Changing Concepts in Lipid Nutrition in Health and Disease

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Summary

Fat remains a hot topic because of concerns over associations between consumption of fats and the incidence of some chronic conditions including coronary artery disease, diabetes, cancer and obesity. Dietary fats serve multiple purposes. The effects of dietary fats generally reflect the collective influences of multiple fatty acids in the diet or food. This presentation highlights some recent developments on the role of dietary fats and oils in health and disease.

Debate continues over the role of dietary modification in coronary prevention by lipid lowering. The degree to which a recommended diet will result in health benefits for an individual is difficult to predict, because the outcome will depend on the influence of other factors such as a person's genetic constitution, level of physical activity and total diet composition. There can now be little doubt about the importance of genetic factors in the etiology of cardiovascular disease, diabetes, obesity and cancer. The importance of antioxidant status in the prevention of cardiovascular disease as well as many cancers is being increasingly recognised.

It is now evident that not all saturated fatty acids are equally cholesterolemic. Recent accounts evaluating palm oil's effects on blood lipids and lipoproteins suggest that diets incorporating palm oil as the major dietary fat do not raise plasma total and LDL cholesterol levels to the extent expected from its fatty acid composition. Palm oil is endowed with a good mixture of natural antioxidants and together with its balanced composition of the different classes of fatty acids, makes it a safe, stable and versatile edible oil with many positive health and nutritional attributes.

In recent times, adverse health concerns from the consumption of trans fatty acids arising from hydrogenation of oils and fats have been the subject of much discussion and controversy. Trans fatty acids when compared with cis fatty acids or unhydrogenated fats have been shown to lower serum HDL cholesterol, raise serum LDL cholesterol and when substituted for saturated fatty acids, increase lipoprotein Lp (a) level, an independent risk factor for the development of coronary heart disease.

The idea of which foods, nutrients and supplements are "healthy" is often being amended as new scientific data is presented and then simplified for the consumers. What was once perceived as a healthy diet is often no longer considered as such and vice versa. Dietary recommendations have to change with time and the evidence available. Nutritional recommendations should encourage eating a great variety of nutrient sources within our food supply in moderation. Various lifestyle options to improve health should also be promoted.

Key Words: Lipid nutrition, Fatty acid effects, Palm oil, Antioxidants, Dietary recommendations

Introduction

Fat is a hot topic. Population growth, economic progress and urbanization lead to an increase in the consumption of oils and fats as well as greater dietary diversity in both developing and developed nations. Fat consumption is usually greater than the recommended levels in developed countries. In health conscious individuals, there is a growing awareness of the adverse effects of excessive dietary fat intake. Dietary fat continues to be a major research priority because of its association with heart disease, diabetes, cancer, obesity and other chronic diseases[1]. The evidence is clear that a lower total fat, saturated fat and cholesterol in the diet reduces the risk of chronic health problems, such as heart disease, some types of cancer, diabetes, and obesity. For well over a decade, the attention of health experts and consumers has focussed on issues related to fat and cholesterol. The quantitative importance of changes in dietary fat type and amount, and dietary cholesterol continues to be a subject of considerable scientific production and debate[2]. Yet many people are puzzled about the changes needed to lower their fat intake. Misconceptions about fats abound. Frequent and conflicting reports in the media about their health effects often create confusion in the minds of the public.

This presentation will address the subject of dietary fats with special reference to the edible oils and hopefully assist to combat some common misinformation and misconceptions surrounding lipid nutrition.

Sources of Fats

The term 'lipid' is sometimes used interchangeably with 'fat', but it is actually somewhat broader in meaning. Lipids include fats, oils, and other fatty substances - cholesterol, phospholipids. The principal sources of fat in the diet are visible fats and oils, red meats, poultry, fish and dairy products (Fig. 1). However, the relative contribution of the different sources varies in different countries[3]. Combined ,they account for 90% of the total fat intake. Dietary fats can be broadly grouped as (i) visible fats: e.g. cooking oils, butter, margarine and external fat on meats. (ii) invisible fats: (fats not readily seen in foods) fats contained in nuts, lean meats, potato chips, pastries, grains etc. Hydrogenation is a process that makes oil more solid at room temperature and hydrogenated vegetable oils give some processed foods such as margarine and crackers a longer shelf life.

A very large variety of oils and fats are in common use in different parts of the world. The common oils and fats used in Malaysia are shown in Table Ia. Traditionally the type of fat consumed in a region depends upon its availability in the region. However, this situation has changed through technological means as well as

Table Ia
Average Per Capita Consumption of the Most Visible Fats in Malaysia

Type of Fat	Malays (n=30)		Chinese (n=20)		Indians (n=47)		Combined (n=107)	
	g/day	kg/yr	g/day	kg/yr	g/day	kg/yr	g/day	kg/yr
Butter	1.3	0.48	0.2	0.07	1.5	0.55	1.2	0.44
Margarine	1.9	0.69	2.0	0.73	1.7	0.62	1.6	0.58
Ghee	0.6	0.22	Not Consumed		1.8	0.66	1.1	0.40
Palm Olein	39.6	14.45	42.7	15.59	41.6	15.18	40.3	14.71
Others*	2.8	1.02	3.5	1.28	3.1	1.13	3.2	1.17
Total Visible Fats Consumed	46.2	16.87	48.4	17.67	49.7	18.14	47.4	17.30

