**A COMPREHENSIVE ANALYSIS ON THE IMPACT OF VEGETABLE OIL ON HEART**

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**ABSTRACT: -**

Cardiovascular disease is the main cause of illness and mortality worldwide. The incorrect consumption of dietary vegetable oils is strongly associated to the etiology of CVD. Because of its low cost, the practice of frequently heating oil is widespread. Consumption of these oils generates free radicals, which may have a potentially dangerous and deleterious effect on CVS by accumulating total cholesterol (TC) and triglycerides (TG), resulting in an increase in blood pressure, endothelial dysfunction, and vascular inflammation. It eventually causes atherosclerotic plaques in the arteries.Growing research supports good dietary habits and ties daily cooking oil consumption to chronic diseases such as cardiovascular disease and diabetes. However, there is little food-based data to support the usage of cooking oils in terms of total and cardio metabolic mortality. We intend to conduct a prospective study of the relationship between cooking oils and death from cardio metabolic (CVD and diabetes) and other causes.

*KEY WORD:- CARDIOVASCULAR, PUFA, MUFA, INFLAMMATION, OIL*

**INTRODUCTION: -**

Lipids are considered one of the most important human nutrients. Lipid metabolism produces many bioactive lipid molecules, which are essential mediators of several signaling pathways and are also important compounds of cell membranes. Any changes in lipid metabolism can cause alteration in membrane composition and subsequently variation in its permeability. It can also lead to disruption of signaling pathways is undeniably linked to various pathological conditions, such as cancer, cardiovascular, neurodegenerative and metabolic diseases, as well as inflammatory complications. Lipids comprise of unsaturated fats (FA), which are chiefly grouped by the presence or absence of double bonds as saturated (SFAs - without double bonds), monounsaturated (MUFAs - with one double bond) and polyunsaturated fatty acids (PUFAs - with two or two links) up to six twin bonds); in addition, based on the configuration of the double bond, cis or trans and n-3 or n-6 PUFA, depending on the position of the first double bond at the methyl end of the fatty acid, can also be cis or trans depending on the double bond configuration. The Human body cannot synthesize polyunsaturated fatty acids (PUFAs) with the essential double bond at the methyl end of C3 and C6 due to the lack of corresponding enzymes. These fatty acids are therefore classified as essential fatty acids (EFAs) and must be obtained from food, particularly from fish and fish oil. Essential fatty acids (EFAs) are undeniably functional food and nutraceuticals, owing to their crucial roles in various biochemical pathways. Numerous research studies have documented their significant cardio-protective effects, resulting from their potent anti-atherogenic, antithrombotic, anti-inflammatory, anti-arrhythmic, and hypo-lipid emic properties. EFAs have the immense potential to reduce the risk of serious diseases, particularly cardiovascular diseases, cancer, osteoporosis, and diabetes. Their complex influence on concentrations of lipoproteins, fluidity of biological membranes, function of membraned enzymes and receptors, modulation of eicosanoids production, regulation of blood pressure, and metabolism of minerals make them excellent health promoters.

Fats & Oils are the simple lipids which consist of esters of fatty acids with glycerol. The difference between fat & oil is only in physical appearance that oils are liquids at 200 C while fats are solids at 200 C. Vegetable oils are derived from oil seeds grown mainly for their oil. According to the United States Department of Agriculture (USDA), global vegetable oil production is expected to reach 222.8 million tons in the 2023/24 marketing year. This is a 6.5 tons increase from 2022/23, and is expected to cover an estimated demand of 217.5 tons. Oilseed crops, such as soybean, groundnut, and mustard, contribute over 80% of the primary sources of vegetable oil. Additionally, 3 million tons of vegetable oil are obtained from secondary sources like cottonseed, rice bran, palm, and coconut. The primary sources of domestic oil production from 2015-16 to 2019-20 were annual oilseeds at 67.4%, cottonseed at 11%, rice bran at 9.8%, coconut at 5.1%, palm at 2.2%, and the remaining from the Solvent Extractors Association of India, and tree and forest origin.

