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Review Article

Spices and condiments: safer option for treatment of hyperlipidemia

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ABSTRACT

Hyperlipidemia is a lipoprotein metabolic disorder characterized by high serum Low density Lipoprotein and blood cholesterol. It is a major risk factors in the development and progression of atherosclerosis that eventually lead to cardiovascular diseases. This poses a major problem to majority of society because of the close correlation between cardiovascular diseases and lipid abnormalities. There are various features which are associated directly or indirectly as etiological factors viz. heredity, age, obesity, sex, diet, physical inactivity, hypertension, lifestyle disorders and various stress factors. For alleviation and treatment there are many ways such as allopathic medications, alternative systems like Ayurvedic, Diet control, lifestyle discipline etc. Recently Spice therapies are seen useful and effective. In India, Ayurveda and other Indian literature mentions the use of various plants and spices. Spices in diet are useful as they play effective role in the functioning of various body systems such as gastrointestinal, cardiovascular and nervous system. Along with proper food habits, diet which contains variety of spices which have been proved as hypolipidemic, can be effective in controlling hyperlipidemia. Spices used in day-to-day life as food, can also be used in the treatment of various human ailments. Along with the taste, flavor, colour and preservative property, spices also possess hypolipidemic effects. This review is focused mainly on the beneficial hypolipidemic effect of five spices (Dill, Garlic, Fenugreek, Ginger, Coriander) in the management of hyperlipidemia. This article is based on the traditional knowledge, mechanism of action for hypolipidemic activity and some experimental scientific studies done to support the use of these spices in the management of hyperlipidemia.

Introduction

Hyperlipidemia is the main causative factor in the development of cardiovascular diseases like Atherosclerosis, Coronary Artery Disease (CAD) and many other cardiac conditions like Angina, Ischemic heart disease, Myocardial Infarction etc. It is a common disorder in developed as well as developing countries and is one of the main factors leading to Morbidity and mortality. World Health Organisation (WHO) reports that high blood cholesterol levels contributes to approximately 56% of the cases of Cardiovascular diseases worldwide and causes about 4.4 million deaths each year. It results from abnormalities in lipid metabolism or plasma lipid transport or a disorder in the synthesis and metabolism of plasma lipoproteins resulting in high level of fat in blood [1]. It may noticeable with the elevation of serum total cholesterol(TC), low-density lipoprotein (LDL), triglyceride (TG) concentrations, and a drop off in the high-density lipoprotein (HDL) concentration It may be responsible for oxidative modification of LDL, glucose-auto oxidation with excess production of free radicals and lipid peroxidation products[2]which represents elevated risk for ischemic heart diseases. The conditions like abdominal obesity, defective lipid metabolism are reported to be the major risk markers for Coronary Artery Disease (CAD). Insulin resistance develops because of the loss of insulin sensitivity due to the high concentrations of lipids in the cell. These high intracellular concentrations of lipid may lead to the chronic conditions like Diabetes Mellitus thus there is possibility of increased blood glucose levels.

Classification of Lipids

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The term lipids describe an entire class of fats and fat like substances in the blood. The most important lipids in the blood are fatty acids, cholesterol, cholesterol esters, Triglycerides, and phospholipids. Fatty acids are identified as esters of a long-chain monobasic organic acid, which are derived from fats by hydrolysis. Phospholipids (PL) are similar to the TGs but with one fatty acid residue replaced by phosphate and a nitrogenous base.

Triglycerides

Triglycerides (TGs) are esters consisting of a glycerol molecule coupled to three fatty acid residues of varying carbon chain lengths and degrees of unsaturation. TGs are found in dietary fats, and can also be synthesized in the liver and adipose tissue to provide a source of stored energy. They can be mobilized when required, for example, during starvation. TGs containing both saturated and unsaturated fatty acids are important components of cell membranes [3].They are atherogenic because they are rich in apo C-III, which delays the lipolysis of Very Low Density Lipoproteins and inhibits its uptake and Clearance from plasma.

Cholesterol and cholesterol esters

These are essential elements contained in all human cell membranes. Cholesterol is a structural component of steroid hormones and bile acids. It is present in dietary fats and can also be synthesized in many tissues, including liver. It is transported in the blood as part of large molecules called lipoproteins [4]. It works to build and repair cells; produces hormones such as estrogen and testosterone, and bile acids proven to aid in the digestion of fats [5]**.**However, the high levels of cholesterol in the blood can cause clogging, which in turn can raise the risk for heart disease and/or stroke. Cholesterol along with some other types of fats cannot be dissolved in the blood. Thus in order to be transported to and from the cells, they have to be specially carried by molecules called ``lipoproteins``

Lipoproteins

They are macromolecular complexes that carry hydrophilic plasma lipids. They are spherical particles made up of hundreds of lipid and protein molecules. The major lipids of the lipoproteins are cholesterol, TGs, and phospholipids. Five major lipoproteins exist, each with a different function are chylomicrons, VLDLs, IDLs, LDLs, and HDLs [6].

Types of lipoproteins

Very Low Density Lipoproteins (VLDL)

VLDLs are produced in the liver when Triglycerides production is stimulated by an increased flux of free fatty acids or by increased de novo synthesis of fatty acids by the liver.

Low Density Lipoproteins (LDL)

LDLs are made by the liver to transport cholesterol to the body's cells and tissues. LDL may form deposits on the walls of arteries and other blood vessels. Therefore they are considered as the lazy or bad cholesterol.

The main benefits of lowering LDL-C include,

- Decreases the chance of heart attack and/or stroke.
- Reduces the formation of new cholesterol plaques.
- Eliminates existing plaques.
- Prevents the rupture of existing plaques [6].