**Soya bean oil, corn oil, sunflower seed oil*
Source: Personal Communication. Dr. Kalyana Sundram, PORIM, 1997

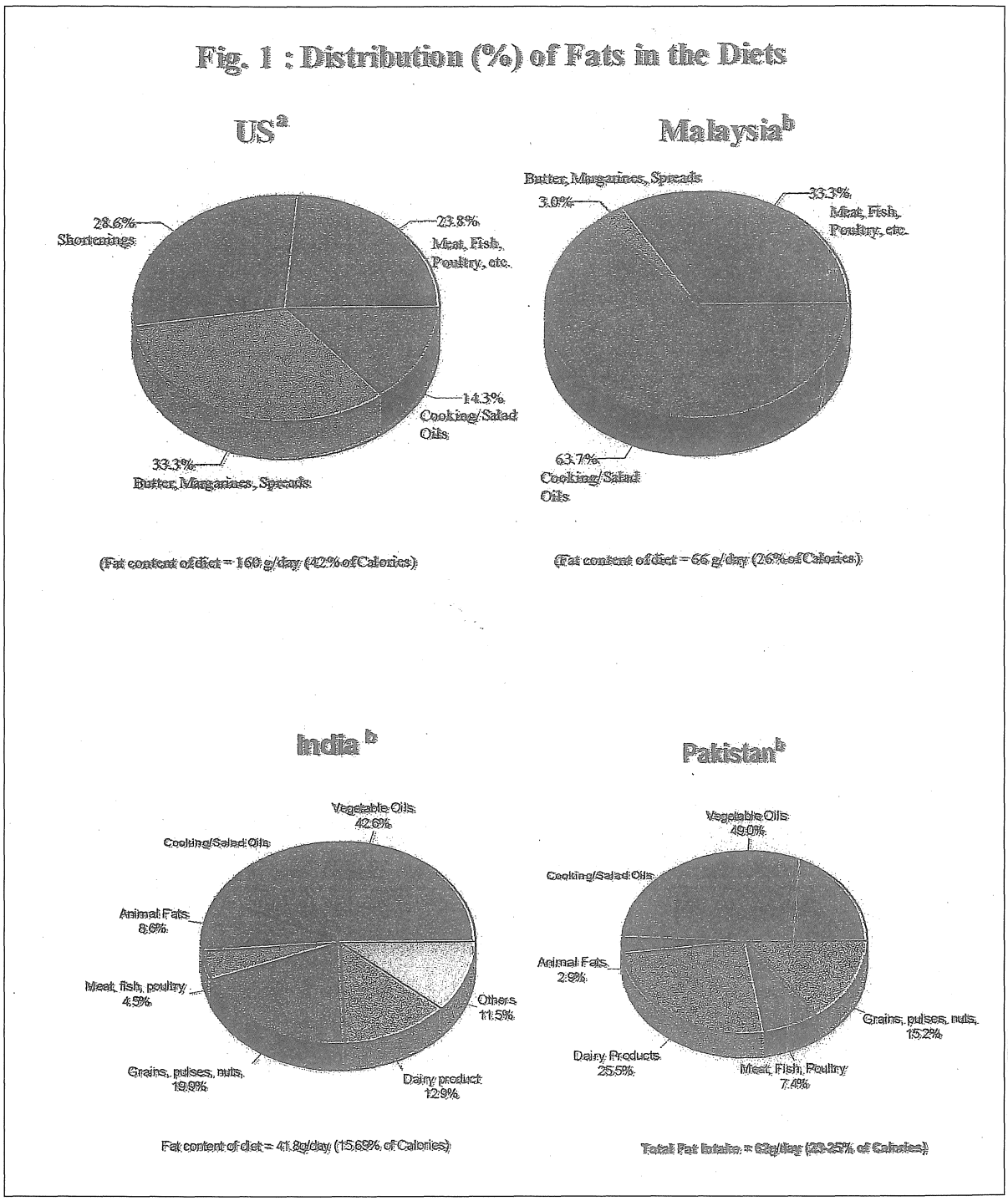

Fig. 1: Distribution (%) of fats in the diets

developments in international trade. In this regard, oil palm cultivation and palm oil production have contributed significantly to the edible oil needs of the world. During the past decade, palm oil's share of total vegetable oil production increased from 15 percent to about 21 percent[4].

Role of Dietary Fats

Fats play an important role in the health of the body. Dietary fats serve multiple functions. Linoleic and alpha linolenic acids are essential fatty acids that play a functional role in all tissues. Fat is also an important source of energy. It helps to meet daily energy needs under normal circumstances and, when stored in adipose tissue, provides a vital reserve to meet demands when other energy sources are unavailable (e.g. in starvation), unusable (e.g. in diabetes) or inadequate (e.g. during stress of illness). These stores also help maintain body temperature and protect body organs from trauma. Fats serve as a vehicle for the delivery and absorption of fat soluble nutrients. They also contribute to the satiety value and the sensory appeal of foods[5].

Fats have such a wide array of functions because the family of fatty acids in the food supply is diverse and has a range of properties. Subtle differences in the particular mixture of fatty acids, which vary in chain length and degree of saturation can markedly alter the sensory properties and nutritional implications of a food. Because these attributes generally reflect the collective influences of multiple fatty acids in a product, it is unlikely they will ever be replicated with a single natural or synthetic compound. We all need some fat in our diets to maintain health. In addition it would be extremely difficult and unwise to eliminate fat from the diet totally.

Trends in Consumption of Oils and Fats

Our selection and consumption of foods containing fat are influenced throughout our lives by a complexity of external, social, cultural and economic factors, as well as by internal physiological and psychological factors and furthermore their relative importance will vary between persons and within a person over time. We have little control over many of these.

Until the decade following World War 11, the majority of fats available for human consumption in the West were: animal fats, milk, butter and meat. There was a growing concern over the adverse health effects, especially cardiovascular risks due to consumption of animal fats and cholesterol. These health concerns fuelled worldwide demand for vegetable oils and fats[6].

The diet structure in many countries is changing. The traditional Asian diet high in carbohydrate and low in fat is undergoing profound change. Consumption of fats has been increasing steadily over the years and the proportion of fats from animal sources has been decreasing, while the amount from vegetable sources has been increasing[7]. Table Ib shows the trends in per caput food supply of fats and oils in Malaysia.

The world average per capita consumption of oils and fats has increased substantially from 14.57kg in 1987 to 17.12kg in 1997, with developed nations having higher consumption than the world average. The per capita consumption of oils and fats in the EU and USA was 43.75kg and 46.99kg respectively in 1997, whereas in the populous developing nations such as China (12.04kg) and India (9.69kg) it remains far below the world average[4].

Table Ib
Per Capita Supply of Vegetable Oils in Malaysia (1992-94)

	G/day	%
Soyabean	9.8	22.79
Groundnut	0.4	0.93
Sunflower	0.1	0.23
Rape/Mustard	0.3	0.69
Palm Oil	20.5	47.60
Palm Kernel Oil	8.3	19.30
Coconut Oil	2.2	5.11
Sesame	0.5	1.16
Corn	0.9	2.09
Total:	43	100

Source: FAO, Food Balance Sheets, Rome, FAO, 1996

An analysis of the relationship between the percentage of energy from fat and GNP per capita for the period 1962 - 1990 reveals that the structure of the income-diet relationship has undergone a significant change. The data suggest that the percentage of energy from fat was less dependent on income than previously. The growth in demand for vegetable oils is strongest in the developing nations of Asia. The proportion of energy from vegetable fats in 1990 was much higher than in 1962, accounting for up to 15% of the total energy[7].

