A REVIEW OF INDIAN MEDICINAL PLANTS WITH
HYPOLIPIDEMIC ACTIVITY AND THEIR MEDICINAL
IMPORTANCE

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ABSTRACT
Medicinal plants have always been considered as healthy source of life for all people due to its rich therapeutic properties and being 100% natural.[1] Medicinal plants are widely used by majority of populations to cure various diseases and illness and have high impact on the world’s economy.[2] The plant extracts and their constituents plays the major role in traditional medicines and therapies.[3] Number of studies are there reporting the hypolipidemic activity of various traditional medicines from different regions of India. The present review constitutes of plants with hypolipidemic activity and some recently isolated phytoconstituents, and special emphasis on those found in different regions of India, including mainly Satpuda region of Maharashtra. The information is recorded in alphabetical order of plant along with their taxonomy, part used, route of administration, dose given, pharmacological screening method and references.

KEYWORDS: Hypolipidemic activity, Phytoconstituents, Herbal medicine, Traditional medicine.

INTRODUCTION
Hypercholesterolemia is often associated with obesity, diabetes mellitus and hypertension, each and all contribute to elevated cardiovascular mortality.[4] There is a general consent that these metabolic disorders share hyperinsulinemia and insulin resistance as a common link[5,6] leading to both micro- and macro-angiopathies.[7] During the last two decades, statins have been in clinical use as selective inhibitors of the key enzyme, Hydroxy methyl glutaryl Coenzyme-A (HMG-Co A)-reductase that determines the rate of cholesterol synthesis in
hepatocytes. In population studies, statins have been evidenced to reduce cholesterol levels by about 25% and mortality due to myocardial infarction by about 42%. Atherosclerosis is a multifactor process that includes oxidative modification of LDL which triggers pathological events through multiple pathways leading to atherosclerosis.

Research in recent years has been directed towards dietary antioxidants from plant-derived sources to normalize the elevated levels of cholesterol atherogenous fractions, mainly LDL, and of glucose in an attempt to reduce the cardiovascular risk.

The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world. A plant-based diet that is rich in fruits, vegetables, and legumes and low in saturated fat, along with regular aerobic exercise program, is an effective prescription for anyone with elevated risks of cardiovascular diseases.

In this review, information on plant species and some phytoconstituents have been explored for their potential hypolipidemic profile using pharmacologically validated animal models have been complied and discussed. In future, the work on isolation and characterization of phytoconstituents and pharmacological action has high prospects. It is also important to develop various animal models for evaluation of toxicity and safety and also need of conducting clinical research in plant based drugs.

SOME MEDICINAL PLANTS WITH ACCOUNTABLE HYPOLIPIDEMIC ACTIVITY

**Amaranthus caudatus** L.

**Family** Amaranthaceae

**Vernacular name** Grain amaranth, Inca wheat

The methanolic and aqueous extracts of *Amaranthus caudatus* leaves at doses 200, 300 and 400 mg/kg body weight showed hypolipidemic activities. Methanolic extract showed significant decrease (P<0.01) in the level of total cholesterol, triglycerides, LDL and increase in level of HDL at 400 mg/kg p.o, after 24 hr and 48 hr in Triton induced hyperlipidemic rats whereas aqueous extract showed significant decrease (P<0.05) only in the level of triglycerides at 400 mg/kg p.o, after 24 hr and 48 hr. Thus the results of this study suggested that methanolic extract of leaves *Amaranthus caudatus* possesses anti hyperlipidemic activities.
**Butea monosperma** Lam.

