IJAAR PUBLISHING®

Open Access Journal of Science Research | ISSN: 3027-1185
Vol. 3, Issue 1 (2025) | www.ijaar.org

Anti-Hyperlipidemic Effects of Combined Aqueous Extract of Tumeric and Curry Leaves on High Salt Fed Wistar Rats

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Abstract

This study aimed at investigating the antilipidemic effects of combined aqueous extract of turmeric and curry leaves on high salt fed male wistar rats. A total of 36 animals were divided into 6 groups with 6 animals each. Group 1 was normal control group. Group 2 was high salt negative control group. Group 3 was high salt treated with 30mg/kg vitamin C. Group 4 was high salt fed rats treated with 250mg/kg of TCL extract. Group 5 was high salt fed rats treated with 500mg/kg of TLC extract. Group 6 was high salt fed rats treated with 1000mg/kg of TCL extract. Blood samples were collected from the animals on the 14th and 28th day. The effect of Vitamin C and combined extract of turmeric and curry leaves on serum glucose (mmol/L) levels in High salt-fed Wistar rats showed that High salt control group had considerably higher serum glucose level approximately 1.7 and 2.0-fold than those of normal group at day 14 and day 28 respectively. The effect of vitamin C and combined extract of turmeric and curry leaves on Very-Low-Density Lipoprotein (VLDL) levels in high salt-fed wistar rats is shown in Table 7. It was observed that High salt control group had considerably higher VLDL level approximately 1.7 and 1.8-fold than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly attenuated the elevation VLDL levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg. This result has shown that combined extract of turmeric and curry leaves have antilipidemic and antihyperglycemic effects on high salt fed Wistar rats, and demonstrated the use of combined aqueous extract of turmeric and curry leaves is safe, effective, cheap and more comfortable for the management of hyperlipidemia and hyperglycemia.

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Keywords: Antihyperglycemic effects, Antilipidemic effect, Curry leaf, Hyperglycemia Turmeric rhizome, Wistar rats

Ajuru, G., Bogare, O. E., & Ajuru, M. G. (2025). Anti-Hyperlipidemic Effects of Combined Aqueous Extract of Tumeric and Curry Leaves on High Salt Fed Wistar Rats. *Open Access Journal of Science Research. 3*(1), 73-86. DOI: https://doi.org/10.5281/zenodo.15691876

Introduction

Hyperlipidemia is a condition in which there is an excess of lipids (fats) in the blood, it is a condition characterized by abnormally increased levels of lipids (triglycerides, phospholipids, cholesterol and cholesterol esters) in the blood. It is a major modifiable causative factor for the prevalence of cardiovascular disease (CVD) [1]. Hyperlipidemia can be caused by a number of things, including an unhealthy diet, genetics, and certain medical conditions. The fact that hyperlipidemia is a strong risk factor for CVD is well established. Hyperlipidemia refers to elevated cholesterol, elevated TG or both. The problem can be due solely to hereditary factors, but more commonly it is an acquired condition [2].

Most of plants and herbs contain natural antioxidants which can give synergistic interaction effects. However, as the interaction of phytochemical are not inevitable, they might also exert antagonistic, additive and indifferent effect [3].

High blood glucose, or hyperglycemia, is a condition that occurs when the blood glucose (or blood sugar) level is above the normal range. In people without diabetes, a normal blood glucose level is typically below 100 mg/dL after fasting (not eating) for at least eight hours. In people with diabetes, a normal blood glucose level may be slightly higher. When blood glucose levels are consistently above the normal range, it can cause serious health problems. These problems can include damage to the eyes, kidneys, nerves, and blood vessels. It can also increase the risk of heart disease, stroke, and other health conditions.

Medicinal plants have been used for century before the advent of orthodox medicine. Leaves, flowers, stems, roots and seeds can all be constituents of herbal medicines [4].Turmeric (*Curcuma longa*), also known as ‘Curcuma domestica’, is a perennial herbaceous plant of the ginger family Zingiberaceae [5]. Turmeric is a common spice that comes from the root of Curcuma longa. It contains a chemical called curcumin. It has a bright yellow color and a distinct, earthy flavor that's often described as slightly bitter. Turmeric has been used for centuries in traditional Indian and Chinese medicine. Today, it's often used as a natural anti-inflammatory and antioxidant supplement. Turmeric has been used as food additives, skin treatment and other anti-inflammation properties.