Intermediate density lipoproteins (IDL)

IDLs are formed as TGs are removed from VLDLs. The fate of IDLs is either conversion to LDLs or direct uptake by the liver. The liver takes up IDLs after they have interacted with the LDL to form a complex, which is endocytosed by the cell.

High Density Lipoproteins (HDL)

HDLs pick up and transport excess cholesterol from the walls of arteries and bring it back to the liver for processing and removal. Therefore, they are called the healthy or good cholesterol.

Table 1: Physical properties of Lipoproteins

	VLDL	LDL	HDL
Density	0.94-1.006	1.006-1.063	1.063-1.210
Diameter	600	250	70-120
Total lipid (weight %)	91	80	44
Triacylglycerols	55	10	6
Cholesterol esters	18	50	40
Cholesterol	7	11	7
Phospholipids	20	29	46

Atherogenic index

The atherogenic index of plasma (AIP), defined as the base 10 logarithm of the ratio of plasma total cholesterol (TC) to high density lipoprotein cholesterol (HDL-C), has been employed as a predictor of cardiovascular risk. As the ratio of total cholesterol/HDL (TC/HDL) increases, so does the risk of

coronary heart disease (CHD). In populations with low CHD incidences, average values of TC/HDL are below 4.0.

Hyperlipidemia

Hyperlipidemia is basically classified as of Primary and secondary type depending upon the cause of the disease in individual. Primary hyperlipidemia (Familial hyperlipidemia) is caused mainly due to the specific genetic abnormalities. This results from defects in the hepatic uptake and degradation of LDL via the down regulation of LDL -R. The latest gene discovered, is, PCSK9. Mutation defects of this gene causes hyperlipidemia. This is, the gene encoding a member of the proprotein convertase family. General function of PCSK9 is down regulation in the LDL R pathway by causing degradation of LDL R protein [7]. Secondary Hyperlipidemia (Acquired hyperlipidemia) occurs due to the presence of other disorder in the body which leads to the changes or alterations in the plasma lipid profile or lipoprotein metabolism [8].Hyperlipidemia may be idiopathic. The most common causes are modern lifestyle habits or treatable medical conditions. Lifestyle habits include obesity, negligible physical activity, intake of high amount of dietary fat, and smoking. Medical Conditions that may lead to hyperlipidemia are diabetes, kidney disease, pregnancy, and hypothyroidism [9].This type generally needs the treatment of the causes rather than the treatment of hyperlipidemia.

Table no. 1: **Causes of secondary Hyperlipidemia** [1]

Causes	High LDL-C	High TG	Low HDL-C
Diabetes Mellitus	✓	✓	✓
Hypothyroidism	✓	✓	✓
Nephrotic syndrome	✓	-	-
Liver disease	✓	-	-
Renal insufficiency	-	✓	-
Alcoholism	-	✓	-
Cigarette smoking	-	-	✓

Complications due to high LDL levels in the blood

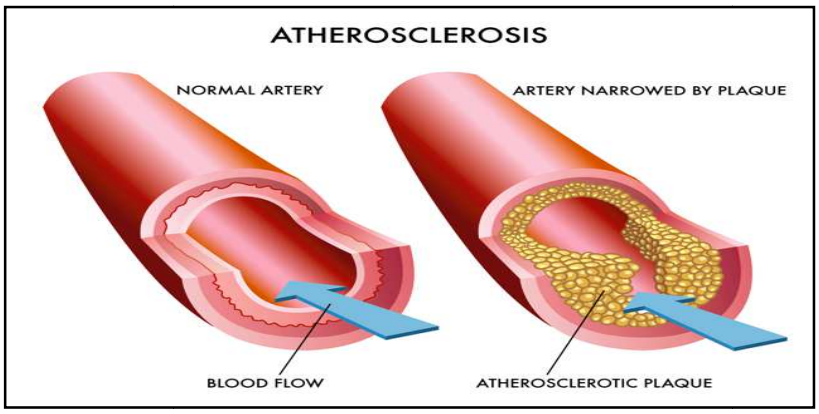

Fig 1: Formation of plaque

One of the complications of higher LDL concentrations in blood is Atherosclerosis. Atherosclerosis, or hardening of the arteries, is a condition in which plaque builds up inside the arteries. Plaque is made of cholesterol, fatty substances, cellular waste products, calcium and fibrin (a clotting material in the blood). The arterial wall becomes markedly thickened by these accumulating cells and surrounding material. The artery narrows and blood flow is reduced, thus decreasing the oxygen supply.Often a blood clot forms and blocks the artery, stopping the flow of blood. If the oxygen supply to the heart muscle is reduced, a heart attack can occur. If the oxygen supply to the brain is cut off, a stroke can occur.Allopathic products available in the market today (statins, fibrates, niacin derivatives, cholesterol absorption inhibitors, bile acid sequestrants) are associated with many side effects like rhabdomylosis, hyperuricemia, nausea, myositis, gastric irritation, flushing , dry skin and abnormal liver function and contraindications with other medicines[10].This creates the need for effective and safe drug which not only cures the disease but also takes care of the complex situations caused by

the disease. So current interest in the search of lipid lowering agents aims to lower the side effect profile of allopathic drugs and also to increase the overall efficiency of the treatment.Ayurvedic herbs or natural products are the medicinal systems considered traditional way of treating the diseases in India. These natural products are the combinations of medicinal plants which commonly occur in India and are inevitable part of the Indian culture. These herbal solutions are also well documented with the safety profile and the therapeutic applications for various pathological conditions. Hence, these medicinal products are on their way to the world market as alternatives to the prescribed drugs for various treatment conditions. At this time, most of the world population uses herbal medicines. The main reason behind the increased use of herbal remedies is the compatibility and less damaging nature resulting on long term use [11]. In the past few years, there has been tremendous growth in the field of herbal medicine and herbal products [12].

