



HEART- HEALTHY NATURAL INGREDIENTS FOR CHOLESTEROL REDUCTION

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ABSTRACT

Now-a-days people are shifting towards western lifestyle and food which is increasing the level of cholesterol and hence increase in risk of cardiovascular diseases. Cardiovascular disease is causing premature death at the highest rate than any other disease. In market various cholesterol reducing drugs are present which people are consuming. Intake of these drugs causes various life threatening side effects. People can switch to natural sources of reducing cholesterol level which will be healthy as well as safe. Plant sterol, plant stanol and plant stanol ester are safe as they are from a plant source and is proven to lower cholesterol level. Foods enriched in these components should be consumed to reduce the risk of cardiovascular disease. There are several cholesterol reducing ingredients which is still not known among the mass. Dietary fibers, all type of nuts, garlic, apple, soy products, green tea are some of the many natural cholesterol reducing ingredients which is discussed in this review. Various studies have been conducted to show that these ingredients do reduce the cholesterol level in a noticeable way. FDA has also approved various health claims regarding these ingredients.

KEYWORDS: Cardiovascular disease, Cholesterol, Plant sterols, Natural cholesterol reducing ingredients.

INTRODUCTION

Now-a-days there is an increase in uptake of fast foods which is causing an increase in cardiovascular disease. Cardiovascular disease is causing death at the highest rate than any other disease it is number one cause of death globally. A study conducted in 2012, estimated 17.5 million people died from CVDs; representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke. Disorders of the heart and blood vessels are called cardiovascular diseases. The different type of heart diseases: coronary heart disease – in this there is disease of blood vessels supplying blood to the heart muscle; congenital heart disease – it is by birth disease caused due to deformed heart structure; cerebro vascular disease – in this blood vessels supplying blood to the brain is diseased; peripheral arterial disease – disease of blood vessels supplying blood to arms and legs; rheumatic heart disease – it is caused by streptococcal bacteria which damage heart muscle and heart valves; deep vein thrombosis and pulmonary embolism – in this disease leg veins are clogged due to formation of blood clots, and these blood

clots move to heart and lungs and cause blockage. Therefore, the main reason of acute events like heart attacks and strokes is blockage of veins and arteries which prevents blood flow to heart or brain. Most common reason for the blockage is accumulation of fatty deposits on the inner walls of the blood vessels which supply blood to heart or brain. Heart attacks and strokes are caused mainly due to increased intake of bad cholesterol but it may be also due to tobacco use, physical inactivity and harmful use of alcohol, hypertension, diabetes and hyperlipidemia. In every cell in our body cholesterol is found - which is a type of fat (lipid) made by our body and found in foods and is essential for good health. Changes need to there in our western diet and lifestyle to avoid or delay the risk of CVDs, but this change is not practicable. Now-a-days most of the people are taking cholesterol-lowering drugs. Randomized trials has shown that cholesterol lowering drugs lower three risk factors—low density lipoprotein (LDL) cholesterol or the bad cholesterol, blood pressure and platelet function (with aspirin)—which reduce the incidence of ischemic heart disease

(IHD) events and stroke. There is several cholesterol reducing drugs available in the market which include: Statins, Niacin, Bile-acid resins, Fibric acid derivatives, cholesterol absorption inhibitors Zetia. But there are many side effects related to intake of these drugs such as Stomachpain, Stomachupset, Gas,Bloating, Cramping, Nausea, Diarrhea, Constipation, Headache, Mild muscle pain but these are mild effects. There are more serious side effects of these drugs which include: problems with liver, problems with muscles. It is suggested not to take these drugs and avoid theses health threatening side effects. As replacement of these drugs now food with cholesterol reducing agents are becoming popular. Still people are not aware of these natural cholesterol lowering foods which give only health benefits and no side effects. Benecol is the leading company producing food products which lowers cholesterol. Phytosterols are also becoming popular. Phytosterols are cholesterol-like molecules found in all plant foods, with the highest concentration occurring in vegetable oils. Phytosterol are absorbed in trace amounts but inhibit the absorption of intestinal cholesterol including recirculating endogenous biliary cholesterol, a key step in cholesterol reduction. In this review article there is discussion about cholesterol, plant sterol, plant stanol, plant stanol ester and different studies related to cholesterol reducing natural agents.