**Family** Fabaceae

**Vernacular name** Palash

The ethanolic extract of the leaves *Butea monosperma* showed the hypolipidemic activity in high fat diet induced atherosclerotic rat at doses of 200 and 400 mg/kg body weight. Administration of leaf extract alone and in combination with Atorvastatin significantly reduced the serum lipid parameters like Total cholesterol, triglycerides, LDL-Cholesterol along with increase in HDL-cholesterol after 28 days treatment. It is also observed that there was drastic reduction in total protein and all the above parameters indicating that leaves of this plant may contain the active constituents that may be effective in treatment of hyperlipidemia and atherosclerosis.\[15\]

**Cassia fistula** L.

**Family** Fabaceae

**Vernacular name** Amaltas

The effect of 50% ethanolic extract of *Cassia fistula* Linn. (Family: Fabaceae) legume was assessed on serum lipid metabolism in cholesterol fed rats. Oral feeding of cholesterol (500mg/kg/day) dissolved in coconut oil (0.5 ml/rat/day) for 90 days caused a significant (P<0.001) elevation in total and LDL-cholesterol, triglycerides and phospholipids in serum of rats. Administration of *C. fistula* legume extract at the doses 100, 250 and 500 mg/kg/day
along with cholesterol significantly prevented the rise in the serum total and LDL-cholesterol, triglycerides and phospholipids in a dose dependent manner. The ratio of HDL-cholesterol / total cholesterol ratio were elevated in serum of *C. fistula* extract treated groups as compared to cholesterol alone fed control rats.\textsuperscript{[16]}

\textit{Commiphora mukul}

\textbf{Family} Burseraceae

\textbf{Vernacular name} Guggul

The lipid lowering action of guggulsterone, the active constituent of guggulipid, has been studied in triton and cholesterol fed hyperlipidemic rats. Serum lipids were found to be lowered by guggulsterone (50 mg/kg) in triton WR-1339 induced hyperlipidemia. Chronic feeding of this drug (5 mg/kg) in animals simultaneously fed with cholesterol (25 mg/kg) for 30 days caused lowering in the lipid and apoprotein levels of very low density and low density lipoproteins in experimental animals. Guggulsterone activates lipolytic enzymes in plasma and liver as well as stimulated receptor mediated catabolism of low density lipoprotein. The hyperlipidemic activity of this drug is mediated through inhibition of hepatic cholesterol biosynthesis, increased fecal bile acid excretion and enhanced plasma lecithin: cholesterol acyltransferase activity.\textsuperscript{[17]}
**Eclipta alba** L. Hassk

**Family** Asteraceae

**Vernacular name** Kesuti, Kesraj

Antihyperlipidemic activities of ethanolic extracts of *Eclipta alba* in adult Wistar rats of both sexes, weighing 140-150 g were studied and compared with those of Atorvastatin. Rats were given high fat diet (HFD) for 49 days to produce hyperlipidemia. Then drugs were given for 45 days without stopping HFD. Rats on atorvastatin (80 mg/kg) showed most significant improvement (55.46, 57.76 and 66.50% decrease in mean total cholesterol, triglyceride and LDL respectively; 28.37% increase in mean HDL). Rats on *E. alba* (200 mg/kg each) showed significant improvement (39.78, 42.30, 51.73% decrease in mean total cholesterol, triglyceride and LDL respectively; 13.42% increase in mean HDL). To conclude, *E. alba* seems to have significant antihyperlipidemic activities.[18]

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**Eugenia jambolana** Lam.

**Family** Myrtaceae

**Vernacular name** Jam, Kalojam, Kalajam

The effect of oral administration of ethanolic extract of *Eugenia jambolana* kernels (100 mg/kg body weight) was examined on the levels of cholesterol, phospholipids, triglycerides and free fatty acids in the plasma, liver and kidney tissues of STZ (55 mg/kg body weight)-induced diabetic rats. The plasma lipoproteins and tissue fatty acid composition were also monitored. STZ-induced diabetic rats, showed significant increase in the levels of cholesterol, phospholipids, triglycerides and free fatty acids which were significantly restored to near normal in *Eugenia jambolana* kernel or Glibenclamide treated animals. The plasma lipoproteins (HDL, LDL, VLDL-cholesterol) and fatty acid composition were changed in STZ-induced diabetic rats and these levels were also reverted back to near normal by *Eugenia*.
jambolana kernel or Glibenclamide treatment. It may be concluded that, Eugenia jambolana kernel possesses hypolipidemic effects.\textsuperscript{[19]}

\textbf{Ficus racemosa} L.