Curry leaves (*Murraya koenigii)* belonging to the family Rutaceae are used as a spice due to their distinctive flavor and aroma. Since ancient times, Indians have been using curry leaves (also called curry pata) as a spice. Found in Tarai areas and all over South India, the curry tree is also cultivated in Australia, Sri Lanka, Pacific Island, and China [6]. Phytochemical investigations revealed that curry leaves contain volatile oil, xanthotoxin, alkaloid, sesquiterpene, and glycozoline. The leaves of M. koenigii have incredible therapeutic value and are also used externally to cure eruptions [7,8]. The leaves possess antidiabetic, hypoglycemic, antimicrobial, antioxidant, antibacterial, and anticarcinogenic properties [9].

Studies have reported curry leaves to have hypoglycemic, antidiabetic [10,11], hepatoprotective [12], antibacterial [9,13,14], anti-inflammatory [15] and antioxidative properties [9,16].

Herbal remedies showed an imperative role in healthcare programs in developing countries [17]. Turmeric (*Curcuma longa*) and curry leaves (*Murrya koenigii*) are frequently used as ingredients in food industry. Previous researches proved that these plants contain phytochemicals which contributed to the antioxidant properties. However, the evaluation was done individually and rarely in mixtures. Therefore, this present study was conducted to examine the antioxidant properties as well as their interaction effect when mixed together. Therefore, this present study was conducted to examine the antioxidant properties as well as their interaction effect when mixed together.

High salt intake has been associated with cardiovascular diseases resulting in increase in lipid profile markers such as LDL cholesterol. These cardiovascular diseases resulting from increased level of LDL have been reported to be on the increase due to high intake of salt among the increasing population especially the Nigerian society. However, there is paucity of research into potential herbal remedies to ameliorate this form of illness resulting from high salt intake.

Herbal plant such as Turmeric and curry leaves have been reported to be rich in phytochemical and bioactive compounds which can have beneficial effect in reducing lipid profile markers such as LDL and increase in HDL parameters. More so the paucity of research in the use of turmeric and curry leaves to syngerstically mitigate the increase in lipid profile markers such as LDL negates the needful for this research, hence this study is to investigate the effect of Turmeric and curry leaves on lipid profiles markers and anti-hyperglycemic effect of high salt fed male wistar rat

Materials and Methods

Procurement of Animals

Thirty-six (36) adult male Wistar rats weighing 150–200g were procured from the Animal House of the Department of Pharmacology, Faculty of Basic Clinical Sciences, University of Port Harcourt. The rats were allowed to acclimatize for two weeks in the animal house. During this period, they free access to clean water and standard animal feed. The rats were housed in clean, disinfected wooden cages with sawdust as bedding and were kept under standard laboratory conditions (12-hour light-dark cycle, 50–60% humidity and a temperature of roughly 30°C). These conditions were maintained throughout the acclimatization and experimental period.

Collection of Plant Materials

Fresh turmeric rhizomes and curry leaves were purchased from Rumuokoro market within the University of Port Harcourt environment.

Preparation of Aqueous Extracts

The turmeric rhizomes were carefully cleaned to remove any dirt or debris, using clean water and a soft brush. The curry leaves were plucked from the stems and thoroughly washed to eliminate any impurities. The cleaned turmeric rhizomes and curry leaves were spread out in a single layer on clean trays. They were placed in a well-ventilated area with controlled temperature and airflow to facilitate drying. The turmeric rhizomes and curry leaves were left to dry naturally for 14 days, until they become completely dry and brittle.

Once dried, the turmeric rhizomes and curry leaves were sent to the pharmacy department or extraction under the supervision of Mr Gospel. The plants were separately ground into fine powders using an electric grinder. The powders will be carefully sieved through a fine mesh to obtain a consistent and uniform texture, ensuring the removal of any coarse particles. 60g of the powdered turmeric and curry leaves will be accurately weighed using a digital scale and was put into a maceration jar, distilled water was added in a ratio of 1:1. The mixture was kept for 72 hours, with the maceration jar tightly closed. The mixture was agitated on a daily basis. After 72 hours the mixture was filtered and the chaff was discarded

Experimental Design

Thirty-six (36) adult male Wistar rats were randomly divided into six (6) groups of six (n=6) animals each.

