Department of botany delta state university Abraka After gathering much for the analysis the cashew seeds were The cashewnuts were roasted at 125oc for 30 minutes in an open pan. The nuts were mechanically removed from the shell and the edible nut were easily obtained without being damaging. The edible nut were pulverized and stored for further uses crushed and finely grinded into a fine powder using a mortar and pestle (The seed of *Anarcandium occidentale* was picked under the cashew tree in Abraka) while the almond fruits were peeled crushed and finely grinded into a fine paste using a mortar and pestle. Paraphrase

Oil Extraction

100 g of the seed powder was extracted using a Soxhlet apparatus for seven hours with n hexane.The filtered extract was then put in a rotary evaporator at 40°C to remove solvent

till a light golden yellow oil sample was obtained and dried in Air oven at 103°C for 30 minutes (Dos Santos 2015) (Afolayan 2021)

Experimental Animals

Twenty male Wistar rats (Rattus norvegicus), with body weights ranging from 135 to 160 g, were utilized for this experiment. The animals were procured and maintained at the Animal House Unit within the Department of Pharmacology, Faculty of Basic Medical Sciences, Delta State University, and Abraka. Throughout the experimental period, laboratory animal care principles were strictly adhered to, and the study received ethical approval from the Faculty of Science, Delta State University, with the assigned approval number provided for the experimental protocol.

The rats were accommodated in standard housing cages under controlled environmental conditions, maintaining an ambient temperature of 20 ± 1°C with a 12-hour light/12-hour dark photoperiod. The experimental animals had unrestricted access to standard rodent feed and water throughout the study duration.

Tissue and Blood Sample Collection

Upon completion of the 14 days exposure period, all animals were subjected to a three-hour fast prior to weighing. They were subsequently euthanized humanely using chloroform anesthesia. During anesthesia, blood samples were obtained by heart puncture using a hypodermic syringe and needle. The obtained blood was promptly transferred to heparinized tubes and gently agitated. Plasma was subsequently extracted by centrifuging the blood at 4000 rpm for 10 minutes. Subsequent to blood collection, the brain and Testes were swiftly removed, placed on ice, and weighed individually. Segments of testes and brain tissues were subsequently homogenized to create 10% homogenates. The homogenates were centrifuged at 4000 rpm for 10 minutes to get clean supernatants, which were subsequently used for biochemical tests.

Determination of Various Biochemical Parameters

The supernatants derived from testes and brain tissues were examined for the activities for

Total Cholesterol, triglyceride, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)

Assay for total Cholesterol

Assay for total cholesterol was determined by the method of Castelli *et al.* (1977)

Principle for Total Cholesterol

The cholesterol is determined after enzymatic hydrolysis and oxidation. The indicator is a quinonimine formed from hydrogen-peroxide, and 4-aminoantipyrine in the presence of phenol and peroxidase.

Cholesterol ester + H_2O

Cholesterol + fatty acids

Cholesterol + O_2

Cholestene-3-one + H_2O_2

$2H_2O_2$ + phenol + 4-aminoantipyrine

Quinonimine + $4H_2O$

Reagent Composition for Total Cholesterol

4-aminoantipyrine (0.30mmol/l), phenol (6mmol/l), peroxidase (≥0.5µ/ml), cholesterol esterase

(≥0.15µ/ml), cholesterol oxidase (≥0.1µ/ml), pipes buffer (80mmol/l pH 6.8).

Procedure for Total Cholesterol

Into test tube labelled standard, sample and blank respectively, 10µl of standard, sample and water were pipetted. 1.0 ml of reagent was added into the various test tube then mixed and incubated for 5 minutes at 37oC. The absorbance of the sample and standard was read against blank within 60 minutes at 500nm. Total cholesterol concentration is calculated as follows:

Total cholesterol conc (mg/dl) = Δ Δ A A standard sample × conc. of standard (mg/dl)

Assay for Triglyceride

The method of Fossati and Prencipe (1982) was adopted for the determination of triglyceride.

Principle for Triglyceride Test

The triglycerides are determined after enzymatic hydrolysis with lipases. The indicator is a

Quinonimine formed from hydrogen-peroxide, 4-aminophenazone and 4-chlorophenol under the

Catalytic influence of peroxidase.

Triglycerides + H_2O

Glycerol + fatty acids

Glycerol + ATP

Glycerol-3-phosphate + ADP

Oxidase peroxidase cholesterol esterase

Cholesterol

Lipases

Glycerol Kinase

GPO

Glycerol-3-phosphate + O_2

dihydroxyacetone + phosphate +H_2O_2

$2H_2O_2$ + 4-aminophenazone + 4-chlorophenol

Quinonimine + HCL +$4H_2O$

Reagent Composition for Triglyceride Test

Pipes Buffer (40mmol/l pH 7.6), 4-chloro-phenol (5.5mmol/l), and magnesium-ions (17.5mmol/l).

Procedure for Triglyceride Test

Into test tube labelled standard, sample and blank respectively, 10µl of standard, sample and water were pipetted. 1.0ml of reagent was added into the various test tube then mix and incubated for 10 minutes at 20-25oC. The absorbance of the sample and standard was read against blank within 60 minutes at 500nm.

