

## Prophylactic Role of Dietary Fixed Oils and Fats: A Review

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### ABSTRACT

Fixed oils and fats are integral and essential parts of normal human diet since time immemorial. These are linked to normal physiological functioning as well as to the etiology of diseases; and on the other hand, their dietary prophylaxis. Consumption of fats and oils along with other life-style factors has been attributed to the pathogenesis of several disease conditions. Dietary supplementation of some health beneficial fixed oils and fats and avoiding certain deleterious ones can definitely prevent the occurrence of disease conditions and may improve the existing disease conditions. The present review attempts to furnish the contemporary scientific views in this context.

**Key words:** Fixed oils, polyunsaturated fatty acids, cholesterol, atherosclerosis, obesity.

### INTRODUCTION

The fixed oils and fats consumed in diet are of animal and plant origin. They are mainly triglycerides of different fatty acids with minor amounts of phospholipids, glycolipids, free sterols, sterol esters along with several minor components. Fixed oils and fats are an essential part of the human life for the following reasons: They are the most efficient source of energy. Fats are the richest source of energy on a weight basis and excess of fat beyond that required for daily energy requirements is laid down as reserve depot fat, usually after some chemical modification. They are a source of many biologically active compounds and they contain important acids (essential fatty acids, EFA) which animals need but cannot bio-synthesize and must obtain from natural sources. They serve as carriers of important minor components such as

fat soluble vitamins, nutrients and sterols. Finally fats and oils impart palatability to our food and contribute taste.

However, fixed oils and fats have a very negative image at the present time regarding health issues and it needs rectification. Fat is an essential part of the diet and is linked to good health as well as to disease. It is important to optimize the quality and the quantity of fat consumed in relation to other aspects of lifestyle. This implies that we should know what fats we should consume and in what quantity.

Some of the important disease states that are considered as having a connection to dietary fats and oils are briefly addressed in the present review. These currently include various forms of vascular disease (both cardiovascular and cerebrovascular), several cancers, diabetes, obesity, immune dysfunction, and mental illness (schizophrenia and depression). There are also a number of genetic disorders, which involve lipids, and a few of these are tied to dietary fats. Based on the recent research, the important physiological issues of dietary fixed oils and fats related to health and disease prevention are

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specifically discussed in the present review, briefly emphasizing the disease conditions involved.

### **ATHEROSCLEROSIS (CORONARY HEART DISEASE)**

Cardiovascular disease (CVD) is a broad term embracing diseases of the blood vessels of the heart, brain (cerebrovascular disease, stroke) and the limbs (peripheral vascular disease). CVD is usually a culmination of atherosclerosis (accumulation of material – plaque, in the walls of arteries of cells comprising connective tissue, lipids, calcium and debris resulting from cellular breakdown) and thrombosis. [1]

Coronary heart disease (CHD) is a major cause of death in the developed world with a peak age of death, but its too-common occurrence at an earlier stage in life is of greater concern. There are three stages in the development of CHD. Initial arterial injury leads to deposition of lipid and cell material (atherosclerosis) and to small blood clots (thromb) which contribute to the build up of fibrous plaque. Finally, instability of the plaque triggers formation of a major blood clot (thrombus) in the already-narrowed artery. This gives the potential for the blood (and oxygen) supply to the heart muscle to be blocked completely leading to myocardial infarction (heart attack). More simply, the three stages are: injury of coronary arteries, fibrous plaque formation and thrombosis leading to heart attack or stroke. The following have been recognized as risk factors: high blood pressure, high levels of plasma LDL (low density lipoprotein) cholesterol, low levels of plasma HDL (high density lipoprotein) cholesterol, high levels of plasma fibrinogen and low levels of plasma antioxidants.