Spices as an alternative treatment in hyperlipidemia

Spices are dried parts of herbs used as flavouring agents in cooking around the globe owing to their taste and aroma. Spices are the common dietary adjuncts that contribute to the taste and flavor of foods. Balanced diet has always been recognized as a basis in the management of hyperlipidemia. Since ancient times, various herbs and spices are being used to treat hyperlipidemia. Scientific investigations have confirmed the effectiveness of these herbs spices. Besides spices, are also known to exert several beneficial physiological effects [13]. Spices supplements and diet-based therapies for weight loss are among the most common complementary and alternative medicine (CAM) modalities.A vast range of these natural products and medicinal plants, including crude extracts and isolated compounds from plants. They can be used to induce weight loss and prevent diet-induced obesity. In the recent decades, these have been vastly used in management of obesity.Due to the presence of large variety of components with different anti-obesity and anti-oxidant effects on body metabolism and fat oxidation.This article gives brief overview of the five common spices that are routinely used in diet all over india.

Anethum graveolans

Table no. 2: Classification of Dill

Kingdom	**Plantae**
Phylum	Angiosperms
Subphylum	Eudicots
Class	Asterids
Order	Apiales
Family	Apiaceae
Genus	Anethum L
Species	Anethum Graveolens

Anethum graveolens L. known as dill is a sparse looking plant with feathery leaves and tiny yellow flowers growing in the Mediterranean region, Europe, central and southern Asia and is widely cultured in south eastern region of Iran [14]**.**

Phytoconstituents: Anethum graveolens contain 1 - 4% essential oil comprising of major compounds: carvone (30 - 60%), limonene (33%), α-phellandrene (20.61%), including pinene, diterpene, dihydrocarvone, cineole, myrcene, paramyrcene, dillapiole, isomyristicin, myristicin, myristin, apiol and dillapiol. Anethum graveolens also contains essential oil, furanocoumarin, 5-(4”-hydroxy-3”methyl-2”-butenyloxy)-6, 7- furocoumarin, oxypeucedanin, oxypeucedanin hydrate and falcarindiol.

Uses: As a folk remedy Anethum graveolens or dill is considered for some gastrointestinal ailments such as flatulence, indigestion, stomachache and in traditional Iranian medicine (TIM), it has been used as carminative, antispasmodic, sedative, galactagogue, diuretic and for hyperlipidemia [15]**.** Pharmacological effects of dill such as anti-inflammatory, antimicrobial, or antibacterial, anti hyperlipidaemic, anti hypercholesterolaemic , antioxidative and hypoglycemic activities have been shown[16].

Mechanism of action: Possible explanations for hypolipidemic effects of the Anethum graveolens included that this compound could inhibit carbohydrate absorption and metabolism [17]. The cholesterol lowering effect of the plant extract is possibly associated with a decrease in intestinal absorption of cholesterol resulting in an increase in fecal excretion of neutral lipids [18]. Improvement in the biological antioxidant status by reducing lipid peroxidation in liver and modulating the activities of antioxidant enzymes is another mechanism for dill acting as hypolipidemic [19].

Hypolipidemic studies reported

Ali esmail al-snafi have reported the anti-hyper cholesterolaemic and anti-hyperlipidaemic activities of crude extract of Anethum graveolens. Treatment with defatted ethanolic Anethum graveolens extract to hyperlipidemic rats for 30 days showed significant increase in HMGCoA/mevalonate ratio [19].

Mansouri *et al* have proved the significant reduction in TG levels from baseline in 12 weeks on administration of Dill extract [20].

Ahmed Salih Sahib *et al* have studied the effect of Dill leaves powder on hyperlipidemic patients for duration of 4 weeks. The pre-treatment values of serum lipids for both treatment groups were significantly ($P \leq 0.05$) higher than that of control, except that of HDL-C which was non-significantly lower than control. Post treatment values resulted in highly significant reduction of TC, TG, LDL-C and VLDL-C, at 95% confidence level. Dill extract was considered safe and tolerable as no side effects were reported during the study [21].Hermansen *et al* have proved the beneficial modulatory influence of dill extract on cholesterol metabolism. Administration of alkaloid compound A of Anethum graveolens extract caused a significant decrease in serum total cholesterol, LDL-cholesterol, VLDL-cholesterol. Extract treated rabbits showed decrease in the ratio of total cholesterol / HDL-cholesterol and LDL-cholesterol / HDL-cholesterol .It might be a consequence of higher proportion of HDL-cholesterol which reduced atherogenic index by increased transport of cholesterol from peripheral organs to liver [22]. A significant decline in the serum triglycerides level observed in plant extract treated rabbits supporting the cardiovascular protective influence. Mirhosseini M have reported 18% reduction in the mean level of cholesterol as compared to that of the Gemfibrozil group which showed reduction of upto 9.41%($P < 0.05$) on administration of Dill . Gemfibrozil and Dill has shown reduction in triglyceride by 32.7% and 7.38%, respectively ($P < 0.05$). Increased HDL –C level was observed in Gemfibrozil (3.91%) , as compared to reduction by Dill (0.8%). However, 21.4% of patients who used gemfibrozil reported gastrointestinal complications whereas Dill treated patients did not report any signs of adverse effects [23].

Alium sativum

Table no. 3: Classification of Garlic

Kingdom	Plantae
Phylum	Angiosperms
Class	monocots
Order	Asparagales
Family	Amaryllidaceae
Subfamily	Allioideae
Genus	Allium
Species	*Allium sativum*

Allium Sativum (Lat.), (Eng: Garlic, Urdu: ‘Lahsan’) commonly known as garlic, is a species in the onion genus. It is native to central Asia, and has long been used a food ingredient in the Mediterranean region, as well as a frequent seasoning in Asia, Africa, and Europe.