The major food oils consumed as cooking and salad oils are canola (rapeseed), corn, cottonseed, olive, palm, palm kernel, coconut, peanut, safflower, soya bean and sunflower. ICAR-Indian Institute of Oilseeds Research conducted an online survey to analyze the domestic consumption pattern of vegetable oils. Results showed that rural households consumed 15.6 kg of oil per person per annum while urban households consumed 12.4 kg. Mustard oil was the most preferred in North and East India, followed by sunflower oil. Sunflower oil was the most popular oil in the Southern zone, followed by groundnut oil. Total per capita consumption of oil, including other purposes, was 14.43 kg per annum.

Cardiovascular diseases (CVDs) are a group of disorders that affect the heart and blood vessels. They include various conditions such as coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, and deep vein thrombosis and pulmonary embolism.

Coronary heart disease is a condition that affects the blood vessels that supply the heart muscles, while cerebrovascular disease affects the blood vessels that supply the brain. Peripheral arterial disease affects the blood vessels that supply the arms and legs. Rheumatic heart disease is caused by streptococcal bacteria, which can damage the heart muscles and heart valves. Congenital heart disease is caused by birth defects that affect the normal development and functioning of the heart. Deep vein thrombosis and pulmonary embolism are caused by blood clots in the leg veins that can move to the heart and lungs.

Heart attacks and strokes are acute events that can be caused by a blockage in the blood vessels that supply the heart or brain. The most common cause of this blockage is a build-up of fatty deposits on the inner walls of the blood vessels. Strokes can also be caused by bleeding from a blood vessel in the brain or from blood clots.

**SCENARIO OF VEGETABLE OIL CONSUMPTION AND CVD: -**

According to the World Heart Federation's World Heart Report 2023, Cardiovascular diseases (CVDs) have been the primary cause of death worldwide for several decades. In 2021, 20.5 million people died due to CVDs, which accounted for approximately one-third of all global deaths. This figure is a significant increase from the 12.1 million CVD deaths recorded in 1990. Ischemic heart disease has become the leading cause of premature death in 146 countries for men and 98 countries for women.

It has been projected that by 2030, cardiovascular disease (CVD) will be responsible for more than 23 million deaths worldwide (Amini et al., 2021). In 2016, CVD accounted for one-third of all deaths recorded in the USA (Benjamin et al., 2019) and a quarter of all mortality in India (Prabhakaran et al., 2016). CVD is even more concerning in developing countries where two-thirds of patients succumb to the disease (Cappuccio and Miller, 2016).

cardiovascular diseases (CVDs) are conditions that affect the heart or blood vessels, and they can be caused by a combination of various risk factors such as socio-economic, metabolic, behavioral, and environmental. These risk factors can include high blood pressure, an unhealthy diet, high cholesterol, diabetes, air pollution, obesity, tobacco use, kidney disease, physical inactivity, harmful use of alcohol, and stress.

The prevalence of cardiovascular diseases (CVD) is expected to rise due to the increase in risk factors such as dyslipidemia, hyperglycemia, insulin resistance, hypertension, and inflammation. Therefore, it is crucial to implement effective practical strategies to reduce the impact of CVD risk factors and lessen the burden on healthcare systems. Lifestyle and behavioral modifications, which include healthy eating habits, physical activity, and psychosocial factors, have a significant impact on CVD mortality, morbidity, and progression. It is widely recommended to replace saturated fats with unsaturated fats, such as monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs), as a dietary modification to lower the risk of cardiovascular disease (CVD). Plant-based oils have been observed to be protective against CVD. MUFAs can lower blood lipids and lipoproteins, improve glycemic control, and reduce blood pressure. Thus, MUFAs are inversely associated with several CVD risk factors beyond plasma lipids and lipoproteins alone. In addition to this, plant-based n-3 fatty acids, such as α-linolenic acid (ALA), which is a precursor for long-chain n-3 PUFAs, have been supported by both observational and randomized controlled trials.

Canola oil (CO) is commonly considered a healthy plant oil due to its high content of monounsaturated fatty acids (MUFAs) and alpha-linolenic acid (ALA), which can lead to higher levels of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in humans. While several studies have reported positive effects of CO on blood lipids, insulin sensitivity, fasting blood sugar (FBS), and blood pressure (BP), others have shown no effect on these markers. CO has also been compared to other dietary oils, such as olive oil, sunflower oil, saturated fats, and soybean oil, with mixed results.