Triglyceride is calculated as follows:

Triglyceride conc(mg/dl) = change A standard sample × standard concentration (mg/dl)

Determination of High-density Lipoprotein

The method of Castelli *et al.*, 1977 was adopted for the determination of high-density lipoprotein.

Principle of Determination of High-density Lipoprotein

The HDL-Cholesterol reagent reacts directly with LDL and VLDL at pH 10 is to form insoluble

Complexes. The precipitate can be removed by centrifugation and the supernatant is analyzed for

HDL cholesterol. This method involves the hydrolysis of cholesterol esters to form free

Cholesterol and subsequent oxidation using oxygen to produce H2O2.

Cholesterol ester + H2O

Cholesterol + fatty acids

Cholesterol + O2

Cholestene-3-one + H2O2
2H2O2 + phenol + 4-aminoantipyrine quinoneimine + 4H2O

Procedure for Determination of Low-density Lipoprotein
Into test tube labelled standard, sample and blank respectively, 10µl of standard, sample and water were pipetted. 1.0ml of reagent was added into the various test tube then mix and incubated for 5 minutes at 37oC. The absorbance of the sample and standard was read against blank within 60min at 500nm.

Determination of Low-density Lipoprotein
Low density lipoprotein (LDL) was determined using the formula by Friedewald *et al.*, 1972
LDL = TC – HDL – (TG/5)

Sodium Estimation
The sodium content was determined by the method described by Henry, (1974) with the aid of Teco diagnostic kit.

Principle
The present method is based on modifications of those first described by Maruna, (1958) and Trinder, (1951) in which sodium is precipitated as the triple salt, sodium magnesium uranyl acetate, with the excess uranium then being reacted with ferrocyanide, producing a chromophore whose absorbance varies inversely as the concentration of sodium in the test specimen.

Procedure
Filtrate Preparation
Test tubes were labeled as blank standard. 1.0 ml of filtrate reagent was pipette to all tubes. 50µl of sample was added to all tubes and distilled water to the blank. All test tubes were continuously and vigorously mixed for 3 minutes. All test tubes were centrifuged at high speed (1,500g) for 10 minutes and the supernatant fluids were tested as described below, taking care not to disturb the protein precipitate.

Colour Development
Test tubes were labeled in correspondence to the above filtrate tubes. 1.0 ml acid reagent was pipette to all tubes. 50 µl of supernatant was added to respective tubes and mixed. 50 µl of colour reagent was also added to all tubes and mixed. Spectrophotometer was zeroed with distilled water at 550 nm. Absorbance of all the test tubes was read and recorded.

Calculations

Sodium (mEq/L) = Assay (sample) x Conc. of Standard
Absorbance of Standard
Concentration of standard = 150 mEq/L

Potassium Estimation
The potassium content was determined using the direct spectrophotometric measurement of potassium with the aid of Teco diagnostics kit.

Principle
The amount of potassium is determined by using sodium tetraphenylboron in a specifically prepared mixture to produce a colloidal suspension (Terri and Sesin 1958).

Procedure
Label test tubes standard,control, samples etc. A blank is necessary.Pipette 1.0ml of Potassium Reagent to all tubes. Add 0.01ml(10µl) of samples to respective tubes. Mix and let sit at room temperature for 3minutes. After 3 minutes set the wavelength of spectrophotometer to 500nm, zero spectrophotometer with reagent blank, Read and record the absorbance of all tubes.

Calculation
Potassium content =
Abs. blank – Abs. sample × concentration of standard (mEq/L)
Abs. blank – Abs. standard
= Potassium Conc. (mEq/L)

Chloride Estimation
The Chloride estimation is a direct method based on a modification of the colorimetric method of Skeggs and Hochestrasser (Skeggs and Hochestrasser 1964) with the aid of Teco diagnostic kit

Principle for Chloride Estimation
$Hg(SCN)_2 + 2Cl^- > HgCl_2 + 2SCN^-$
$3SCN^- + Fe^{3+} > 4Fe(SCN)_3$ red complex
Chloride ions form a soluble, non-ionized compound with mercuric ions and will displace thiocyanate ions react with ions to form a coloured complex that absorbs light at 480nm. The intensity of the colour produced is directly proportional to the chloride concentration.

Procedure
Label test tube blank, calibrator, sample etc. Pipette 1.5ml Chloride Reagent to each tube. Add 0.01ml(10µl) of calibrator or sample to respective mix.Incubate at room temperature for at least five(5) minutes. Set Spectrophotometer to 480-520nm may be used. Read and record the absorbance readings of all tubes.

Calculation
Chloride Concentration =
Abs. blank – Abs. sample× concentration of standard (mEq/L)
Abs. blank – Abs. standard
= Chloride Conc. (mEq/L)

Bicarbonate Estimation
The bicarbonate content was determined enzymatically with the aid of Teco diagnostics kit which is the modification of the method of Forrester *et al* (Forrester *et al*., 1976).