Cholesterol: A class of molecule Sterols includes Cholesterol. Cholesterol is made up of two words: Khole which is a Greek word which means bile because it was first time isolated from gallstones and *stereos*,^[1] or solid, which indicates that it is part of a class of molecules that are known collectively as sterols. Common root word is steroids. Vitamin D, steroid hormones and bile acids are produced only because of cholesterol. Cell membranes are also having cholesterol as its components. Cholesterol travels through our bloodstream in small packages called lipoproteins (lip-o-PRO-teens). These lipoprotein are made of fat (lipid) on the inside and proteins on the outside.

There are two types of lipoprotein which carries the parcel of cholesterol.^[2] First is Low-density lipoprotein (LDL - cholesterol carried in this parcel is known as 'bad' cholesterol). Bad fats or bad cholesterol mean “Trans” and saturated fats, which increase the risk for certain diseases especially the cardiovascular disease. Cholesterol from liver to rest of the body is carried by Low-density lipoproteins (LDL).^[3] Body cells attach themselves to these LDL particles and extract cholesterol from them. Too much LDL cholesterol in the blood form deposits in the walls of the coronary arteries and other arteries

throughout the body. Such deposits narrow arteries and limit blood flow are called plaque. When plaque breaks apart, it can cause a heart attack or stroke. Because of this, LDL cholesterol is often referred to as bad, or harmful, cholesterol.

Trans fatty acids, more commonly called trans fats, is made by a process called hydrogenation. In this process liquid vegetable oil is heated in the presence of hydrogen gas and a catalyst. Trans fats are worse than saturated fats because they raise bad LDL and lower good HDL. They also fire inflammation,^[4] an over activity of the immune system which has implicated in heart disease, stroke, diabetes, and other chronic conditions and contribute to insulin resistance.^[5] A recent study has shown that even small amounts of Trans fat in the diet can produce harmful health effects. For every 2% additional calories in the form of Trans fat in daily diet, the risk of coronary heart disease will be increased by 23%.

High-density lipoprotein (HDL - cholesterol carried in this parcel is known as 'good' cholesterol). Good fats and good cholesterol, meaning monounsaturated and polyunsaturated fats or cholesterol. This cholesterol is good for the heart and most other parts of body. Recently, a randomized trial known as “Optimal Macronutrient Intake Trial for Heart Health” (OmniHeart) has shown that-blood pressure is lowered, lipid levels is improved and there is reduction in CVDs risks if a diet rich in unsaturated fat is replaced by a diet rich in mainly mono saturated fats.^[6] High-density lipoproteins (HDL) scavenge cholesterol from every place whether it is from bloodstream, or from LDL, or from artery walls and finally ferry it back to the liver for disposal. It causes no deposition on walls of arteries

Recent developments on cholesterol:

Dementia health is also affected by cholesterol levels-The balance of LDL and HDL cholesterol levels is important not just for heart health but for brain health too, according to a December 2013 study. The research, published in *JAMA Neurology*, found that control of cholesterol reduced the brain plaques linked to Alzheimer's disease.

High cholesterol linked to infertility - prospective parents with high cholesterol levels could be in for a long wait to become pregnant, a new study published in the Endocrine Society's *Journal of Clinical Endocrinology & Metabolism* states.

Study links high LDL cholesterol to aortic valve disease - a study published in *JAMA* claims to have found evidence to support a causal association between high levels of "bad"

cholesterol and aortic valve stenosis - a form of aortic valve disease in which the valve is narrowed, restricting blood flow from the heart.