A recent meta-analysis found that compared to sunflower oil and saturated fats, CO decreased serum total cholesterol (TC) and low-density lipoprotein (LDL), with no effect on other blood lipids. However, some methodological concerns were raised as several potentially relevant trials were excluded from the analysis, no dose-response analysis was conducted, and important cardiovascular disease (CVD) risk markers such as glycemic indices and blood pressure were not analyzed. Therefore, we conducted a comprehensive systematic review to investigate the impact of CO on blood lipids, Apo lipoproteins, glycemic indices, and blood pressure compared to other oils in adults. We also performed meta-analyses to determine the overall effects of CO and examined the dose-response curves.

Coconut oil is popular for its supposed health benefits but contains 90% saturated fat, which dietary guidelines suggest limiting. Arguments in favor of consuming coconut fat include its medium-chain fatty acids (MCFAs) that provide energy through beta-oxidation. However, lauric acid, which makes up half of coconut oil's fatty acids, may not act as other MCFAs. Clinical trials show mixed results for coconut oil's effect on lipid profiles, but it has been suggested to reduce inflammation, improve glucose homeostasis, and lower body fatness.

Dietary patterns with healthy sources of fats, high in unsaturated fat and low in saturated fats, are recommended for preventing CVD. Olive oil is high in monounsaturated fat and other minor components with anti-inflammatory and antioxidant properties. Studies have shown that olive oil consumption is inversely associated with CVD and all-cause death. A Mediterranean diet supplemented with extra-virgin olive oil has been found to reduce the risk of CVD events. A recent U.S. study examined the association between olive oil consumption and CVD risk, replacing other fats with olive oil.

Apparently, in animal studies suggest that 52.17% of them support the idea that consuming Palm Oil (PO) increases the risk of Cardiovascular Disease (CVD). This is because of the saturated nature of the oil which can lead to hypercholesterolemia and further cause CVD. Additionally, PO consumption may cause fatty liver, narrowing of blood vessels, thickening of the aorta of the heart, and may lead to non-alcoholic steatohepatitis, a severe condition that can eventually result in cirrhosis, all of which can increase the risk of CVD. On theother hand, 47.83% of animal studies refute the claim that POconsumption is associated with CVD risk. Based on human studies 45.45% support the claim while 54.55% refute it. Consuming palm oil has been linked to high levels of cholesterol, which can increase the risk of cardiovascular disease (CVD). However, no study has conclusively proven a direct relationship between palm oil consumption and CVD. Additionally, repeatedly heating palm oil, such as when deep-frying, may cause oxidative stress that can further increase the risk of CVD.

LDL-cholesterol, HDL-cholesterol, and TAG have long been identified as risk factors for cardiovascular diseases, especially IHD (myocardial infarction being the most important one). Several studies have positively correlated LDLcholesterol with cardiovascular disease, leading to the emergence of new drugs, namely statins and fibrates. Even in the food industry, LDL-cholesterol has become a new target for “health products” with the use of vegetable sterols and stanols in margarines or yogurts.

Recent studies have shown that elevated TAG and low HDL-cholesterol are independent risk factors for IHD with opposite signs. LDL-cholesterol level raised by 10% increases IHD risk by 15%, while a similar raise of 10% in TAG enhances the risk by 7%, and a decrease of 10% of HDL-cholesterol raises the risk by 13%.

Numerous studies have shown that vegetable oils have many health benefits due to their antioxidant properties. They can boost the body and cellular antioxidant defense system, scavenge free radicals, prevent lipid peroxidation, reduce inflammation, and protect the cardiovascular system from various harmful effects. However, consuming vegetable oils in an improper manner can be linked to the development of cardiovascular disease (CVD). Despite this, many people still use repeatedly heated oil for deep frying due to its cost-effectiveness. During deep frying, a series of physical and chemical reactions occur, producing various oxidation by-products that affect the quality of the oil. Consuming these oils can generate free radicals that may lead to harmful effects on the cardiovascular system by increasing blood pressure, causing endothelial dysfunction, and vascular inflammation. This eventually leads to the formation of atherosclerotic plaque in the arteries. (1-14)