Principle **PEPC**
Phosphoenol Pyruvate + HCO_3^- .> Oxalate + H_2PO_4
MDH
Oxalate + NADH > Malate + NAD
Phosphoenol pyruvate carboxylase (PEPC) catalyzes the reaction between phosphoenol pyruvate and carbon dioxide (bicarbonate) to form oxalacetate and phosphate ion. Oxalacetate is reduced to malate with simultaneous oxidation of an equimolar amount of reduced nicotinamide adenine dinucleotide(NADH) to NAD; the reaction is catalyzed by malate dehydrogenase (MDH). This results in a decrease in absorbance at 340nm that is directly proportional to CO_2 concentration in the sample.

Procedure
Prepare CO_2 Reagent according to REAGENT PREPARATION. Label tubes "Blank", "Standard","Controls","Samples" etc. Pipette 1.0ml Carbon Dioxide Reagent in each tube. Incubate all tubes for three (3) minutes at 37^oC. Set spectrophotometer wavelength at

340nm, temperature to 37°C.Place 5μL(0.005mL) of water, standard, and sample to the cuvette labeled "Blank", "Standard" and "Sample" respectively. Mix gently by inversion and incubate for five (5) minutes. Read and record absorbance (Abs) of all cuvettes at 340nm.

Calculation

Determine CO_2 content as follows:

CO_2 Content of = Abs. blank – Abs. sample ×concentration of standard Sample (nmol/L) Abs. blank – Abs.

RESULTS AND DISCUSSION

Serum Cholesterol Levels in Rats Treated with *Terminalia catappa* and *Anacardium occidentale* Oils

Figure 1 shows the effect of *Terminalia catappa* and *Anacardium occidentale* oils on serum cholesterol concentration in male Wistar rats. The control group (Group 1) exhibited a baseline serum cholesterol level against which the treated groups were compared. Administration of *T. catappa* oil at 200 mg/kg (Group 2) and 400 mg/kg (Group 3), as well as *A. occidentale* oil at 200 mg/kg (Group 4) and 400 mg/kg (Group 5), resulted in varying degrees of alteration in serum cholesterol concentration. A Dunnett's post hoc test was employed to assess statistical differences between the control and treatment groups. The data indicated that none of the treatment groups showed a statistically significant difference compared with the control group (ns, $p > 0.05$). Although there were slight fluctuations among the treated groups, the changes were not sufficient to denote a relevant effect on serum cholesterol.

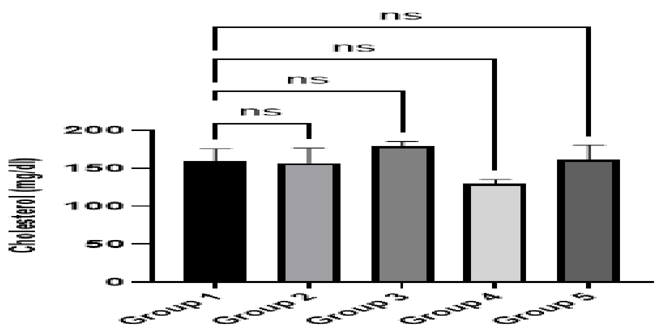

Figure 1: Serum Cholesterol was Measured in Control Animals (Group 1) and in rats Treated with T. catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* Oils on Serum High Desity Cholesterol in Male Wistar Rats

The serum high density lipoprotein cholesterol concentrations of rats administered *T. catappa* and *A. occidentale* oils are presented in Figure 2 The control group (Group 1) exhibited the normal baseline serum HDL level, while treatment with *T. catappa* oil at 200 mg/kg (Group 2) and 400 mg/kg (Group 3), and *A. occidentale* oil at 200 mg/kg (Group 4) and 400 mg/kg (Group 5), showed slight but statistically non-significant variations compared to the control ($p < 0.05$, Dunnett's test). Although a mild decrease in cholesterol was observed in some treatment groups, the reduction did not reach statistical significance, suggesting that administration of either *T. catappa* or *A. occidentale* oils at these doses does not significantly alter HDL cholesterol in normal rats.

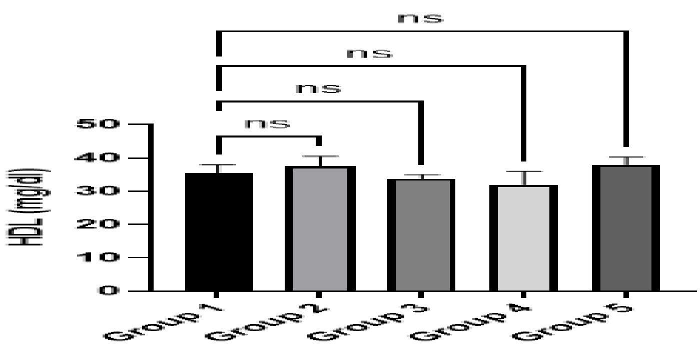

Figure 2: Serum High Density Lipoprotein Cholesterol was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered significant (* = significant; ns = not significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* Oils on Serum Low Desity Cholesterol in Male Wistar Rats

Figure 3 shows the control group exhibited the highest mean LDL cholesterol levels. Treatment with *T. catappa* at both 200 mg/kg and 400 mg/kg (Groups 2 and 3) resulted in a marked reduction in LDL levels, with both doses demonstrating statistical significance compared to the control group ($p < 0.05$). Notably, the 400 mg/kg dose of *T. catappa* (Group 3) appeared to be more effective, suggesting a dose-dependent response. In contrast, treatment with *A. occidentale* yielded differential effects. At 200 mg/kg (Group 4), there was a slight reduction in LDL cholesterol; however, this change was not statistically significant ($p > 0.05$; ns). The higher dose (400 mg/kg, Group 5) produced a more noticeable decrease in LDL levels compared to the control, reaching statistical significance.