Table 1. Experimental Protocol

Groups	Description	No. of Rats	Treatment Protocol
Group 1	Normal control	6	Will be administered 2ml of normal saline and feed for 28 days
Group 2	Negative control	6	Will be administered high-salt containing 1ml of 20% sodium chloride without treatment for 28 days
Group 3	Vitamin C	6	Will be administered high-salt containing 1ml of 20% sodium chloride and 30mg/kg of vitamin C for 28 days
Group 4	Low Dose	6	Will be administered high-salt containing 1ml of 20% sodium chloride and 250mg/kg of combined extract for 28 days
Group 5	Medium Dose	6	Will be administered high-salt containing 1ml of 20% sodium chloride and 500mg/kg of combined extract for 28 days
Group 6	High Dose	6	Will be administered high-salt containing 1ml of 20% sodium chloride and 1000mg/kg of combined extract for 28 days

Preparation of High Salt

A high-salt solution containing 20% sodium chloride was prepared and 1ml of the solution was administered to the rats daily and were observed for signs of toxicity.

Dose Administration

The determined dose of the combined aqueous extract was administered orally to the rats in the experimental group.

Sample Collection

Sample collection involved blood samples from the rats on days 14th and 28th of the experiment. These samples were collected using standard techniques and handled with appropriate precautions to ensure accurate and reliable results.

Biochemical Assays

Biochemical assays were performed to analyse the levels of specific biomarkers associated with organ function and systemic changes. These assays included measurements of blood glucose level and cholesterol level. The parameters were: HDL, LDL, VLDL, Triglycerides, Total cholesterol, Serum glucose level

Procedures

Lipid Profile

Cholesterol (Enzymatic and end-point method) Unit mmol/L

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

Procedure

The tubes werelabelled as as sample, standard and blank, then 1.0ml of the reagent was pipetted into all the tubes.10ul of the standard, samples and Distilled water were added into appropriate tubes. They were mixed and incubated for 10mins at 25'c. The absorbance of sample and Standard. /Calculation was read within 60 minutes against the reagent blank.

Calculation: Cholesterol [mg/dL] = $\frac{\text{A Sample}}{\text{A Std /Cal}}$ x conc. Std/Cal [mg/dL]

Unit Conversion: mg/dL x 0.02586 = mmol/L

Triglycerides Unit mmol/L

Principle:

The triglycerides are determined after enzymatic hydrolysis with lipases. The indicator is a quinoneimine formed from hydrogen-peroxide, 4 – aminophenazone and 4 – chlorophenol under the catayltic influence of peroxidase.

Procedure:

The tubes were labelled as test, standard and blank, then, 1.0ml of the reagent was pipetted into all the tubes.10ul of standard, sample & d/w was added into appropriate tubes: Mix and incubate for 10mins at 25'c. The absorbance was read and recorded at 540nm.

HDL – Cholesterol (Precipitant Method) Unit mmol/L

Principle:

Low density lipoprotein, VLDL and Chylomicron fractions are precipitated by the addition of phosphotungestic acid in the presence of magnesium ions. After centrifugation the cholesterol concentration in the HDL fraction which remains in the supernatant is determined.

Procedure:

The tubes were labelled as standard, blank and test, then, 0.7m of the reagent was pipetted into all the tubes.40ul of the standard, sample and d/w were added into respective tubes They were mixed and centrifuged for 10mins at 4000rpm. 1.0ml of Chol (reagent) was pipetted into all the

tubes, and 0.1ml of the supernatant was added into appropriate tubes. It was mixed and incubated for 10mins at 25'c. The absorbance was read and recorded at 540nm

LDL – Cholesterol (Colorimetric, endpoint method) Unit mmol/L

Procedure:
Label the tubes as sample and blank, then, 10ul of the samples was added into appropriate tubes. 1.0ml of the reagent was pipetted into all the tubes. It was mixed and incubated for 5 min. at 37 °C; the absorbance (A1) was read and recorded at 540nm.

250ul of the reagent was pipetted into all the tubes. It was mixed and incubatedfor 5 min. at 37 °C and absorbance (A2) was read. □ A = [(A2– A1) sample or calibrator] – [(A2 – A1) blank]

- Calculation: LDL-C [mg/dL] = $\frac{\Delta A \text{ Sample}}{\Delta A \text{ Calibrator}}$ x Conc. Cal [mg/dL]
- Unit Conversion: mg/dL x 0.02586 = mmol/ L

VLDL – Cholesterol (Colorimetric/Fluorometric Method) Unit mmol/L
Separation of HDL and LDL/VLDL:
100 µl of 2X Precipitation Buffer was mixed with 100 µl of serum sample in microcentrifuge tubes. It was incubated for 10 min at room temperature, centrifuged at 2000 x g (5000 rpm on bench-top microcentrifuge) for 10 min. The supernatant was transferred into new labelled tubes. This is the HDL fraction. The precipitates are the LDL/VLDL fraction.