These risk factors are linked to a range of controllable and uncontrollable factors. The uncontrollable factors are family history, being male, advancing age, racial origin (Asians show higher rates of incidence than white Caucasians) and possibly low birth weight. Controllable factors include smoking, exercise (lack of), stress and diet. Serum cholesterol level should be below 230 mg/ 100 ml but low cholesterol levels (below ~160/180mg/ml) are also undesirable. [2, 3]

The lipid hypothesis in respect of CHD is concerned with the relationship of blood cholesterol and saturated fatty acids (SFA) with CHD mortality. Diets with a high content of fat/SFA/cholesterol lead to high concentrations of total cholesterol in the blood and especially of LDL-cholesterol which results in a high morbidity and mortality from CHD. However, reducing the amount of fat/SFA/cholesterol in the diet reduces the concentration of cholesterol in the blood and especially in the LDL. This results in a lower risk of CHD and eventually a fall in morbidity and mortality. There is also, however, some concern how far reduced CHD mortality is linked to dietary changes and how far it is related to improved methods of treatment which reduce mortality levels. [4]

Atherosclerosis (or coronary heart disease) and a causative relationship between dietary fats, oils, and cholesterol has been the object of much research and conjecture for more than four decades. It has been established that: 1) the consumption of natural saturated fats and oils was causing heart disease; 2) that the consumption of polyunsaturated fixed oils would cure and prevent heart disease; and, further, 3)

that the consumption of cholesterol-containing foods was also a causative factor.

Therefore, saturated fats and cholesterol are the major culprits of coronary heart diseases, although there are several other known and unknown factors. The research shows that a rise in saturated fatty acids leads to a rise in cholesterol levels, whereas the polyunsaturated acids have the opposite effect and that monounsaturated acids were considered to be neutral. They help to reduce cholesterol formation and/or deposition hence prevents risks of atherosclerosis and ischaemic heart diseases. [5]

One study of CHD concludes that fats in the diet should not exceed 33 energy per cent with saturated acids (10%), polyunsaturated fatty acids (6 per cent and not exceeding 10%), monounsaturated fatty acids (12%) and *trans* fatty acids (<2%) at the levels indicated. The evidence for a beneficial role for long-chain n-3 polyunsaturated fatty acids is becoming stronger, especially for secondary prevention. Intakes of 800-1000 mg/day are considered to be prudent for those at risk of a secondary attack. At the same time, high intake of linoleic acid should be discouraged because of its antagonistic effect on the incorporation of n-3 acids into membranes. The minimum that can be claimed is that consumption of long chain n-3 acids may reduce the risk of CHD. [6]

### CEREBROVASCULAR DISEASES

Cerebrovascular disease has also been touted to be the result of too much saturated fat in the diet. Nonetheless, the research has been showing that those with higher intakes of polyunsaturated fats have been more likely to have strokes, and the

more saturated fats are protective. The research has also reported that older individuals with serum cholesterol below 200 mg/dL percent are at greater risk for stroke. [7]

### DIABETES MELLITUS

Diabetes mellitus is a chronic disease in which the metabolism of sugars (and of fats and proteins) is disturbed by lack of or by decreased activity of the hormone insulin, produced by the endocrine part of the pancreas. Type 1 diabetes, representing only about 15 per cent of cases, is found particularly in children, adolescents and young adults. It results from auto-immune destruction of the insulin-secreting cells of the pancreas. Production of insulin declines and eventually ceases. However, most diabetic individuals (85%) have type 2 diabetes. Two dysfunctions are involved: decreased insulin secretion after a glucose challenge and a decrease in its activity on target organs (liver and muscles). This is called insulin resistance. Obesity is a major pre-disposing factor of this type of diabetes which is largely determined by genetic factors. The metabolic consequences of this defect may not be apparent until the appearance of chronic complications. [2]

Many clinicians believe that diabetes is made worse by saturated fats. This consensus appears to be based on the prevailing attitude about causes of heart disease. Research has shown that dietary *trans* fatty acids have adverse effects in diabetes, including interference with insulin binding. There is no proven mechanism for any adverse effect from consumption of saturated fatty acids. [8]

It is known that the various desaturases involved in the conversion of C<sub>18</sub> polyunsaturated fatty

acids to the important acids of longer chain length such as AA, EPA, and DHA are decreased in diabetic patients. As a consequence, the phospholipids in tissue lipids contain more saturated and monounsaturated acids and less long chain PUFA, especially AA. This, in turn, affects membrane fluidity and eicosanoid production. [3]

People who have poor control of their diabetes are very susceptible to the potentially damaging effects of oxidized lipids. When polyunsaturated fats and oils are not carefully protected, the levels of oxidized lipids are increased. Diabetics should avoid oxidized fixed oils and fats. [9]

### INFLAMMATORY DISEASES

Inflammation is characterized by swelling, redness, pain and heat in localized areas of the body. These symptoms result from a series of interactions between cells of the target tissue, cells of the immune system, and their products such as eicosanoids, cytokines, immunoglobulins and blood components. [1]

