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Nutritional and Health Effects of Dietary Fats

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Abstract: In the 80's and early 90's, nutrition recommendations for the prevention of developing coronary heart disease called for a reduction of total fat in the diet through the substitution of carbohydrate for fat. However, the current scientific evidence does not support a position that a reduction in total fat has a beneficial effect on coronary heart disease, or risk factors for coronary heart disease. The cumulative evidence from recent scientific literature suggests that unless there is a concomitant reduction in saturated fat and *trans* fatty acids, a reduction in total fat will not lower the risk of developing coronary heart disease. It was also established during the last decade that increased intakes of dietary monounsaturated and polyunsaturated fats, in particular those fats containing moderate amounts of n-3 fatty acids, might play a role in reducing the risk of cardiovascular disease. The fatty acid composition of canola oil is consistent with current nutrition recommendations aimed at reducing the dietary amount of saturated fat and increasing the amounts of monounsaturated and n-3 fats. Canola is characterized by a low level of saturated fatty acids. It is also characterized by high level of monounsaturated fatty acids (viz. oleic acid) and moderate level of n-3 fatty acids, in the form of "-linolenic acid. Clinical and epidemiological studies have shown that canola oil is one of the most desirable source of dietary fat in terms of human health.

Key words: Canola oil, cholesterol, dietary fats, linolenic acid, monounsaturated fatty acids

Introduction

Dietary fat composition is the primary determinant of serum total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides, which are the main blood lipid risk factors for cardiovascular disease. It is well known that saturated fatty acids (especially lauric, myristic and palmitic) elevate serum cholesterol, and conversely, dietary polyunsaturated fatty acids (especially linoleic acid) lower serum cholesterol (Grundy, 1994). High fat diets, regardless of their fatty acid composition, were considered hypercholesterolemic compared to low fat diets. However, there is very little scientific evidence supporting an association between total fat intake and serum cholesterol and the etiology of heart disease (Barr *et al*., 1992; Oliver, 1997). In general, favourable serum lipid profile attributed to lower fat intake have been confounded by accompanying reduction in saturated fat intake. Barr *et al*. (1992), for example, in a cross over study involving 48 subjects, found that reducing total fat from 37% of energy to 30% of energy had no effect on plasma total or LDL-cholesterol levels unless it was accompanied by a reduction in saturated fatty acids. Nelson *et al*. (1995) tested two fat levels (22 and 39% of calories) in 11 healthy subjects, and reported that higher fat may not raise blood cholesterol. More recently, Gilani *et al*. (2002) investigated the influence of three dietary levels (5, 10 and 20% by weight) of soybean oil (mainly an unsaturated fat) and of a 4:1 mixture of coconut oil (a saturated fat) and soybean oil on cholesterol metabolism in a rat model. Amount of dietary fat had no effect on serum triacylglycerols and cholesterol and *de novo* fat synthesis and cholesterol kinetics.

The objectives of this manuscript were to focus on some fundamental chemistry and biochemistry aspects of dietary fats and blood lipid risk factors for cardiovascular disease, to highlight the relationship between dietary fats and blood lipid profile, and to compare health effects of commonly used dietary oils with a focus on the health and nutritional beneficial effects of canola oil.

Fatty acids profiles of dietary fats: The nutritional effects and biological properties of dietary fats are primarily related to their component fatty acids which are classified into three broad categories: saturated, monounsaturated and polyunsaturated (Table 1). The most common saturated fatty acids found in vegetable oils and animal fats include lauric, myristic, palmitic and stearic and the most common monounsaturated fatty acid includes oleic acid. Animals and humans have the ability create these fatty acids starting from acetate units derived from carbohydrates and proteins. Another common dietary fat, particularly widespread in the North American diet, is elaidic acid which is the trans isomer of oleic acid. Trans fatty acids are not natural components but are formed during partial hydrogenation of unsaturated oils and are used in the production of margarines and shortenings.