To measure the LDL/VLDL level, the precipitate was spun again, and the trace amount of HDL supernatant carefully removed. The precipitate was resuspendedin 200 µl PBS. This is the LDL/VLDL fraction.

VLDL=TG/2.2

Serum Glucose Unit mmol/L

GOD-PAP enzymtic colorimetric method.

Assay Principle:
Glucose is determined after enzymatic oxidation in the presence of glucose oxidase. The formed hydrogen peroxide reacts under catalysis of peroxidase (PAP) with phenol and 4 aminoantipyrine to form a red violet quinoneimine dye as indicator.

Procedure:
The tubes were labelled as standard, specimen and blank, then 1.0ml of the reagent was pipetted into all the tubes. 10ul of the standards and specimen was added into appropriate tubes. It was mixed and incubated for 10 minutes at 37^{o}C or 20 minutes at 15 -25^{o}C. Absorbance of specimen (Aspecimen) and standard (Astandard) were measured against reagent blank within 30 minutes.

Calculation

Glucose concentration (mg/dl) = $\frac{(\text{Aspecimen}}{(\text{Astandard }\ )}$ x 100

Statistical Analysis

Statistical analysis was performed with SPSS 21.0. Data were expressed as means ± standard error of the mean (Mean ± SEM). Student t-test was used for significance differences between mean values. The results of the mean differences were considered statistically significant at P-values were less than 0.05 ($P<0.05$).

Results

The effect of Vitamin C and combined extract of turmeric and curry leaves on serum glucose (mmol/L) levels in High salt-fed Wistar rats is shown in Table 2. It was observed that High salt control group had considerably higher serum glucose level approximately 1.7 and 2.0-fold than those of normal group at day 14 and day 28 respectively. Administration with TLC extracts significantly attenuated the elevation serum glucose levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in the blood glucose throughout the experimental period. The result showed serum glucose level in high salt control ($p<0.05$) increase compared to control while serum glucose level of TCL extract significantly ($p<0.05$) decreased compared to high salt control group.

Table 2. Effect of Vitamin C and combined extract of turmeric and curry leaves on serum glucose (mmol/L) levels in High salt-fed Wistar rats.

Group	Day 14	Day 28
Normal control	3.80 ± 0.06^{b}	3.80 ± 0.06^{b}
1ml of 20% NaCl	6.34 ± 0.27^{a}	7.20 ± 1.03^{a}
Vitamin C	4.10 ± 0.32^{b}	4.01 ± 0.30^{b}
250mg/kg Extract of TCL	5.10 ± 0.23^{a}	$4.20\pm0.22^{a,b}$
500mg/kg Extract of TCL	$4.16\pm0.14^{a.b}$	$3.13\pm0.45^{a.b}$
1000mg/kg Extract of TCL	3.96 ± 0.42^{b}	3.20 ± 0.40^{b}

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, n=4

The effect of vitamin C and combined extract of turmeric and curry leaves on total cholesterol (mmol/L) levels in high salt-fed wistar rats is shown in Table 3. It was observed that High salt control group had considerably higher TC level approximately 1.9 and 2.1-fold than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly attenuated the elevation TC levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in TG levels on day 14 and 28. The result showed TC level of high salt control ($p<0.05$) increase compared to control while serum TC level of TCL extract significantly ($p<0.05$) decreased compared to high salt control group.

Table 3. Effect of Vitamin C and combined extract of turmeric and curry leaves on Total Cholesterol (mmol/L) levels in High salt-fed Wistar rats.

