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ROLE OF COMPOUNDS PRESENT IN FRUITS AND VEGETABLES IN PREVENTING HEART DISEASES

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ABSTRACT

Cardiovascular diseases and coronary heart diseases are the most common cause of mortality. The compounds present in fruits and vegetables like polyphenols, flavonoids, dietary fibers, dietary nitrates, alkaloid, phytosterols, lycopenes are considered important for preventing cardiovascular diseases.

Importance of fruits and vegetables in diet can be used further to create insight of risk factors as well as the cure of Cardiovascular Diseases. Several studies including many experiments and surveys were selected in which the intake of fruits and vegetables were measured and the incidence of mortality due to CVDs was recorded. Intake of FBV (fruit, berries and vegetables) 3 times a day in young age can reduce the risk of CVDs in adulthood and also lowers blood pressure, reduce the stiffness of coronary arteries, and prevent from the damaging effects of reactive oxygen species and metal ions. The compounds present in FBV lower the risk of cardiovascular diseases with their antioxidant properties (polyphenolics, flavonoids), reducing properties (dietary nitrates) and chelating properties (polyphenolics, flavanoids). So the inclusion of vegetables and fruits in daily diet can reduce the risk factors associated with CVDs.

Key Words: Cardiovascular Diseases, Coronary Heart Diseases, Low Density Lipoproteins, Fruit Berries and Vegetables

INTODUCTION

Cardiovascular diseases and cancer are the two most common causes of death in United States and in other developing countries. In US every 1 min and 23 sec an American dies due to coronary heart disease.[1] In Pakistan one out of four middle age adults has prevalent coronary artery disease.[2] Consumption of cereals, fruits and vegetables can lower the chances of onset of many coronary and cardiovascular diseases (CVD).[3] Food not only provides the nutrient needed for the survival but it also contains some bioactive molecules such as polyphenols, dietary fibers and flavonoids that can play important role in protection against CVD.[3,4]

Artery stiffness and oxidative damage are probably the main cause of high systolic blood pressure that eventually leads to stroke and more mortality rate.[3] Dietary fibers can reduce the risk of heart diseases as they are involved in lowering the blood pressure, make cells more sensitive to insulin and loss of body weight.[4,5] Oxidative damage by reactive oxygen species that are produce as end products during lipid peroxidation and some malondialdehyde, can be the cause of degenerative diseases like CVD.[6]

Polyphenols and flavonoids that are present in fruits and vegetables have antioxidant properties and scavenging activity.[6] Polyphenolics present in tea and grape seed extract can reduce the risk of CVD, these compounds also reduce the lipid peroxidation. These polyphenols also show chelating effects for iron taken up by the cells of small intestine (Caco-2) and decrease the transport of iron that is in oxidized form, across the endothelial cells.[7] Flavonoids are the most common polyphenols that is present in different forms in the vegetables and fruits. Flavonoids reduce the esterification of cholesterols and decrease the synthesis of Apoprotein-B.[8] Some dietary nitrates present in the beetroots are the agents that causes dilation of the blood vessels by converting first to nitrites and then to Nitric Oxide (NO).[9]

Allicin and phytosterols lower the blood pressure by reducing the level of bad cholesterol LDL.[10,11] Alkaloids block the calcium channels as antagonist and lower blood pressure.[12] Lycopene, a carotenoid, is an antioxidant. It reduces the risk of CVD by inhibiting the cholesterol synthesizing enzyme.[13]

The reason of exploring this topic is to find out the bioactive compounds in fruits, cereals and vegetables that have important role in prevention of the onset of cardiovascular diseases.

Studies have shown that the intake of fruits and vegetables has lowered the mortality rates due to cardiovascular diseases. In a survey based study it was seen that the intake of fruits more than 3 times a day as compared with one time a day lowers 27% of strokes, 24% of ischemic heart disease, 27% risk of cardiovascular disease and about 15% of all cause of mortality in US adults.[3] It is also observed that taking vegetable soups and juices rich in carotenoids increases the plasma concentration of different types of carotenoids like à-carotene, ß-carotene and lycopene and decrease the concentration of oxidative markers like homocysteine and hence can reduce the risk of cardiovascular diseases.[14] The use of fruits and vegetables also play a significant role in protection against estrogen receptor negative post-menopausal breast cancer and some other chronic degenerative diseases by enhancing immunity of the body.[15,16] Different vitamins like vitamin C and vitamin E concentrations in plasma can be used as biomarker of dietary intake of fruits and vegetables.[17]