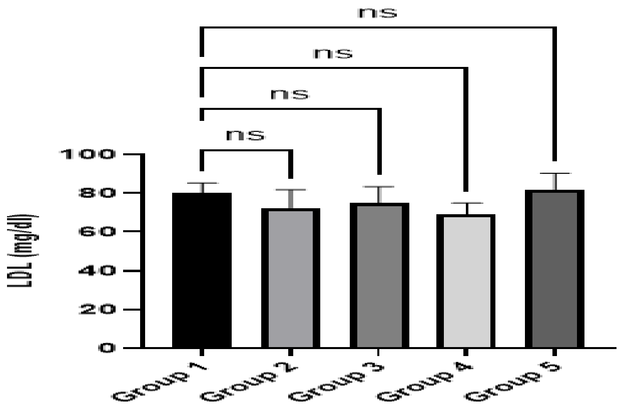

Figure 3: Serum Low Density Lipoprotein Cholesterol was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet test was used for Statistical Analysis; p < 0.05 vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* Oils on Serum Triglyceride Levels in Male Wistar Rats

The serum triglyceride (TG) concentrations of rats treated with *T. catappa* and *A. occidentale* oils are shown in Figure 4. The control group (Group 1) maintained a baseline triglyceride level, while groups administered *T. catappa* oil at 200 mg/kg (Group 2) and 400 mg/kg (Group 3), and *A. occidentale* oil at 200 mg/kg (Group 4) and 400 mg/kg (Group 5), showed minimal differences compared with the control group, With no significamt difference indicating that the treatments did not significantly influence serum triglyceride levels. Although slight variations were observed, particularly a mild elevation in Group 5 (*A. occidentale* 400 mg/kg), these differences were not significant, suggesting that administration of the oils at the studied doses had no adverse effect on triglyceride metabolism.

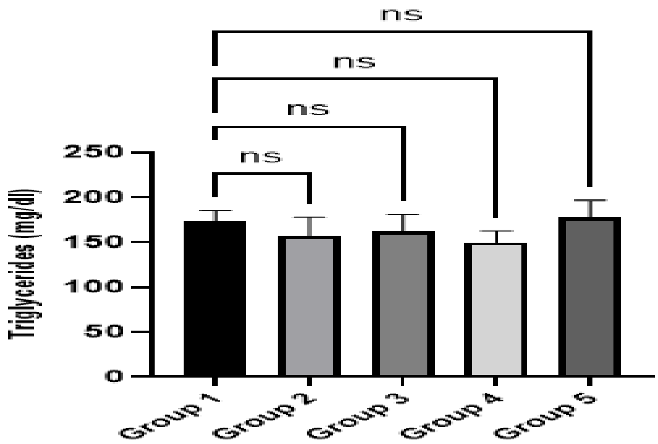

Figure 4: Serum Triglycerides was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet test was used for Statistical Analysis; p < 0.05 vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum VLDL Cholesterol Levels in Rats

Figure 5 shows serum very low-density lipoprotein (VLDL) cholesterol concentrations were assessed in control rats (Group 1) and in rats treated with *Terminalia catappa* at 200 mg/kg (Group 2) and 400 mg/kg (Group 3), or *Anacardium occidentale* at 200 mg/kg (Group 4) and 400 mg/kg (Group 5). As depicted in the bar chart, there was a clear elevation of serum VLDL cholesterol in the control group (Group 1). Treatment with *T. catappa* at both 200 mg/kg and 400 mg/kg (Groups 2 and 3) led to a reduction in VLDL levels. However, these reductions did not reach statistical significance ($p > 0.05$; ns), indicating that although there may be a downward trend, *T. catappa* at the tested doses does not significantly affect VLDL levels under these experimental conditions. Similarly, treatment with *A. occidentale* at both 200 mg/kg (Group 4) and 400 mg/kg (Group 5) resulted in modest decreases in VLDL cholesterol relative to the control. Interestingly, the 400 mg/kg dose of *A. occidentale* showed a slightly higher VLDL level compared to the lower dose, suggesting a potential lack of dose-dependence or even a reversal at higher concentration.