The importance of oils and fats in meeting the ever increasing population demand for food and non-food products continues to grow. The past five decades have seen a revolution in the production and processing of oil seed based fats. In this regard oil palm cultivation and palm oil production have contributed significantly to the edible oil needs of the world (Table II). Positively, hectare for hectare, oil palm is the most efficient among the oil crops in addition to being ecofriendly in every aspect of its activities[8].

Dietary Fats in Health and Disease

Today many of us are concerned with the amount of fat in our diets as consumption of a diet high in fat is associated with increased incidence of obesity, coronary heart disease, hypertension, insulin resistance, certain cancers (breast, colon or prostate) and gallbladder disease. These observations have resulted in recommendations for reduced intake of total and saturated fat. The degree to which a diet meeting these guidelines will result in health benefits for an individual is difficult to predict, because the outcome will depend on the influence of other factors such as genetic constitution, level of physical activity and total diet composition.

Table II
Productivity of Major Oil Crops

Crops	Oil/ha/yr (kg)
Palm Oil	3200
Rapeseed	556
Sunflowerseed	504
Palm Kernel Oil	454
Groundnut	384
Copra	356
Soyabean	351
Cottonseed	188
Sesameseed	178

Source: Yusof B. Oil Palm and the Environment, 1998

However, for many countries, calorie malnutrition due to a lack of fat may be a more serious problem than protein malnutrition (Table III). This is apparent from the per capita consumption of oils and fats in different countries (the per capita consumption of oils and fats for some countries is shown in Table IV). An important health concern of such countries therefore is to ensure a sufficient level of fat intake. Since there is a gap between demand and supply of edible oils in many countries[4], new sources have come into the market and palm oil is becoming a major edible oil for such countries (Table V).

Genetics and Disease

There is evidence now that many common diseases such as atherosclerosis, diabetes and cancer involve not only changes in the gene or a genetic predisposition to the illness but also dietary factors that may enhance or inhibit expression of the genetic predisposition. Genetics determines the susceptibility to disease, but whether or not a predisposed individual develops the disease may depend on environment factors such as nutrition[9]. As genetic variants are expressed in a specific environment, populations should not copy each other's dietary recommendations for the prevention of some diseases such as coronary heart disease. Further, the varying needs of people have always made mass diet prescription scientifically, culturally and sociologically incorrect[10].

Methods to predict dietary responsiveness should be developed to target those likely to receive the greatest benefit. Research on the interaction of genes and diet should, in the future, lead to dietary plans and possibly drug regimes that are tailored to an individual's predisposition for specific diseases including heart disease and stroke.

Table III
Per Capita Income and Calorie Supply in Selected Asian Countries

Country	GNP per capita (US$)	Daily Calorie Supply (per capita)
Bangaladesh	220	2019
China	490	2729
India	300	2395
Indonesia	740	2755
Malaysia	3140	2884
Mongolia	390	1899
Nepal	190	1957
Pakistan	430	2316
Philippines	850	2258
Sri Lanka	600	2275
Thailand	2110	2443
Vietnam	170	2250

Source: UNDP Human Development Report, 1996, Oxford University Press

Lipids and Cardiovascular Disease

The relationship between diet and heart disease is the most widely debated diet disease issue among professionals. It appears to be no closer to resolution today than it was 30 years ago in-spite of a great deal of research that has been done in the interim[11].

The lipid profile and its effects on disease risks have been the subject of many reviews. Ideally the following blood lipids should be within normal ranges: total cholesterol, low density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides. LDL is known as bad cholesterol because it deposits fats and cholesterol on the lining of arteries. HDL is called good cholesterol because it transports cholesterol to the liver for subsequent excretion as bile acids. There are reports, which imply that cholesterol risks have been overstated[12]. The multi-factorial etiology of coronary heart disease (CHD) is well established. Elevated serum cholesterol concentrations, particularly LDL-cholesterol is an important risk factor for CHD. Nevertheless, it is to be reiterated that elevated blood cholesterol levels represent one risk factor of many.

Predominance of small dense LDL particles (LDL subclass pattern B) is associated with increased risk of myocardial infarction and angiographically documented coronary artery disease. Small LDL particles are potentially more atherogenic than larger LDL because of their increased susceptibility to oxidation and increased promotion of intracellular cholesterol ester accumulation. There are studies to suggest that changes in dietary saturated fat was associated positively with mass of larger LDL particles and diets high in saturated fats increase LDL particle size[13,14,15].

Dietary cholesterol comes only from animal sources such as the fat in dairy products, egg yolks, meats, poultry and seafood. Vegetables, fruits, and grains do not contain cholesterol to any significant extent. Cholesterol is an essential constituent of all cell membranes, and is required for the formation of vitamin D, steroid hormones, and bile acids.

Cholesterol biosynthesis is a major factor regulating cholesterol, which in turn is linked to risk of atherosclerosis. Dietary fatty acid composition is known to influence de novo cholesterol synthesis. The effects of

Table IV
Per Caput Supply of Fats and Oils (g/day) in Selected Countries

	India	China	Pakistan	Malaysia	UK	USA
1961 - 63: Total	30.9	15.6	31.2	49.1	137.6	113.2
Vegetable Oils	(10.8)	(3.3)	(5.2)	(19.7)	(22.3)	(27.0)
1964 - 66: Total	29.8	22.2	33.4	52.2	138.1	116.8
Vegetable Oils	(10.5)	(4.4)	(6.8)	(22.2)	(21.3)	(31.3)
1969 - 71: Total	29.8	22.4	34.1	55.0	141.0	122.2
Vegetable Oils	(10.6)	(4.5)	(7.8)	(23.5)	(25.3)	(38.1)
1974 - 76: Total	30.5	23.4	38.8	63.8	134.9	123.7
Vegetable Oils	(11.9)	(4.5)	(12.4)	(27.8)	(24.1)	(44.0)
1979 - 81: Total	32.7	30.8	43.5	77.5	135.0	131.3
Vegetable Oils	(13.6)	(7.6)	(17.8)	(39.0)	(24.0)	(45.4)
1982 - 84: Total	35.1	36.3	47.6	84.4	134.7	135.7
Vegetable Oils	(13.8)	(10.2)	(21.8)	(46.1)	(28.9)	(48.1)
1984 - 86: Total	36.0	40.7	51.2	85.8	136.0	139.3
Vegetable Oils	(14.4)	(11.2)	(24.8)	(47.6)	(37.8)	(50.3)
1987 - 89: Total	38.0	45.0	57.1	89.8	136.5	139.8
Vegetable Oils	(15.6)	(12.1)	(29.2)	(50.3)	(37.2)	(52.1)
1989 - 91: Total	39.8	49.3	57.1	92.4	135.4	139.1
Vegetable Oils	(16.7)	(13.4)	(27.7)	(50.0)	(39.4)	(52.0)
1992 - 94: Total	41.8	58.1	62.0	88.3	139.1	142.3
Vegetable Oils	(17.8)	(13.9)	(30.6)	(43.0)	(46.3)	(51.3)
Calories	2397	2757	2400	2782	3216	3610

Note:
The figures in parenthesis indicate the amount of vegetable oils.
The Table shows the trends in the overall national food supply. The amount actually consumed may be lower.
Source: FAO Food Balance Sheets, 1992-94. Rome, FAO, 1996.

qualitative fat intake on cholesterol and fatty acid biosynthesis have been extensively investigated[16]. The state of energy balance is one potentially important factor influencing circulating lipid levels and lipid biosynthesis in response to diets differing in fatty acid composition.