\textbf{Family} Moraceae

\textbf{Vernacular name} Pipal

The hypolipidemic activity of ethanolic extract of \textit{Ficus racemosa} bark (FrEBet) in alloxan-induced diabetic rats. A total number of 30 animals were divided into 5 groups of six each. Diabetes mellitus was induced by single intraperitoneal injection of freshly prepared solution of alloxan monohydrate (150 mg/kg) dissolved in physiological saline in overnight fasted Wistar rats. A dose dependent study for FrEBet (100-500 mg/kg) was carried out to find out the effective pharmacological dose (antidiabetic and hypolipidemic) to alloxan-induced diabetic rats. An increase in blood glucose was accompanied by an increase in total cholesterol, phospholipids, triglycerides, FFA and decrease in HDL cholesterol in diabetic rats. Oral administration of FrEBet (300 mg/kg) to diabetic rats restored the status of blood glucose, lipids and lipoproteins to near normal range. The FrEBet has potent antidiabetic and hypolipidemic effects in alloxan-induced diabetic rats and these effects were compared with standard drug, Glibenclamide.\textsuperscript{[20]}
**Glycyrrhiza glabra** Linn.

**Family** Leguminosae  
**Vernacular name** Mulethi

The ethanolic (95%) extract of root of *Glycyrrhiza glabra* and its fractions were investigated for its antidyslipidemic activity on HFD induced dyslipidemic hamsters. Ethanolic extract and its ethyl acetate soluble, water soluble and hexane soluble fractions decreased serum level of total cholesterol by 25.9, 38.0, 39.0 and 26.3%, respectively. On the other hand ethanolic extract, ethyl acetate soluble, water soluble and hexane soluble fraction increased the serum HDL-cholesterol level by 14.8, 34.3, 27.3 and 17.2%, respectively. Ethanolic extract, ethyl acetate fraction, aqueous fraction and hexane fraction decreased triglyceride levels by 31.3, 37.2, 41.2 and 28.9%, respectively. The reduction in LDL-cholesterol level by ethanolic extract, ethyl acetate soluble fraction and water soluble fraction were 43.9, 31.0, 33.4 and 24.6%, respectively.[21]

**Lagenaria siceraria** Standly  
**Family** Cucurbitaceae  
**Vernacular name** bottle gourd

The antihyperlipidemic effect of four different extracts viz. petroleum ether, chloroform, alcoholic and aqueous extracts *Lagenaria siceraria* in Triton-induced hyperlipidemic rats and their hypolipidemic effects in normocholesteremic rats. Oral administration of the extracts, at doses of 200 and 400 mg/kg body weight in rats, dose-dependently inhibited the total cholesterol, triglycerides, low-density lipoproteins level, and significantly increased the high density lipoproteins level. However, petroleum ether extract did not show the significant effects. Both the chloroform and alcoholic extract exhibited more significant effects in lowering total cholesterol, triglycerides and low density lipoproteins along with increase in HDL as compared to the others. The results obtained suggest noticeable antihyperlipidemic activity of the extracts.[22]
Morinda citrifolia L.

Family Rubiaceae

Vernacular name Indian Mulberry, Great morinda

The Aqueous extract of *Morinda citrifolia* fruit in concentrations ranging from 0.25 g/kg (low dose), 0.50 g/kg (medium dose) and 1.00 g/kg (high dose) were orally administered on streptazocin-induced diabetic rats for 6 weeks. The hypolipidemic effect of *M. citrifolia* extract in rats was determined by measuring the total lipid, total cholesterol and triglyceride concentrations in blood (plasma) and liver tissue. The administration of medium dose of *M. citrifolia* extract had significantly (*p* <0.05) reduced the cholesterol content in blood and liver of normal rats as compared to the normal control rats.[23]

Moringa oleifera Lam.

