

Full Length Research Paper

Effect of *Solanum aethiopicum* aqueous extract on acute hyperlipidemia in Triton X-100 induced Wistar albino rats (*Rattus norvegicus*)

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Hyperlipidemia is a significant risk factor for coronary heart disease, making the reduction of plasma lipid levels a key strategy for management. While existing studies have explored the properties of *Solanum aethiopicum*, there is a notable lack of research specifically addressing the dose-response relationship of its aqueous extracts. This study aims to assess the impact of aqueous extract from garden egg leaves (*S. aethiopicum*) on acute hyperlipidemia in Wistar rats (*Rattus norvegicus*) at the 200, 400, and 600 mg/kg body weight. A total of thirty adult Wistar rats weighing between 150 and 250 g, were randomly assigned to six groups of five rats. Group 1 served as the control, receiving only distilled water and a pellet diet. Group 2 was induced with hyperlipidemia but left untreated. Group 3 received simvastatin at a dosage of 10 mg/kg following hyperlipidemic induction with Triton X-100 for three days. Groups 4, 5, and 6 were induced but treated with *S. aethiopicum* extract at 200, 400, and 600 mg/kg body weight, respectively. Blood samples were collected for biochemical analysis after three days of treatment. The induced untreated group showed a significant decrease ($p \leq 0.05$) in total cholesterol and low-density lipoprotein levels with the administration of *S. aethiopicum* extract at 200, 400, and 600 mg/kg. Additionally, triglyceride and very low-density lipoprotein levels significantly decreased ($p < 0.05$) at 200 and 400 mg/kg doses. High-density lipoprotein levels increased at all doses of *S. aethiopicum*, but were not statistically significant ($p \geq 0.05$). The findings suggest that *S. aethiopicum* possesses desirable antihyperlipidemic properties at 200 and 400 mg/kg doses, and could serve as a viable solution for managing hyperlipidemia.

Key words: *Solanum aethiopicum*, hyperlipidemia, Wistar rat, Triton X-100, dose-response, Awka.

INTRODUCTION

Hyperlipidemia is a significant risk factor that precipitates coronary heart disease (Abbasi et al., 2024). Coronary heart disease is a leading cause of death in developing

and some developed countries (Hu et al., 2024). Hyperlipidemia is characterized by elevated serum total cholesterol, low-density and very low-density lipoprotein

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cholesterol, and decreased high-density lipoprotein (Tian et al., 2024).

While the use of therapeutic drugs, especially statins, has significantly decreased the risk of developing cardiovascular diseases (Stacy and Egger, 2006), these drugs are expensive and inaccessible to rural populations in various parts of the world (Li et al., 2024). The use of alternative medicine had shown growing interest among researchers (Khan et al., 2014; Khairnar et al., 2024) especially garden egg (*Solanum aethiopicum*), a popular traditional vegetable in tropical Africa grown for its leave and fruit (Anosike et al., 2012). While a few existing studies have explored the properties of *S. aethiopicum*, there is a notable lack of research specifically addressing the dose-response relationship of its aqueous extracts. Understanding the optimal dosage for therapeutic effects is essential for effective application in hyperlipidemia management. Moreover, comparative studies evaluating the efficacy of *S. aethiopicum* against established pharmaceuticals remedies for hyperlipidemia are limited. This comparative analysis is crucial for determining the relative effectiveness of *S. aethiopicum* in managing lipid levels, particularly in the context of Triton X-induced hyperlipidemia. Addressing these research gaps could significantly enhance our understanding of the therapeutic potential of *S. aethiopicum* in managing hyperlipidemia, particularly in the context of Triton X-induced rat models, and could pave the way for further exploration in phytotherapy and cardiovascular health.