The eicosanoids (prostaglandins, leukotrienes, hydroxy and hydroperoxy fatty acids and molecules such as platelet activating factor or PAF) are all regulators of inflammation affecting vascular permeability, vasodilation and vasoconstriction, platelet aggregation and deaggregation, further eicosanoid synthesis and serve as chemotactic agents. Dietary oils and fats modulate inflammation and influence the course of diseases such as arthritis, psoriasis, asthma, and inflammatory bowel disease mainly through changing the production of eicosanoids particularly by macrophages and neutrophils. [3, 8]

Inflammation is a component of a range of acute and chronic human diseases characterized by the production of inflammatory cytokines, arachidonic acid-derived eicosanoids, inflammatory mediators such as platelet activating factor, and adhesion molecules. Polyunsaturated fatty acids of the n-3 series act directly by inhibiting arachidonic acid metabolism and indirectly by altering the expression of inflammatory genes. They are considered to be of therapeutic value for a variety of acute and chronic inflammatory conditions. But the appropriate balance between n-6 and n-3 acids may differ at different parts of the life cycle such as early development and aging and has yet to be determined. [10]

Coconut oil and fish oil decrease pro-inflammatory cytokines (TNF- $\alpha$ , IL-1 $\beta$ , IL-6) relative to omega-6 fixed oils. Research suggests that these oils might be useful as therapies in acute and chronic inflammatory disease. The enhanced production of IL-10 by coconut oil shows an additional anti-inflammatory effect. [11]

### CANCER

The possibility of a link between cancer and dietary fat has received intensive study but no consensus has emerged. Such studies are complicated by the fact that cancers in different organs may react differently to dietary fats.

Gamma-linolenic acid (GLA) from sources such as borage oil, and eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) from sources such as fish oil can enhance the effectiveness of radiation treatment against malignant cells and are protective of normal cells. [12, 13] Dietary supplementation of conjugated linoleic acid has

been shown to reduce the number and size of mammary tumours.

### IMMUNOLOGICAL DYSFUNCTIONS

Immune dysfunction has been recognized as related to an inappropriate balance of fatty acids. Lipids are considered important nutrients in the regulation of immune function. Diets high in omega-6-fatty acids (PUFA) and diets high in partially hydrogenated vegetable fats have been reported to adversely alter immune function. On the other hand, diets high in coconut oil or fish oil have been reported to improve immune response by decreasing pro-inflammatory cytokines. It has been claimed that in animals, conjugated linoleic acid influences the immune function and has an effect on bone re-modeling. [14]

### PSYCHIATRIC DISORDERS

In view of the importance of phospholipids in human brain and their component fatty acids it is not surprising that the relation between dietary lipids and psychiatric disorders such as schizophrenia and depression have been investigated. Schizophrenic patients are known to have lower levels of polyunsaturated fatty acids (especially linoleic and arachidonic) in their brain phospholipids. This may be the consequence of increased phospholipid hydrolysis and/or decreased incorporation. [9]

Mental illness has recently been connected to inadequate omega-3 fatty acid consumption or to inappropriate processing of alpha-linolenic acid to the longer-chain omega-3 fatty acids such as docosahexaenoic acid and eicosapentaenoic acid. Problems such as attention deficit disorders (ADD) and attention deficit hyperactivity disorders (ADHD) have been studied in

relationship to essential fatty acid deficiency and adverse effects of the partially hydrogenated plant derived fixed oils and fats. [6]

### OBESITY

Obesity is a major health problem, especially in developed countries, the cause of which is currently under intense investigation. In the United States, nearly two thirds of the population is overweight or obese and almost 40 per cent are clinically obese. Concern is growing about the increase of obesity in children and adolescents. In tackling this problem, attention is focused on fat because it is the most energy-producing nutrients.