 **PALM OIL AND ITS EFFECT ON DEVELOPING CVD: -**

The fruit of the palm tree (Elaeis guineensis) yields palm oil, which has a balanced composition of unsaturated and saturated fatty acids: 40% acid oleic(monounsaturated fatty acid), 10% polyunsaturated fatty acid linoleic acid, 45% palmitic acid, and 5% saturated fatty acid stearic acid. Margarine, shortening, Vanaspati, frying fats, and confectionery fats are among products that frequently contain palm oil. Of all the major oilseed crops, palm treefruit provides the greatest percentage (32%) of the world and total output yet occupies the leastamount of land used for oil and fat production (5.5%). Because of these benefits, palm oil is now the most popular vegetable oil worldwide. PO and palm kernel oil (PKO) are the two different oils that are extracted from the fruits of the oil palm tree. Rich in palmitic acid, crude palm oil (CPO) is the main oil extracted from the meaty orange-red mesocarp of oil palm fruits. To create the liquid fraction of palm olein and the solid fraction of palm stearin, the edible CPO, which is in a semi-sold form at room temperature, is refined &amp; fractionated.Cooking oil is often bottled from palm olein that is fully liquid at room temperature. However, the solid form of palm stearin is frequently utilized to make shortening, margarine, and vegetable ghee. (1) This review examined the relationship between palm oil consumption and cardiovascular disease (CVD) outcomes, alongside the impact of related dietary factors. It found that while palmitic acid, a component of palm oil, showed a potential association with increased risk of myocardial infarction (MI), the overall evidence regarding palm oil and CVD risk was inconclusive. Various studies explored different aspects, such as total saturated fatty acid (SFA) intake, fried food consumption, and the use of palm oil in cooking. However, the findings were not consistently significant, and the evidence was deemed very low in quality. Some associations were observed, the overall picture regarding palm oil& and role in CVD risk is uncertain. Thus, promoting a balanced and healthy diet remains crucial for maintaining good cardiovascular health. (2) According to a survey, 52.17% of respondents agree that PO intake is linked to CVD, which has been linked to the substance and saturated nature. Reports state that consuming PO caused hypercholesterolemia because to its saturated nature, which could lead to CVD. Additionally, PO intake may result in fatty liver, constriction of blood vessels, thickening of the heart and aorta, and non-alcoholic steatohepatitis, a dangerous condition that raises the risk of CVD and can develop to severe cirrhosis. However, 47.83% of respondents dispute the idea that using PO does not increase the risk of CVD. 45.45% and 54.55% of human research, respectively, substantiate and dispute the propositions that PO is linked to CVD. (15-17)

TABLE 1.

**REPEATEDLY HEATED VEGETABLE OIL AND DEVELOPING CVD**

Cardiovascular disease (CVD) is the number one leading disease which causes morbidity andmortality worldwide. The improper consumption of dietary vegetable oils is highly linked tothe pathogenesis of CVD. The practice of using repeatedly heated oil is common among thepopulations due to its cost-effectiveness. Consumption of these oils generates free radicalsthat may cause potentially harmful and detrimental effect on CVS through the accumulationof total cholesterol (TC), triglycerides (TG) causing an increase in blood pressure, endothelialdysfunction, and vascular inflammation. It eventually leads to atherosclerotic plaque in thearteries. (2)It has been common practice to use repeatedly heated cooking oil (RHCO) without beingaware of its potential risks. Current studies showed that when edible oils are heated to theirboiling temperatures, free radicals are produced, which lead to oxidative stress and damageto molecules and cells. Animals that were given hot oil three times over showed notabledamage to their liver, colon, and jejunum upon histopathological examination. An adaptiveresponse to oxidative stress is reflected in the altered antioxidant level. Changes in theseenzyme levels could be caused by the oxidation of electrophilic components inside RHCO via Nenzyme-catalysed oxidation or auto-oxidation, which produces reactive oxygen species(ROS). The blood samples from the repeatedly heated cooking oil group showed decreasedlevels of protein and albumin and increased levels of glucose, creatinine, and cholesterol.There was no statistically significant difference found in hematological parametersbetween the control and treatment groups. The present study findings verify that cookingoil thermal oxidation produces free radicals, and eating such oil has a negative impact onone health. (18,19)

