

RESEARCH ARTICLE

INVESTIGATION OF HERBAL EXTRACTS ON LIPID PROFILE AND ANTIOXIDANT STATUS IN DIET-INDUCED HYPERLIPIDEMIA

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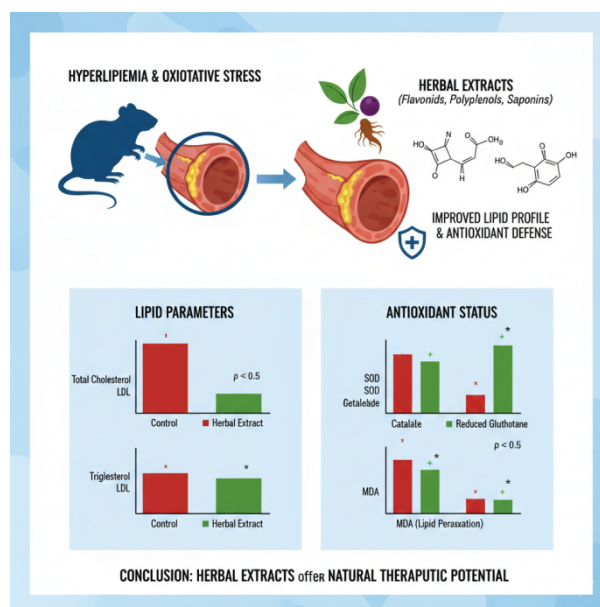
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Received: 10.07.2025**Revised:** 14.07.2025**Accepted:** 05.08.2025**Published:** 08.09.2025**Abstract:**

Hyperlipidemia is a major risk factor for cardiovascular diseases and is associated with oxidative stress, leading to endothelial dysfunction and atherosclerosis. Herbal extracts rich in bioactive compounds such as flavonoids, polyphenols, and saponins have been reported to modulate lipid metabolism and enhance antioxidant defense. The present study aimed to evaluate the effects of selected herbal extracts on lipid profile and antioxidant status in diet-induced hyperlipidemic rats. Adult Wistar rats were fed a high-fat diet for 8 weeks to induce hyperlipidemia and then divided into control, standard (atorvastatin 10 mg/kg), and herbal extract-treated groups. Lipid parameters (total cholesterol, triglycerides, LDL, HDL) and antioxidant markers (SOD, catalase, reduced glutathione, MDA) were assessed after 4 weeks of treatment. Herbal extract administration significantly improved lipid profiles by reducing total cholesterol, triglycerides, and LDL levels while increasing HDL levels ($p < 0.05$). Antioxidant enzyme activities were enhanced, and lipid peroxidation was reduced compared to the control group, indicating attenuation of oxidative stress. These findings suggest that the tested herbal extracts possess hypolipidemic and antioxidant properties, highlighting their potential as natural therapeutic agents for managing hyperlipidemia and associated oxidative damage.

Keywords: Herbal extracts, Hyperlipidemia, Lipid profile, Antioxidant enzymes, Oxidative stress, Total cholesterol, Triglycerides, LDL, HDL.



Graphical abstract:

INTRODUCTION

Hyperlipidemia, defined as the abnormal elevation of plasma lipids including total cholesterol, low-density lipoprotein (LDL), and triglycerides, is a major contributor to the global burden of cardiovascular diseases (CVDs). Elevated lipid levels promote the formation of atherosclerotic plaques, endothelial dysfunction, and chronic inflammation, which are key mechanisms underlying coronary artery disease, stroke, and peripheral vascular disorders. Oxidative stress, resulting

from an imbalance between reactive oxygen species (ROS) and endogenous antioxidant defenses, further exacerbates lipid peroxidation and vascular injury, accelerating the progression of hyperlipidemia-related complications [1].

Although conventional lipid-lowering agents such as statins, fibrates, and bile acid sequestrants are clinically effective, long-term use is sometimes limited by side effects including hepatotoxicity, myopathy, and gastrointestinal disturbances. This has led to a significant focus on natural and plant based interventions that have the potential to offer safer alternatives with diverse effects, including lipid regulation and antioxidant effects [2].

