**RESEARCH ARTICLE**

# Hypolipidemic Activity of a Polyherbal Formulation in Triton WR-1339 and High Fat Diet-induced Hyperlipidemic Rats

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**ABSTRACT**

In hyperlipidemic wistar albino rat models produced by triton and diet, the efficacy of polyherbal formulations containing four different plants was assessed. Rats exposed to Triton WR 1339 had their blood cholesterol and triglyceride levels raised. However, this was reversed when the rats were given syrup or a comparable formulation. Both formulations better lipid outlines in rats with high-fat diet-induced hyperlipidemia. Effects were marginally better with the usual medication Atrovastatin. Liver sinusoidal capillary dilations, cytoplasmic fatty infiltration, and granular degeneration were considerably reduced in polyherbal formulation-treated group II animals related with other groups. As per results, polyherbal formulations in dyslipidaemic circumstances reduce lipid levels by blocking the production of cholesterol and reducing lipid utilization.

**Keywords:** High-fat diet, HDL-C, Triglycerides, Polyherbal formulations, Anti-hyperlipidemic activity, Triton WR 1339.

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**Conflict of interest:** None

## INTRODUCTION

Hyperlipidemia is an ailment of lipidic metabolism and risk factor for atherosclerosis and these are causes for various cardiovascular like coronary heart disease, osteoarthritis, ischemic cerebrovascular disease, hypertension, obesity and diabetes mellitus.[1]

The National Commission on Macroeconomics and Health (NCMH), an initiative of the Government of India, estimates that by 2015, around 62 million Indians will have coronary artery disease (CAD), including 23 million Indians under the age of 40.[2]

The current hypolipidemic medications (statins) have certain undesirable side effects. The risk of hepatotoxicity is much increased with slow-release niacin compared to crystalline niacin or immediate-release niacin. people treated with fibrates often experience a 15 to 20% increase in plasma creatinine, with much greater increases possible in people with preexisting renal impairment. As a result, researchers have been looking for a novel, reliable treatment for dyslipidemia.[3] Herbs have long been valued for both their culinary and medicinal potential.[4,5] Many different herbs have been studied for their potential as an adjuvant in lowering cardiovascular disease risk because of their hypolipidemic action.

Plants including *Azadirachta indica, Curcuma longa, Allium sativum, Ocimum sativum*, and *Punica granatum* are found in polyherbal combinations; these plants have been documented to have varying degrees of pharmacological activity. To try and establish the traditional use of this Poly herbal composition, the current study was conducted to look at its anti-hyperlipidemic effects in wistar rats.

## MATERIALS AND METHOD

### Animals

Wistar male and female rats weighing between 150 and 200 g were used in the studies. After a vet checked on them, the rats were housed in their cages under the standard laboratory conditions (22–23°C, relative humidity 50–60%) for five days before being dosed in the experimental room. Pelletized meal and ad libitum water were provided for the animals. The Research Centre's Institutional Animal Ethical Committee gave their stamp of approval to the project.

### Chemical and Instrument

*Drugs and standards*

Tyloxapol (Triton WR-1339, Sigma Aldrich, USA), atorvastatin (Zydus Research Centre, Ahmedabad), enzyme kits (Lab care diagnostic Pvt.Ltd., India), and remaining compounds were of superior quality.

*Acute toxicity studies*

Rendering to OECD guidelines 423,[6] wistar rats were used in acute toxicity tests on the polyherbal formulation's aqueous

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extract. The aqueous extract of the polyherbal preparation was orally fed to each animal. Upto 48 hours, the animals were monitored for signs of mortality. Up to 2000 mg/kg body weight, aqueous extract of the polyherbal mixture was deemed safe.

**Experimental Protocol**

*Triton-induced hyperlipidemia*

Five sets of six animals were put into distinct groups.[7] There were five different groups: Triton was administered to group 2, a control group. Polyherbal syrup (200 mg/kg body weight) to Group 3 for Triton-induced hyperlipidemia, polyherbal syrup (400 mg/kg body weight) to Group 4 and gold standard drug atrovastatin (100 mg/kg body weight) to group.[5]

All the animals were kept in a controlled laboratory environment with a constant temperature of 25 to 26°C, humidity of 60 to 80%, and 12-hour light/12-hour dark cycle. Fresh water and a standard pellet meal (from NutrivaIndia Ltd) were given. A single intraperitoneal dose of tritonWR-1339 (400 mg/kg b. w.) caused hyperlipidemia in rats. After the rats were given their treatment, we made them fast for 18 hours before drawing blood under light ether anesthesia from their retro-orbital sinuses. The serum was separated from the other samples by centrifuging them at 2500 rpm for 10 minutes. Just prior to the sacrifice, bloodwork and biochemistry analyses were performed. Tissues from the primary organs (liver, kidney, and aorta) were stored in 10% formalin and histopathology was done on them (Figure 1a-c).