Within the polyunsaturated fatty acids, there are several

Table 1: Common Dietary Fatty Acids of Populations Following a Western Diet

Fatty acid	Formula	Typical intake (g/d)	Some common sources
Saturated fatty acids (SFA)			
Lauric	12:0	2	coconut oil
Myristic	14:0	8	coconut oil, milk fat
Palmitic	16:0	30	milk fat, meat, palm oil
Stearic	18:0	15	meat
Monounsaturated fatty acids			
Oleic	cis-18:1	32	meat, olive oil, canola oil
Elaidic	trans-18:1	6	partially hydrogenated fats
Polyunsaturated fatty acids			
Linoleic	18:2n-6	12	Sunflower oil, corn oil, soybean oil
"-Linolenic	18:3n-3	2	canola oil, soybean oil, green vegetables
Arachidonic	20:4n-6	0.1	meat, eggs
Eicosapentaenoic	20:5n-3	0.3	marine fish
Docosahexaenoic	22:6n-3	0.1	marine fish

Table 2: Risk Factors for Coronary Heart Disease

Non-Modifiable risk factors
Age
Male sex
Family history
Modifiable risk factors
Elevated levels of blood cholesterol, LDL-cholesterol and triglycerides
Low levels of blood HDL-cholesterol
Elevated levels of lipoprotein (a)
Elevated levels of homocysteine
Elevated levels of c-reactive proteins
Low levels of circulating long-chain n-3 fatty acids
Diabetes
Depression
Smoking
Lack of exercise
Obesity

families of which two are of nutritional importance. These are called omega-3 and omega-6 families. The parent fatty acid of the omega-6 family is linoleic acid and that of the omega-3 family is "-linolenic acid. In addition, there are three other important polyunsaturated fats in our diet. One is arachidonic acid, which is also an omega-6 fatty acid like linoleic acid. The other two are eicosapentaenoic acid and docosahexaenoic acids. Both are of the omega-3 family. Fish is the primary source of the long chain omega-3 fatty acids. Just like linoleic and "-linolenic acids, long-chain polyunsaturated fatty acids also play several crucial biological and nutritional roles.

Humans as well as animals have the capacity to convert the two essential fatty acids derived from the diet to a series of longer chain polyunsaturated fatty acids via a biosynthesis process that involves several desaturation and chain-elongation steps (Fig. 1). Linoleic acid is converted to arachidonic acid, which is the nutritionally most important fatty acid of the omega-6 series. In the omega-3 series, eicosapentaenoic and docosahexaenoic acids are the most nutritionally important fatty acids derived from "-linolenic acids. Similar to linoleic and "-linolenic acids, the longer chain (C20 and C22) polyunsaturated fatty acids are also needed to maintain the fluidity of membrane structure, and for growth, especially arachidonic acid, whereas eicosapentaenoic acid retards the growth. Then on the other hand a large amount of docosahexaenoic acid is required for the optimum growth of the brain and the retina of the eye during the early stages of human development.

Risk factors for coronary heart disease: Coronary heart disease (CHD) is the primary cause of death in affluent societies. Currently it accounts for about 54% of total death in Western countries. CHD is a complex disorder; several modifiable and nonmodifiable factors contribute to its development. Among the modifiable factors, high levels of blood cholesterol, in particular LDL cholesterol, constitute a major risk factor in CHD (Table 2). LDL is the major lipoprotein fraction that carries cholesterol in the blood and large levels of LDL-cholesterol in blood lead to arterial cholesterol deposition and consequently blockage of the arteries. If this occurs in the coronary arteries, insufficient oxygen reaches the heart muscle and ischemia results. Increased level of LDL-cholesterol is the most recognized lipid risk factor for CHD. But in recent years lower levels of HDL cholesterol and high levels of triglycerides have also been implicated as risk factors for CHD. HDL particles are involved in reverse cholesterol transport, i.e., HDL particles take cholesterol from peripheral cells and deposit in the liver and from which a portion of cholesterol is put back into the circulation and another portion is excreted after conversion to bile acids.