Herbal extracts are rich sources of various bioactive compounds of flavonoids, polyphenols, saponins, alkaloid, and terpenoids with hypolipidemic, antioxidant, anti-inflammatory, and cardioprotective effects. Flavonoids and polyphenols have been identified to prevent lipid production, promote LDL receptor induced clearance, and increase high-density lipoprotein (HDL). Additionally, these phytochemicals scavenge free radicals, enhance endogenous antioxidant enzyme activities (superoxide dismutase [SOD], catalase, reduced glutathione [GSH]), and inhibit lipid peroxidation (measured as malondialdehyde [MDA]), thereby mitigating oxidative stress associated with hyperlipidemia [3].

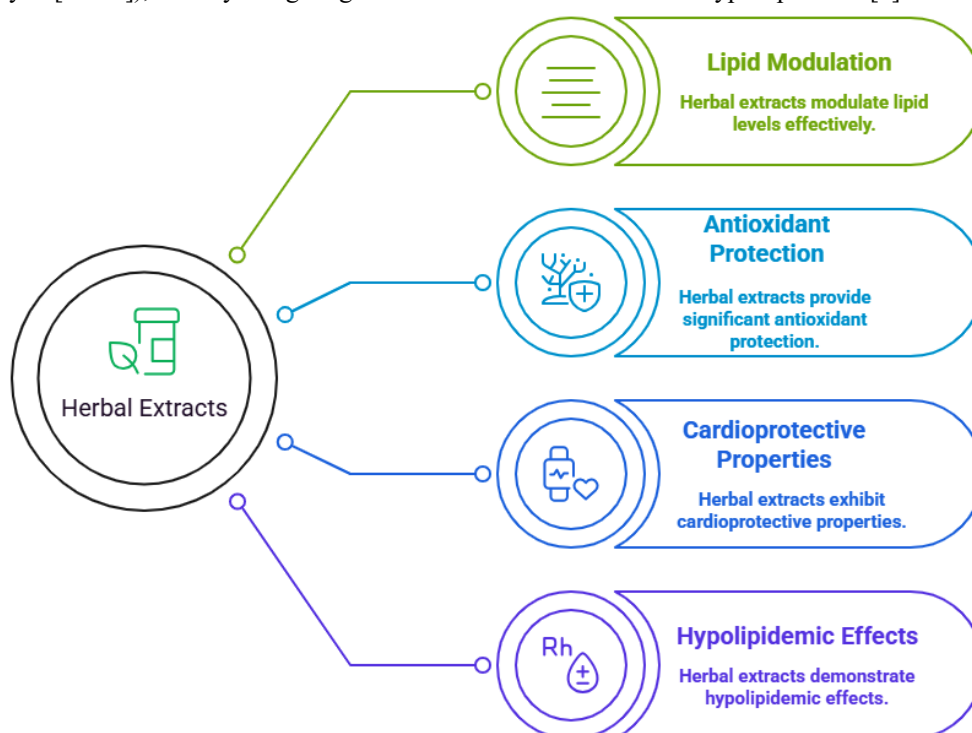


Figure 1: Unveiling Herbal Interventions for Hyperlipidemia

In animal models, especially Wistar rats fed on high-fat diet, hyperlipidemia induced by diet is very similar to human dyslipidemia, such as serum cholesterol, triglycerides, and LDL increase, and oxidative stress products. This model enables a holistic evaluation not only of lipid-lowering but also antioxidant activity of natural compounds and can offer mechanistic information on their cardioprotective effect [4].

The current research was aimed to examine the influence of two sources of herbal extracts on lipid profile and antioxidant in hyperlipidemic rats fed on a diet. Measurement of parameters is total cholesterol, triglycerides and LDL, HDL and oxidative stress markers (SOD, catalase, GSH, MDA). The researchers seek to investigate the dual pharmacological exploitation of these herbal extracts as natural remedies to hyperlipidemia and other oxidative stress conditions to provide a foundation of creating safer plant therapeutic interventions of cardiovascular health [5].

MATERIAL AND METHODS

Chemicals and Reagents

The content of high-fat diets, such as cholesterol, cholic acid, and lard were sourced out of certified suppliers. Medicinal plants were chosen and extracted in ethanol or aqueous technique to produce herbal extracts which were standardized on the basis of their active constituents. Assay kits for lipid profile (total cholesterol, triglycerides, HDL, LDL) and antioxidant markers (SOD, catalase, reduced glutathione [GSH], malondialdehyde [MDA]) were obtained commercially [6].