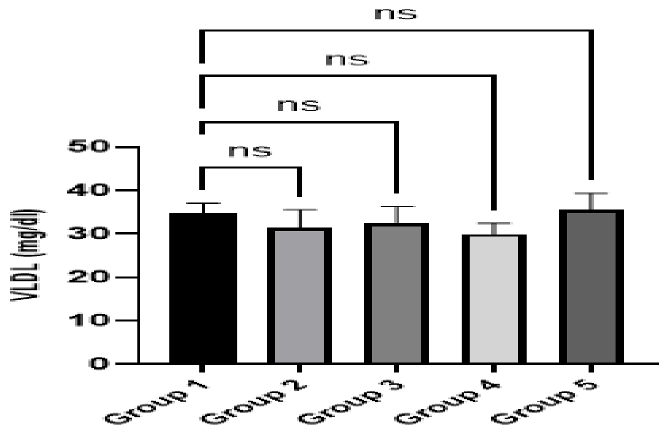

Figure 5: Serum Very Low Density Lipoprotein Cholesterol was Measured in Control Animals (Group 1) and in Rats Treated with T. catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered Significant (* = Significant; ns = not Significant)

Serum Electrolytes

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum Sodium Levels in Rats

Figure 6 shows Serum sodium electrolyte levels were determined in control rats (Group 1) and in rats administered *Terminalia catappa* at 200 mg/kg (Group 2) and 400 mg/kg (Group 3), or *Anacardium occidentale* at 200 mg/kg (Group 4) and 400 mg/kg (Group 5). As illustrated in the bar chart, all treatment groups—regardless of the extract or dose—displayed serum sodium levels comparable to the control group. There were no statistically significant differences among any of the experimental groups ($p > 0.05$; ns). While a slight numerical reduction in serum sodium was noted with the 400 mg/kg *T. catappa* and 200 mg/kg *A. occidentale* doses, the variation did not reach statistical significance.

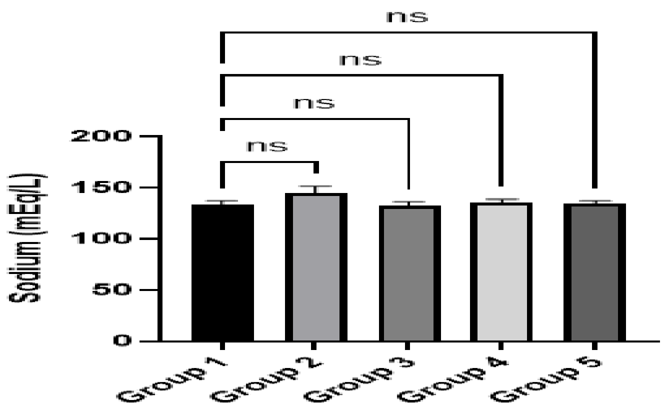

Figure 6: Serum Sodium Electrolyte was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum Chloride Levels in Rats

Serum chloride levels were determined in control rats and those treated with *Terminalia catappa* (200 and 400 mg/kg) or *Anacardium occidentale* (200 and 400 mg/kg). As shown in figure 7, the mean serum chloride concentration in the control group remained within the normal physiological range. Treatment with *T. catappa* at 200 mg/kg (Group 2) and 400 mg/kg (Group 3) did not cause any statistically significant alteration in serum chloride compared to the control group. Similarly, *A. occidentale* at both 200 mg/kg (Group 4) and 400 mg/kg (Group 5) produced no significant difference in chloride levels relative to control.

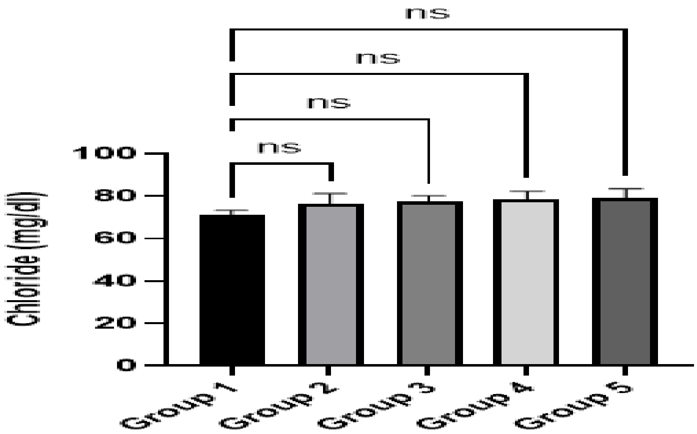

Figure 7: Serum Chloride Electrolyte was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered Significant (* = Significant; ns = not Significant).

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum phosphorus Levels in Rats

Serum phosphorus concentrations were evaluated in control rats (Group 1) and in animals treated with *Terminalia catappa* (200 and 400 mg/kg; Groups 2 and 3, respectively) or *Anacardium occidentale* (200 and 400 mg/kg; Groups 4 and 5, respectively). As presented in figure 8, administration of *T. catappa* at 200 mg/kg resulted in no statistically significant change in serum phosphorus compared to the control group ($p > 0.05$). Likewise, treatment with the higher dose of *T. catappa* (400 mg/kg) did not significantly alter serum phosphorus levels. A similar trend was observed in rats treated with *A. occidentale*, as both 200 and 400 mg/kg doses produced no significant difference in serum phosphorus relative to the control. Overall, no significant dose-dependent variation was evident among the treatment groups.