*High-fat diet-induced hyperlipidemia*

There were 12 animals in all, so we divided them in four groups of six. First group acted as a control, second was given a high-fat diet, the third developed hyperlipidemia as a result of the high-fat diet and was given polyherbal syrup (200 mg/kg body weight), fourth developed hyperlipidemia as a result of the high-fat diet and was given polyherbal syrup (400 mg/kg body weight); fifth was given the gold-standard drug Atrovastatin (100 mg/kg body weight). All group except the Normal Controls were given HFD and their respective therapy. Confirming the establishment of hypercholesterolemia in rats, elevated cholesterol levels were seen on day 10 in all groups with the exception of normal rats. The HFD was abandoned on day 28 and other therapies were maintained. Once a week, blood samples were taken from all participants to record their glucose, cholesterol, HDL cholesterol, and triglyceride levels. A blood sample was taken through retro-orbital sinus puncture while the patient was under little ether anaesthesia.[8] The serum was separated from the other samples by centrifuging them at 2500 rpm for 10 minutes. Just prior to the sacrifice, bloodwork and biochemistry analyses were performed (Figures 2a, b and c).

**Evaluation Parameters**

*Observational parameter*

Food intake as well as weight gain in each group of rats were observed for 28 days.

*Blood glucose test*

An electronic glucometer determined glucose concentration in blood.

*Estimation of lipid profile and atherogenic index*

Triglyceride, cholesterol, high-density lipoprotein and, and C-reactive protein (CRP) levels in the serum were measured per established protocols. Formula used:

$$VLDL = TG/5$$

$$LDL = TC - HDL - TG/5$$

$$\text{Atherogenic index} = (TC - HDL)/HDL$$

**Histopathology**

Histological examinations were performed on liver tissue that had been fixed in 10% buffered neutral formalin. Tissues were fixed, then paraffin embedded, and slices were cut at a 4 to 5 mm thickness before being stained with eosin and hematoxylin; sections were photographed and analyzed using a light microscope.

**Statistical Analysis**

Statistics was analyzed by One-way ANOVA (Graph Pad Prism 5.0) and a comparison test and the findings were provided as Mean + SEM.

## RESULTS

**Changes in Serum Lipid Profile Caused by Polyherbal Formulation in Triton-Induced Hyperlipidemic Rats**

Serum levels of cholesterol, triglycerides, low-density lipoprotein cholesterol, very low-density lipoprotein cholesterol, and the atherogenic index were dramatically reduced in Triton-induced hyperlipidemic rats following oral treatment with polyherbal formulation (200 and 400 mg/kg, p.o.). Serum HDL-cholesterol levels were increased in the polyherbal formulation-treated mice compared to the Triton-treated mice (Tables 1 and 2).

**Hyperlipidemic Rats were Fed a High-fat Diet, and Their Serum Lipid Profiles were Analyzed to see the Effect of a Polyherbal Formulation**

Total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL) cholesterol (LDL-C), and very low-density lipoprotein (VLDL-C) cholesterol were all significantly decreased while high-density lipoprotein (HDL) cholesterol (HDL-C) was significantly increased when comparing rats fed an LFD and rats fed an HFD (Tables 3 and 4).

**Effects of Polyherbal formulation on liver histopathology**

Liver sinusoidal capillary dilations were observed under light microscopy in group II fed a high-fat diet, but not in group I fed a standard diet of chow. Hepatocytes of Group II animals fed a high-fat diet were fatty and vacuolated in their cytoplasm. Group V animals given atorvastatin had significantly fewer sinusoidal capillary dilatations and less cytoplasmic fat deposition and granular degeneration. Group III animals given 200 mg/kg had less sinusoidal capillary dilations, fat infiltration, and granular degeneration than group II animals