Experimental Animals

The Wistar rats were male adults (180-220 g) kept under optimal laboratory conditions (25±2°C, 50-60 humidity, 12 hr light cycle and 12 hr dark cycle) with ad libitum food and water. The experiment was authorized by the Institutional Animal Ethics Committee (IAEC) and the work was done as per the CPCSEA guidelines [7].

Induction of Hyperlipidemia

The rats received 8 weeks of high-fat diet (HFD) which included cholesterol, cholic acid and lard to induce hyperlipidemia in them. Weight and dietary intake were observed after every one week [8].

Experimental Design

Rats were induced to hyperlipidemia, after which they were randomly split into five groups (n six each) [9]:

- Group I: Normal control (standard diet + vehicle)
- Group II: HFD control (high-fat diet + vehicle)
- Group III: HFD and standard medication (atorvastatin 10 mg/kg, p.o.)
- Group IV: HFD + Herbal extract A (200 mg/kg, p.o.)
- Group V: HFD + Herbal extract B (200 mg/kg, p.o.)

Treatment was administered orally once daily for 4 weeks.

Assessment of Lipid Profile

At the end of the treatment period, blood samples were collected via retro-orbital puncture under light anesthesia. Serum was separated and analyzed for total cholesterol, triglycerides, LDL, and HDL using standard enzymatic kits according to manufacturer instructions [10].

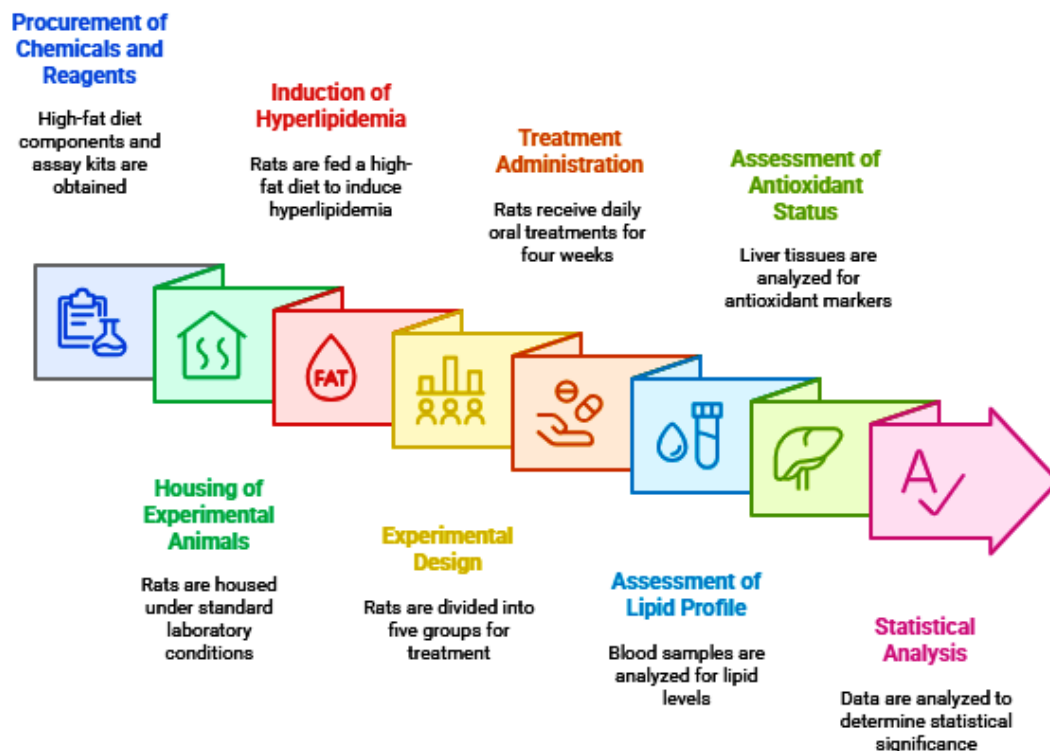
Assessment of Antioxidant Status

Liver tissues were harvested and homogenized for antioxidant assays. Superoxide dismutase (SOD) activity, catalase activity, reduced glutathione (GSH) levels, and lipid peroxidation (malondialdehyde, MDA) were measured using standard spectrophotometric methods [11].