Because of the unusual emphasis today on fats and oils, some people hold the misconception that all fat storage in the body is unnecessary. This is unfortunate because the normal amount of depot fat varies from one person to another, and preoccupation with those fat deposits that are genetically determined can only be counterproductive. The person who has lost a major portion of fat padding due to illness or excessive exercise may have great difficulty sitting or lying on hard surfaces. The internal organs are supported and cushioned by the internal fat padding. A normal amount of fat under the surface of the outer skin keeps that organ from sagging and wrinkling by providing necessary support for the tissues. The fat layer also prevents undue dehydration of the skin. [2]

Although obesity is an abnormal accumulation of fat cells and triglycerides, the exact reasons for this accumulation, beyond what is caused by the simple consumption of excess calories, are not known with any certainty. The problem of obesity is now regarded as partly genetic and

partly environmental (food intake and physical inactivity). Attention is often focused on long hours spent watching TV where physical inactivity is often accompanied by poor eating habits. There have been reports in the scientific literature that individuals who consume diets high in partially hydrogenated fats tend to gain more weight for the same caloric intake. It has been noted that saturated fatty acids in the adipose and in other cell membranes pack more densely than the unsaturated fatty acids (i.e., fixed oils from plants). Obesity has close relationship with cardiovascular disease risk and diabetes mellitus. [15]

There are factors other than dietary fat that are important in obesity and attention has been drawn to the beneficial role of dietary calcium in the partitioning of dietary energy, resulting in reduction in body fat and acceleration of weight loss and fat loss during periods of energy restriction. Dairy sources of calcium exert substantially greater effects than supplemental or fortified sources of calcium. This is considered to have important implications in the prevention of pediatric and adult obesity particularly in the light of the marginal calcium intakes exhibited by the majority of the population. [15]

## PREGNANCY AND LACTATION

Pregnant and lactating women have numerous requirement for additional nutrients during the period of pregnancy and while they are nursing their infant(s). In addition to the obvious need for additional energy from fats and carbohydrates, as well as the need for adequate protein, vitamins and minerals, there is a requirement for additional special fats and oils. This is because there is the need to include more adequate

omega-3 and omega-6 essential fatty acid sources. Recently, novel sources of long chain PUFA have been developed from algae and microalgae and can be incorporated into infant formulations at levels similar to those in breast milk. This is particularly important for pre-term infants. [16]

Infants need cholesterol for proper brain development. Large amounts of cholesterol are supplied to the infant in human milk. Also the mammary gland secretes a special enzyme into the human milk that ensures that almost all of the cholesterol will be absorbed by the infant. Whole cows milk, also supplies about the same amount of cholesterol.

Recent research demonstrates that the *trans* fatty acids have an undesirable effect on the birth weight of the infant. It was observed that the *trans* fatty acids consumed by the lactating mother go directly into her milk at levels up to 18 percent of the total milk fat, and the *trans* fatty acids in human milk were found to correlate significantly with decreased visual acuity in the infants. This shows quite clearly that *trans* fatty acid-containing products should be avoided by lactating women. [17] Fortunately, *trans* fatty acids are not present in normally occurring fixed oils form plant source.

## CONCLUSION

Fixed oils and fats are essential part of the normal diet and are linked to good health as well as to the etiology of diseases and their dietary prophylaxis. It is important to optimize the quality and the quantity of fat consumed in relation to other aspects of lifestyle. Table 1 shows fatty acids that are natural and beneficial to the human body. However, it is worthwhile to

realize that fat is only part of our diet and that diet is only part of the problem. Therefore, it is inadvisable to focus on a single issue and ignore other etiologic factors. There are several diseases which are related in some part to life-style, of which diet, pollution of the environment, and levels of physical activity are important factors. Dietary supplementation of some beneficial fixed oils and avoiding certain deleterious ones can definitely prevent the disease conditions, may improve the existing disease conditions but can not afford complete cure from these disease states. Their prophylactic recommendations are also variable, depending on multiple factors stated above. The present scientific views in this context may have to be modified in the light of new and further research.

**Table 1: Fatty acids natural and beneficial to the human body**

Saturated fatty acid	Monounsaturated fatty acids	Polyunsaturated fatty acids
** palmitic acid	** palmitoleic acid	* linoleic acid
** stearic acid	** oleic acid	* $\alpha$ -linolenic acid
** myristic acid		** $\gamma$ -linolenic acid
*** lauric acid		** arachidonic acid
		** eicosapentaenoic acid
		** docosahexaenoic acid

\* These fatty acids are used and needed by the body, but they are not made by the body; they are called essential fatty acids.

\*\* These fatty acids are used and needed by the body and they are made by the body.

\*\*\* This fatty acid is made by certain parts of the body such as the lactating mammary gland, but it must come from the diet so it is a conditionally essential fatty acid.

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