Dietary advice with regard to lipids has changed with developments in our understanding of their metabolic effects. First it was- avoid high cholesterol foods as fats

Table V
World Production of 17 Major Oils Fats*

Total vegetable oils	79,425,000 tonnes
(Palm oil	15,518,000) tonnes
Total animal fats/oils	20,487,000 tonnes
Grand total	99,912,000 tonnes

**PORLA - 1997*

consumed in the West were mainly derived from animal sources and animal fats contain cholesterol to varying degrees. Then it was - use polyunsaturated fats. Now it is -use olive oil. So what is the key to lowering blood cholesterol? Lowering cholesterol should play an essential role in the prevention and management of coronary disease in persons at high risk and in persons with established disease. Lowering cholesterol is like many other medical issues: there is no one magic answer. However, there are two key trends: first limit the total amount of fat you eat and second limit saturated fats. As per study conducted in the USA, the incidence of CHD mortality dropped by 42% between 1963 - 1986, although the average serum cholesterol level dropped only by 3%[12].

Because of overzealousness in carrying out extreme dietary recommendations, nutrition experts are concerned that some people are cutting dietary fat too drastically. That is they are choosing eating patterns that are too low in fat and too high in carbohydrate, especially simple sugars. While very low fat diets lower total cholesterol and LDL levels, they also lower the beneficial HDL levels and may raise blood triglycerides, which is not desirable. Also calorie intake may be too high, leading to obesity, another risk factor for heart disease.

Trans Unsaturated Vegetable Fats and the Risk of Coronary Heart Disease

The trans fatty acids arising from hydrogenation of polyunsaturated oils have been the subject of much discussion and debate. Metabolic studies in humans have shown that *trans* hydrogenated fats can adversely affect lipoprotein cholesterol profiles[17]. Recent concerns about the adverse health effects arising from consumption of trans fatty acids have been raised by some epidemiological studies showing a positive association between trans fatty acids consumption and cardiovascular disease risks[18]. *Trans* fatty acids can deleteriously affect lipoproteins by increasing total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), lipoprotein Lp(a) and decreasing high density lipoprotein cholesterol (HDL-C) relative to their cis isomers[19,20]. Table VI summarizes some of the effects of trans fatty acids on serum lipids/lipoproteins. The Lp(a)

Table VI
The Effect of Trans Fatty Acids on Serum Lipids

Serum Lipids	Effect	
	Increased	Decreased
Total Cholesterol	↑	
LDL-Cholesterol	↑	
HDL-Cholesterol		↓
LDL/HDL ratio	↑	
Lipoprotein Lp(a)	↑	

level is an independent and important risk factor for the development of coronary heart disease that is not very sensitive to environmental factors.

The Alpha Tocopherol Beta Carotene Cancer Prevention Study found a relative risk of coronary heart disease of 1.39 for men in the upper quintile of trans fat intake[21]; the Framingham Study found that after the first decade of follow up, the relative risk of coronary heart disease was 1.1 for each additional teaspoon of margarine eaten per day[22], and the EURAMIC study showed a relative risk of breast cancer of 1.4 for women in the highest quartile of *trans* fatty acids in adipose tissue[23].

The report by Hu et al. showed an association between *trans* fats and coronary heart disease[24]. They studied 80,082 women who were 34 to 59 years of age and had no known coronary heart disease, stroke, cancer, hypercholesterolemia or diabetes in 1980. During 14 years of follow up, they documented 939 cases of non-fatal myocardial infarction or death from coronary heart disease.

Total fat intake was not significantly related to the risk of coronary heart disease (for a 5% increase in energy from fat, the relative risk was 1.02). As compared with an equivalent energy from carbohydrates, the relative risk for a 2% increment in energy intake from `unsaturated fat was 1.93; that for a 5% increment in energy from monounsaturated fat was 0.81; and that for a 5% increment in energy from polyunsaturated fat

Table VII
Relative Risk of CHD Associated with Increases in the Percentage of Energy from Specific Types of Fat and Dietary Cholesterol

Variable	Relative Risk
Saturated fat (each increase of 5% energy)	1.17
Mononunsaturated fat (each increase of 5% energy)	0.81
Polyunsaturated fat (each increase of 5% energy)	0.62
Trans unsaturated (each increase of 2% energy)	1.93
Cholesterol (each increase of 200 mg/1000 kcal)	1.12

Source : Hu et al. (1997)

0.62. Each increase of 5 percent energy intake from saturated fat, as compared with equivalent energy intake from carbohydrates, was associated with a 17% increase in the risk of coronary heart disease and a relative risk of 1.17. The relative risks for women in the upper quintile were estimated as 1.35 and 1.27 in comparable models. They concluded that the quality of fat rather than the total amount of fat is important in modifying the risk profiles for CHD (Table VII).

These findings have raised the need to replace hydrogenated fats with natural solid fats in a large number of food formulations. The nutritional efficacy of the solid fats replacing hydrogenated fats should be such that they do not adversely affect plasma lipids and other CHD risk factors. In this context palm oil is perceived as a suitable alternative[25].

While there seems to be wide agreement that *trans* fats have adverse effects on cholesterol profiles and CHD risks, yet there is little agreement about either the magnitude of the problem or what actions should be taken. The per capita consumption of trans fats works out to about 15kg in the US, whereas in India it is one kg per capita, which is far too meagre[26]. The reluctance to recommend measures remains an enigma especially when reducing the intake of *trans* fats may not be particularly difficult[27].