Table 3: Plasma cholesterol in subjects fed saturated (SFA) or polyunsaturated (PUFA) fat and high or low levels of cholesterol (Data adopted from McNamara *et al*., 1987)

Dietary cholesterol amount (mg/d)	Total plasma cholesterol level (mg/dl)	Plasma LDL-cholesterol:HDL-cholesterol
PUFA Diet (39 subjects)		
250	218	3.12
800	224	3.14
SFA Diet (36 subjects)		
250	243	3.20
800	248	3.26

Table 4: Comparison of the effects of canola oil with other polyunsaturated fatty acid (PUFA) sources of vegetable oils on plasma cholesterol levels of healthy human volunteers

PUFA source	Plasma cholesterol	Baseline value (mmol/l)	% Change after canola diet	% Change after other PUFA diets	Reference
Sunflower	Total cholesterol	4.42	-20	-15	McDonald *et al*. (1989)
	LDL-cholesterol	2.76	-25	-21	
Sunflower	Total cholesterol	5.36	-15	-12	Valsta *et al*. (1992)
	LDL-cholesterol	3.17	-23	-17	
Soybean	Total cholesterol	4.40	-18	-18	Chan *et al.* (1991)
	LDL-cholesterol	2.98	-25	-18	
Safflower	Total cholesterol	5.39	-9	-15	Warlaw *et al*. (1991)
	LDL-cholesterol	3.71	-12	-15	

Table 5: Effects of canola oil, corn oil and olive oil based diets on plasma lipids in hyperlipidemic humans (data adopted from Lichtenstein *et al*., 1993)[1]

Plasma lipid parameter	Baseline value (mg/dl)	Canola oil diet (mg/dl)	Corn oil diet (mg/dl)	Olive oil diet (mg/dl)
Total-cholesterol	221	194	194	205
LDL-cholesterol	152	126	125	132
HDL-cholesterol	48	44	44	46
Triglycerides	107	109	108	112

[1]Study design: 15 subjects consumed a test diet composed of low fat (30% of total energy)-low saturated fat (7% of total energy) made from canola oil, corn oil or olive oil, Test diet provided two-thirds of the dietary fat. Cross over design; each diet fed for 32 d with 1-2 weeks break between each phase.

Association between serum lipid and coronary heart disease: The total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides are collectively called serum (or blood) lipids. Their levels could be modified by the type and amount of fat in the diet. Before discussing the effects of dietary fats on serum lipid profiles, there is a need to provide evidence that demonstrates the association between serum lipid risk factors and coronary heart disease.

During the last 30 years several large interventions studies have provided convincing evidence that higher serum cholesterol levels are associated with increased risk of coronary heart disease. One such study was the Multiple Risk Factor Intervention Trial (MRFIT) of the United States (Stamler *et al*., 1986). This was a very large study which involved more than 356 000 men aged 35 to 57 years at the start of the trial in 1973 and were free of history of myocardial infarction. Their serum cholesterol levels and the death rates were followed for six years. The death due to coronary heart disease was directly proportional to the serum cholesterol levels; i.e., the risk of developing fatal coronary heart disease increased as the serum cholesterol increased (Fig. 2). The study also showed that coronary heart deaths increased with age. It was calculated from the data that a 1% increase in serum cholesterol would increase the risk of death due to coronary heart disease by 2%.

The results of MRFIT and other similar epidemiological studies of the 1970s and 1980s led to studies to determine the benefit of reducing serum cholesterol. In 1994 the results of the Scandinavian Simvastatin Survival Study (4S) gave one of the clearest indicators of the benefits of cholesterol reduction (The Scandinavian Study, 1994). This study involved a total 4444 hypecholesterolemic patients who had a history of myocardial infarction. Half of the patients were treated

Table 6: The Lyon Diet Heart Study: Comparison of the effects of consumption of a Canola Oil Based Cretan Mediterranean Diet[1] and the American Heart Association Step 1 Diet[2] on coronary heart disease events and overall mortality over 27 months follow-up (data adopted from de Lorgeril *et al*., 1994)[3]

Event	American Heart Association Step 1 Diet[2]	Canola Oil Based-Cretan Mediterranean Diet[1]
Coronary heart Disease Deaths	16	3
Non-fatal myocardial infarction	17	5
Non-coronary heart disease deaths	4	5
Overall mortality	20	8

[1]Canola Oil Based Cretan Mediterranean Diet - rich in oleic acid (primary source: olive oil), "-linolenic acid (primary source: canola oil), fruits and vegetables.