Plant sterols, Plant stanols and Plant stanol ester:

Phytosterols and phytostanols are plant sterols are common plant and vegetable constituents which has structure similar to cholesterol except the side chain and act in the intestine to lower cholesterol absorption. They have a very low systemic absorption and are already present in healthy diets. To reduce coronary heart disease one should increase the intake of phytosterols, this method has least side effects. The specific plant sterols that are currently incorporated into foods intended to lower blood cholesterol levels are extracted from soybean oil or tall (pine tree) oil. Phytosterols for commercial purpose are isolated from vegetable oils, such as soybean oil, rapeseed (canola) oil, sunflower oil or corn oil, or from so-called "tall oil", a by-product of the manufacture of wood pulp. These sterols can be hydrogenated to obtain phytostanols. Phytostanols can be esterified to obtain phytostanol ester. This tremendously reduces the risk of CVDs. The Food and Drug Administration (FDA) has even approved a health claim on phytosterols which states: "Foods containing at least 0.65 gram per serving of vegetable oil plant sterol esters eaten twice a day with meals for a daily total intake of at least 1.3 grams as part of a diet low in saturated fat and cholesterol may reduce the risk of heart disease".

Difference between plant sterols and plant stanols/plant stanols ester:

Plant sterols and stanols are structurally very similar but the following differences have been found between them:

Efficacy: Until recently, it has generally been considered that increasing the intake of plant stanols or sterols to greater than 2 grams per day will not result in an enhanced cholesterol lowering efficacy. However, this assumption is not valid for plant stanol ester. When increasing plant stanol ester dose up to 9 grams of plant stanols per day, the maximal LDL cholesterol lowering efficacy is -17%^[7, 8]. In the recent meta-analyses^[9] the maximal LDL lowering efficacy of plant sterol ester is -18.3%, whereas the corresponding maximal LDL lowering of plant sterol remained at 10.7%. Increased daily doses of plant stanol ester were found to be safe without adverse effects.

Absorption

The intestinal absorption of plant stanols is very low varying from 0.04 to 0.1% when compared with 0.5 to 1.9% of plant

sterols.^[10] Serum and tissue levels of plant stanols are less than 10% of the concentrations of corresponding plant sterols. However, it is worth noticing that the serum levels of both plant stanols and plant sterols are still very low when compared with the serum cholesterol levels.

Mechanism of action:

Plant sterol and plant stanol blocks the adsorption of cholesterol.^[11] Due to structure similarity of plant stanols and cholesterol, plant stanols can replace cholesterol from so called mixed micelles. A pre-requisite for cholesterol absorption is that it is solubilized into the lipid core of the mixed micelles. Additionally, plant stanols may activate certain transport proteins in the enterocytes. These transport proteins excrete cholesterol from an enterocyte back into the intestinal lumen and out of the body.

In case of plant stanol ester it is first hydrolyzed into plant stanols and fatty acids^[12] in the digestive tract where the plant stanols work in similar manner as stated above. Fatty acid part of plant stanol ester^[13] is absorbed into the body in the same way as other fatty acids in the food. Plant stanol ester reduces the absorption of both dietary and biliary cholesterol.

Plant sterols/stanols reduce LDL cholesterol through interfering with cholesterol absorption.^[14] Plant sterols and stanols has to be formulated before use. They cannot be used in pure form because of their inert crystalline structure. In order to optimize the effect of plant sterols and plant stanols two things can be done: First, esterification to fatty acids and second is dissolving these plant stanols and plant sterols in food fat products.^[15] Some studies have shown that free plant sterols/stanols when mixed with fat spread is also effective in reducing LDL cholesterol levels.^[16, 17] Various studies have been conducted in which plant sterols/stanols is being added to low and non-fat food products. The results presented here show that when compared with plant sterol/stanol containing fat spreads, mayonnaise and salad dressing, milk and yoghurt, other plant sterol/stanol containing food products, including chocolate^[18, 19], orange juice^[20], cheese^[21], non-fat beverage^[22, 23], meat^[24], croissants and muffins^[25], oil in bread^[26], and cereal bars^[27] demonstrated less of a LDL-reduction efficacy. All these finding highlight the importance of food carrier and proper formulation of plant sterols/stanols. Although milk and yoghurt drinks contain much less fat than fat spreads and mayonnaise, milk and yoghurt drinks demonstrate similar efficacy as of products with higher fat content. So this study proved that it is not necessary that food