The Role of Saturated Fat

In spite of the physico-chemical differences between saturated fats and other types of dietary fats, they are equivalent in their caloric vale. All fats - saturates (SATS), monounsaturates (MONOs) and polyunsaturates (PUFAs) provide the same number of calories and hydrogenation of fats does not affect their caloric content. Saturated fats primarily come from animal foods such as meat, poultry, butter and whole milk, cheese, sour cream and yogurt and the proportion present in vegetable oils varies.

Saturated fatty acids have important biological roles[28]. The best weight gain in experimental animals was obtained with fat mixtures containing 30% saturated fatty acids in diets. Low levels of dietary saturated fatty acids are incompatible with maximum weight gain in weanling rats. In newborn piglets fed a milk replacer, a low platelet count occurred with vegetable oils having a low level of saturated fatty acids.

Saturated fats can increase blood cholesterol levels, but it doesn't do this in every case, or for every individual. A 1990 WHO report[29] points out that "epidemiological data suggest that as the intake of saturated fatty acids decreases to about 10% energy there is a progressive fall in mortality due to cardiovascular disease". The evidence for lowering the level of saturates further in the total diet is still missing.

The role of different saturated fatty acids in regulating lipoprotein metabolism continues to be under investigation. Saturated fat has often been cast as the villain in the continuing debate over serum cholesterol levels. The claim is unsupported by existing evidence. It is now well established that all saturated fatty acids are not equivalent in terms of their hypercholesterolemic effects. Stearic acid, for example, is neutral in its

cholesterolemic action. What is important is the quantity and quality of fat in the diet as is becoming evident from recent studies[30].

The human study of Cook et al. investigated the relationship between endogenous synthesis of cholesterol and the content of palmitic acid in a diet contributed by palm oil[31]. The high levels of palmitic acid in the diet did not significantly affect serum total and LDL-cholesterol levels. Fractional synthetic rate of cholesterol was not different between dietary treatments (high versus low palmitic acid contents). This suggested that there was no relation between endogenous synthesis of cholesterol and the palmitic acid content in the diet.

Studies show that the maximum effect attributable to increased consumption of saturated fat is between 10 - 30mg/dl or roughly 10% of the total cholesterol for a person with a serum level of 200mg/dl. Increases in polyunsaturated fat intake are associated with a similar minimal decrease in the blood cholesterol levels of some person's[32].

Omega - 3 Fatty Acids

Omega 3-fatty acids are present in fish oils. Research points out the benefits - its role in lowering the risk of heart disease. There is some evidence that the omega 3 fatty acids may help to reduce the burden of CHD. These acids decrease triglyceride and also thin the blood, easing the pain of arthritis and possibly helping premature infants. It also helps the nervous system development[33].

Very Low Fat Diets May Harm Some People

The genetic make up of a person influences how he or she responds to a particular diet, and although very low fat diets may benefit some people, they could be harmful to others[34]. Individual responses to food cannot be predicted reliably on the basis of studies of large populations of people. Studies in healthy people show that there are genetic differences in the response to a low fat diet. Those who from their metabolic profiles, are at highest risk of heart disease show the greatest benefit from very low fat diets, but the remaining two thirds of the population show only minimal benefit, and for some they would be harmful. Dietary approaches to reducing CHD do not benefit all individuals to the same degree[35]. The lipid lowering response to a low saturated cholesterol lowering diet designed to cut risk for CHD varied widely among 120 individuals studied[36].

The Mediterranean Diet

For a long time the low rates of coronary heart disease in populations in the Mediterranean was specifically attributed to their diets being low in saturated fat and high in monounsaturates. This was based on the classic study of Ancel Keys in the 1950s[37]. The argument of several scientists from the Mediterranean countries that the diet of their region was more than a low-saturated fat diet and had implications for diseases other than CHD was lost to the wider scientific community.

It is recognized now that the overall Mediterranean dietary pattern is more important than individual nutrition components. The common components identified in the Mediterranean diet include: the energy intake from fat is very high (40%), a large fraction of dietary fat, close to 50%, is monounsaturated and mainly derived from olive oil with a high monounsaturated/saturated fatty acid ratio; ethanol consumption at moderate levels and mainly in the form of wine; high consumption of vegetables, fruits, legumes, and grains; moderate consumption of milk and dairy products, mostly in the form of cheese; and low consumption of meat and meat products (Table VIII).

Table VIII
Some Characteristics of the Mediterranean Diet

High monounsaturated/saturated fat ratio
Ethanol consumption in the form of wine at moderate levels
High consumption of vegetables, fruits, legumes and grains
Moderate consumption of milk and dairy products (cheese)
Low consumption of meat and meat products
Physical activity
Relaxing psychosocial environment
Afternoon siesta habit
Favourable climate

Source : Trichopoulou and Lagiou (1997)

Recognition is growing that several aspects of the Mediterranean diet, and in particular consumption of olive oil in conjunction with vegetables and legumes, can convey a substantial degree of protection against a wide range of chronic diseases[38]. Nevertheless, it is to be appreciated that substitution of traditional edible oils with olive oil would not transfer all the benefits of the Mediterranean diet and so one should not get the wrong message and consume monounsaturated fats with impunity. Although the popular press portrays monounsaturates as miracle foods, they are not. There are no bad oils or good oils or miracle foods[39]. Studies conducted in Malaysia have shown that palm oil and olive oil incorporated into diets resulted in similar serum lipid profiles in healthy individuals[40,41,42].

Dietary Fats and Stroke

Stroke is a leading cause of mortality and morbidity in developed countries. The origin of stroke is multifactorial. Hypertension and atherosclerosis increase the risk of stroke. Since specific treatments for acute stroke are few, primary prevention is paramount. Diet may be important in the genesis of stroke and could offer avenues for its prevention. The type of fats consumed is of interest because of their known relationships with atherosclerosis and coronary heart disease. There appears to be an inverse correlation between stroke and fat intake. Stroke rates are relatively high in Japan and China which have relatively low levels of fat intake, while stroke rates have been falling in the United Kingdom during the last fifty years and the consumption of fats as a proportion of energy intake remains around 40 - 42%[43].

Gillman and colleagues[44] using data from the Framingham Heart study, have reported that lower levels of dietary fat are associated with an increased risk of ischaemic stroke. The study involved 832 men aged 45 - 65 years at baseline, and the incidence of stroke over the following 20 years was compared with dietary data collected at baseline. The subjects were divided into quintiles on the basis of their total fat intake. The lowest and highest quintiles had average fat intakes of 26.4% and 50.6% energy respectively. The authors reported a substantial trend in protection against stroke as intakes of total fat, monounsaturates and saturates increased. This has to some extent debunked the theory of saturated fats being bad for health. The impact of monounsaturates and saturates was similar in magnitude whereas no association was seen with polyunsaturates (Table IX).