[2]American Heart Association Step 1 Diet-Low in total fat (30% of total dietary energy) and saturated fat (10% of total dietary energy).

[3]Study design: Patients (< 70 y) who survived a myocardial infarction within 6 months were provided either the Canola Oil Based Cretan Mediterranean Diet or the American Heart Association Step 1 Diet. Initial design of the study was to follow the cardiac morality and morbidity out come for 5 years. However, the study was terminated after four years, because it was became clear during the course of the study that the Canola Oil Based Mediterranean Diet provides significantly higher cardioprotective effect than the American Heart Association Step 1 diet. The results shown in this Table were after 27 months of follow-up.

Table 7: The Lyon Diet Heart Study: Plasma Fatty Acid Levels (% total plasma fatty acids) After 52 Weeks of Follow-up (data adopted from de Lorgeril *et al*., 1994)[1]

Fatty Acid	American Heart Association Step 1 Diet[1]	Canola Oil Based-Cretan Mediterranean Diet[1]	P value
18:0	7.1	6.6	<0.001
18:1	19.5	21.8	<0.001
18:2n-6	29.3	27.3	<0.002
18:3n-3	0.3	0.6	<0.001
20:4n-6	6.9	6.4	<0.005
20:5n-3	0.8	1	<0.001
22:6n-3	2	2.2	<0.05

[1]For a description of diets and study design see Table 6.

with Simavastin. This belongs to a class of drugs called statin, introduced in the early 1990s. Statins lower serum cholesterol by inhibiting the activity of HMG-CoA reductase, which is a key enzyme involved in the biosynthesis of cholesterol. The other half was given a placebo. The patients were followed for 5.4 years. The treated group achieved and maintained a 25% reduction in total cholesterol, whereas there was no change in the placebo group. This reduction was primarily due to reduction in LDL-cholesterol. The serum lipid changes in the Simavastin group were associated with fewer deaths. 111 deaths or 5% cardiovascular deaths compared to 189 deaths in the placebo group; i.e. a 30% decrease in total mortality compared to the control group. Equally important was the fact that there was no indication of an increase in deaths from other causes. This study clearly demonstrated the benefit of lowering serum total cholesterol level.

Modulation of lipid profiles by dietary fats: It is well established that the dietary fat plays an important role in modulating the lipid profile. This has been known from a large number of human studies. The effects of fat on the lipid profile to a large extent depend on the type of fat. Katan *et al*. (1995) performed meta analysis of data from well-controlled 27 human studies on the effect of dietary fatty acids on plasma lipids. The results of their analysis are summarized in Fig. 3, which correlates the changes in serum lipids and lipoprotein that take place when 1% of dietary energy in the form of carbohydrate is replaced by saturated, mono unsaturated and polyunsaturated fats. Replacement of carbohydrates by any type of fat raises concentrations of HDL-cholesterol, with the effect being more pronounced with increasing saturated fat content in the diet. In addition, increasing fat intakes at the expense of carbohydrates decreases the fasting concentration of triglycerides in blood plasma. All three classes of fat, i.e., saturates, monounsaturates and n-6 polyunsaturated fatty acids all produce this effect to the same extent. In other words, compared to fats, carbohydrates tend to have negative effects on HDL-cholesterol and triglycerides. Effects on LDL-cholesterol and therefore, total cholesterol, however, are markedly different. Saturated fatty acids strongly raise the concentration of total cholesterol, while linoleic acid and monounsaturated fatty acids slightly lower the concentration. In summary, with respect to carbohydrates, saturated fat increases the blood lipid risk factors for CHD whereas monounsaturates and linoleic acid produce a favourable blood lipid profile. Lauric, myristic, palmitic, and stearic are the principal saturated fatty acids in human diets, and are