carrier should contain high fat content the only important thing is proper formulation of plant sterol. Unfortunately, exact method which is used to formulate plant sterols/stanols in the milk and yoghurt studies is not described in adequate detail. It is also possible that plant sterols/stanols in milk, may be more readily incorporated into milk globule membranes and thus more readily compete with cholesterol for transfer into the micelles, while on the other hand low fat foods plant sterols/stanols may be trapped in the center of the lipid droplets and not be available until the fat is digested^[28]. Future scope is to identify proper formulation of plant sterols/stanols and to improve their efficacy in food products other than those with high fat contents, i.e. vegetable and dairy spreads and mayonnaise, or milk and yoghurts.

Reactions and fate in foods:

Stability at high temperature:

□ Phytosterols and their fatty acid esters are quite stable compounds and undergo only limited degradation during oil processing.^[29]

□ Only under harsh conditions, such as high temperatures (>100°C) in the presence of oxygen, oxidation of the phytosterol moiety may occur, in the same way as for cholesterol. phytosterols are mono-unsaturated compounds (double bond in the B-ring), which are much more stable than the mono-unsaturated fatty acids (e.g. oleic acid), because of steric hindrance by the ring structure.

□ Factors affecting phytosterol oxidation include, as would be expected, temperature and heating time, but also the composition of the lipid matrix. Phytosterol esters were found to be more susceptible to oxidation at elevated temperatures than free phytosterols.

□ Phytostanols are generally heat stable and phytostanol esters also show an oxidative stability.

Stability during product manufacturing and storage:

□ Phytosterols and phytostanols are microbiologically largely inert as shown by the absence of an effect during the fermentation process used to produce yoghurt.

□ The ester added to various food products show excellent stability at different pH values during long term storage (up to at least a year).^[30]

□ Phytostanol and phytosterol esters are also stable in milk and fermented milk and products with viable bacteria like yoghurts and yoghurt drinks.

There is circumstantial evidence supporting the relationship between ingestion of sterols and stanols and a reduction in cardiovascular risk and it would seem to suggest the following conclusions:^[31, 32]

□ Systematic reviews to date do seem to suggest a general trend that shows that stanols and sterols reduce LDL cholesterol in people with normal and moderately raised cholesterol and that this effect is related to dose. They are also effective in reducing LDL cholesterol in more severe cases as in familial hypercholesterolaemia, including homozygous individuals.^[33]

□ The advent of powerful statins has led to neglect of dietary manipulation but sterols can be used in addition to statins to gain maximal effect.^[34]

□ Plant sterol/stanol supplements, as part of a healthy diet, may represent an effective means of delivering LDL cholesterol lowering similar to plant sterols/stanols delivered in various food formats.^[35]

□ It is not yet clear as to the optimum intake of sterols/stanols [36]. Foods enriched with 2 g of phytosterols/stanols per day have been shown to have a significant cholesterol-lowering effect.^[37]

□ One study suggests that plant sterols work best when taken 'little and often' rather than in one large daily dose.^[38]

Natural cholesterol lowering agents:

Dietary fibers: A dietary fiber plays an important role in cardiovascular risk as well as body weight management. Important source of dietary fiber are oatmeal and oat bran. This fiber contains a mixture of about half soluble and half insoluble fibers. Beta-glucans is a soluble fiber which has proven effective in lowering blood cholesterol. It is effective in lowering blood cholesterol in the following manner as the soluble fiber passes through the digestive tract it breaks down and form a gel that traps some substances related to cholesterol such as cholesterol-rich bile acids. This entrapment reduces the absorption of cholesterol into the bloodstream. The bad cholesterol LDL is trapped without lowering good cholesterol (HDL). Oat beta glucans^[39] is sufficiently characterized. There has been a study to check the cause and effect relationship of oat beta glucans and