**OLIVE OIL IS SAFE FOR CVD: -**

Olive oil is an another source of fat, which is good for human health. Olive oil is classified into two varieties based on its production mechanism: extra virgin olive oil (EVOO) and refined olive oil (ROO). EVOO is produced directly from olives, the fruit of *Olea Europea*, through mechanical extraction, which involves crushing and pressing the olives. On the other hand, ROO is sensitive to chemical extraction techniques such as refining, which removes the majority of the small components. The derived benefits of olive oil consumption are primarily due to its high MUFA content. However, few research has been undertaken on the potential function of minor components and the differences between EVOO and ROO**.** The properties of olive oil components are directly related to the degree of ripeness of the fruit and the region of growth (olives grown in colder climates appear to have a greater MUFA concentration. Olive oil is made up of 99% glycerin fraction and 0.5% non-glycerin fraction (Figure 4 [50]). Among the MUFA components, oleic acid is the most represented (70-80% of the total), responsible for numerous good health effects, such as a decrease in CVD, neurological disorders, and cancer. Olive oil includes monounsaturated fats, antioxidant phenols, and other micronutrients that promote cardiovascular health by reducing oxidative stress, endothelial dysfunction, inflammation, thrombosis, blood pressure, and lipid and carbohydrate metabolism. Consuming olive oil, particularly extra virgin olive oil, which is high in phenolic antioxidants, appears to help against coronary heart disease. The Coronary Diet Intervention with Olive Oil and Cardiovascular Prevention (CORDIOPREV research) is an ongoing study that aims to determine how a TMD rich in extra virgin olive oil, compared to a low-fat diet, affects the composite incidence of cardiovascular events in people with CHD after seven years. Consuming olive oil has been linked to a slower progression of atherosclerosis.(20)

**MUSTARD OIL IS PARTIALLY SAFE FOR CVD: -**

Mustard oil is safe partially because it is rich in monounsaturated fatty acid, omega-3-fatty acid and alpha-linolenic acid, all these plays an important role in the management of inflammation and oxidative stress. Cold press mustard is safe. It has a low amount of saturated fatty acids and poly unsaturated fatty acids. The alpha linolenic acid reduces the adhesion aggregation tendency of blood platelets which decreases the risk of heart attack. Mustard oil also contains a phytochemical compound allyl isothiocyanate which has an anti-inflammatory effect. All these help in increasing good cholesterol and decrease bad cholesterol. Mustard oil does not contain no trans-fat for this it does not turn rancid and not produce free radicals. But mustard oil is not used worldwide, because outside India there is too much controversy for the presence of erusic acid, which is present in mustard oil. Different research shows that excess consumption of mustard oil increase bad cholesterol level which is not heart healthy.

**RICE BRAN OIL IS SAFE FOR CVD: -**

Rice bran oil is derived by cold pressing the hard outer coating of rice grains known as the husk or chaff. It is used as a cooking oil in India, Bangladesh, and several Southeast Asian countries like Indonesia, Japan, and Malaysia. It has a high smoke point; therefore, it can be used to fry food. It has a lovely flavor, making it perfect as a salad oil. Rice bran oil contains significant quantities of vitamin E. Rice bran oil contains phytosterols or oryzanol components, which inhibit cholesterol absorption and lower LDL, or low-density lipoproteins, sometimes known as bad cholesterol. It also raises HDL, or good cholesterol, which improves heart health. The American Heart Association promotes rice bran oil as a heart-healthy vegetable oil that can be used to replace cooking oils high in saturated fats, which are known to cause cardiovascular disease.(21)

**CONCLUSION: -**

Vegetable oil is mandatory food ingredient in regular cooking. Different oil is available in market but many of them are not heart healthy because trans-fat are present in these and sometimes many oils are adulterated with mineral oil & seeds. All these are not safe for consumption. So, heart healthy cooking oil is important for better health. So, many doctor and dietitian recommended rice bran oil, olive oil and mustard oil.

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