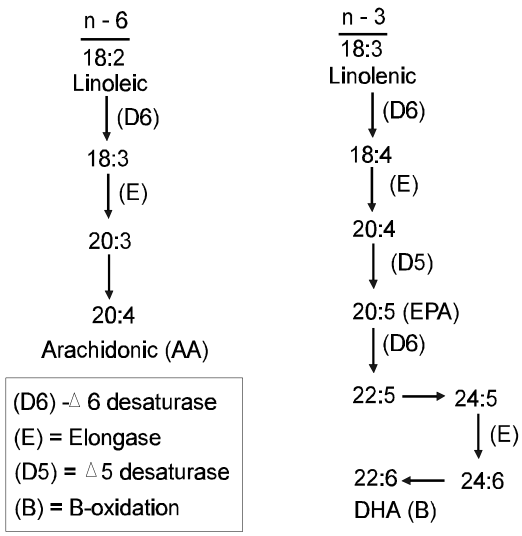


Fig. 1: Metabolism of linoleic and linolenic acids

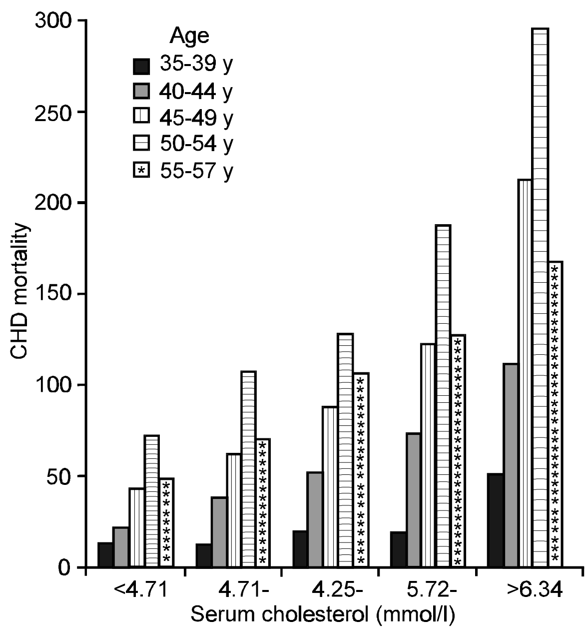


Fig. 2: Multiple risk factor intervention trial: US study of 356 000 men (Stamler *et al*., 1986)

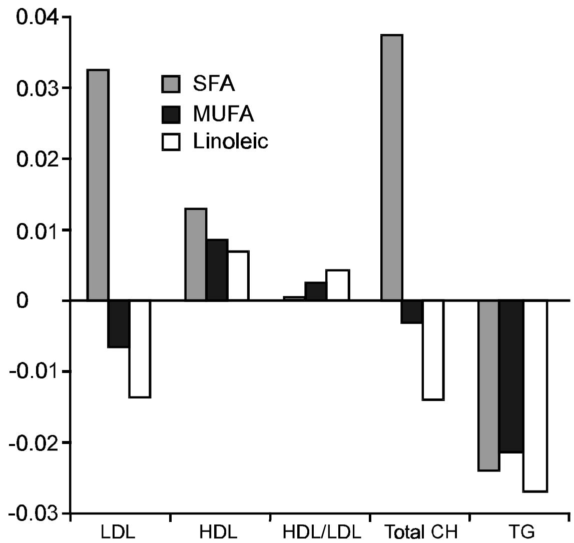
responsible for the cholesterol raising effect of saturated fat (Fig. 4). The relative potential of the individual saturated fatty acids, however, is different from each other. Myristic acid, which is present in large proportions in coconut oil, palm oil, palm kernel and dairy fats, is the most cholesterol raising of all the fatty acids. This is followed by palmitic acid, the major fatty acid in palm oil and lauric acid, which is the major saturated fat in coconut oil. Cholesterol raising ability of myristic acid is about 1.5 times that of palmitic acid. However, half of the effect of myristic acid on total cholesterol was due to its effect on HDL-cholesterol. So that the differences in cholesterol raising potential between lauric, myristic and palmitic acids appear modest. However, all three fatty acids raise LDL-cholesterol compared with unsaturated fatty acids. In contrast to lauric, myristic, and palmitic acid, the other common saturated fatty acid, stearic acid is cholesterol lowering. Its effect is very much close to that of oleic acid, the most common dietary unsaturated fat.