Phytoconstituents: Garlic contains at least 33 sulfur compounds like aliin, allicin, ajoene, allylpropl, diallyl, trisulfide, s-allylcysteine, vinyldithiines, S-allylmercaptocystein, and others. Besides sulfur compounds garlic contains 17 amino acids and their glycosides, arginine and others.

Uses: It is used not only as spice but also as a popular remedy for prevention and treatment of a variety of diseases like rheumatism, dermatitis, abdominal disorders and diabetes mellitus. It has natriuretic and diuretic effects, antiplatelet and fibrinolytic, cardioprotective effects have also been reported.

Mechanism of action: Human study report suggests that,, the active principle of garlic against hyperlipidemia is the essential oil, which contains a combination of sulphur-containing compounds, mainly allyl propyl disulphide and diallyl disulphide. The lipid-lowering effect of Garlic may occur via inhibition of HMG-CoA reductase or other enzymes, possibly by diallyl di- and trisulphide components of garlic. Other suggested mechanisms include increased loss of bile salts in feces and mobilization of tissue lipids into circulation.Scientists have also suggested that garlic may act by increasing the excretion of cholesterol end products and by affecting it's synthesis in the liver. Aqueous garlic extract also made the LDL significantly resistant to oxidation, it may be one of the powerful mechanism accounted for the benefits of garlic in atherosclerosis [24].

Hypolipidemic studies reported: Raghuveer Choudhary have studied the benificial effect of Allium Sativum and Allium Tuberosum on experimental hyperlipidemia and atherosclerosis. Both the species of garlic produced significant reduction in serum cholesterol, triglycerides, LDL-C and atherogenic index by 95% confidence interval as compared to control group. There was no significant increase in HDL-C. Garlic also prevents fall of HDL, which is nonatherogenic and transfers cholesterol from the periphery to the liver [25].Effect of garlic in cardiovascular diseases was found to be more encouraging in experimental studies, which led to conduct of several clinical trials. Since 1993, data of 25 clinical trials have been published that have investigated the hypolipidemic effects of garlic .Out of 25, 11 studies have been successfully proven the reduction in serum cholesterol [26]. A systematic

review of the effectiveness of garlic as an antihyperlipidemic agent was published in 2003 included 10 studies and found that in 6 studies garlic was effective in reducing serum cholesterol levels. The average fall in total cholesterol was 9.9%, LDL 11.4%, and triglycerides 9.9% [26]. Earlier meta analysis has confirmed that garlic is superior to a placebo in reducing total cholesterol levels [27].Khalid Rahman *et al* have performed *in vitro* study inidicating inhibition of enzymes involved in cholesterol and fatty acid synthesis by Garlic and its constituents. The studies were carried out in cultured rat hepatocytes and human HepG2 cells. Final measurements of enzyme activity showed that garlic and its constituents inhibit human squalene mono oxygenase and HMG-CoA reductase, which are enzymes involved in cholesterol biosynthesis. It has also been shown that the more water-soluble compounds like S-allylcysteine (SAC), sethylcysteine, and S-propylcystein present in aged garlic extract are less cytotoxic and more efficient in inhibiting cholesterol biosynthesis than the lipid-soluble sulfur compounds such as diallyl sulfide (DAS) [28].

Md.Asaduzzaman *et al* have proved the Pet ether, ethyl acetate and chloroform fractions of the Alium sativum to be hypolipidemic as they showed reduction in total cholesterol upto 51.2%, 30.4%, 29.9% respectively.

Mechanism proposed for the lipid lowering activity of this extract was the inhibition of the enzyme hydroxyl methyl glutaryl Co-A reductase, which participates in De-Novo cholesterol synthesis [29].

Prema Ram Choudhary *et al* have studied the effect of aqueous and alcoholic extracts of garlic for hypolipidemic activity. In the study, a significant reduction in the serum cholesterol, serum triglyceride, LDL-C, VLDL-C and atherogenic index in hyperlipidemic guinea pigs ($p<0.001$) was observed as compared to control group. On comparison between the two extracts, aqueous extract of garlic was found to be more potent hypolipidemic agent than the alcoholic extract [30].

Fenugreek

Table no. 4: Classification of Fenugreek

Kingdom	**Plantae**
Phylum	Angiosperms
Subphylum	Eudicots
Class	Rosids
Order	Fabales
Family	Fabaceae
Genus	Trigonella
Species	T.FoenumGraecum

Fenugreek (*Trigonellafoenum-graecum*) is known as 'Methi' in Hindi and commonly used as a spice in cooking. Fenugreek is cultivated in India, Egypt, Middle East and North Africa.

Phytoconstituents: Major active compound of fenugreek is Diosgenin, a steroid sapogenin. Other sapogenins found in fenugreek seed include yamogenin, gitogenin, tigogenin, and neotigogens. Fenugreek seeds also contain alkaloids, including trigonelline, gentianine and carpaine compounds. The seeds also contain fiber, 4-hydroxyisoleucine and fenugreekine.

Uses: The seeds of the plant have been used as a traditional remedy for conditions including gastrointestinal disorders, gout, inflammation, hyperlipidemia and diabetes. Fenugreek seeds are used for their wound healing, carminative, tonic and aphrodisiac effects.

Mechanism of action: Fecal bile acid and cholesterol excretion are increased by fenugreek administration. Fenugreek also contains a biologically significant level of saponins [31].Cholesterol excretion may be secondary to a reaction between the bile acids and fenugreek-derived saponins causing the formation of micelles too large for the digestive tract to absorb. Another theory suggests the cholesterol lowering activities to the fiber-rich gum portion of the seed that reduces the rate of hepatic synthesis of cholesterol. The soluble fiber from fenugreek appears to decrease reabsorption of bile acids in the small intestine increasing the excretion of cholesterol and bile acids into the feces. Consequently, the need of cholesterol for bile acid biosynthesis is enhanced and blood cholesterol concentrations are reduced [32]. It is likely that both mechanisms contribute to the overall effect [33].