Family Moringaceae

Vernacular name Horseradish tree, Radish tree, Drumstick tree,

The methanolic extract of *Moringa oleifera* (150, 300 and 600 mg/kg, p.o.) and simvastatin (4 mg/kg, p.o.) along with hyperlipidemic diet were administered to Albino Wistar rats for 30 days in order to observe hyperlipidemic effect. It was found that the serum cholesterol,
triacylglyceride, VLDL, LDL, and atherogenic index were reduced by *M. oleifera* and simvastatin but HDL level was increased as compared to the corresponding high fed cholesterol diet group (control). *M. oleifera* was also found to increase the excretion of fecal cholesterol. Thus, it can be concluded that *M. oleifera* possesses a hypolipidemic effect.\[24\]

\[Pterocarpus marsupium\] Roxb.

**Family** Fabaceae

**Vernacular name** Indian Kino Tree, Malabar Kino Tree,

The ethanol extracts of *Pterocarpus marsupium* wood, bark and combined extracts of wood and barks were investigated for its antidiabetic and hypolipidemic effect in Wistar albino rats. Diabetes was induced in Albino rats by administration of alloxan monohydrate (150mg/kg, i.p). The ethanol extracts of *Pterocarpus marsupium* wood and bark at a dose of 150 mg/kg of body weight respectively and combined extracts of wood and bark at a dose of 150 +150mg/kg of body weight were administered at single dose per day to diabetes induced rats for a period of 14 days. The effect of ethanol extracts of *Pterocarpus marsupium* on blood glucose, plasma insulin, serum lipid profile [total cholesterol, triglycerides, low density lipoprotein - cholesterol (LDL-C), very low density lipoprotein - cholesterol (VLDL-C), and high density lipoprotein-Cholesterol(HDL-C)] serum protein were measured in the diabetic rats. The ethanol extracts of *Pterocarpus marsupium* resulted in significant reductions of blood glucose (p<0.01), lipid parameters except HDL-C, serum enzymes and significantly increased HDL-C. The extracts also caused significant increase in plasma insulin (p<0.01) in the diabetic rats. From the above results it is concluded that ethanol extracts of *Pterocarpus marsupium* possesses significant antidiabetic and antihyperlipidemic effects in alloxan induced diabetic rats.\[25\]
Salvadora persica L.

Family Salvadoraceae

Vernacular name Salt Bush, Toothbrush

Salvadora persica was evaluated in diet-induced rat hypercholesterolemia. The decoction was administered for 15 and 30 days. Cholesterol, HDL, LDL and triglyceride plasma levels were assayed. The results showed that the Salvadora persica decoction significantly lowered Cholesterol and LDL plasma level in rats, providing to be more active at 30th day of treatment. The systemic administration of Triton results in a rise in plasma Cholesterol and triglyceride levels. The results obtained show that Salvadora persica decoction was inactive at 18 hr after treatment, whereas at 27 hr, it was able to reduce Cholesterol and LDL levels. In all experiments HDL and triglyceride were unchanged.[26]

Sapindus emarginatus Vahl.

Family Sapindeae

Vernacular name Aritha

The anti-hyperlipidemic activity of methanol extract of pericarps of SE against Triton induced hyperlipidemia in rats. SE was administered at a dose of 100 and 200 mg/kg
(p.o) to Triton induced hyperlipidemic rats. Fenofibrate was used as reference standard. The statistical analysis was carried out using one way ANOVA followed by Dunnet’s multiple comparisons test. SE shows a significant decrease in the levels of serum cholesterol, phospholipids, triglyceride, LDL, VLDL and significant increase in the level of serum HDL at the dose of 100 and 200mg/kg (p.o) against Triton induced hyperlipidemic in rats. Methanol extracts decreased serum level of total cholesterol by 69.72%. On the other hand aqueous extract of SE increased the serum HDL cholesterol level by 24.11%. The reduction of LDL cholesterol level by extract was 30.31%.[27]

*Spergularia purpurea* (Pers.) G. Don f.