lowering of LDL and blood cholesterol. The result of this study was positive. Blood cholesterol lowering may reduce the risk of (coronary) heart disease. In order to bear the claim, foods should provide at least 3 g of oat beta-glucans per day. This amount can reasonably be consumed as part of a balanced diet. The target population is adults who want to lower their blood cholesterol concentrations. Oats and grains are also one of the best sources of compounds called tocotrienols. These are antioxidants which together with tocopherols form vitamin E. The tocotrienols inhibit cholesterol synthesis and have been found to lower blood cholesterol. The accumulation of cholesterol is implicated in many types of cardiovascular disease. Oats, like all cholesterol-lowering agents is most effective when consumed as part of a low-fat, high-fiber diet taken together with plenty of exercise. The beneficial health effects of oats are best if ½-1 cup (1½-3 ounces) of oats is eaten every day. One study found that the 1/10th ounce (3 grams) of soluble fiber from this amount of oatmeal decreased total cholesterol by approximately 2%, which correlates to a 4% decrease in coronary artery disease. Another study showed 1½ ounces (43 grams) of oatmeal resulted in a loss of 3% in total cholesterol and a 14% reduction in bad cholesterol after two months. Another study found that a 6-8 week diet of 1½-3 ounces (43-85 grams) of oat bran daily lowered total cholesterol by 20% and bad cholesterol (LDL) by as much as 25%. Another study found 3.5 ounces (100 grams) of oat bran (one-third of a cup of oat bran eaten twice a day) lowered cholesterol up to 15%. New research has also discovered that the antioxidants found in oats reduce cholesterol by reducing the ability of blood cells to stick to the inside of artery walls. Flaxseeds are a good source of dietary fibers, and a large proportion of these are water-soluble viscous fibers. Both Flax drink and Flax bread resulted in decreased plasma total and LDL-cholesterol and increased fat excretion, but the food matrix and/or processing is of importance. Viscous flaxseed dietary fibers may be a useful tool for lowering blood cholesterol and potentially play a role in energy balance.^[40] It was found that the effect of Flax bread was less pronounced than with a similar dose of dietary fiber provided as a drink, both with regard to cholesterol-lowering properties and reduction of apparent fat digestibility, although only the latter was significantly different between Flax drink and Flax bread. Further, Flax fiber's ability to directly adsorb fat and bile acids may have been compromised by processing or the inclusion of a viscous drink with MCS in the Flax bread period may have interfered with the water-interaction of the flaxseed fibers. In a study it was found that addition of a flax dietary fiber extract rich in viscous dietary

fibers significantly increased fat excretion and lowered total and LDL-cholesterol although no effect on appetite was observed.^[41, 42]

Green tea: Green tea is a widely consumed beverage worldwide and is traditionally used in Asian countries as medication. Green tea is produced from fresh leaves of *Camellia sinensis* and is not traditionally fermented. Green tea contains antioxidants and other beneficial nutrients such as protein, carbohydrates, minerals, vitamins, and flavonoid-like polyphenols.^[43] Epidemiologic studies have reported an inverse relation between green tea consumption and CVD risk. Subjects who drink >2 cups of green tea had lower plasma total cholesterol (TC) concentrations and have been shown to reduce their risk of death from CVD by 22–33%.^[44, 45] In vivo and in vitro studies have shown that green tea catechins (which belong to the family of flavonols and serve as an essential component of green tea), exert a cardio protective effect via multiple mechanisms^[46, 47] including the inhibition of oxidation, vascular inflammation, thrombogenesis and improvement in blood lipid concentrations. The analysis of eligible studies showed that the administration of green tea beverages or extracts resulted in significant reductions in serum TC and LDL-cholesterol concentrations but no effect on HDL cholesterol was observed. Sensitivity analyses showed that these changes were not influenced by the type of intervention, treatment dose of green tea catechins, study duration, individual health status, or quality of the study. Animal experiments indicated that the inhibition of cholesterol absorption may be the mechanism to explain the cholesterol-lowering effects of green tea. Catechins with gallate esters were shown to interfere with the biliary micelle system in the lumen of the intestine by forming insoluble co-precipitates of cholesterol and increasing the fecal excretion of cholesterol.^[48] This apparent decrease in cholesterol absorption and reduction in liver cholesterol concentrations lead to an increase of LDL-receptor expression and activity.^[49] This cell-surface protein is present on the outer surface of most cells, but in particular liver cells, it can remove cholesterol-carrying LDL from the circulation. Studies in animals have provided evidence that green tea extracts and their catechin constituents can reduce plasma, liver, and thoracic aorta cholesterol and up-regulate hepatic LDL receptors.^[49, 50]