This study aimed to assess the impact of aqueous extract from garden egg leaves (*S. aethiopicum*) on acute hyperlipidemia in Wistar rats (*Rattus norvegicus*) at 200, 400, and 600 mg/kg body weight. Specifically, the study seeks to assess the effect of the extract of bitter garden egg leaf (*S. aethiopicum*) on total cholesterol (TC), triacylglycerol (TRG), high density lipoprotein-cholesterol (HDL-C) and low-density lipoprotein-cholesterol (LDL-C), and very low-density lipoprotein (VLDL) in hyperlipidemic Wistar rats at 200, 400, and 600 mg/kg body weight. To ascertain which dosage is the most effective antihyperlipidemic agent.

MATERIALS AND METHODS

Study location

The study was carried out at the laboratory of the Chris experimental and research unit, Mgbakwu, Anambra State, Nigeria, with geographical coordinates 6° 16' 0" North, 7° 3' 0" East.

The leaf extraction, rat acclimatization, hyperlipidemia induction and treatment, and biochemical analysis were done in the laboratory (Figure 1).

Data collection

The eggplant (*S. aethiopicum*) leaf used for the experiment was obtained as fresh leaves from the market. The leaves were washed,

air dried at room temperature (25±2°C) for 48 h and grinded into fine powder using Panasonic MJ-176-NR-3899, mixer grinder. Leaf extract preparation was done using ethanol extraction method as recommended by Garcia-Vaquero et al. (2020). The standard drug Simvastatin used as control was purchased in tablets of 10 mg. They were dissolved in 20 ml of normal saline to desired concentrations and administered orally.

The experimental animals, adult Wister albino rats, were obtained from Chris' experimental and research unit, Mgbakwu. The animals of either sex weighing between 150 and 250 g.

Experimental design

A total of 30 Wister rats (*Rattus norvegicus*) of either sex weighing between 150 and 250 g was randomly assigned to six groups of five animals each as follows:

- Group 1: Normal control (administered distilled water and pellet diet only throughout the experiment and served as the positive control)
- Group 2: Triton X-induced hyperlipidemic rats, untreated, administered distilled water and pellet diet only throughout the experiment and served as the negative control
- Group 3: were Triton X-induced hyperlipidemic Wistar rats, treated with standard drug (Simvastatin) + distilled water and pellet diet.
- Group 4: were Triton X-induced hyperlipidemic Wistar rats, administered *S. aethiopicum* leaf extract treatment at 200mg/kg body weight + distilled water and pellet diet.
- Group 5: were Triton X-induced hyperlipidemic Wistar rats administered *S. aethiopicum* leaf extract treatment at 400 mg/kg body weight + distilled water and pellet diet
- Group 6: were Triton X-induced hyperlipidemic Wistar rats administered *S. aethiopicum* leaf extract treatment at 600 mg/kg body weight + distilled water and pellet diet.

Experiment procedure

Thirty adult Wistar rats were used for the study. The animals were weighed and randomly distributed into six groups of five rats each. Each group was housed in aluminum box cages dimension 40 cm × 15 cm × 20 cm. They were kept under standard environmental conditions of room temperature (25 ± 2°C), relative humidity (60 ± 5%) and light and dark cycle (12 h) in an environmentally controlled animal house. The animals were acclimatized to laboratory environment conditions for 2 weeks prior to experiment by feeding with grower's mash pellet (Vital feed) and distilled water. The animals were then fasted for 18 h prior to the experiment but allowed access to drinking water. On commencement of the experiment, hyperlipidemia was induced in Wistar albino rats' groups 2, 3, 4, 5 and 6 by single intraperitoneal injection of 0.2 ml of freshly prepared solution of Triton X-100 (100 mg/kg) in physiological saline solution. After 72 h of Triton X-100 induction, group 3 Wistar albino rats received the standard drug (Simvastatin), while groups 4, 5 and 6 rats were administered *S. aethiopicum* leaf extract treatment at 200, 400, and 600 mg/kg body weight, respectively. The treatment was administered for 3 days. Groups 1 and 2 received no treatment. All groups received distilled water and pellet diet daily throughout the experiment. The animals were weighed at the beginning and end of the experiment. The animals were sacrificed at the end of the experiment and blood samples collected for lipid profile analysis.