The effect of *trans* fatty acids on the serum lipid profile markedly differs from that of the natural *cis* isomer, oleic acid (Fig. 4). *Trans* isomers have been shown to raise serum total cholesterol and LDL-cholesterol and to decrease HDL-cholesterol. Thus, the overall effect of *trans* fatty acids on the plasma lipid profile is unfavourable.

A continuing area of confusion to the general public is effect of dietary cholesterol on blood lipid risk factors for coronary heart disease. It appears quite logical that eating cholesterol increases plasma cholesterol. As such, many people believe that it is the cholesterol content of meat rather than the saturated fat content is the problem. However, as shown in Table 3, dietary cholesterol probably has only a modest effect on plasma cholesterol levels. In a study by McNamara *et al*. (1987), plasma cholesterol concentrations in volunteers fed diets containing higher amounts of saturated or polyunsaturated fats in combination with low or high amounts of dietary cholesterol were investigated. With both saturated or polyunsaturated diets the dietary amount of cholesterol had no significant influence on serum cholesterol (Table 3). The only increase was associated with saturated fat.

Dietary recommendations on coronary prevention: As summarized above, only saturated fat and *trans* fat have negative effects on the lipid profile whereas unsaturated fats have positive effects. In relation to prevention of cardiovascular diseases, a healthy diet recommended by the Second joint task force of the European and other societies on Coronary Prevention is characterized by: a low intake of saturated fat (less than 10% of energy per day); a low intake of *trans* fatty acids per day (less than 2% of energy per day); at least 4%/d of energy of linoleic acid, 2 g/d of "-linolenic acid and 200 mg/d of very long chain n-3 polyunsaturated fatty acids per day (Wood *et al*., 1998).

Fatty acid composition of some common dietary oils and fats: Fatty acid profile of some of the commonly consumed dietary oils and fats is shown in Fig. 5. Canola oil is unique among all the edible oils; it is characterized by a very low level of saturated fatty acids. The saturated fat content is only 7%, about the half the level present in corn oil, olive oil and soybean oil and



LDL, Low-density lipoprotein cholesterol; HDL, High-density lipoprotein cholesterol; Total CH, Total cholesterol; TG, triglycerides

Fig. 3: Predicted changes in serum lipids when 1% of dietary carbohydrate is replaced by saturated (SFA), monounsaturated (MUFA) or linoleic acid (Katan *et al*., 1995)

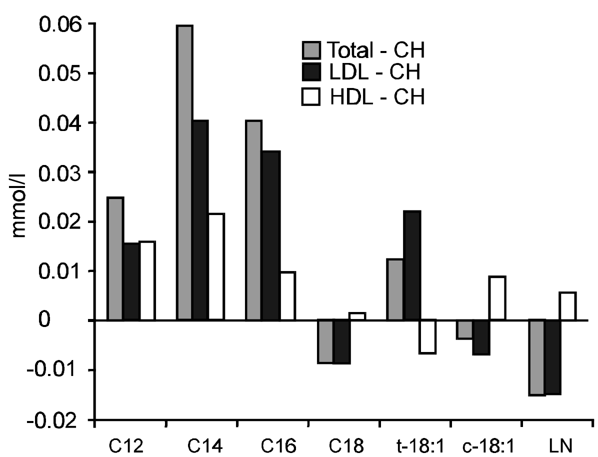


Fig. 4: Predicted changes in serum lipids when 1% of dietary carbohydrates replaced by lauric (C12), myristic (C14), palmitic (C16), stearic (C18), elaidic (t-18:1), oleic (c-18:1) or linoleic (LN) acids (Katan *et al*. 1995)

about 1/4th the level present in cottonseed oil, and about 1/7th the level present in palm oil; the oils most frequently consumed in Pakistan. In addition canola oil has a relatively high level of monounsaturated fatty acids and intermediate levels of polyunsaturated fatty acids with a good balance of between the omega-6 and omega-3 fatty acids. This balance is quite important for maintaining a balance in the production of eicosanoids of the omega-6 and omega-3 fatty acids, which in turn is required to maintain a balance between bleeding and clot formation.