Statistical Analysis

Data were expressed as mean ± SEM. Statistical significance was determined by one-way ANOVA followed by Tukey's post hoc test. A p-value < 0.05 was considered statistically significant [12].

Figure 2: Experimental Study of Hyperlipidemia in Rats



RESULTS AND OBSERVATIONS:

Effect on Lipid Profile

Rats fed a high-fat diet (HFD) exhibited significant increases in total cholesterol, triglycerides, and LDL levels, along with a decrease in HDL levels, compared to normal controls ($p < 0.01$), confirming the induction of hyperlipidemia. Treatment with atorvastatin (10 mg/kg) significantly normalized these parameters. Both herbal extracts (A and B) significantly reduced total cholesterol, triglycerides, and LDL levels while increasing HDL levels compared to the HFD control group ($p < 0.05$). Herbal extract B showed slightly superior lipid-lowering effects compared to extract A, approaching the efficacy of atorvastatin.

Effect on Antioxidant Status

High-fat diet-fed rats demonstrated a significant reduction in antioxidant enzymes (SOD, catalase, GSH) and a marked increase in lipid peroxidation (MDA), indicating oxidative stress. Treatment with herbal extracts significantly restored SOD, catalase, and GSH levels while reducing MDA content ($p < 0.05$). The effect was more pronounced with herbal extract B, suggesting stronger antioxidant activity.

The findings indicate that both herbal extracts possess significant hypolipidemic and antioxidant effects in diet-induced hyperlipidemic rats, with herbal extract B showing slightly higher efficacy. These results support the potential use of these herbal extracts as natural agents for managing hyperlipidemia and oxidative stress (Table 1, Figure 3).

Table 1: Effect of Herbal Extracts on Lipid Profile and Antioxidant Status in Diet-Induced Hyperlipidemic Rats

Group	Treatment	Total Cholesterol (mg/dL)	Triglycerides (mg/dL)	LDL (mg/dL)	HDL (mg/dL)	SOD (U/mg protein)	Catalase (U/mg protein)	GSH ($\mu\text{mol/g}$ tissue)	MDA (nmol/mg tissue)
I	Normal control	110.5 $\pm$ 4.2	85.3 $\pm$ 3.5	35.6 $\pm$ 2.1	55.2 $\pm$ 2.8	8.5 $\pm$ 0.3	42.3 $\pm$ 1.5	7.8 $\pm$ 0.4	2.5 $\pm$ 0.2
II	HFD control	198.7 $\pm$ 5.1**	165.4 $\pm$ 4.8**	92.3 $\pm$ 3.2**	32.4 $\pm$ 2.1**	4.1 $\pm$ 0.2**	22.5 $\pm$ 1.2**	3.5 $\pm$ 0.3**	6.8 $\pm$ 0.3**
III	HFD + Atorvastatin (10 mg/kg)	118.4 $\pm$ 3.8**	95.7 $\pm$ 3.1**	42.6 $\pm$ 2.5**	52.3 $\pm$ 2.4**	7.9 $\pm$ 0.3**	40.1 $\pm$ 1.3**	7.2 $\pm$ 0.3**	2.9 $\pm$ 0.2**
IV	HFD + Herbal extract A (200 mg/kg)	135.6 $\pm$ 4.0*	115.8 $\pm$ 3.5*	55.2 $\pm$ 2.7*	45.6 $\pm$ 2.2*	6.2 $\pm$ 0.3*	33.4 $\pm$ 1.2*	5.8 $\pm$ 0.3*	4.1 $\pm$ 0.2*
V	HFD + Herbal extract B (200 mg/kg)	124.3 $\pm$ 3.9**	103.7 $\pm$ 3.3**	48.1 $\pm$ 2.6**	50.2 $\pm$ 2.3**	7.1 $\pm$ 0.3**	38.2 $\pm$ 1.3**	6.8 $\pm$ 0.3**	3.2 $\pm$ 0.2**

*Values are expressed as mean $\pm$ SEM, n = 6.

*Significant at $p < 0.05$, **highly significant at $p < 0.01$ compared to HFD control (ANOVA followed by Tukey's post hoc test).