Biochemical analysis

Blood sample was collected from the heart using syringe of each rat



Figure 1. Location of study laboratory. O ---- Study laboratory.
Source: Google Map.

through intra-cardiac method. About 3 mL of blood of blood was collected from each rat. Lipid profile test was done to obtain the serum levels of total cholesterol, triglycerides, low density lipoprotein, very low cholesterol and high-density lipoprotein using assay kits from Randox Laboratories Ltd., UK according to the instructions of the manufacturer.

Statistical analysis

All the data were presented as mean $\pm$ standard deviation (SD). A test for significance was performed using the One-way analysis of variances (ANOVA) and the appropriate post hoc test. The level of statistical significance was set at $p < 0.05$.

Ethical approval

The experimental protocol used in this study was approved by the Animal Research Ethics Committee, Nnamdi Azikiwe University, Awka.

RESULTS

Effect of *S. aethiopicum* extract on total cholesterol level of Triton X-100 induced hyperlipidemic rats.

Induction of hyperlipidemia with Triton X-100 significantly ($p < 0.05$) increased the total cholesterol concentration in all the groups except the normal control group, which was not induced. Treatment with the standard drug (Simvastatin)

and the ethanol extract of *S. aethiopicum* at a dose of 200, 400 and 600 mg/kg bodyweight significantly decreased the total cholesterol concentrations compared with the hyperlipidemic untreated group ($p < 0.05$) (Figure 2).

Effect of ethanol extract of *S. aethiopicum* on HDL cholesterol level of Triton X-100 induced hyperlipidemic rats

Induction with Triton X-100 decreased the high-density lipoprotein concentration in all the groups except the normal control group, which was not induced. This was not statistically significant ($p > 0.05$). Treatment with the standard drug (Simvastatin) and the ethanol extract of *S. aethiopicum* at a dose of 200 and 600 mg/kg bodyweight increased the high-density lipoprotein concentration when compared with the hyperlipidemic untreated group although the increase was not significant ($p > 0.05$) (Figure 3).

Effect of ethanol extract of *S. aethiopicum* on the triglyceride level of Triton X-100 induced hyperlipidemic rats

Induction of hyperlipidemia with Triton X-100 significantly increased the triglyceride concentration in all the groups except the normal control group which was not induced

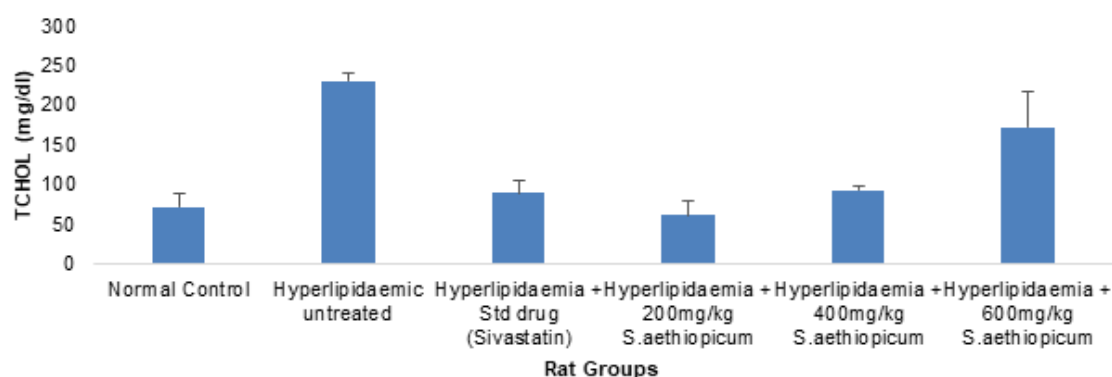


Figure 2. Effect of ethanol extract of *S. aethiopicum* on total cholesterol level of Triton X-100 induced hyperlipidemic rats.