Nuts: Nuts have lots of protein, fiber, healthy monounsaturated fats, vitamins, nutrients, and antioxidants. And many studies have shown that nuts have powerful cholesterol-lowering effects. The benefits were clear enough for the FDA in 2003 to

issue a "qualified health claim" for peanuts and certain tree nuts -- almonds, hazelnuts, pecans, some pine nuts, pistachios, and walnuts. The claim allows some nuts and foods made with them to carry this claim: "Eating a diet that includes one ounce of nuts daily can reduce your risk of heart disease."

1) Walnuts: Walnuts are great because they have high levels of omega-3 fatty acids. Omega-3 fatty acids are also found in fatty fish like tuna and salmon. Omega-3 fatty acids lower levels of triglycerides, a type of fat in the bloodstream. It also slows down the growth of plaques in the arteries and prevents blood clots. There are a number of small studies that show that walnuts help lower cholesterol. One 2004 study of 58 adults with diabetes looked at the effects of eating a handful of walnuts each day in addition to a healthy diet. The researchers found that on average, people who ate the walnuts had an increase in their good HDL cholesterol and a drop of 10% in their bad LDL cholesterol levels. The results were published in the journal *Diabetes Care*. Walnuts received their own, separate qualified health claim from the FDA in 2004, stating that they may reduce the risk of heart disease.

2) Almonds: Many studies show that almonds have real health benefits too. Like other nuts, they are high in protein, fiber, healthy monounsaturated fats, minerals, and other nutrients. They are also high in vitamin E, an antioxidant. There are several studies to check the effect of nuts on cholesterol level. A study was conducted by David Jenkins MD and the result is published in journal *Circulation*. The result was that people with high cholesterol lowered their LDL by 4.4% by eating a handful of almonds and by 9.4% by eating two handfuls of almonds. In a study published in the *American Journal of Clinical Nutrition* in 2005, researchers tested cholesterol-lowering drugs against cholesterol-lowering foods. Almonds, soy protein, legumes, oats, and fruits and vegetables were among the chosen cholesterol-lowering foods. The results were striking. The diet lowered cholesterol levels about as well as cholesterol drugs.

Garlic: Garlic in its natural bulb form or as a tablet, capsule, dried powder, and aged extract of it can be used to lower cholesterol. However, raw garlic which has a high concentration of a sulfur-containing compound called 'allicin' is more medicinally powerful than cooked garlic. New Australian research finds garlic supplements reduce high cholesterol and greatly decrease risk of heart disease. New research at The University of Adelaide and the National Institute of Integrative

Medicine has found garlic supplements can reduce cholesterol in those people with elevated levels by percent.^[51] 8% reduction is significant as it is associated with a 38% decrease in the risk of coronary events for those at 50 years of age.^[52, 53] In one study it was seen that garlic supplements to be effective in reducing total serum cholesterol by 17 +/- 6 mg/dL and low-density Lipoprotein (LDL) cholesterol by 9 +/- 6 mg/dL in individuals with elevated cholesterol levels (>200 mg/dL) if taken for at least two months. The research also found garlic supplements to be associated with minimal side effects in comparison to the potentially debilitating side effects of the commonly used pharmaceutical 'Statins' which include muscular pain, memory loss, sexual dysfunction and an increased risk of diabetes."