Group	Day 14	Day 28
Normal control	3.17 ± 0.27^{b}	3.17 ± 0.27^{b}
1ml of 20% NaCl	6.18 ± 0.17^{a}	6.78 ± 0.25^{a}
Vitamin C	4.50 ± 0.23^{b}	3.54 ± 0.20^{b}
250mg/kg Extract of TCL	$4.25\pm0.23^{a,b}$	$3.48\pm0.18^{a,b}$
500mg/kg Extract of TCL	4.01 ± 0.14^{b}	3.30 ± 0.16^{b}
1000mg/kg Extract of TCL	3.40 ± 0.09^{b}	3.18 ± 0.11^{b}

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, n=4

The effect of vitamin C and combined extract of turmeric and curry leaves on Triglyceride (mmol/L) levels in High salt-fed wistar rats is presented Table 4. It was observed that High salt control group had considerably higher TG level approximately 2.3 and 2.4-fold than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly attenuated the elevation TG levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in TG levels on day 14 and 28. The result showed TG level of high salt control ($p<0.05$) increase compared to control while serum TG level of TCL extract significantly ($p<0.05$) decreased compared to high salt control group.

Table 4. Effect of Vitamin C and combined extract of turmeric and curry leaves on Triglyceride (mmol/L) levels in High salt-fed Wistar rats.

Group	Day 14	Day 28
Normal control	1.57 ± 0.05^{b}	1.57 ± 0.05^{b}
1ml of 20% NaCl	3.64 ± 0.22^{a}	3.72 ± 0.18^{a}
Vitamin C	2.60 ± 0.14^{b}	1.80 ± 0.08^{b}
250mg/kg Extract of TCL	2.82 ± 0.12^{b}	2.04 ± 0.10^{b}
500mg/kg Extract of TCL	2.16 ± 0.08^{b}	1.68 ± 0.09^{b}
1000mg/kg Extract of TCL	1.89 ± 0.17^{b}	1.44 ± 0.13^{b}

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, n=4

The effect of vitamin C and combined extract of turmeric and curry leaves on High-Density Lipoprotein (HDL) levels in high salt-fed wistar rats is shown in Table 5. It was observed that High salt control group had considerably lower HDL level approximately 2.8 and 3.8-fold lower than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly increases the HDL levels as compared with High salt fed control group ($P<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in HDL levels on day 14 and 28. The result showed HDL level of high salt control ($p<0.05$) decrease compared to control while HDL level of TCL extract significantly ($p<0.05$) increased compared to high salt control group.

Table 5. Effect of Vitamin C and combined extract of turmeric and curry leaves on High-Density Lipoprotein (HDL) levels in High salt-fed Wistar rats.

Group	**Day 14**	**Day 28**
Normal control	1.67 ± 0.04^{b}	1.67 ± 0.04^{b}
1ml of 20% NaCl	0.58 ± 0.08^{a}	0.43 ± 0.05^{a}
Vitamin C	1.33 ± 0.15^{b}	1.48 ± 0.17^{b}
250mg/kg Extract of TCL	1.26 ± 0.11^{b}	1.60 ± 0.14^{b}
500mg/kg Extract of TCL	1.54 ± 0.07^{b}	1.82 ± 0.09^{b}
1000mg/kg Extract of TCL	1.68 ± 0.07^{b}	2.02 ± 0.20^{b}

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, $n=4$.

The effect of vitamin C and combined extract of turmeric and curry leaves on Low-Density Lipoprotein (LDL) levels in high salt-fed wistar rats is presented in Table 6. It was observed that High salt control group had considerably higher LDL level approximately 1.7 and 1.8-fold than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly attenuated the elevation LDL levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in LDL levels on day 14 and 28. The result showed LDL level of high salt control ($p<0.05$) increase compared to control while serum LDL level of TCL extract significantly ($p<0.05$) decreased compared to high salt control group.

Table 6. Effect of Vitamin C and combined extract of turmeric and curry leaves on Low-Density Lipoprotein (LDL) levels in High salt-fed Wistar rats.

Group	Day 14	Day 28
Normal control	2.25±0.26[b]	2.25±0.26[b]
1ml of 20% NaCl	3.84±0.11[a]	4.02±0.20[a]
Vitamin C	2.72±0.23[b]	2.50±0.08[b]
250mg/kg Extract of TCL	2.66±0.19[a,b]	2.51±0.21[a,b]
500mg/kg Extract of TCL	2.54±0.13[b]	2.30±0.16[b]
1000mg/kg Extract of TCL	2.37±0.10[b]	2.28±0.15[b]

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, n=4.