**Family** Caryophyllaceae

**Vernacular name** sandspurry

The aqueous extract of *Spergularia purpurea* (SP) was administered at a dose of 10mg/kg in normal and streptazocin-induced diabetic rats. In normal rats, the aqueous extract of SP induced a significant decrease of the plasma cholesterol concentrations, 6 h after a single oral administration (p< 0.05) and 2 weeks after repeated oral administration (p< 0.05). The plasma triglycerides levels increased significantly 6 h after a single oral administration (p< 0.05) and decreased 2 weeks after repeated oral administration (p< 0.05). In diabetic rats, SP treatment caused a significant decrease of plasma cholesterol levels after a single (p< 0.01) and repeated (p< 0.01) oral administration. A significant increase of triglycerides levels was observed 6 h after a single oral administration of the SP aqueous extract (p< 0.01). One week after repeated oral administration of SP aqueous extract, the plasma triglycerides levels were significantly decreased (p< 0.005) and still dropped after 2 weeks (p< 0.01).[28]
Terminalia arjuna (Roxb.) Wight & Arn.

Family Combritaceae

Vernacular name Arjun or Koha

Ethanolic fraction of Terminalia arjuna on blood lipids and atherosclerosis in rabbits fed with high fat diet (HFD). Twenty New Zealand rabbits of either sex were randomly divided into five groups: the first two were normal diet group and HFD (21% fat) group and the remaining three groups received high cholesterol diet with addition of standard drug (Atorvastatin 10 mg/kg), T. arjuna ethanolic fraction (100 and 200 mg/kg), respectively. The concentration of total cholesterol (TC), low density lipoprotein (LDL) cholesterol, triglycerides (TG), very low density lipoprotein (VLDL) cholesterol and high density lipoprotein (HDL) cholesterol was determined in rabbits at the start of the experiment, at the 14th, 30th days and at the end of the study. Anti-atherogenic index was calculated from the lipid profile of the rabbits before sacrifice. At the end of the experimental period, the aorta was removed for assessment of atherosclerotic plaques. Results show that T. arjuna significantly decreases TC, LDL and TG levels and increases HDL and lessens atherosclerotic lesion in aorta (P < .05). Hence T. arjuna extract can effectively prevent the development of atherosclerosis.\[29\]
ANIMAL MODELS FOR EVALUATION OF HYPOLIPIDEMIC ACTIVITY\textsuperscript{[30]}

- High Cholesterol diet induced method
- High Fructose diet induced method
- Triton induced hyperlipidemic method
- Streptozotocin induced diabetic method
- Alloxan induced diabetic method
- Tylaxapol induced hyperlipidemic method
- High fat diet induced hyperlipidemic method
- Hydrocortisone induced hyperlipidemic method
- Atherogenic diet induced Normocholesterolemic method