Hypolipidemic studies reported:Saxena B.*et al* evaluated lipid lowering effect of fenugreek seed extract in Triton and high fat diet induced hyperlipidemic models of albino rats. Aqueous seed extract of fenugreek (120 mg/kg,) inhibited the elevation in plasma cholesterol in Triton administrated rats. The aqueous seed extract at the same dose level significantly attenuated the plasma total cholesterol, triglycerides, lipoprotein cholesterol (HDL, LDL and VLDL) in high-fat diet-induced hyperlipidemic rats. It also found to improve the atherogenic index (AI) in high fat diet model [34].

Sharma *et al* investigated 15 non-obese, asymptomatic, hyperlipidemic adults. After intake of 100 gm fenugreek powder per day for three weeks, the subjects showed a reduction in their triglyceride (TG) and Low density

Lipoprotein cholesterol (LDL-C) levels as compared with baseline values. Slight decrease in high density lipoprotein (HDL) levels were also noted [35].

M. Al-Habori *et al* have demonstrated the effect of fenugreek on plasma lipid levels when given along with the high fat diet. This Experiment clearly showed the plasma cholesterol and triglyceride values of rabbits fed on diets 20%, 30% and 60% were lower than the group with high fat diet ($p < 0.01$). There was no effect on the HDL-cholesterol. None of the diets containing fenugreek had any significant effect on the body weight gain relative to the control group [36].Sowmya and Rajyalakshmi observed significant reductions in total cholesterol and low density lipoprotein cholesterol (LDL-C) levels in 20 adults with hypercholesterolemia who received 12.5- 18.0 gm powdered, germinated fenugreek seeds for one month [37]. Abu Saleh M *et al* have undertaken the study to demonstrate the effect of fenugreek seed powder on lipid profile in hyper-lipidemic Type 2 diabetic patients. The fenugreek seed powder significantly ($p < 0.001$) reduced serum total cholesterol, serum triacylglyceride level and serum LDL-cholesterol level in hyperlipidemic Type 2 diabetic patients. The serum HDL-cholesterol level increased but not significantly by the fenugreek seed powder. No significant changes found in control group i.e. hyperlipidemic patients not taking fenugreek [38].

Ginger

Table no. 5: Classification of Ginger

Kingdom	Plantae
Phylum	Angiosperms
Subphylum	Monocots
Class	Commelidins
Order	Zingibareles
Family	zingiberaceae
Genus	Zingiber
Species	Zingiberofficinale

Ginger (*Zingiber officinale* Roscoe, family Zingiberacae) is a herbaceous perennial comprising a rhizome, fibrous roots and aerial shoots . It is cultivated extensively across India, Southeast Asia, tropical Africa, Pacific Ocean islands and Australia.

Phytoconstituents : Ginger contains essential oils including gingerol and zingiberene. It also contains pungent principles such as zingerone, gingerol and shogaol

Uses: It has been widely used in Chinese, Ayurvedic and Unani herbal medicines all over the world for the treatment of arthritis, rheumatism, sprains, muscular aches, pains, sore throats, cramps, constipation, indigestion, vomiting, hypertension, dementia, fever, infectious diseases and helminthiasis.

Mechanism of action: The plasma lipid lowering effect of Ginger extract is possibly associated with several processes, including disruption of cholesterol absorption from the GI tract [39].and interference with cholesterol biosynthesis in liver [42]. Literature suggests that ginger contains antioxidant properties are hypocholesterolemic and anti-atherogenic, and these activities might be attributed to the inhibition of LDL oxidation and the suppression on the activity of HMG-CoA (3-hydroxy- 3methyglutaryl co-enzyme A) reductase [40]. This also might occur due to the elevation of hepatic cholesterol 7-alpha-hydroxylase activity, which is a rate-limiting enzyme in the biosynthesis of the bile acids and stimulates the conversion of cholesterol to bile acids leading to the excretion of cholesterol from the body [41].

Hypolipidemic studies reported: P.Paul *et al* have evaluated the hypolipidemic effect of ginger in vanaspati(Hydrogenated vegetable fat) fed rats. The total cholesterol, LDL-C, triglycerides levels were found to be increased by the administration of vanaspati whereas HDL-C level was found to be decreased significantly ($p<0.05$). Simultaneous administration of ginger extract reversed the effect significantly ($p<0.05$). No significant changes in liver were found in histopathological study [43].U Bhandari *et al* have studied the effects of ethanolic extract of ginger (200 mg/kg). The increased serum and tissue cholesterol, serum triglycerides, serum lipoproteins and phospholipids due to 70 days of cholesterol feeding, was significantly reduced by the administration of the ethanolic ginger extract and results were compared with gemfibrozil. The test drug and standard drug significantly ($P< 0.01$) reduced the levels of serum and tissue cholesterol, serum triglycerides, LDL+VLDL-C, serum phospholipids and increased HDL-C levels when compared with pathogenic group. Animals receiving ginger extract along with cholesterol also showed a lower degree of atherosclerosis [44]. Abd-Elraheem A. Elshater *et al* investigated the effects of daily oral administration of ginger extract for 60 days on plasma glucose, lipid profile and kidney functions in alloxan-induced diabetic rats.The treatment with ginger extract reduced plasma cholesterol, triglyceride and LDL-cholesterol, but the pre-treatment with ginger extract produced insignificant change only in plasma triglyceride level. The plasma HDLcholesterol was significantly increased in post-treated and pre-treated groups [45].