**Table 1:** Effect of poly-herbal formulations on cholesterol, triglyceride and total glucose in triton-induced hyperlipidemia

| *Group* | *Cholesterol* | *Triglycerides* | *Glucose* |
|---|---|---|---|
| Normal Control | 71.26 ± 2.24 | 66.56 ± 2.10 | 82.4 ± 4.17 |
| Hyperlipidaemic Control | 158.74 ± 2.66** | 137.9 ± 2.27** | 271.2 ± 9.68*** |
| Triton+Polyherbal syrup(200mg/kg b. w.) | 108.71 ± 2.28 | 115.02 ± 2.86 | 209.7 ± 7.97** |
| Triton+Polyherbal syrup(400mg/kg b. w.) | 94.14 ± 2.04 | 90.45 ± 2.35 | 175.8 ± 7.73*** |
| Triton+Standard Drug (1.5mg/kg b. w.) | 82.33 ± 1.46 | 87.89 ± 1.74 | 152.08 ± 7.44*** |

*p-value*: ***p < 0.001, **p < 0.01 & *p < 0.05 compared with normal group. Values are as mean ± SEM (n=6)

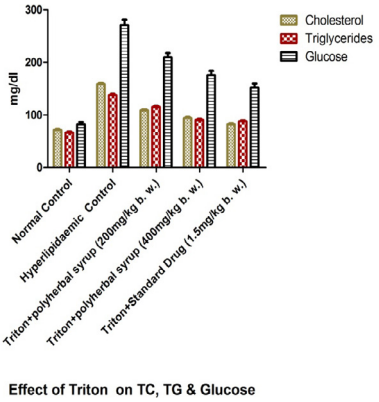


**Figure 1(a):** Triton induced hyperlipidemia

fed a high-fat diet. Compared to animals fed a high-fat diet (group II), those given 400 mg/kg PHF showed much less evidence of liver sinusoidal capillary dilations, cytoplasmic fatty infiltration, and granular degeneration. Hepatocytes in Group I (A) have a typical structure (Figure 3, A to E).

- Hepatocytes from Group II: Control (with HFD) show significant fatty infiltration into the cytoplasm and granular degeneration (B).
- Hepatocytes from the Group III: 200 mg/kg (High fat diet) animals show some fatty infiltration into the cytoplasm and granular degeneration.
- Microscopic examination of hepatocytes from Group IV: 400 mg/kg (on an HFD) revealed no cytoplasmic fatty infiltration and granular degeneration.
- Hepatocytes in the Group V: Std atorvastatin medication 1.5 mg/kg (with HFD) show minimal fatty infiltration into the cytoplasm and granular degeneration.

## DISCUSSION

For many reasons, including testing natural or chemical hypolipidemic medicines, the non-ionic detergent Triton WR-1339 is utilized extensively to inhibit peripheral tissue

**Table 2:** Effect of poly-herbal formulations on HDL, LDL, VLDLandAI in triton induced hyperlipidaemia

| *Group* | *HDL (mg/dL)* | *LDL (mg/dL)* | *VLDL(mg/dL)* | *AI (mg/dL)* |
|---|---|---|---|---|
| Normal control | 22.66 ± 1.52 | 35.46 ± 3.18 | 13.10 ± 0.44 | 2.16 ± 0.24 |
| Hyperlipidaemic control | 16.35 ± 1.06* | 112.2 ± 2.71** | 31.12 ± 0.57* | 8.35 ± 5.53 |
| Triton + Polyherbal syrup (200 mg/kg b. w.) | 22.88 ± 0.9 | 62.44 ± 2.64 | 22.04 ± 0.56 | 3.85 ± 0.22 |
| Triton + Polyherbal syrup (400 mg/kg b. w.) | 24.2 ± 1.12 | 52.2 ± 2.52 | 18.47 ± 0.45 | 2.89 ± 0.23 |
| Triton+ Standard drug (1.5 mg/kg b. w.) | 26.04 ± 1.52 | 40.26 ± 2.48 | 17.95 ± 0.33 | 2.34 ± 0.24 |

*p-value*: ***p < 0.001, **p < 0.01 & *p < 0.05 compared with normal group. Values are as mean ± SEM (n = 6)