ROLE OF POLYPHENOLS

Bioactive polyphenols are the compounds, found in fruits, grains, tea and wine. Green tea, grape seed extract and sweet cherries contains Epigallocatechin-3-gallate and epicatechin-3-gallate, epicatechin, proanthocyanidins and anthocyanin respectively.[18,19] Due to their antioxidant properties polyphenols they are considered to be beneficial in preventing CVD. These polyphenols can scavenge free radicals and also act as chelating agents for iron that has been absorbed in the intestinal cells. When inside the lumen it is reduced to ferrous with the help of ferrireductase. Now this ferrous binds with the transporter protein and is transported outside but due to polyphenols, a chelating agent, iron is not available for the transport and thus polyphenols reduces the absorption of iron.[20]

Avenanthramides (Avns) are the soluble phenolic compounds.[21] More the 20 Avns are known to be found in oat extract. Avns-C is one of these 20 Avns that shows high antioxidant activity in vitro.[22] Also these Avns increase the activity of superoxide dismutase in different muscles and the activity of glutathione peroxidase in heart muscles.[23]

Some studies have shown that coffee contains some polyphenols that are important in lowering the serum lipid concentration by oxidizing LDL. Chlorogenic acids (group of esters), are present in 7-d standardized coffee that are involve in this oxidative modification. Chlorogenic acid is present in 5-caffeoylquinic acid form while after hydrolysis these are converted to caffeic, p-cumaric, and ferulic acids and these metabolites of phenolic compounds are responsible for oxidative modification of LDL.[24] Also the antioxidant properties of the polyphenols that are extracted from apple are important for preventing CVD. Polyphenols basically inhibit esterification (inhibiting ACAT) of the cholesterol mostly LDL and also inhibit synthesis of Apoproteins specially Apo-B that is involved in the transport of lipid molecules. Polyphenol procyanidine inhibits ACAT2 enzyme that would inhibit esterification of cholesterol and of

Apo B, so that cholesterol taken up by the cell is not able to transfer between the body organs and hence there would be less chances of hyperlipemia cause of CVD.[7] Polyphenols such as anthocyanins also has anti-inflammatory properties as they inhibit activities of cyclooxygenase.[18]

ROLE OF DIETARY NITRATES

Consumption of more vegetables reduces the cardiovascular diseases. This was first considered due to antioxidant properties but results of some experiments show that inorganic nitrates are also present in vegetables that help in lowering the blood pressure. It has been suggested that Beetroot contains some of the dietary nitrates (>250mg/100g) that can then be converted to nitrites by reduction with the help of some bacteria that are present at the dorsal surface of the tongue and then to nitrous acid this reduction takes place inside the stomach due to acidic environment. This nitrous acid is unstable and spontaneously converts to NO. This NO then dilates the arteries and lowers the blood pressure by stimulating vasodilation of arteries. About 24 participants were taken that meet the criterion some of them were asked to take about 200mg of beetroot bread while others were provided with white bread (control) with low nitrate water for two weeks and then the amount was reduced to 100mg. During this period LDL, blood pressure, urine test, pulse wave analysis, pulse wave velocity were performed to check the blood pressure, arterial stiffness and levels of nitrates and nitrites in serum and in urine. The results show that more consumption of beetroot bread lowers the blood pressure and lessens arterial stiffens in healthy individuals. This is because the beetroot contains sufficient amount of dietary nitrates.[9] Grape wines and grape juices also increase the ability of endothelial isoform nitric oxide synthase to produce NO thus reducing the risk of cardiovascular diseases.[25] Dilute grape juices shown to inhibit the platelet aggregation by increasing the NO production in platelets.[26]

ROLE OF DIETARY FIBERS

Long term consumption of food containing dietary fibers can reduce the risk of coronary heart disease (CHD) as dietary fibers can lower the cholesterol levels, reduce body weight, make cells more sensitive to glucose and lessen CHD mortality. This statement was testified by a longitudinal study that started in 1960 in Zutphen. About 878 participants were selected for this study. Their food consumption and dietary fiber intake were assessed. And the results showed that consumption of cereals reduce the risk of mortality to 29% while consumption of fruits reduce risk to 35% and is inversely proportional to CHD mortality.[4]

The long term intake of dietary fibers also helps to reduce the stiffness of the arteries. This in turn reduces the risk of coronary heart diseases. The statement was proved by a longitudinal study that was done in 1976-1977 and 600 children (13 years old) of 2 secondary schools were selected as participants. Their diet was assessed. They also checked the blood pressure and arterial stiffness in those patients and the results showed that those who took less dietary fibers in young age had stiffer carotid arteries in adulthood.[5]