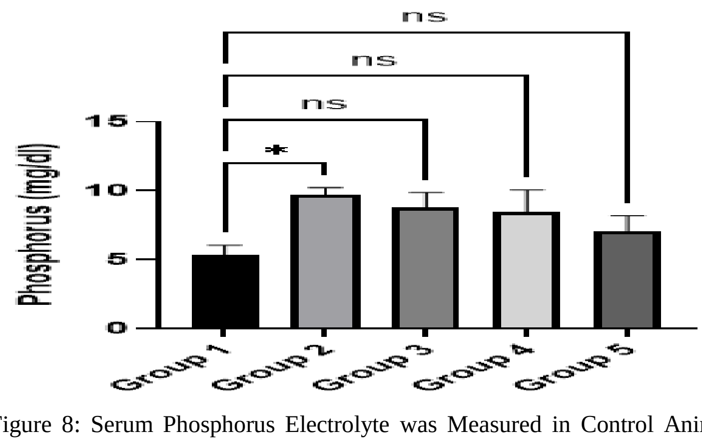

Figure 8: Serum Phosphorus Electrolyte was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; $p < 0.05$ vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum Potassium Levels in Rats

Figure 9 Serum potassium levels were assessed in five experimental groups comprising control animals (Group 1) and rats treated with either *Terminalia catappa* (T. catappa) at 200 mg/kg (Group 2) or 400 mg/kg (Group 3), or *Anacardium occidentale* (A. occidentale) at 200 mg/kg (Group 4) or 400 mg/kg (Group 5). The graphical data reveal a non-significant decrease in serum potassium levels in Group 2 compared to the control (Group 1), followed by a slight increase in Group 3, which also did not reach statistical significance. In contrast, administration of *A. occidentale* resulted in a dose-dependent increase in serum potassium. Notably, the high dose of *A. occidentale* (400 mg/kg, Group 5) significantly elevated serum potassium levels relative to control animals ($p < 0.05$), as indicated by the asterisk on the bar chart. This effect was not observed in Group 4 (200 mg/kg), which was statistically non-significant.

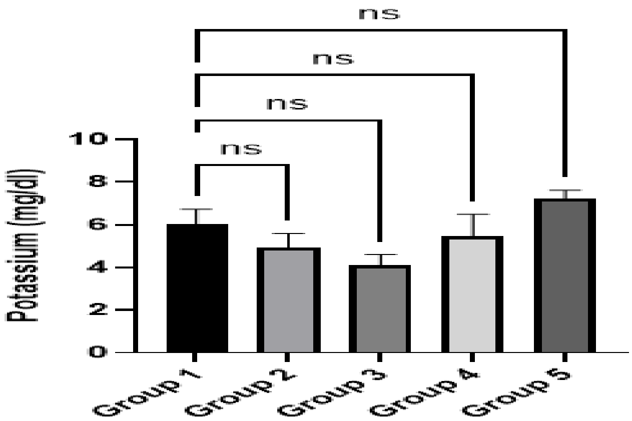

Figure 9: Serum Potassium Electrolyte was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; p < 0.05 vs. Control was Considered Significant (* = Significant; ns = not Significant)

Effect of *Terminalia catappa* and *Anacardium occidentale* on Serum Bicarbonate Levels in Rats

Figure 10 presents the serum bicarbonate levels in control and treated male Wistar rats. Group 1 represents the control animals, while Groups 2 and 3 received *Terminalia catappa* oil at doses of 200 and 400 mg/kg respectively. Groups 4 and 5 were treated with *Anacardium occidentale* oil at 200 and 400 mg/kg respectively. The serum bicarbonate levels showed a slight but non-significant variation across treatment groups compared to the control. Both *T. catappa* and *A. occidentale* oil-treated rats demonstrated values that were within the normal physiological range, indicating no significant disturbance in the acid-base balance. Although minor decreases were observed in the higher-dose groups, these changes were not statistically significant

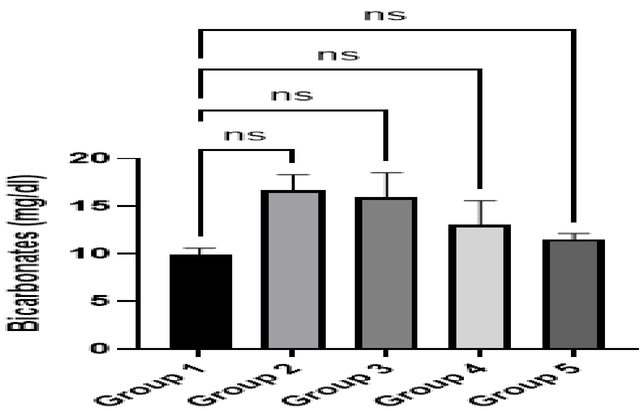

Figure 10: Serum Bicarbonate Electrolyte was Measured in Control Animals (Group 1) and in Rats Treated with T. Catappa (200 mg/kg, Group 2; 400 mg/kg, Group 3) or A. Occidentale (200 mg/kg, Group 4; 400 mg/kg, Group 5). Data Represent mean ± SEM (n = 4 per group). Graph Prism Dunnet Test was used for Statistical Analysis; p < 0.05 vs. Control was Considered Significant (* = Significant; ns = not Significant)