**Table 3:** Effect of poly-herbal formulations on cholesterol, triglyceride and glucose in HFD induced hyperlipidaemia

| *Group* | *Cholesterol* | *Triglycerides* | *Glucose* |
|---|---|---|---|
| Normal control | 97.05 ± 0.933 | 77.73 ± 0.660 | 74.58 ± 0.775 |
| Hyperlipidaemic control | 268.10 ± 2.282*** | 186.35 ± 2.810 | 138.43 ± 0.800 |
| HFD+ Polyherbal syrup (200 mg/kg b. w.) | 239.06 ± 0.560** | 171.53 ± 1.382*** | 120.95 ± 1.097 |
| HFD+ Polyherbal syrup (400 mg/kg b. w.) | 204.81 ± 1.167** | 133.3 ± 0.497*** | 116.62 ± 0.582 |
| HFD+Standard drug (1.5 mg/kg b. w.) | 116.81 ± 1.050** | 91.15 ± 0.432** | 93.98 ± 0.511 |

*p-value*: ***p < 0.001, **p < 0.01 & *p < 0.05 compared with normal group. Values are as mean ± SEM (n = 6)

**Table 4:** Effect of poly-herbal formulations on HDL, LDL, VLDL and AI in HFD induced hyperlipidaemia

| *Group* | *HDL (mg/dL)* | *LDL (mg/dL)* | *VLDL(mg/dL)* | *AI (mg/dL)* |
|---|---|---|---|---|
| Normal control | 47.04 ± 0.909** | 34.06 ± 1.420* | 15.41 ± 0.193 | 0.71 ± 0.038 |
| Hyperlipidaemic control | 26.13 ± 0.452 | 204.02 ± 2.284*** | 37.33 ± 0.387 | 7.83 ± 0.167 |
| HFD+polyherbal syrup (200 mg/kg b.w.) | 30.40 ± 0.380* | 174.08 ± 0.902* | 34.30 ± 0.676* | 5.72 ± 0.081*** |
| HFD+polyherbal syrup (400 mg/kg b. w.) | 39.75 ± 0.395* | 138.46 ± 1.366*** | 26.37 ± 0.360* | 3.48 ± 0.062*** |
| HFD+Standard drug (1.5 mg/kg b. w.) | 56.33 ± 0.573** | 42.25 ± 1.035* | 18.24 ± 0.083** | 0.78 ± 0.032*** |

*p-value*: ***p < 0.001, **p < 0.01 & *p < 0.05 compared with normal group. Values are as mean ± SEM (n = 6)