Reza Alizadeh-Navaei *et al* carried out double blind controlled clinical trial study to investigate hypolipidemic effect of ginger in 85 human individuals. There was a significant decrease (p<0.05) in triglyceride, cholesterol, low density lipoprotein (LDL), very low density lipoprotein (VLDL) levels of before and after study separately in each group. Mean changes in triglyceride and cholesterol levels of ginger group were significantly higher than placebo group (p<0.05). Mean reduction in LDL level and increase in high density lipoprotein level of ginger group were higher than the placebo group, but in VLDL level of placebo was higher than ginger (p>0.05) [46].

Zainab M *et al* have studied the effect of an aqueous extract of raw ginger on Streptozotocin (STZ)-induced diabetic rats. The aqueous extract was administered daily (500 mg/kg ip) for a period of 70 days. At a dose of 500 mg/kg, raw ginger was significantly effective in lowering serum glucose, cholesterol and triacylglycerol levels in the ginger-treated diabetic rats compared with the control diabetic rats. After treatment, the serum cholesterol levels of ginger-treated diabetic rats significantly decreased by 44% in comparison with control diabetic rats. A significant reduction of 41% in serum triacylglycerol levels was observed during the 7 weeks of treatment. In contrast, the serum cholesterol and triacylglycerol levels were elevated in the control diabetic group throughout the experimental period [47].

Coriander

Table no. 6: Classification of coriander

Kingdom	Plantae
Phylum	Angiosperms
Subphylum	Eudicots
Class	Asterids
Order	Apiales
Family	Apeaceae
Genus	Coriandrum
Species	C.Sativum

Coriander,(Coriandrum sativum) also known as Cilantro, dhania or Chinese parsley , is an annual herb belonging to the family Apiaceae. Coriander is native to regions spanning from southern Europe and North Africa to south west Asia.

Phytoconstituents: The seed of Coriandrum sativum contain 0.5-1% essential oil which is rich in beneficial phytonnutrients including carvone, geraniol, limonene, borneol, camphor, elemol and linalool. The flavonoides present in Coriander include quercitin, kaempferol, rhamentin and apigenin. It also contains active phenolicacid compounds including caffeic and cholorogenic acid.

Uses: The health benefits of coriander include its use in the treatment of skin inflammation, high cholesterol levels, diarrhoea, mouth ulcers, anemia, indigestion, menstrual disorders, small pox, conjunctivitis, skin disorders, and blood sugar disorders, while also benefiting eye care.

Mechanism of action: Coriander enhances the Bile acid synthesis and increases the degradation of cholesterol to fecal bile acids and neutral sterols. Hence coriander can reduce high levels of lipid in the body by increasing their metabolism and eventual excretion. The coriander oil also reduces the activity of the enzyme HMG-CoA which is the key regulatory enzyme in cholesterol synthesis. As a result, significant hypolipidemic effect of coriander oil is observed [48].

Hypolipidemic studies reported: Sam lal *et al* have demonstrated the effect of coriander in the biphasic model of Triton induced hyperlipidemia in rats. Coriander at a dose of 1gm/kg body weight, proved to reduce cholesterol and triglycerides level in both synthesis and excretory phases in rats and the results were comparable with that of the Liponil, a commercially available hypolipidemic agent [49]. Essa H. Al-Mashhadani *et al* have conducted the study to investigate the potential effect of coriander oil on 135 day old broiler chicks for 42 days. Chicks were randomly assigned in to three dietary treatments with three replicate pens per treatment. Birds were fed on diets containing 0, 0.5 and 1% coriander oil. Results showed that the inclusion of coriander oil at levels of 0.5% and 1% significantly (p<0.05) decreased plasma cholesterol and glucose. Increased HDL-C level was also observed [50]. Ullagaddi Rajeshwari *et al* have carried out comparison of aniseeds and coriander seeds for antidiabetic, hypolipidemic and antioxidant activities. Significant decrease in serum cholesterol and triglycerides upto 15% and 30% respectively was observed in coriander seed-treated Type 2 diabetics respectively was observed at final stages of the experiment. No significant change was observed with respect to VLDL, LDL and HDL-C in control group where as significant decrease of 31% (p<0.001) in VLDL –C and 9% (P<0.001) in LDL-C was noticed respectively in group treated with coriander seeds. Also, 42% (P<0.001) increase was observed in HDL-C levels in the coriander treated group. With respect to VLDL-C, LDL-C and HDL-C, treatment with coriander was found to be better compared to that of aniseeds treatment [51].

Chitra V *et al* have studied the effect of the administration of coriander seeds on the metabolism of lipids in rats fed a high fat diet with added cholesterol. The spice was proven to have a significant hypolipidemic action. The levels of total cholesterol and triglycerides decreased significantly in the tissues of the animals of the experimental group which received coriander seeds. Significant increases in beta-hydroxy, beta-methyl glutaryl CoA reductase and plasma lecithin cholesterol acyl transferase activity were noted in the experimental group. The level of LDL and VLDL cholesterol decreased while that of HDL cholesterol increased in the experimental group compared to the control group [52]**.**

Conclusion

Spices are dietary supplementary herbs used widely in Indian foods as flavouring agent, colouring agent and preservative from thousands of years. There available is ancient literature which reveal significance of these spices, their uses, cultivations, economical aspects. The proven efficacy of the actives in these spices have led to their pharmacological applications in the indigenous system of medicine all over the world. The research envisaged about the active phytochemicals derived from these spices have reached upto the molecular level giving the actual mechanism of actions of the herbs. Numerous studies have been carried out in past few decades which proved digestive stimulatory, anti-inflammatory, antioxidant, anti diabetic, hypolipidemic, anti mutagenic actions of a range of spices, proving the safety and efficacy of herbal medicines. Thus, India 'the house of spices' is having wide scope of development and opportunity to assess the spice therapy as alternative and complementary in the treatment of hyperlipidemia. At present, there is availability of the satisfactory data on the basis of which we can support the consumption of food rich in spices for the management of hyperlipidemia. In future, we can expect more bulk of the scientific evidence supporting the benefits of herbs and spices in the overall maintenance of health and protection from disease. Inclusion of these herbs and spices cannot only satisfy Culinary but also improve desired quality of life.