Discussion

The non-significant changes observed suggest that both *T. catappa* and *A. occidentale* oils, within the tested doses, did not markedly disrupt lipid homeostasis or elicit hypercholesterolemic or hypocholesterolemic effects in normal rats. This finding aligns with previous reports indicating that plant-derived oils rich in unsaturated fatty acids may help maintain normal lipid metabolism by modulating cholesterol biosynthesis and clearance without exerting toxic effects (Eilam *et al* 2022).The lack of significant change in serum cholesterol could imply that these natural oils exert a neutral or stabilizing effect on cholesterol metabolism (Eilam *et al* 2022). *T. catappa* and *A. occidentale* oils are known to contain bioactive compounds such as oleic, linoleic, and palmitic acids, which are beneficial in maintaining cardiovascular health through membrane fluidity and lipid transport regulation (Quoc 2023). However, the absence of marked reduction may also indicate that their hypolipidemic potential becomes more evident under hyperlipidemic or oxidative stress conditions rather than in healthy physiological states (Zhou *et al* 2024)

The observed non-significant reduction in serum HDL cholesterol may indicate that both *T. catappa* and *A. occidentale* oils possess mild lipid-modulating potential, p6ossibly attributable to their rich composition of unsaturated fatty acids such as oleic, linoleic, and palmitic acids (Santos, *et al* 2022). However, since the rats used were healthy and not hyperlipidemic, the magnitude of response may have been minimal, consistent with previous findings that lipid-lowering effects of plant oils are more pronounced in dyslipidemic or oxidative stress models (Silva *et al* 2024) the absence of a significant difference indicates that the oils are biocompatible at the administered doses. HDL plays a crucial role in reverse cholesterol transport, facilitating the removal of excess cholesterol from peripheral tissues to the liver for excretion. Therefore, an increase in HDL concentration is often associated with cardioprotective outcomes (Ouimet *et al* 2019). The phytochemical constituents of these extracts, including flavonoids, polyphenols, and tannins, may contribute to this effect by enhancing antioxidant defense mechanisms, reducing lipid peroxidation, and modulating key enzymes involved in lipid regulation such as lecithin–cholesterol acyltransferase (LCAT) (Arshad et al 2025)

The observed non-significant reduction in serum LDL cholesterol indicates that *A. occidentale* may also exert hypolipidemic effects, although potentially requiring a higher dose to achieve a similar efficacy to *T. catappa*. These findings suggest that both *T. catappa* and *A. occidentale* possess lipid-lowering properties, particularly at higher doses. The more pronounced effect observed with *T. catappa*, even at the lower dose, supports previous evidence of its potent antihyperlipidemic activity. The mechanism underlying these effects may involve antioxidant activity, inhibition of cholesterol biosynthesis, or enhanced LDL clearance, though further studies are needed to clarify these pathways (Tabansi et al 2023). *T. catappa* demonstrated significant LDL-lowering effects at both tested doses, while *A. occidentale* required a higher dose to achieve a comparable outcome. These results support the potential therapeutic use of these plant extracts in managing dyslipidemia, especially in the context of elevated LDL cholesterol.

The maintenance of near-normal triglyceride levels following treatment implies that both *T. catappa* and *A. occidentale* oils may not induce hypertriglyceridemia, which is an important cardiovascular risk factor. (Parhofer et al 2019). The fatty acid composition of these oils—rich in monounsaturated and polyunsaturated fatty acids such as oleic and linoleic acids—may contribute to lipid balance by promoting fatty acid oxidation and reducing hepatic triglyceride synthesis (Orsavova et al 2015)The non-significant effect could also be attributed to the physiological status of the animals; since the rats were not hyperlipidemic, triglyceride levels were already within normal range, limiting the magnitude of lipid-lowering response. Previous reports have shown that plant-derived oils exhibit stronger hypolipidemic activity in models of lipid dysregulation rather than in normal conditions (Andreadou et al 2020) Moreover, the results indicate that both *T. catappa* and *A. occidentale* oils are biocompatible and safe at the administered doses, as they did not produce abnormal elevations in circulating triglycerides.

Overall, it suggest that neither *T. catappa* nor *A. occidentale*, at the doses tested, exert significant effects on serum VLDL cholesterol levels in rats. VLDL particles are primarily involved in triglyceride transport, and their regulation may be governed by different pathways than those affecting LDL levels. The lack of significant reduction in VLDL may also suggest that the extracts' lipid-lowering properties do not extend robustly to triglyceride-rich lipoproteins or that higher doses and/or longer treatment durations might be necessary to observe effects.