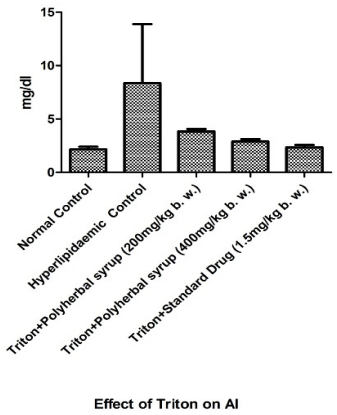


**Figure 1(c):** Triton induced hyperlipidemia

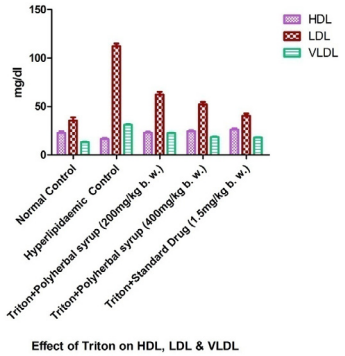


**Figure 1(b):** Triton induced hyperlipidemia

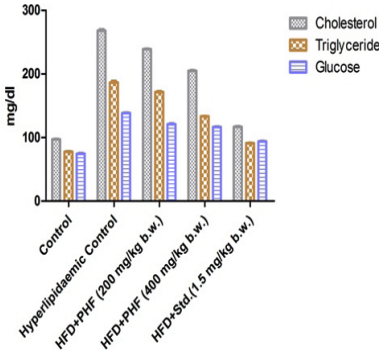


**Figure 2(a):** HFD induced hyperlipidemia

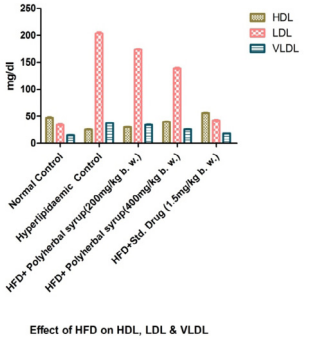


**Figure 2(b):** HFD induced hyperlipidemia

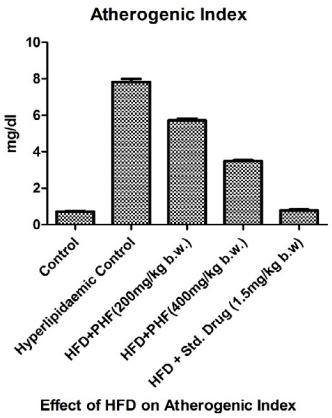


**Figure 2(c):** HFD induced hyperlipidemia

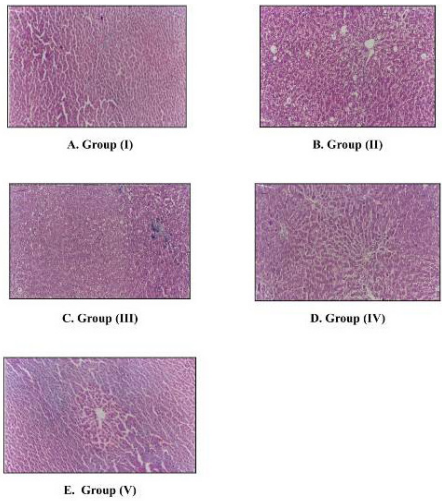


**Figure 3 (A to E):** Analysis of liver slices from HFD-induced hyperlipidemic rats using histopathology

uptake of triacyl glycerol-rich lipoproteins from plasma. To achieve this goal, the hypolipidemic effects of many medicinal plants were evaluated against Triton WR-1339-induced hyperlipidemia. Examples of such herbs are *Camellia sinensis, Cassia tora Linn,*[9] *and Sapindus emarginatu*s. After 24 hours of parenteral therapy with triton in adult rats, blood cholesterol and triglyceride levels peaked and returned to normal values.[10]

Our results reveal that Triton WR-1339 injection significantly elevates serum cholesterol and triglyceride levels. This increase is due primarily to a decrease in VLDL and LDL catabolism,[11] and an increase in VLDL production by the liver.

Success in decreasing cholesterol with the polyherbal formulation leads todecline in the LDL component of blood and liver cholesterol, the target of many hypolipidemic drugs. Fast LDL cholesterol breakdown via its hepatic receptors for eventual elimination via bile acids is hypothesized to be responsible for the polyherbal formulation's cholesterol-lowering impact.[12]

When LDL-cholesterol levels in the blood are high, atherosclerosis is more likely to develop,[13] High levels of healthy cholesterol (HDL-Cholesterol) have been shown

to reduce the risk of developing coronary heart disease.[14] Some research suggests that high-density lipoprotein (HDL) cholesterol may have a preventive effect against atherogenesis by lowering the risk of cardiovascular disease.[15] Our polyherbal blend was also shown to have anti-hyperlipidemic efficacy by increasing HDL-cholesterol levels.

The new worldwide epidemic of metabolic problems can be traced back to people not expending as much energy as they take in. Numerous diseases and conditions are linked to obesity.[16-18] Animal studies found that high-fat diets effectively mimicked the effects of high-calorie diets, causing an increase in fatty acids in the circulation, a hastening of lipogenesis, and, ultimately, fatty liver. The antihyperlipemic effect has been greatly mitigated by the multiherbal formula.

Foam cells, plaque, fatty infiltration, and lipids all indicate an elevated risk of oxidative damage in the heart, coronary arteries, aorta, liver, and kidneys.[19] The polyherbal formulation reduced the atherogenic index, a major predictor of the development of atherosclerotic plaques. Other researchers have discovered similar results when studying the hypolipidemic effects of natural products.[20]

By increasing hepatic absorption, plasma LDL levels are lowered and the risk of cardiovascular diseases is lowered.[21] In our trials, we employed a statin, a medicine often used in clinical practise to reduce cholesterol levels, as a positive control to more accurately evaluate the anti-hyperlipemic impact.

Curcuma longa polyphenols, found in aqueous extracts of the herb, have been shown to have protective effects on the cardiovascular system by, among other things, reducing cholesterol and triglyceride levels, lowering LDL's susceptibility to lipid peroxidation, and blocking platelet aggregation.[22] It is likely that the allicin, ajoene, and the nonsulfur component saponin were responsible for *A. sativum's* cholesterol-lowering effects. Saponins are known to influence cholesterol metabolism by forming complexes with cholesterol through binding plasma lipids.[23] *A. indica* leaves have been found to have high concentrations of nimbin, nimbanene, nimbandiol, nimbolide, Quercetin, ß-sitosterol, and polyphenolic flavonoids.[24,25] Cholesterol is reduced by beta-sitosterol because of its ability to block its absorption at the brush boundary of enterocytes. *P. granatum*'s flavonoid and polyphenolic concentration contribute to its ability to reduce blood cholesterol and triglyceride levels.[26] *Ocimum sanctum*'s ability to reduce lipid levels is likely attributable to tannins such gallic acid, which stimulate the production of bile acids from cholesterol.[27,28] Therefore, it is possible that the hypolipidemic activity of our polyherbal formulation is due to all of these ingredients.