Health effects of canola oil: Because of the lower proportion of saturated fatty acids, canola oil is expected to be more efficient in reducing blood cholesterol than most of the other common dietary oils. In fact this was shown to be the case in studies in Canada, Finland, Sweden and the United States (Table 4). These studies found canola oil more effective than sunflower oil, soybean oil and safflower oil in reducing total and LDL-cholesterol levels in subjects with normal blood lipid levels. All diets resulted in significant decreases in plasma total cholesterol from the levels on the baseline diets. This decrease was due primarily to a decrease in LDL-cholesterol. None of these studies had any effect on plasma HDL cholesterol levels even though PUFA provided 13 to 22% of the total energy intake on the PUFA diets.

Canola oil has also been found effective in reducing the plasma total and LDL cholesterol levels in subjects with elevated blood lipid levels (Lichtenstein *et al*., 1993). In this study canola oil and corn oil were equally effective in lowering plasma total and LDL-cholesterol in subjects fed a low fat, low saturated fat, low cholesterol diet where the test diet provided two-thirds of the dietary fat (Table 5). Olive oil also resulted in a decrease in plasma total and LD- cholesterol but the decrease was less.

Indirect evidence of the safety and the beneficial effect of canola oil in the prevention of coronary heart disease was provided by the Lyon Diet Heart Study (de Lorgeril *et al.*, 1994). This was a well designed long term secondary prevention clinical trial aimed at reducing the risk of cardiovascular deaths by diet modification and recurrent myocardial infarction in survivors of a first myocardial infarction. The study involved a total of 411 heart patients. About half of the patients were given a prudent control diet which was designed according to the guidelines of the American Heart Association Step 1 diet. It provided only 30% of calories of fat with saturated fat providing about 10% of calories. The other half was placed on an Experimental Diet, which was based on the Mediterranean diet. The Mediterranean diet has been shown in population studies to be associated with a relatively low mortality rate due to coronary heart disease. The so-called Mediterranean diet is generally characterized as a high oleic acid, i.e., monounsaturated fat from olive oil. The Mediterranean diet, however, is also high in "-linolenic acid. In addition it was rich in fruits and vegetables and thus provided a relatively high intake of antioxidants.

Canola oil and canola oil-based margarines were used in the Experimental diet to provide the level of alpha linolenic acid in Mediterranean diet . The experimental