Table no. 1. Plants having Hypolipidemic activity

<table>
<thead>
<tr>
<th>S.No</th>
<th>Drug</th>
<th>Dose</th>
<th>P Value</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amaranthus caudatus L.</td>
<td>200-400 mg/kg</td>
<td>0.01</td>
<td>Triton induced</td>
</tr>
<tr>
<td>2</td>
<td>Butea monosperma Lam</td>
<td>200-400 mg/kg</td>
<td>0.01</td>
<td>HFD induced</td>
</tr>
<tr>
<td>3</td>
<td>Cassia fistula L.</td>
<td>100-500 mg/kg</td>
<td>0.001</td>
<td>Cholesterol fed</td>
</tr>
<tr>
<td>4</td>
<td>Commiphora mukul</td>
<td>5-25 mg/kg (isolated guggul)</td>
<td>0.01</td>
<td>Triton induced</td>
</tr>
<tr>
<td>5</td>
<td>Eclipta alba L. Hassk</td>
<td>140-200 mg/kg</td>
<td>0.01</td>
<td>HFD induced</td>
</tr>
<tr>
<td>6</td>
<td>Eugenia jambolana Lam</td>
<td>100-200 mg/kg</td>
<td>0.001</td>
<td>STZ induced</td>
</tr>
<tr>
<td>7</td>
<td>Ficus racemosa L.</td>
<td>100-500 mg/kg</td>
<td>0.05</td>
<td>Alloxan induced</td>
</tr>
<tr>
<td>8</td>
<td>Glycyrrhiza glabra Linn</td>
<td>50 mg/kg (isolated fraction)</td>
<td>0.05</td>
<td>HFD induced</td>
</tr>
<tr>
<td>9</td>
<td>Lagenaria siceraria Standly</td>
<td>200-400 mg/kg</td>
<td>0.05</td>
<td>Triton induced</td>
</tr>
<tr>
<td>10</td>
<td>Morinda citrifolia L.</td>
<td>250-500 mg/kg</td>
<td>0.05</td>
<td>STZ induced</td>
</tr>
<tr>
<td>11</td>
<td>Moringa oleifera Lam</td>
<td>150-600 mg/kg</td>
<td>0.01</td>
<td>HFD induced</td>
</tr>
<tr>
<td>12</td>
<td>Pterocarpus marsupium Roxb.</td>
<td>150 -300 mg/kg</td>
<td>0.01</td>
<td>Alloxan induced</td>
</tr>
<tr>
<td>13</td>
<td>Salvadora persica L.</td>
<td>Decoction</td>
<td>0.01</td>
<td>Triton induced</td>
</tr>
<tr>
<td>14</td>
<td>Sapindus emarginatus Vahl.</td>
<td>100-200 mg/kg</td>
<td>0.01</td>
<td>Triton induced</td>
</tr>
<tr>
<td>15</td>
<td>Spergularia purpurea G. Don f.</td>
<td>10 mg/kg</td>
<td>0.05</td>
<td>STZ induced</td>
</tr>
<tr>
<td>16</td>
<td>Terminalia arjuna (Roxb.)</td>
<td>100-200 mg/kg</td>
<td>0.05</td>
<td>HFD induced</td>
</tr>
</tbody>
</table>

RESULT AND DISCUSSION

The majority of the experiments confirmed the benefits of medicinal plants with hypolipidemic effects in the management of cardiovascular disorder. Numerous mechanisms of actions have been proposed for these plant extracts. Some hypotheses relate to their effects on the activity of reabsorption of plant cholesterol or the increase in the protective effect of PPAR-\(\gamma\). Other mechanisms may involve improved cholesterol homeostasis (increase of
Peripheral utilization of Cholesterol), inhibitory effect against HMG Co-A enzyme, blocking absorption of dietary Cholesterol, inhibition of intestinal Cholesterol absorption, transportation of both dietary and synthesized Cholesterol, reduction into the oxidative stress. All of these actions may be responsible for the reduction and or abolition of hyperlipidemic complications.

**CONCLUSION**

Hyperlipidemia is a major cause of cardiovascular disorder. At present, the treatment of hyperlipidemia mainly involves a sustained reduction in lipid level by the use of niacin, bile acid sequestrates, fibrate, in addition to statin derivative. However, due to unwanted side effects the efficacies of these compounds are debatable and there is a demand for new compounds for the treatment of hyperlipidemia. The potency of herbal drugs is significant & they have negligible side effects than the synthetic hypolipidemic drugs. There is increasing demand by patients to use the natural products with hypolipidemic activity. Hence, all the drugs discussed in this review have exhibited significant clinical & pharmacological activity. Isolation & identification of active constituents from these plants, preparation of standardized dose & dosage regimen can play a significant role in improving the hypolipidemic action.

**FUTURE PROSPECT**

The prevalence of Hyperlipidemia continues to rise worldwide and treatment HMG Co-A enzyme inhibitor drugs ends with numerous side effects and huge monetary expenditure. Fortunately the potency of herbal drugs is significant and they have negligible side effects. There is increasing demand by patients to use the natural products with hypolipidemic activity. Therefore active research on identification and isolation of hypolipidemic...
compounds from plants, their phytochemical studies as well as developing new areas where the likelihoods may be increased are in great need.

REFERENCES