## CONCLUSION

The polyherbal syrup has a favorable effect on lowering blood cholesterol levels when administered at doses of 200 and 400 mg/kg; p.o., as shown by results from the Triton WR-1339 and High cholesterol diet-induced hyperlipidemia model. No major adverse effects were discovered during the evaluation of the formulation's acute toxicity. The polyherbal syrup may work by blocking the HMG-CoA reductase enzyme pathway.

## REFERENCES


1. Jaybhaye M, Jagtap P, Unadle V, Shinde S, Bhagvat G, Porwal A, Jagtap V. Evaluation of Hypolipidemic Potential of a Polyherbal Formulation in Experimental Rats. Research Journal of Pharmacy and Technology. 2018;11(11):5037-41.
2. Kumar G, Srivastava A, Sharma SK, Gupta YK. The hypolipidemic activity of Ayurvedic medicine, Arogyavardhini vati in Triton WR-1339-induced hyperlipidemic rats: a comparison with fenofibrate. Journal of Ayurveda and integrative medicine. 2013 Jul;4(3):165.
3. Giri RK, Kanungo SK, Patro SK, Sahoo M, Panda DS. Hypolipidemic effect of prepared Polyherbal formulations in Wistar albino rats. Research Journal of Pharmacy and Technology. 2021;14(8):4314-20.
4. Khanna AK, Rizvi F, Chander R. Lipid lowering activity of Phyllanthus niruri in hyperlipemic rats. Journal of ethnopharmacology. 2002 Sep 1;82(1):19-22.
5. Mahurkar N, Quadri SM. Anti-hyperlipidemic Effect of Polyherbal Formulation (PHF) in High Fat Diet Induced Hyperlipidemia. Research Journal of Pharmaceutical Dosage Forms and Technology. 2015;7(1):11-4.
6. Walum E. Acute oral toxicity. Environmental health perspectives. 1998 Apr;106(suppl 2):497-503.
7. Ji X, Shi S, Liu B, Shan M, Tang D, Zhang W, Zhang Y, Zhang L, Zhang H, Lu C, Wang Y. Bioactive compounds from herbal medicines to manage dyslipidemia. Biomedicine and Pharmacotherapy. 2019 Oct 1;118:109338.
8. Ladde SS, Bhusnure OG. Evaluation of the hypolipidemic activity of polyherbal formulation through In-vivo and In-silico studies. International Journal of Health Sciences, 2022, 6 (S3): 9831–9851.
9. Shah SS, Manigauha A, Dubey B. Formulation and Evaluation of Antidiabetic and Anti-hyperlipidemic Activities of Polyherbal Formulation in Streptozotocin induced diabetic rat. Pharmaceutical and Biosciences Journal. 2019 Jan 22:26-30.
10. Reddy MM, Dhas Devavaram J, Dhas J, Adeghate E, Starling Emerald B. Anti-hyperlipidemic effect of methanol bark extract of Terminalia chebula in male albino Wistar rats. Pharmaceutical biology. 2015 Aug 3;53(8):1133-40.
11. Tacherfiout M, Petrov PD, Mattonai M, Ribechini E, Ribot J, Bonet ML, Khettal B. Anti-hyperlipidemic effect of a Rhamnus alaternus leaf extract in Triton-induced hyperlipidemic rats and human HepG2 cells. Biomedicine and Pharmacotherapy. 2018 May 1;101:501-9.
12. Karole S, Shrivastava S, Thomas S, Soni B, Khan S, Dubey J, Dubey SP, Khan N, Jain DK. Polyherbal formulation concept for synergic action: a review. Journal of Drug Delivery and Therapeutics. 2019 Feb 15;9(1-s):453-66.
13. Mahmud ZA, Bachar SC, Qais N. Anti-hyperlipidemic activity of leaf and root extracts of Premna esculenta (Roxb.) in Poloxamer-407 induced hyperlipidemic mice and rats. Oriental Pharmacy and Experimental Medicine. 2011 Dec;11:263-70.
14. Gajbhiye SS, Naik S, Sharma G, Kohli K. Hypolipidemic Activity Evaluation of DRF/AY/4013, an Herbal Formulation in Experimentally Induced Hyperlipidemic Rats. Journal of Complementary and Integrative Medicine. 2008 Jul 11;5(1):1-14.
15. Kumar AS, Mazumder A, Saravanan VS. Anti-hyperlipidemic activity of Camellia sinensis leaves in Triton WR-1339 induced albino rats. Pharmacognosy magazine. 2008 Jan 1;4(13):60-4.