References

1. Ibrahim A., Mohamed G.,Zainy M., Natural antihyperlipidemic agents: Current status and future Perspectives,Phytopharmacology;2013;4:3:492-531.
2. Manodeep Chakraborty., Antihyperlipidemic activity of divya methi pachak against tritonx100 induced Hyperlipidemia in rats, International research journal of Pharmacy; 2012; 3:8.
3. Aminoff MJ., Nervous System: Current medical diagnosis and Treatment: The Mcgraw- Hill Company; 2004; 43: 956-963.
4. Marshall WJ., Lipids and Lipoproteins: Illustrated Text Book of Clinical Chemistry: Gower Medical Publishing, London.,2012; 2nd edition ,222-237.
5. Aminoff MJ., (2004). Nervous System In: Current medical diagnosis and Treatment: The mcgraw- Hill Company, 2004, 43rd ed. 956-963.
6. Soutar AK., Naoumova RP., Mechanisms of disease: genetic causes of familial hypercholesterolemia, Nature Clinical Practice Cardiovascular Medicine; 2007; 4: 214-225.
7. Chait A., Brunzell JD., Acquired hyperlipidemia (secondary dyslipoproteinemias),Endocrinology and Metabolism Clinics of North America;1990 ; 19: 259-278
8. Ahmed SM., Clasen MD., Donnelly MD., Management of dyslipidemia in adults, American Family Physician;1998 ; 57 : 2192-2204.
9. Harikumar K., Niveditha B., Reddy Pavan Kumar., Anti-Hyperlipidemic activity of Alcoholic and Methonolic extracts of *Crotolaria juncea* In Triton-Wr 1339 Induced Hyperlipidemia , International Journal of Phytopharmacology; 2012; 3:3: 256-262.
10. Priscilla D'Mello., Antioxidant and antihyperlipidemic activity of *Hibiscus sabdariffa* Linn leaves and calyces extracts in rats , Indian journal of Experimental Biology; 2009 ; 47:276-282.
11. Huang T.H.,kota B.P.,Razmovski V.,Roufogalis B.D., Herbal or natural medicines as modulators of peroxisome proliferator-activated receptors and related nuclear receptors for therapy of metabolic syndrome,Basic Clin Pharmacol Toxicol ; 2005; 96 :1: 3-14.
12. Iman A., Al-Blooni M.,Evaluation of anti-hyperglycemic and hyperlipidemic effect of some spices mixture, Peak Journal of Medicinal Plant Research;2014; 2 :3: 27-32.
13. Yazdanparast R., Bahramikia S., Evaluation of the effect of *Anethum Graveolens* L. Crude extracts on serum lipids and lipoproteins profiles in Hypercholesterolaemic rats, DARU Journal of Pharmaceutical Sciences; 2008; 16:2:88–94.
14. Zargari A., Medicinal Plants. Tehran: Tehran University., 1996:528–531
15. Madani H., Mahmood abady N., Vahdati A., Effects of hydroalcoholic extract of *Anethum graveollens* (dill) on plasma glucose and lipid levels in diabetes induced rats, Iranian Journal of Diabetes and Lipid Disorders; 2005; 5:2:35–42.
16. Gosain S., Irrchiaya R., Sharma C., Tharejad S., Kalra A., Hypolipidemic effect of ethanolic extract from the leaves of hibiscus sabdariffa L.In hyperlipidemic rats, Acta Poloniae Pharmaceutica Drug Research; 2010;67:2: 179-184.
17. Purohit A., Vyas K., Antiatherosclerotic effect of *Capparis deciduas* fruit extract in cholesterol-fed rabbits,Pharmaceutical Biology; 2006; 44: 172-177.
18. Jothi G., Antidiabetic and antihyperlipidemic effect of *Parmelia perlata.* Ach. in alloxan induced diabetic rats, International Journal of Pharmacy and Pharmaceutical Sciences; 2014; 6: 1.

19. Ali esmail al-snafi., the pharmacological importance of *Anethum graveolens*:a review, international journal of pharmacy and pharmaceutical sciences; 2014; 6: 4

20. Mansouri ., The effect of 12 weeks *Anethum graveolens* (dill) on metabolic markers in patients with metabolic syndrome; a randomized double blind controlled trial, DARU Journal of Pharmaceutical Sciences; 2012: 20:47.

21. Ahmed S., Mohammed H., Ali Ismail A., Effects of *Anethum graveolens* leaves powder on lipid profile in hyperlipidemicpatients, (www.scopemed.org).Spatula DD- Peer Reviewed Journal on Complementary Medicine and Drug Discovery; 2012: 2:3: 153-158.

22. Hermansen K., Dinesen B., Hole L., Morgenstern E., GHruenwald J., Effect of soy and other natural products on LDL: HDL ratio and other lipid parameters: a literature review, Adv. Therapeutics;2003: 20: 50- 78.

23. Mirhosseini M., Baradaran A., Rafieian-Kopaei M., Anethum graveolens and hyperlipidemia: A randomized clinical trial, J Res Med Sci; 2014; 19:758-61.

24. Raghuveer Choudhary., Benificial effect of *Allium sativum* and *Allium tuberosum* on experimental hyperlipidemia and atherosclerosis, Pak J Physiol; 2008; 4(2).

25. Kannar D., Wattanapenpaiboon N., Savige G., Hypocholesterolemic effect of an enteric-coated garlic supplement, J Am Coll Nutr ; 2001; 20:225–31

26. Alder R., Berry J., Williams M., Lookinland S., A systematic review of the Effectiveness of garlic as an antihyperlipidemic agent, J Am Acad Nurse Pract ; 2003;15:120–9.