Similar observations have been reported previously in Asian and Asian American populations. More recent data from Japan have shown that the risk of stroke, both hemorrhagic and ischaemic, is decreasing as dietary fat consumption has increased[45]. Gillman and colleagues[44] also refer to work in animal models that showed a decreased incidence of stroke in rats fed a high fat diet or a high milk fat diet. They also note that a variety of individual fatty acids have been reported to prevent stroke in genetically prone rats. For example, it has been speculated that palmitoleic acid protects against stroke by stabilizing the vascular wall. Although fat intake can predispose to atherosclerosis of larger vessels, it may protect against altering the integrity of smaller intracranial vessels.

These new data emphasize the potential risks of extreme dietary recommendations especially fat restriction. According to an accompanying editorial[46], the rationale for limiting total fat intake is that the risk of obesity increases as the proportion of dietary fat increases. Obesity, in turn, tends to increase LDL-cholesterol over and above the effect of dietary saturates. In this context it is worth pointing out that dietary guidelines can only be based on the evidence available at the time they are formulated.

Dietary Fats and Cancer

High fat diets have been linked with high rates of colon and breast cancer. Prostate cancer also may be related to high fat consumption. However, a recently released report from the Department of Health (UK) in a rigorous review of the literature found little evidence for a strong association between the intake of total fat or of individual fatty acids and any type of cancer[47].

An inhibitory effect of palm oil on experimental tumourgenesis has been reported[25]. Dietary fats may modulate tumourgenesis through mechanisms independent of their fatty acid composition. The non-

Table IX
Age Adjusted Stroke Cumulative Incidence Rates Per 1000 Subjects By Quintile of Intake of Fat and Type of Fat*

Quintile	Ischemic (No. of events)	Hemorrhagic (No. of events)
Energy intake (mean) kJ		
1. 7879		
2. 9849		
3. 10,697		
4. 12,062		
5. 14,389		
Intake as % of energy		
Total Fat		
1. 26.3	112.3	24.2
2. 34.6	84.8	18.0
3. 39.5 (114g)	57.2	0.0
4. 44.1	63.4	11.4
5. 50.6	41.8	30.0
Saturated Fat		
1.	131.1	12.5
2.	69.3	27.7
3. (15 en %)	61.4	11.9
4.	72.4	6.6
5.	31.8	30.4
Monounsaturated		
1.	132	17.8
2.	70.0	16.7
3. (15.8 en %)	44.2	5.6
4.	53.0	5.7
5.	66.2	36.4
Polyunsaturated		
1.	85.3	18.6
2.	75.4	21.6
3. (5.4 en %)	69.6	26.9
4.	74.4	17.6
5.	58.0	6.3

Data are 20 year follow up data from 832 men aged 45-65 years from baseline The Framingham Heart Study (Gillman et al., 1997)

promoting effects of palm oil on certain types of experimental tumors may be related to the minor constituents in palm oil.

Obesity: The Fattening of Society

Obesity is out of control in most affluent countries of the world and its prevalence is increasing rapidly in developing countries. The World Health Organization describes it as a global epidemic[48]. It is a multifaceted problem with wide reaching medical, social and economic consequences. It is a serious disease which predisposes to heart disease, hypertension, stroke, diabetes, osteoarthritis, obstructive sleep apnea, gallstones and some cancers sensitive to sex hormones. Obesity is often accompanied by disturbances of lipid and carbohydrate metabolism (Table X). Increased adiposity has consistently been associated with elevated triglyceride and depressed high-density lipoprotein cholesterol (HDL-C).

Both genetic and environmental factors modify body weight[49,50]. Obesity presents two challenges: treating people who are currently obese and preventing obesity in people who are still lean or moderately overweight. Diet and exercise programmes remain the cornerstone approaches. There is good evidence that reducing total calories intake is the most important factor in weight loss. Too many calories from any source, fat, carbohydrate or protein can lead to weight gain, even if the diet is low in fat. Increasing physical activity of all individuals who are obese should be an important public health priority[51]. The pursuit of a magic bullet for obesity continues as the rewards are high[52].

Table X
Obesity Associated Serum Lipid Changes

Serum lipids	Effect
Triglycerides	↑
Free Fatty Acids	↑
Total Cholesterol	↑
LDL-Cholesterol	↑
LDL/HDL ratio	↑

Fat Substitutes

Consumer concerns about the amount of fat in foods remains extremely high. One method persons use to reduce fat intake is consumption of fat modified foods. These compounds are designed to replicate the functional and sensory properties of fats, but are not chemically classified as fats and contain less energy than fats. They may be used to replace all or a portion of the fat normally present in a product[53]. The goal of fat reduction is to decrease the incidence of obesity and certain chronic diseases, to reduce total energy consumption to improve health and enhance physical appearance.

The safety of fat replacers has been, and will continue to be, based on a consideration of each compound's toxicologic profile, effect on overall diet (e.g. likelihood of promoting nutrient deficiencies, excesses, or imbalances) and expected level of use by various segments of the population.

Role of Free Radicals and Antioxidants

Free radicals are highly reactive molecules generated by the biochemical redox reactions that occur as part of the normal cell metabolism, and by exposure to environmental factors such as UV light, cigarette smoke, environmental pollutants and gamma radiation. A number of free radical species fulfil physiologically important roles within the body. However, free radical levels in the body must be carefully controlled as they are highly reactive and can cause tissue destruction. Extensive research in the field of free radicals and reactive oxygen species (ROS) has linked them with a wide range of chronic and acute diseases including: atherosclerosis, cancer, diabetes, respiratory disease, liver damage, rheumatoid arthritis, cataracts, inflammatory and neurological conditions[54,55,56].

Antioxidants help regulate and control the levels of free radicals at the required physiological concentrations. When the production of the free radicals and their

removal by the antioxidant system becomes unbalanced, tissue damage and disease can occur. Antioxidants help to protect against degenerative diseases. Increasing antioxidant status by supplementation has numerous benefits. There is a growing body of evidence from basic science, animal models, observational studies and clinical trials on the beneficial effects of antioxidants. These include:

Primary antioxidants which prevent the formation of new free radicals

Secondary antioxidants (Beta-carotene and vitamin E) which remove newly formed free radicals before they can initiate chain reactions. These chain reactions can lead to cell damage and further free radical formation.