The effect of vitamin C and combined extract of turmeric and curry leaves on Very-Low-Density Lipoprotein (VLDL) levels in high salt-fed wistar rats is shown in Table 7. It was observed that High salt control group had considerably higher VLDL level approximately 1.7 and 1.8-fold than those of normal group at day 14 and day 28 respectively whereas administration with TLC extracts significantly attenuated the elevation VLDL levels as compared with High salt fed control group ($p<0.05$ for 250 mg/kg, 500 mg/kg, and 1000 mg/kg) in day 14 and day 28 respectively. Control rats did not show any significant variation in VLDL levels on day 14 and 28. The result showed VLDL level of high salt control ($p<0.05$) increase compared to control while serum VLDL level of TCL extract significantly ($p<0.05$) decreased compared to high salt control group.

Table 7. Effect of Vitamin C and combined extract of turmeric and curry leaves on Very-Low-Density Lipoprotein (VLDL) levels in High salt-fed Wistar rats.

Group	Day 14	Day 28
Normal control	0.71±0.02[b]	0.71±0.02[b]
1ml of 20% NaCl	2.40±0.07[a]	2.62±0.06[a]
Vitamin C	1.55±0.04[b]	0.95±0.05[b]
250mg/kg Extract of TCL	1.15±0.06[b]	0.65±0.09[b]
500mg/kg Extract of TCL	0.99±0.23[b]	0.87±0.16[b]
1000mg/kg Extract of TCL	0.76±0.03[b]	0.61±0.08[b]

[a] value is significant when compared to normal control at $p<0.05$, [b] value is significant when compared to negative control (1ml of 20% NaCl) at $p<0.05$, n=4

Discussion

To date, high salt intake and its complications have been major concerns of mortality by cardiovascular diseases worldwide. Excess salt intake contributes to hypertension and increased cardiovascular disease risk. Efforts to implement effective salt-reduction strategies require accurate data on the sources of salt consumption. This current study provided information on the influence of high salt intake in male wistar rats on lipid parameters and serum blood glucose level in Wistar rats and also the antihyperlipidermic effect of combined aqueous extract of turmeric and curry leaves on high salt fed wistar rats.

In this study, there was significant ($P< 0.05$) increase in triglyceride (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-c), very low density lipoprotein cholesterol (VLDL-c) and reduction in high density lipoprotein (HDL) in high salt fed rats compared with control. These findings agree with the report of [18].

In this study, combined extract of turmeric and curry leaves showed antihyperlipidemic and hypoglycemic effects on experimented rats, it shows that as the dosage increases there was a significant decrease in serum glucose level, TC, TG, VLDL-C, LDL-C and a significant increase in HDL-C, when compared with high salt control group. These results are conforming by [19] who revealed that curcumin significantly lower TC, TG, LDL-C, VLDL-C levels and improved HDL-C level as compared with diabetic untreated rats. These results also agree with reports from [20-23].

Vitamin C which is a powerful antioxidant, were administered at 30mg/kg to the rats, it was noticed that there was a significant decrease in serum glucose level, TC, TG, VLDL-C, LDL-C and a significant increase in HDL-C, when compared with negative control group. This work is in agreement with the work of [24,25], who suggested that the bioactive constituent of herbs and spices certainly makes foods more medicinal and anti-inflammatory.

Lipoprotein metabolism normalizes when the rats were treated with the extracts and this could be attributed to the antioxidant properties of curcumin and flavonoids which were widely distributed in the aqueous extract. The metabolism of lipoproteins correlates well with glycemic control of the extract.

Conclusion

This study confers the anti-hyperglycemic effects of combined extract of turmeric and curry leaves as capable herbal material in managing hyperlipidemia and hyperglycemia due to its availability and efficacy. This research has demonstrated the use of combined aqueous extract of turmeric and curry leaves is safe, effective, cheap and more comfortable for the management of hyperlipidemia and hyperglycemia. This finding will further update scientist in the field of nutrition and all other concerned individuals about the effect of diet, nutrients and natural products in hyperlipidemia management.

This study showed that these spices do not just impact flavour to our foods, but may be useful in reducing the risk of cardiovascular complication arising from accumulation of salt and other

metabolic diseases. Those with underlying cardiovascular diseases should be careful by limiting the amount of salt consumed or avoiding it altogether, as there may be an increased risk of hyperlipidemiaor other risky cardiovascular events. Combined extract of turmeric and curry leaves can be used to treat hyperlipidemia and reduce elevated serum glucose level.

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