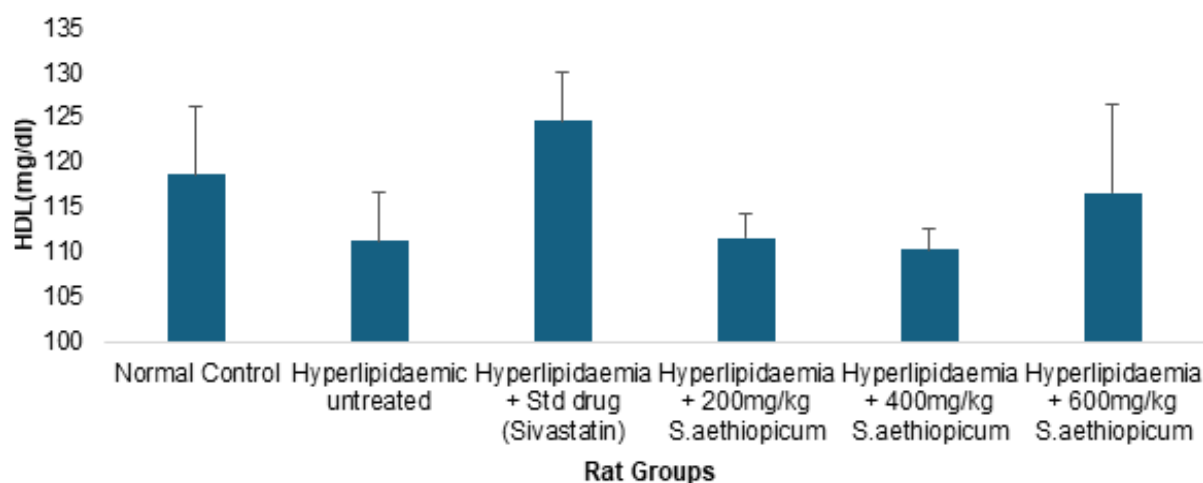


Figure 3. Effect of ethanol extract of *S. aethiopicum* on HDL cholesterol level of Triton X-100 induced hyperlipidemic rats.

($p < 0.05$). Treatment with the standard drug (Simvastatin) and the ethanol extract of *S. aethiopicum* at a dose of 200 and 400 mg/kg bodyweight decreased the triglyceride level when compared with the hyperlipidemic untreated group although the decrease was not significant ($p > 0.05$) (Figure 4).

Effect of ethanol extract of *S. aethiopicum* on LDL cholesterol level of Triton X-100 induced hyperlipidemic rats

Induction of hyperlipidemia with Triton X-100 significantly increased the concentrations of LDL in all the groups except the normal control group which was not induced ($p < 0.05$). Treatment with the Simvastatin and the ethanol extract of *S. aethiopicum* at dose of 200, 400 and 600

mg/kg bodyweight decreased the concentrations of LDL when compared with the hyperlipidemic untreated group. This was significant ($p < 0.05$) (Figure 5).

Effect of ethanol extract of *S. aethiopicum* on VLDL cholesterol level of Triton X-100 induced hyperlipidemic rats

Induction of hyperlipidemia with Triton X-100 significantly increased the concentrations of VLDL in all the groups except the normal control group which was not induced ($p < 0.05$). Treatment with Simvastatin and the ethanol extract of *S. aethiopicum* at dose of 200 and 400 mg/kg bodyweight decreased the concentrations of VLDL when compared with the hyperlipidemic untreated group. This was significant ($p < 0.05$) (Figure 6).