Discussion on Electrolyte

These findings suggest that administration of *T. catappa* or *A. occidentale* at the tested doses does not significantly alter serum sodium homeostasis. Sodium is a key electrolyte involved in fluid balance, nerve conduction, and muscle function, and its levels are tightly regulated by renal and hormonal mechanisms. The absence of significant changes indicates that the plant extracts, at the tested concentrations and duration, do not adversely impact sodium metabolism or kidney function related to sodium regulation (Titze (2014). The stability of serum sodium across all groups suggests that neither *T. catappa* nor *A. occidentale* has a diuretic or natriuretic effect strong enough to disrupt electrolyte balance (Ahmed et al 2016).This is important from a safety perspective, especially for therapeutic applications involving long-term or high-dose administration of plant-based treatments.

Serum chloride serves as a major extracellular anion, essential for maintaining osmotic balance, acid–base homeostasis, and electrolyte equilibrium. In this study, administration of *T. catappa* and *A. occidentale* extracts at the tested doses did not significantly affect chloride concentration, suggesting that neither extract exerts a measurable impact on chloride homeostasis under normal physiological conditions (Chen et al 2025). The lack of alteration in serum chloride may indicate the absence of renal tubular dysfunction or disturbances in electrolyte balance attributable to the plant treatments. This observation aligns with reports that moderate doses of these plant extracts do not compromise renal electrolyte handling or acid–base regulation. Conversely, agents known to cause renal impairment often lead to hypochloremia or hyperchloremia due to altered tubular reabsorption or secretion (Molla et al 2020) the findings imply that both *T. catappa* and *A. occidentale* extracts are unlikely to perturb serum chloride balance at doses up to 400 mg/kg, supporting their safety with respect to electrolyte stability.

Phosphorus is an essential mineral that plays a key role in numerous physiological processes, including bone mineralization, energy metabolism, and acid–base regulation. Its serum concentration reflects a delicate balance maintained by intestinal absorption, renal excretion, and hormonal control (primarily via parathyroid hormone and vitamin D) (Wagner 2024)) In this study, treatment with *T. catappa* and *A. occidentale* extracts did not significantly affect serum phosphorus levels, suggesting that neither extract disrupted phosphorus metabolism or renal phosphate handling at the administered doses. The absence of significant change implies that phosphate homeostasis was maintained, indicating that these plant extracts do not exert adverse effects on renal tubular reabsorption of phosphate or parathyroid-regulated phosphate balance (Prasad & Bhadauria (2013). Overall, these findings reinforce the safety of *T. catappa* and *A. occidentale* extracts regarding electrolyte regulation, particularly phosphate homeostasis, at doses up to 400 mg/kg. The data suggest that *A. occidentale* extract, particularly at the higher dose of 400 mg/kg, exerts a significant effect on potassium homeostasis, leading to elevated serum potassium levels. This may point to an impact on renal function, potassium excretion, or cellular potassium handling. In contrast, *T. catappa* did not significantly alter serum potassium levels at either dose tested, suggesting a lack of effect on systemic potassium regulation under the experimental conditions (Epstein & Lifschitz (2016). These findings highlight potential nephrotoxic or electrolyte-modulating properties of *A. occidentale* at higher doses, which warrants further investigation into its safety profile.

Serum bicarbonate serves as an essential component of the body's buffering system, maintaining acid-base equilibrium and reflecting renal and metabolic status. In this study, treatment with *T. catappa* and *A. occidentale* oils for the experimental duration did not significantly alter bicarbonate concentration, suggesting that neither oil induced metabolic acidosis or alkalosis (Kittiskulnam et al 2020). The maintenance of stable bicarbonate levels implies that both oils preserved normal metabolic homeostasis, supporting previous findings that their phytochemical constituents (such as polyphenols, flavonoids, and fatty acids) possess biochemical stability and low toxicity profiles at moderate doses (Rodríguez-Negrete et al 2024). Moreover, the absence of significant alterations further suggests that *Terminalia catappa* and *Anacardium occidentale* oils do not interfere with renal bicarbonate reabsorption or systemic CO_2 buffering mechanisms, which are critical for maintaining blood pH. Administration of *T. catappa* and *A. occidentale* oils did not significantly alter serum bicarbonate concentration in male Wistar rats. This suggests that both oils are metabolically safe and do not disrupt systemic acid-base balance, even at higher doses, reinforcing their potential as safe dietary or therapeutic oils.

CONCLUSION

The current study demonstrates that Terminalia catappa and Anacardium occidentale oils produced no significant alterations in serum lipid parameters (total cholesterol, HDL-C, LDL-C, triglycerides, and VLDL-C) in healthy male Wistar rats. These non-significant changes indicate that both oils maintain lipid homeostasis at the tested doses without causing hyperlipidemic or hypolipidemic disturbances, confirming their metabolic safety and physiological compatibility.

This study reveals that oral administration of Terminalia catappa and Anacardium occidentale extracts at doses up to 400 mg/kg does not significantly alter serum electrolyte levels (sodium, chloride, phosphorus, and bicarbonate) in healthy male Wistar rats, indicating maintained electrolyte and acid-base homeostasis. The stability of these parameters suggests that neither extract adversely affects renal tubular function, glomerular filtration, or hormonal electrolyte regulation mechanisms.

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