Tertiary antioxidants repair cell structures damaged by free radical attack

Deficiencies in the antioxidant system can develop for a number of reasons: low intake of dietary antioxidants, diseases that reduce the absorption of antioxidant nutrients from food, total parenteral nutrition and renal dialysis.

Antioxidants and cardiovascular disease

The implication of oxidative stress in the process of vascular aging is now clearly established. Numerous studies on the role of free radicals and particularly lipid hydro peroxides in the initiation/and or development of vascular disease have been published. Role of vitamin E as a membrane stabilizer and thereby a factor for protection against erythrocytolysis and cardiovascular disease is well established.

Excess free radicals are thought to initiate atherosclerosis by damaging blood vessel walls. LDL-cholesterol has long been implicated in the development of heart disease. However, LDL poses a threat after oxidation by free radicals, as it is reported to migrate across endothelial membranes into arterial wall. The oxidation of LDL-C is proposed to occur at the early stages of atherosclerosis and vitamin E has been shown to inhibit this oxidative reaction. Vitamin E is an antioxidant carried inside the LDL (which are atherogenic when oxidized). Lowered risk of angina and mortality from ischemic heart disease has been associated with higher vitamin E intake. Reduced incidence of myocardial infarction has been associated with high serum levels of beta-carotene[57]. The antioxidant nutrients have also been shown to have an inverse relationship with cardiovascular risk factors. Several previous studies have shown an increased risk of cardiovascular disease at sub-optimal blood concentrations of essential antioxidants, whereas several epidemiological studies have shown a decrease in the incidence of cardiovascular disease in individuals supplemented with antioxidants[58,59,60,61].

Humans require dietary sources of beta-carotene and vitamin E, since the body is unable to produce these nutrients. Vegetable oils are good sources of vitamin E, which in addition to serving as a nutrient also acts as a natural antioxidant to help prevent the fat from becoming rancid. Palm oil is naturally endowed with a good mixture of antioxidants.

β-carotene and vitamin E, that stabilize free radicals. β-carotene quenches singlet oxygen, a potent generator of free radicals. Vitamin E is the collective name for eight compounds found in nature - four tocopherols and four tocotrienols. It has been shown that the natural type of vitamin E is better utilized than the synthetic variety[62].

Fats high in polyunsaturates are more susceptible to oxidation than saturated fats. (Synthetic antioxidants are added to most vegetable oils and shortenings to prevent oxidation and extend shelf life). The increased consumption of PUFAs necessitates increasing the intake of vitamin E as polyunsaturated fatty acids are vulnerable to peroxidative changes. We should remain alert to the potential hazards of excessive oxidative and thermal abuse of frying fats particularly those that are highly unsaturated. The wisdom of changing our diets and greatly increasing the consumption of polyunsaturated fats in our pursuit to reduce cardiovascular disease, until more is known about how this might affect our risk of developing cancer has often been discussed.

Antioxidants and Carcinogenesis

Free radicals are thought to act principally as promoting agents in the development of cancer. Increased intake of antioxidants either through the diet or as supplements has been associated with a reduced incidence of cancer.

The ATBC study has shown that participants treated with 50mg of alpha tocopherol experienced 32% fewer incidence of prostate cancer compared with participants who did not receive any supplements[62].

Health Effects of Palm Oil

Today palm oil is one of the major edible oils in the world (Fig. 2, Table XI) both in terms of production and trade and finds applications in a wide variety of products, bearing testimony to its versatility, stability and many positive health and nutritional attributes[4].

Recent accounts evaluating palm oil's effects on blood lipids and lipoproteins suggest that diets incorporating palm oil as a major dietary fat do not raise serum total and LDL cholesterol levels to the extent expected from its fatty acid composition[63,64,65].

Notwithstanding the progress made, there is intensification of research on all aspects of the oil palm to enhance both quality and quantity both in terms of production as well as products.

Often fears about palm oil stems from a lack of knowledge of the product and process and that is the basis why a continuous dialogue is necessary between us and all interested.

Coconut and palm kernel oil should be differentiated from palm oil in terms of their composition of fatty acids (Table XII). Consumption of palm oil is an insignificant factor in the diets of many countries with a high prevalence of CHD and certainly not the most important target in the ongoing efforts to reduce the amount of fat we eat[66].

Table XI
World Production of Oils and Fats ('000 tonnes)

Source	1996	2000
Annuals	52,813	57,294
Soya Bean Oil	20,092	23,317
Rapeseed Oil	11,432	10,829
Groundnut Oil	4,180	4,629
Sunflower Oil	9,339	9,962
Corn Oil	1,763	1,780
Castor Oil	522	456
Linseed Oil	669	843
Sesame Oil	740	702
Cottonseed Oil	4,076	4,776
Perennials	22,985	24,808
Palm Oil	16,105	17,498
Palm Kernel Oil	2,080	2,175
Coconut Oil	2,939	3,306
Olive Oil	1,861	1,829
Animals	20,480	23,164
Tallow & Grease	7,453	7,735
Lard	5,948	6,857
Butter as fat	5,816	7,012
Fish Oil	1,263	1,560
Total	96,279	105,266