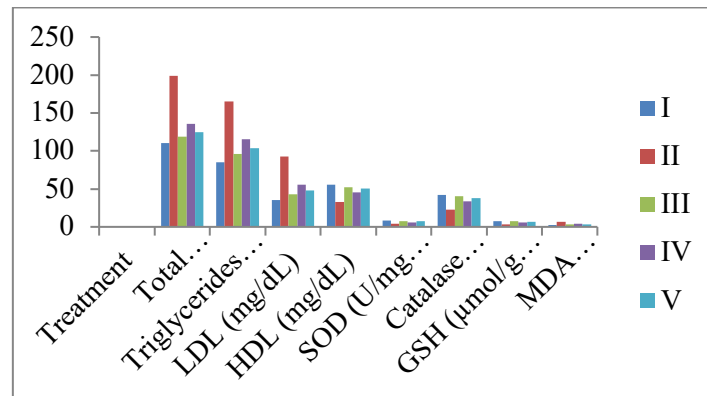


Figure 3: Graphical presentation of Lipid Profile and Antioxidant Status in Diet-Induced Hyperlipidemic Rats

Both herbal extracts improved lipid profile and antioxidant status in HFD-induced hyperlipidemic rats, with herbal extract B showing slightly higher efficacy, approaching the effects of atorvastatin.

DISCUSSION

The present study demonstrates that the selected herbal extracts exert significant hypolipidemic and antioxidant effects in diet-induced hyperlipidemic rats. This was evidenced by the fact that the total cholesterol, triglycerides, and LDL level and the reduction in the HDL level of the rats in high fat diet (HFD) group increased high. These rats were also found to have oxidative stress when antioxidant enzyme activities were found to be reduced such as SOD, catalase and GSH and augmented lipid peroxidation as shown by a rise in the levels of MDA [13]. The lipid profile was significantly favorable due to the presence of a significant large positive effect on the lipid profile by a significant decrease in the total cholesterol, triglycerides and LDL levels and significant increase in the HDL levels by the herbal extracts. All these processes contribute to improved lipid energy and improved antioxidant protection. Extract B of herbs displayed a little more efficacy as compared to extract A, which may imply variations of phytochemical composition or bioavailability [14].

The herbal extracts also increased the endogenous antioxidant defenses, which were indicated by the increased SOD, catalase, and GSH activities and reduced the level of MDA. It means that hyperlipidemia-induced oxidative stress is mitigated. It is also probable that the antioxidant effects of flavonoid and polyphenols are associated with the ability to scavenge reactive oxygen species, prevent lipid peroxidation of cellular components and enhance the overall oxidative balance [15].

In totality, the two hypolipidemic and antioxidant actions of the herbal extracts indicate the possibility of the extracts as natural therapeutic agents in the management of hyperlipidemia and oxidative stress that accompanies the condition. The findings are consistent with reports of prior studies on plant-derived compounds enhancing lipid metabolism and antioxidant status that supports the therapeutic value of herbal interventions in the reduction of cardiovascular risks [16]. The research on identifying mechanistic pathways, dose optimization, and chronic toxicity is justified as it will provide the effectiveness and safety of them to be used in clinical settings.

CONCLUSION

The current research indicates that the sampled herbal extracts are useful in enhancing lipid profile and antioxidant state among diet induced hyperlipidemic rats. The two extracts had potent hypolipidemic effects by reducing the total cholesterol, triglycerides and LDL

and increasing the HDL levels. Also, the increase in antioxidant enzymes (SOD, catalase, GSH) and the decrease in lipid peroxidation (MDA) indicate severe antioxidant properties, which reduces oxidative stress related to hyperlipidemia. Extract B was marginally more effective than extract A and was close to the effects of atorvastatin. This results indicate the relevance of these herbal extracts as natural therapeutic agents to hyperlipidemia and oxidative stress management, which calls on further studies to be conducted to enable clinical use.