16. Jani Dilip K. A study of anti-hyperlipidemic activity of polyherbal formulation using various experimental animal models. Inventi Rapid: Ethnopharmacology. 2011;2(1):3.
17. Shivatare R, Jangra S, Gaikwad A, Kewatkar S, Bhutale N, Suryavanshi DS, Tare H. Development and validation of ICPMS methods for simultaneous determination of elemental impurities in topical cream containing ximenynic acid. Future Journal of Pharmaceutical Sciences. 2023 Dec;9(1):1-3.
18. Choudhari VP, Gore KP, Pawar AT. Antidiabetic, anti-hyperlipidemic activities and herb–drug interaction of a polyherbal formulation in streptozotocin induced diabetic rats. Journal of Ayurveda and Integrative Medicine. 2017 Oct 1;8(4):218-25.
19. Tare H, Pulate C, Shaikh SZ, Khalil SS, Kharat N, Pund S. Nanomedicine in treatment of typhoid fever: A review. Journal of Pharmaceutical Research International. 2022 Mar 15:16-28.
20. Joshi VK, Joshi A, Dhiman KS. The Ayurvedic Pharmacopoeia of India, development and perspectives. Journal of ethnopharmacology. 2017 Feb 2;197:32-8.
21. Rony KA, Ajith TA, Nima N, Janardhanan KK. Hypolipidemic activity of Phellinus rimosus against triton WR-1339 and high cholesterol diet induced hyperlipidemic rats. Environmental toxicology and pharmacology. 2014 Mar 1;37(2):482-92.
22. Salwe KJ, Sachdev DO, Bahurupi Y, Kumarappan M. Evaluation of antidiabetic, hypolipedimic and antioxidant activity of hydroalcoholic extract of leaves and fruit peel of Punica granatum in male Wistar albino rats. Journal of natural science, biology, and medicine. 2015 Jan;6(1):56.
23. Alzohairy MA. Therapeutics role of Azadirachta indica (Neem) and their active constituents in diseases prevention and treatment. Evidence-Based Complementary and Alternative Medicine. 2016 Oct;2016:1-11.
24. Yarmohammadi F, Mehri S, Najafi N, Amoli SS, Hosseinzadeh H. The protective effect of Azadirachta indica (neem) against metabolic syndrome: A review. Iranian Journal of Basic Medical Sciences. 2021 Mar;24(3):280.
25. Sadeghipour A, Eidi M, Ilchizadeh Kavgani A, Ghahramani R, Shahabzadeh S, Anissian A. Lipid lowering effect of Punica granatum L. peel in high lipid diet fed male rats. Evidence-Based Complementary and Alternative Medicine. 2014 Jan 1:1-5.
26. Suanarunsawat T, Devakul Na Ayutthaya W, Songsak T, Thirawarapan S, Poungshompoo S. Lipid-lowering and antioxidative activities of aqueous extracts of Ocimum sanctum L. leaves in rats fed with a high-cholesterol diet. Oxidative Medicine and Cellular Longevity. 2011 Jul;2011:1-9.
27. Maruthappan V, Shree KS. Hypolipidemic activity of Haritaki (Terminalia chebula) in atherogenic diet induced hyperlipidemic rats. Journal of advanced pharmaceutical technology and research. 2010 Apr;1(2):229.
28. El-Saber Batiha G, Magdy Beshbishy A, G. Wasef L, Elewa YH, A. Al-Sagan A, Abd El-Hack ME, Taha AE, M. Abd-Elhakim Y, Prasad Devkota H. Chemical constituents and pharmacological activities of garlic (Allium sativum L.): A review. Nutrients. 2020 Mar 24;12(3):872.