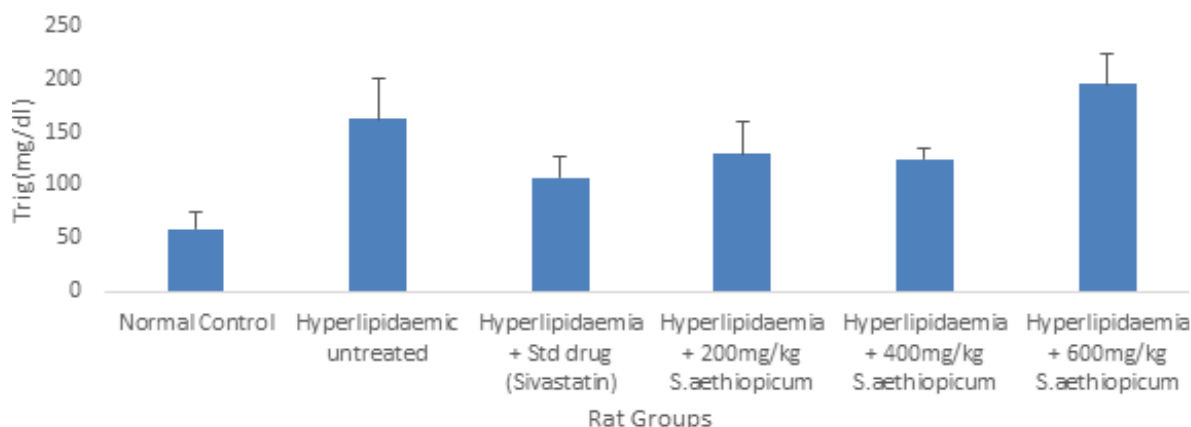


Figure 4. Effect of ethanol extract of *S. aethiopicum* on triglyceride level of Triton X-100 induced hyperlipidemic rats.

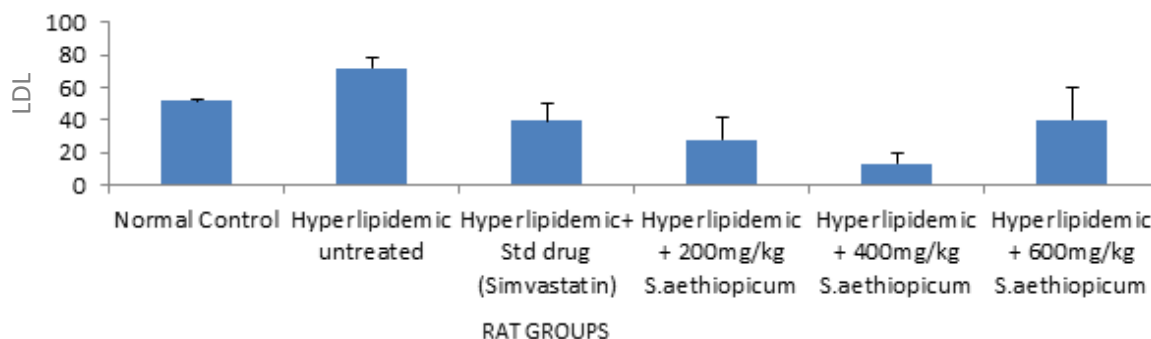


Figure 5. effect of ethanol extract of *S. aethiopicum* on LDL cholesterol level of Triton X-100 induced hyperlipidemic rats.

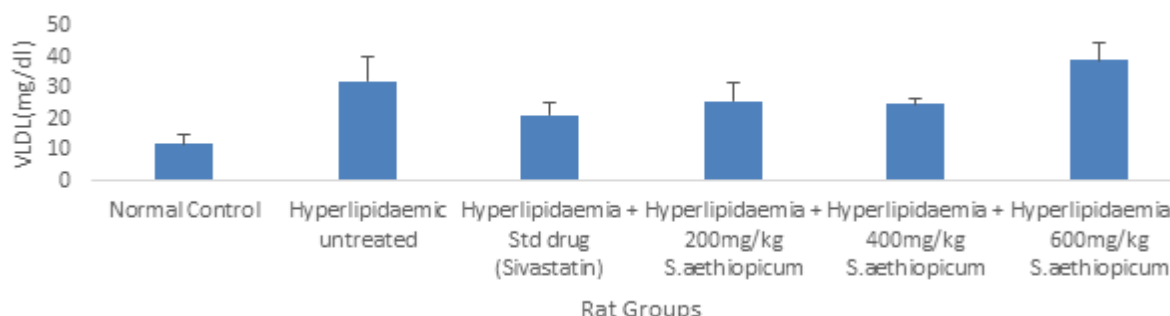


Figure 6. Effect of ethanol extract of *S. aethiopicum* on VLDL cholesterol level of Triton X-100 induced hyperlipidemic rats.