Soy products: Soy products help to control the cholesterol level. As soy is cholesterol-free, the soy proteins reduce the cholesterol level. Most of the fats in soy products are polyunsaturated soy isoflavones which prevent atherosclerosis. Soy contains soluble fibers which reduce the amount of cholesterol circulating in the blood. It is known that in countries where traditional soy products are consumed daily, the rates of cardiovascular diseases are low. Mechanisms of Cholesterol Reduction by Soy.^[53] Several components associated with soy protein have been implicated in lowering cholesterol: trypsin inhibitors^[54], phytic acid^[55], saponins^[56], isoflavins^[57, 58], and fiber.^[59] Food and Drug Administration (FDA) approved a health claim for soy protein allowing food manufacturers to claim that, "25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease." There is some research that suggests that soy foods may help to prevent heart disease by reducing total cholesterol, LDL, blood pressure and possibly preventing plaque build-up in the arteries (atherosclerosis). Before the age of 60, men have more problems than women with their cholesterol levels. After menopause, when the production of natural estrogens drops, cholesterol levels in women will go up and the women become more susceptible to heart attacks. The soy isoflavones have a weak estrogen activity which is large enough to help reduce the cholesterol levels.^[60] Meta-analysis of the effects of soy protein intake on serum lipids. Researcher examined the relation between soy protein consumption and serum lipid concentrations in human in his meta-analysis of 38 controlled clinical trials, involving more than 730 volunteers.^[61] In most of these studies, animal protein was replaced with soy protein (average 47gm per day). The intake of energy, fat and cholesterol was similar when the subjects ingested control and

soy-containing diets. The findings stated that, replacing animal protein with soy protein reduced cholesterol with 9.3%. Volunteers on the soy diet had their LDL cholesterol levels dropped on average by 12.3%. The HDL cholesterol increased by 2.4% in volunteers on soy-containing diets.

Apple: Apples are rich in 'pectin' a soluble fiber which blocks cholesterol absorption in the gut and encourages the body to use rather than store, the waxy stuff. Apple peels are also packed with polyphenols -- antioxidants that prevent cellular damage from free radicals. "Any varieties of apples are good whether it is golden, red or green". "Most of the time, in many studies, the whole is better than the sum of its parts". In a study of healthy, middle-aged adults, consumption of one apple a day for four weeks lowered by 40 % blood levels of a substance linked to hardening of the arteries. Taking capsules containing polyphenols, a type of antioxidant found in apples had a similar but not as large effect. The study funded by an apple industry group, found that the apples lowered blood levels of oxidized LDL -- low-density lipoprotein, the "bad" cholesterol. When LDL cholesterol interacts with free radicals to become oxidized, the cholesterol is more likely to promote inflammation and can cause tissue damage and hardening of the arteries. We got a tremendous effect against LDL being oxidized with just one apple a day for four weeks. The study is published online in the *Journal of Functional Foods*. The Journal of the Academy of Nutrition and Diabetics published a study which revealed that those who ate apples for three months have lowered their total cholesterol levels for up to 9% and their LDL cholesterol lowered as much as 16%. April 12, 2011 -- Eating an apple or two each day may reduce heart disease risk factors, a new study shows. The study, which is the latest to polish the apple's heart-healthy reputation, found that eating apples daily appeared to lower levels of cholesterol and two other markers associated with plaques and inflammation in artery walls.

CONCLUSION

Increase in Cholesterol level of an individual is a serious problem and should be taken care of immediately. People should avoid taking cholesterol reducing drugs and switch to intake of natural cholesterol reducing ingredients. These natural reducing ingredients are safe to consume. People are still not aware of these natural ingredients. There has been various studies which clearly proves their efficiency in reducing the cholesterol level. Still there are many other ingredients which need some more

research to be declared as cholesterol reducing ingredient. In order to reduce the risk of heart disease people should take heart-healthy diet.

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