*Source: Oil World/PORIM *Forecast*

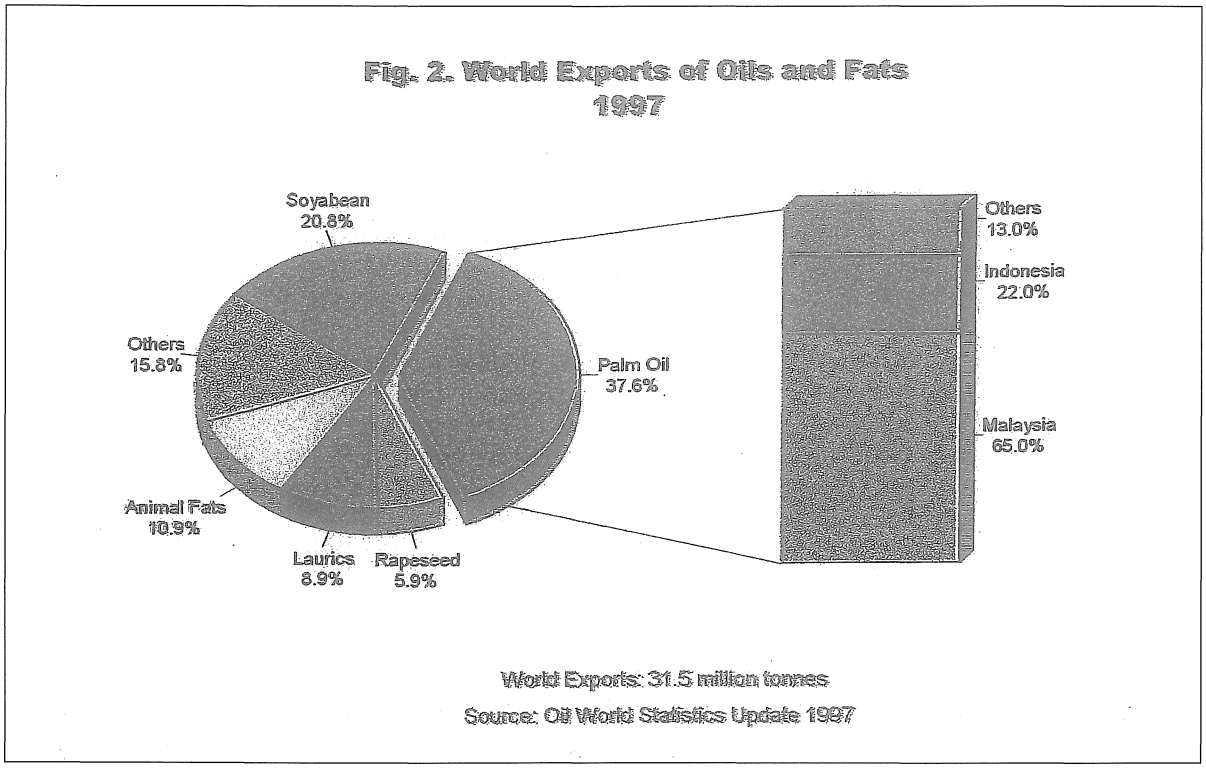

Fig. 2: World Exports of Oils and Fats 1997

Table XII
Composition of Oils (%)

Fatty Acid	Palm Oil	Palm Kernel Oil	Coconut Oil
Lauric	0.2	48.3	48.2
Myristic	1.0	15.6	18.0
Palmitic (SFA)	39.8	7.8	8.5
Stearic	4.4	2.0	2.3
Oleic (MUFA)	42.5	15.1	5.7
Linoleic (PUFA)	11.2	2.7	2.1
Linolenic	0.4	-	-
Vitamin E activity as α TE	33.5	6.2	0.7
Carotenes	700 - 800 ppm*	-	-

**Before refining*

Nutrition Misinformation and Misconception

Dietary fat occasions more concern than any other nutrients to the public and media because of associations which have been drawn between dietary fats and a number of diseases. Public interest in nutrition has grown rapidly over the past several decades and the media is an important source of nutrition information Thanks to the media, consumers are becoming increasingly aware of the connections between their diet and health. Unfortunately media messages surrounding nutrition are often inconsistent, confusing and do not enable the public to make positive changes in health behaviors.

Media coverage of fat consumption has overshadowed all other topics. With all the publicity about the hazards of our high fat diet, we should not get the idea that fat is something we can get along without, however[67]. Trends related to fat consumption also indicate a positive effect of the media. Fat intake as a % of total calories has dropped in some countries, but total calories has increased and so has obesity[68].

The media frequently features stories about research findings pertaining to dietary fats, but often these stories omit details that would allow readers to determine the relevance of the study results to their own lives. Advice is featured on what to eat or what to avoid, but lack information on how much, how often or to whom the advice applies.

The egg long regarded as an economical nutrient has been vilified and many associate eggs only with their cholesterol content. "Eggs are bad" because of the relationship between serum cholesterol and heart disease.

The idea of which foods, nutrients and supplements are "healthy" has often been amended as new scientific data is presented and then simplified for the lay press. What was once perceived as a healthy diet is often no longer considered as such and vice versa[68].

Conclusion

The health implications of consuming increasing levels of fats have elicited much interest. The quantity and quality of dietary fat and the influence of specific fatty acids on lipid metabolism and health continues to be the subject of much research, discussion and debate. It is envisaged that oils and fats consumption patterns will undergo gradual changes due to economic factors, nutritional concerns and environmental considerations.

It is generally accepted now that for various performances the body needs about equal quantities of all three types of fatty acids, namely saturated, monounsaturated (oleic) polyunsaturated (linoleic) and an excess of any one of them may not be desirable.

Disease risk is associated with the total diet over time and we have to take cognizance of public health nutrition principles. The wellness concept has captured the interest of many of us in recent years. Wellness involves eating the right food, in the right amounts (good nutrition) avoiding or reducing the intake of harmful substances, being physiologically active and practising preventive medicine.

It is important to recognize the impact of fats on overall health and focussing on fat alone will not achieve a better overall nutrition. Dietary recommendations have to change with time and the evidence available. Arising from some recent observations on the role of fats in health and disease, a reappraisal of our perceptions of fats and dietary goals are in order.

We look forward to working with the medical community and scientists in consumer countries to assure that palm oil and its products are developed in a timely manner and that these products are safe, effective, and bear claims that are truthful and non misleading.

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MCQs on CME - Changing Concepts in Lipid Nutrition in Health and Disease

1. The functions of fats include
   A. important source of energy
   B. facilitating the absorption of fat soluble vitamins
   C. storage of energy
   D. insulation of vital organs
   E. contributing to the palatability of foods

2. Polyunsaturated fatty acids
   A. cannot be synthesised by humans
   B. are important in determining fluidity of membranes
   C. have no known functions other than as membrane components
   D. are quite susceptible to auto-oxidation
   E. can form free radicals that initiate a sequence of undesirable events

3. Plasma cholesterol
   A. is partly derived from synthesis in the enterocytes and hepatocytes
   B. is partly metabolised to bile salts in the liver
   C. concentration tends to increase with age in people on westernised diets
   D. as (LDL-cholesterol) is positively correlated with the incidence of ischemic heart disease
   E. as (HDL-cholesterol) is negatively correlated with the incidence of ischemic heart disease

4. Palm oil is nutritious and healthy because it
   A. is a rich source of carotenoids in its natural state
   B. is rich in vitamin E
   C. is easily digested and absorbed
   D. contains saturated, polyunsaturated and monounsaturated fatty acids
   E. is not susceptible to auto-oxidation

5. Atherosclerosis
   A. is associated with hypercholesterolemia
   B. tends to occur in older age groups
   C. is an irreversible process
   D. is delayed by anti-oxidants
   E. LDL-C peroxidation is a pre-requisite for its development

6. In obesity the following changes in serum lipids occur
   A. hyperlipidemia
   B. hypercholesterolemia
   C. increased LDL-C concentration
   D. increased VLDL concentration
   E. increased free fatty acids