ROLE OF FLAVONOIDS

Polyphenolic compounds that are present in fruits and vegetables can lower the risk of many heart diseases. Among these phenolic compounds flavonoids are the most common. These flavonoids are further divided into four groups flavanone, flavonol, flavones and dihydrochalcone that are present in different fruits and vegetables. In this study the relationship between intake of fruits and vegetables and the level of flavonoids excreted in urine was assessed so that the amount of flavonoids can be used as biomarker for the intake of flavonoids. Among all the falavonoids, flavonol and flavanone are major ones that are found to be present in fruits and vegetables. In this study about 101 participants were chosen and some were allowed to continue with their normal diet as a control group and others were divided into four groups, one with low FBV diet, second with high FBV diet, third were smokers and fourth were the women taking contraceptive pills. The time period of this study was 6 weeks after that LC-MS was performed. The results showed that there was no difference in gender and the flavonoids excretion in urine. Also those who took more FBV had more flavonoids in their urine than those that took usual diet. So it was concluded that levels of flavonoids in urine can be used as biomarker for the intake of vegetables and fruits.[6]

Different Flavonoids have different structures. The hydroxyl side groups of these flavonoids have part in antioxidant properties. These flavonoids prevent the peroxidation of lipids and prevent the cell from toxic effects of the compounds formed after Fe^{+2} treatment. The flavone and flavonols are seem to prevent Caco-2 cells of intestine from the formation of malondialdehydes. It also prevents the living cells from damage even if these compounds are incubated with flavonoids and before adding hydrogen peroxide and ferrous sulphate the flavonoids are removed. This shows that during incubation cells take up some of the flavonoids and utilize them afterwards.[8] Several isoflavones are also important in protecting heart diseases present in soybeans. These compounds interact with estrogen receptors and are involve in lowering the cholesterol in serum. The exact mechanism of decrease concentration of cholesterol by protein components of soya is not yet known.[27]

Vitamins present in different fruits and vegetables can also lower the risk of heart diseases. Vitamins lower the

homocysteine concentration, inhibit the oxidative modification of certain lipoprotein. Vitamins are also involved in decreasing inflammation.[28]

ROLE OF ALLICIN

It is mainly present in garlic (Allium sativum) that is released on crushing the garlic. Its regular use reduces the risk of CVD because it reduces the level of LDL, total cholesterol and triglycerides without affecting the level of HDL in body.[10] It also inhibits the aggregation of platelets as breakdown of allicin releases ajoenes, vinyldithiins and some other compounds containing sulfur.[29] In kuwait, researchers have found that 3g daily intake of garlic causes 80% reduction in the level of serum thromboxane B2 and 20% reduction in risk of CVD.[30] From a case study of 415 subjects, it has been shown that Allium is successful in lowering the blood pressure.[31] It also has been determined that use of garlic extract results in 5.5% lowering of systolic pressure.[32]

ROLE OF CAROTENOIDS

One of an important carotenoid with antioxidant activity is lycopene that is present in tomatoes and in other fruits. It decreases the risk of CVD.[33] It reduces the level of oxidized LDL which is main culprit to cause CVD. Lycopene also inhibits the activity of an enzyme involved in cholesterol synthesis.[13] Lycopene has strong antioxidant activity among all other carotenoids.[34] Lycopene also regulates the cholesterol metabolism.[35]

ROLE OF PLANT STEROLS

Phytosterols is a natural constituent present in vegetables, nuts and fruits. Clinical studies have shown that phytosterols reduce the level of LDL-cholesterol.[11] It also depends on the genetic factors as Apo E-4 homozygotes influence on taking phytosterols as their absorption capacity for cholesterol becomes drastically increases.[36]

ROLE OF ALKALOIDS

Ephedrine is an alkaloid which is associated with adverse CVD. Ephedrine has moderate effect on blood pressure and CVD at doses of 25 to 50mg.[37] Phenylproponalamine is an ephedrine that has additive effect with caffeine on blood pressure.[38] The natural source of alkaloid reserpine is R serpentine that proves effective against CVD. Reserpine is also now available as drug. It acts basically by destroying the catecholamines resulting in depletion of catecholamines. That's how it works as antihypertensive agent. It lowers the blood pressure by secreting renin and decreasing the cardiac output.[39] Tetrandrine is an alkaloid taken from Stephaniatetrandra.[40] It blocks the calcium ion channels as an antagonist and inhibits the production of aldosterone, resulting in lowering the blood pressure.[12]

CONCLUSION

Cardiovascular diseases are the most common cause of death. The inclusion of vegetables and fruits in daily diet can reduce the risk factors associated with these deadly diseases. So this information would be beneficial in creating an insight of the risk factors that cause CVD and the importance of fruits and vegetables in preventing these diseases. Also the pharmacist can isolate these compounds from extract of fruits and vegetables that can be used to make medicines for diffrent CVD.

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