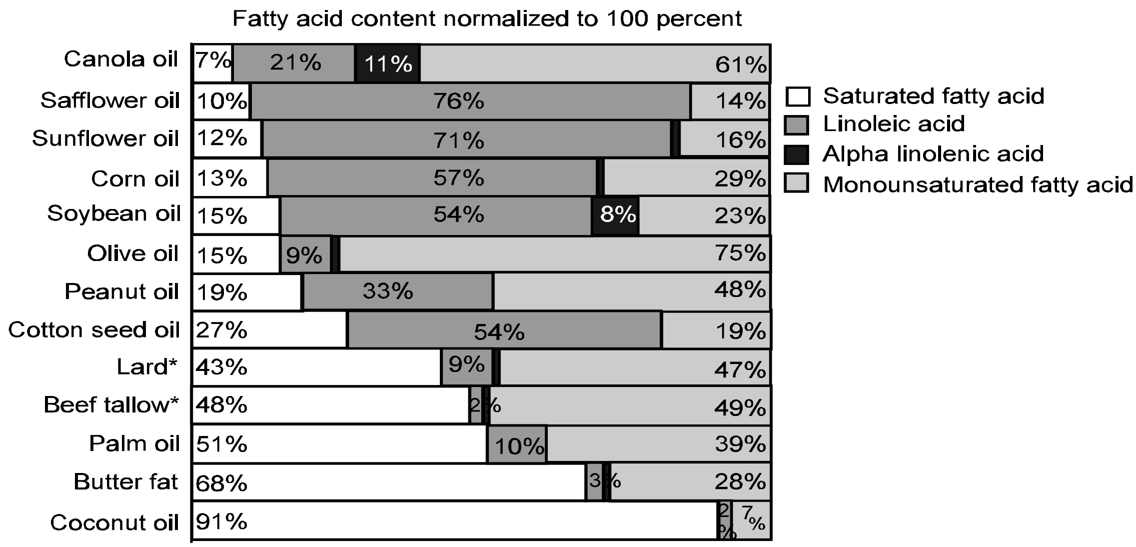


Fig. 5: Fatty acid composition of some common oils and fats

diet contained less butter and cream which was replaced by canola oil margarine, less ham, sausages, and meat. In addition to higher amounts of canola oil, the experimental diet contained larger amounts of bread, legumes, vegetables and fruits. The Experimental diet contained less saturates, due to the lower content of dairy products and meat and slightly higher amounts of monounsaturates, and "-linolenic acids derived primarily from canola oil.

The number of cardiovascular deaths for those on the canola oil-based Mediterranean Diet was remarkably lower (Table 6). The number of non-fatal coronary events was also markedly reduced for those on the Mediterranean diet. There was no difference in the number of non cardiovascular deaths between the two groups. So that the overall mortality was lower for the group on the canola oil based Mediterranean Diet.

An extended follow-up for mean of four years confirmed the benefits of the Canola oil-based Mediterranean diet (de Lorgeril *et al*., 1999). There were only six CHD deaths on the canola oil diet compared to 19 on the control. The results of this study illustrate the importance of a cardioprotective diet. Whether canola oil alone played a protective part cannot be concluded from this study, but canola oil is one of the most striking differences between the Mediterranean Diet and the AHA Step 1 diet. Most importantly this study found no adverse effects with the daily intake of canola oil for more than four years.

A surprising finding of this study was that there was no significant difference between the two groups in established coronary heart disease risk factors; blood pressure was the same as well as there was no difference in the serum lipid profile. So that the cardioprotective effect of the canola-oil based Mediterranean diet appears not to relate to its effects on the serum lipid profile.

However, there was a significant difference in the plasma fatty acid between the two groups (Table 7). Particularly, the experimental group had higher plasma levels of alpha-linolenic acid, EPA and DHA and significantly lower levels of AA acid than the control group. The n-3 fatty acids were most likely originated from canola oil in the diet. The authors (de Lorgeril *et al*., 1994) concluded this higher proportions of n-3 fatty acids in the diet could be one of the factors for the cardioprotective effect of the Mediterranean diet, because it is the eicosanoids derived from the n-3 fatty acids inhibit clot formation whereas eicosanoids from the n-6 fatty acids promote clot formation. The results of this study provide good evidence that canola oil might be a cardioprotective dietary fat. However other components in the diet particularly, the antioxidants from fruits and vegetables may have also contributed to the protective effect of the Mediterranean diet.

It is apparent from the current scientific literature that the fatty acid composition of canola oil is consistent with nutrition recommendations aimed at reducing the amount of saturated fat in the diet. Canola oil is characterized by a very low level of saturated fat (<7% of total fatty acids). In addition it contains a relatively high level of oleic acid (61%) and intermediate level of PUFA (32%) of which "-linolenic acid makes up approximately one third of total fatty acids. "-linolenic acid is the one that contributed to the cardioprotective effect of canola oil based Mediterranean diet. Diets containing canola oil have been found equally as effective as those containing corn oil, safflower oil, soybean oil and sunflower oil in reducing plasma total and LDL cholesterol in both normal and hyperlipidemic subjects. The Lyons

Heart study indicated that canola oil as a part of a nutritious diet may protect against coronary heart disease. Therefore, it could be concluded that canola oil is one of the most desirable source of dietary fat in terms of human health.

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