DISCUSSION

The investigation into the impact of aqueous extract from *S. aethiopicum* leaves on hyperlipidemia in Wistar albino rats (*Rattus norvegicus*) is crucial, as hyperlipidemia is a

prevalent metabolic disorder and a significant risk factor for cardiovascular diseases. This research is relevant for gaining insights into managing some of its underlying causes. The study demonstrated a notable reduction in total cholesterol levels following the administration of

S. aethiopicum leaf extract at doses of 200, 400, and 600 mg/kg body weight. These reductions may be attributed to the extract's capacity to enhance the transport of cholesterol and triglycerides from the bloodstream into tissues, potentially through the activation or inhibition of specific enzymes involved in lipid metabolism. This finding aligns with the results of Wang et al. (2023), who reported a significant decrease in elevated lipid levels using *Ganoderma lucidum*, a traditional fungus administered to mice.

Furthermore, the study observed an increase in HDL concentrations with *S. aethiopicum* leaf extract at doses of 200 and 600 mg/kg body weight. HDL is widely recognized as "good" cholesterol, which is beneficial for overall health, particularly cardiovascular health (Jomard and Osto, 2020). This suggests that *S. aethiopicum* leaf extract has the potential to lower LDL and triglyceride levels while simultaneously increasing HDL concentrations. This is consistent with findings by Asghar et al. (2023), who noted a significant rise in HDL levels in hyperlipidemic rabbits treated with *Azadirachta indica* leaf extract. The study also reported a decrease in triglyceride levels with *S. aethiopicum* leaf extract at doses of 200 and 400 mg/kg body weight, indicating the extract's ability to reduce triglycerides in plasma.

This effect could be linked to its high fiber and antioxidant content, which may contribute to lowering triglyceride levels. A similar outcome was observed by Mahdi et al. (2020), who found that rice bran therapy significantly reduced triglyceride levels in rats on a high-cholesterol diet. Additionally, there was a significant reduction in LDL concentrations with *S. aethiopicum* leaf extract at all tested doses (200, 400, and 600 mg/kg body weight). This finding is supported by Zahra et al. (2014), who reported similar results when examining the effects of dietary ethanolic extract of *Lavandula officinalis* on serum lipid profiles in rats. Previous research has indicated that *S. aethiopicum* extract contains saponins, flavonoids, alkaloids, steroids, and other compounds with antioxidant properties (Ebi and Kamalu, 2001). The high antioxidant capacity may help diminish free radical formation by lowering serum LDL levels, inhibiting LDL oxidation, and reducing thrombotic tendencies (Zahra et al., 2014). These results are comparable to those obtained by Tabansi et al. (2023), who observed a decrease in LDL levels in diet-induced atherogenic Wistar rats treated with *Terminalia catappa* fruit. Moreover, the study found a significant reduction in VLDL concentrations with *S. aethiopicum* leaf extract at doses of 200 and 400 mg/kg body weight. This effect may be attributed to the presence of glycosides in the extract, which could lower VLDL levels in hyperlipidemic rats by influencing HDL levels. The findings indicate that the administration of *S. aethiopicum* leaf extract may regulate genes associated with lipid metabolism in rats. This aligns with the results from Abduh et al. (2023), who observed a significant reduction in very

low-density lipoprotein levels following the use of *Averrhoa carambola* fruit extract in rats with poloxamer-407 induced acute hyperlipidemia

Conclusion

This study revealed that the ethanol extract of *S. aethiopicum* has an anti-hyperlipidemic effect. The current research indicates that the leaf extract of *S. aethiopicum* reduces serum cholesterol, triglycerides, LDL, and VLDL levels, as well as the LDL/HDL ratio, while potentially enhancing HDL levels in hyperlipidemic rats. It is concluded that the ethanol extract of *S. aethiopicum* could serve as a natural treatment for hyperlipidemia and its related complications. However, the limited number of rats used in the study may impact the statistical power of the results and the ability to generalize the findings to a broader population. Future research should consider increasing the sample size and exploring the biochemical pathways through which *Solanum* affects lipid metabolism.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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