27. Stevinson C., Pittler M., Ernst E., Garlic for treating hypercholesterolemia. A meta-analysis of randomised clinical Trials, Ann Intern Med; 2000; 19:420–9.

28. Khalid R.,Gordon M., Garlic and Cardiovascular Disease: A Critical Review, J. Nutr ; 2006; 136: 736S–740S.

29. Md.Asaduzzaman., Md. Arifulislam., Afia A., Evaluation of Anti-diabetic, Anti- Hyperlipidemic, hepatoprotective effects of *Alium sativum* (Linn) in alloxan induced Daibetic rats, Bangladesh Pharmaceutical Journal; 2010:13: 1.

30. Prema Ram C., Jaidev Singh S., MeghShyam S., effect of *Allium sativum* on experimentally induced hyperlipidemia in guinea pigs, Pak J Physiol; 2013; 9:2:38–40.

31. Sharma RD., Effects of fenugreek seeds and leaves on blood glucose and serum insulin responses in human subjects, Nutr Res; 1986; 6: 1353-64.

32. Jasim Naeem Al-Asadi., Therapeutic Uses of Fenugreek (*Trigonella foenum-graecum* L.), American journal of social issues and humanities; ISSN: 2276 – 6928, 21-26.

33. Rashmi Y., Rahul K., Dipeeka G., The health benefits of trigonella Foenum-graecum: a review. International Journal of Engineering Research and Applications;2011; 1:1:032-035

34. Saxena B., Saxena U., anti-hyperlipidemic activity of fenugreek (*Trigonella foenum graecum)* seeds extract in Triton and high fat diet induced hyperlipidemic model: a potent anti-atherosclerotic agent, Pharmacology online;2009: 616-624.

35. Sharma RD., Raghuram TC., Dayasagar Rao V., Hypolipidaemic effect of fenugreek seeds: A clinical study, Phytother Res; 1991; 3:145-147.

36. M. Al-Habori., M. Al-Aghbari., M. Al-Mamary., Effects of Fenugreek Seeds and its Extracts on Plasma Lipid Profile: A Study on Rabbits, phytotherapy research;1998; 12: 572–575.

37. Sowmya P., Rajyalakshmi P., Hypocholesterolemic effect of germinated fenugreek seeds in human subjects, Plant Foods Hum Nutr; 1999; 53:359-365.

38. Abu Saleh M., Rashid M., Asadi A., Mojibuddin M., Hypolipidemic effects of fenugreek seed powder, Bangladesh J Pharmacol; 2006; 1: 64-67.

39. Newall CA., Anderson LA., Philpson JD., Herbal Medicine: A Guide for Health Care professionals ,The Pharmaceutical Press, London, UK ; 1996 :135-137.

40. Fuhrman B., Roseblate M., Hayek T., Coleman R., Aviram m., Ginger extract consumption reduces plasma cholesterol, inhibits LDL oxidation and attenuates development of atherosclerosis in atherosclerotic, apolipoprotein E-deficient mice, The Journal of Nutrition;2000; 130: 1124-1131.

41. Stoilova I., Krastanov A., Stoyanova A., Denev P., Gargova S., Antioxidant activity of ginger extract(*Zingiber officinale*),Food Chemistry ; 2007; 102: 764-770.

42. Srinivasan K., Sambaiah K., The effect of spices on cholesterol 7 alpha-hydroxylase activity and on serum and hepatic cholesterol levels in the rat, International Journal for Vitamin and Nutrition Research; 1991; 61: 364-369.

43. P.Paul ., M.K.Islam., A.Mustari., M.Z.I.Khan., hypolipidemic effect of ginger extract in vanaspati fed rats, Bangl. J. Vet. Med; 2012; 10 (1&2).

44. U. Bhandari., J.N. Sharma., R. Zafar., The protective action of ethanolic ginger (Zingiber officinale) extract in cholesterol fed rabbits, Journal of Ethnopharmacology ; 1998;61: 167–171.

45. Abd-Elraheem A., Salman M .,Meharous M., Effect of Ginger Extract Consumption on levels of blood Glucose, Lipid Profile and Kidney Functions in Alloxan Induced-Diabetic Rats, Egypt. Acad. J. biolog. Sci; 2009; 2 :1: 153-162.

46. Reza A., Fatemeh R., Mehrdad S., Mehdi P., Investigation of the effect of ginger on the lipid levels, A double blind controlled clinical trial, Saudi Med J; 2008; 29 :9: 1280-1284.

47. Muslim Ali., Zainab M.,Martha T., Khaled K., Anti-diabetic and hypolipidaemic properties of ginger (*Zingiber officinale*) in streptozotocin-induced diabetic rats, British Journal of Nutrition; 2006; 96: 660–666

48. Crowell P., Prevention and therapy of cancer by dietary monoterpenes, J. Nutr.; 1991; 129: 775-778.

49. Sam lal., Hypolipidemic effect of *Coriandrum Sativum* in Triton induced hyperlipidemic rats,Indian J Exp Biol; 2004; 42:9:909-912.

50. Essa H., Farah K., Sunbul J., Hanan E.,Effect of Different Levels of Coriander Oil on Broiler Performance and Some Physiological Traits under Summer Condition, Pakistan Journal of Nutrition ; 2011;10 :1: 10-14.

51. Ullagaddi R., Iyer S., Bondada A., Comparison of aniseeds and coriander seeds for antidiabetic, hypolipidemic and antioxidant activities, Spatula DD-Peer Reviewed Journal on Complementary Medicine and Drug Discovery; 2011; 1:1:9-16.

52. Chithra V., Leelamma S., *Coriandrum sativum* changes the levels of lipid peroxides and activity of antioxidant enzymes in experimental animals, Indian J Biochem Biophys; 1999; 36.

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