REFERENCES

1. AslamMand Najam R.Hypolipidemic and Anti-Atherogenic Activity of Aqueous Extract of Leaves of *Lagenaria Siceraria* in Wistar Rats. *Journal of Natural Remedies.*, 2010; 14(1):53-57.
2. Khaledi M, Khaledi F, Samani M.S, Gholipour A and Kouhi A.M.Phytochemical evaluation and antibacterial effects of *Medicago sativa*, *Onosma sericeum*, *Parietaria judaica* L., *Phlomis persica* and *Echinophora platyloba* DC.On *Enterococcus faecalis*. *Biomed Res Ther.*, 2018; 5(1): 1941-1951.
3. Seida A, HefnawyH, Abou-Hussein D,Mokhtar F.A andAbdel-Naim A.Evaluation of *Medicago sativa* sprouts as antihyperlipidemic and antihyperglycemic agent. *Pak. J. Pharm. Sci.*, 2015; 28(6): 2061-2074.
4. D andPadhyeM.R.Evaluation and comparison of hyperlipidemic effect of *Curcuma longa* Linn. With atorvastatin in albino rats.*National Journal of Physiology, Pharmacy and Pharmacology.*, 2019; 9(8):704-708.
5. Lopes R.H.O, MacoriniL.F,B, Antunes K.A, Espindola T.P.P, Alfredo T.M, RochaP.S, Pereira Z.Vet al.. Antioxidant and Hypolipidemic Activity of the Hydroethanolic Extract of *Curatella americana* Leaves. *Oxidative Medicine and Cellular Longevity.*,2015; Volume: 1-6.
6. Ahmad A, Hayat I, Arif S,Masud T, Khalid Nand Ahmed A.Mechanisms Involved In the Therapeutic Effects of Soybean (*Glycine Max*).*International Journal of Food Properties.*, 2014; 17:1332–1354.
7. I,Steven O.O,AguC.E,Orji O.C, Chekwube B.Eand Nwosu T.F.Anti-hyperlipidemic effect of crude methanolic extracts of *Glycine max* (soy bean) on high Cholesterol diet-fed albino rats. *J Med Allied Sci.*, 2017; 7(1):34-40.
8. CrossRef
9. Sikarwar M.S and Patil M.B. Antihyperlipidemic activity of *Hibiscus rosa sinensis* ethanolic extract fractions. *International Journal of Health & Allied Sciences.*, 2015; 4(2):73-78.
10. Singh P, Khan M andHailemariam H. Nutritional and health importance of *Hibiscus sabdariffa*: a

- review and indication for research needs. *J Nutr Health Food Eng.*, 2017; 6(5):125-128.
11. Gaffer E.Y and Mustafa H.A. The Hypolipidaemic Effect of the Ethanolic Extract of Hibiscus sabdariffa Calyces on Induced Hyperlipidaemia in Albino Rats. *EC Veterinary Science.* 2019; 4(6): 379-386.
 12. JawaidaT, KhatoonaS and Kamal M.. Antihyperlipidemic effect of the aqueous extract from Cinnamomum tamala leaf in hyperlipidemic rats. *Journal of Pharmacy Research*, 2014; 8(8):1098-1104.
 13. Sharma S, SinghL, Sagar B.P.S and Das M.K. Evaluation Of Antihyperlipidemic Activity Of Ethanolic Extract of Withania Somnifera In Triton X-100 Induced Hyperlipidemic Rats. *IJPBS.*, 2018; 8 (2): 639-646.
 14. Mocelina R, Marcona M, Santoa G.D, Zanattaa L, Sachettb A and Schönellb A.P et al. Hypolipidemic and antiatherogenic effects of Cynara scolymus in cholesterol-fed rats. *Revista Brasileira de Farmacognosia.*, 2016; 26: 233-239.
 15. B, Tanwar R.S, Nasir A and PrabhuK.M. Antihyperlipidemic Effect of Active Principle Isolated from Seed of Eugenia jambolana on Alloxan-Induced Diabetic Rabbits. *J Med Food.*, 2011; 14(4): 353-359.
 16. Sripradha R, SridharM.G.K and Maithilikarpagaselvi N. Antihyperlipidemic and antioxidant activities of the ethanolic extract of Garcinia cambogia on high fat diet-fed rats. *J Complement Integr Med.*, 2016; 13(1): 9-16.
 17. M, DevavaramJ.D, Dhas J.S, Adeghate E and Emerald B.S. Anti-hyperlipidemic effect of methanol bark extracts of Terminalia chebula in male albino Wistar rats. *Pharm Biol.*, 2015; 53(8): 1133-1140.