

Insights into Media Modulated Confusion and Controversy in Lipid Nutrition

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INTRODUCTION

With the growing awareness of the central role of nutrition in disease prevention and health promotion, public interest in nutrition and food safety has increased dramatically in recent years. Concomitantly, the public is increasingly becoming nutrition conscious and actively seeks reliable sources of nutrition information. Dietary studies make headlines and the media is replete with nutrition advertisements and advice. In fact, consumers receive more information about food, nutrition and health from the news media than from any other source. In Malaysia, publications with stereotype articles on health, fitness and diet, reminiscent of their counterparts in the West are common. In this context, an area of continuing and intense interest is lipid nutrition, because of its implications for good health and association with risks for some diseases (Lichtenstein *et al.*, 1998). Fat intake or content of the diet has been a nutritional issue of growing concern to consumers and naturally the role of dietary fat has been the focus of considerable media scrutiny. However, this high volume of media blitz instead of bringing clarity or improving understanding, has more often brought about greater confusion and controversy. This is partly because of the ever changing research outputs and contradictory messages which have an impact on all. At times, the messages conveyed appear irrelevant, inconsistent and not in keeping with scientific developments with the result it is not possible to distinguish nutrition facts from nutrition misin-

formation (Chandrasekharan and Yusof, 1998). The resultant unhealthy consequence both amongst consumers and the scientific community is not conducive to make positive changes in health behaviours. In view of the confusion and controversy in certain aspects of nutrition, it has become critical for better communication between those involved in nutrition research and the public or consumers in appropriate language and detail so as to make it easy for comprehension (Morgan, 1998). This can be useful in raising public awareness. A better informed public/consumer group would be expected to have a higher appreciation of the many factors impacting modern day living. The influence of the media in promoting healthy lifestyles and dietary habits is considerable.

This paper highlights some of the common misperceptions on lipids, with special reference to oils and fats and attempts to put them in a proper perspective. In doing so, it appraises the available research on many of the frequently raised issues concerning lipid nutrition and health. It also provides reasoned discussion of some of the issues in the light of current available scientific evidence as these have considerable implications for palm oil consumption.

FATS AND OILS SHOULD BE PERCEIVED AS SOMETHING USEFUL

Dietary fat and the nutrients associated with dietary fat play a critical role in the health and functioning of the human body. Fats and oils are components of normal diets and consumed by the vast majority of the population on a regular basis. It is therefore also a component of the diet of people with

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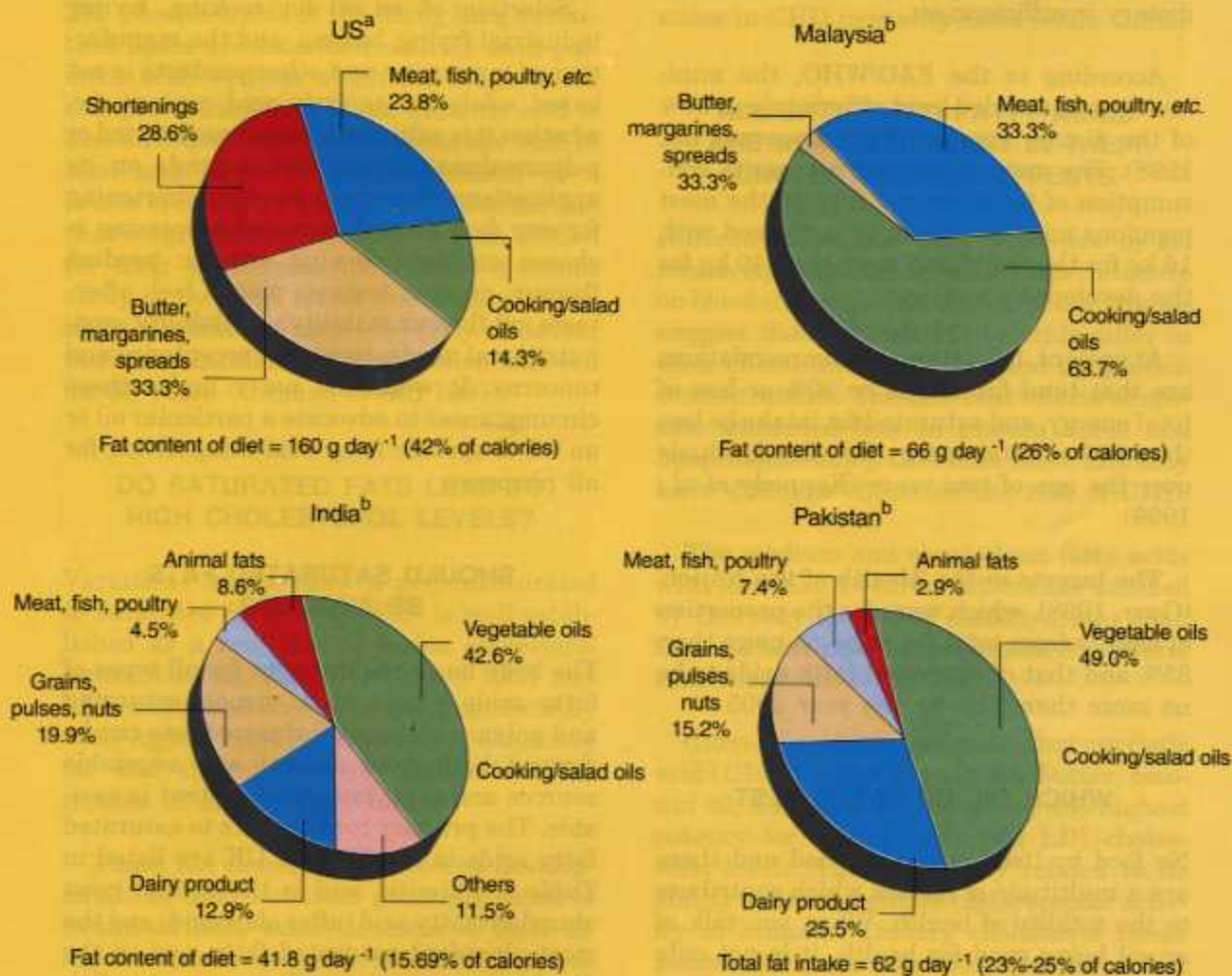
a variety of medical conditions.

Dietary fat clearly serves a number of essential functions in the human body. They support structural aspects of the body, important for insulation, and are vital components of cells, cell membranes and nervous tissue. They are a concentrated energy source relative to carbohydrates and proteins and fat is an efficient storage form of energy, facilitates the utilization and are a source of some of the fat soluble vitamins and provide essential fatty acids required for metabolism and formation of regulatory substances. The various fats also contribute to the physical and functional properties of most food products, affecting sensory as well

as nutritional aspects of foods, thus making food more palatable (Gurr, 1999).

USES OF OILS AND FATS

There is a wide ranging use of oils and fats, and fat products are used for human food. The vegetable oils used in cooking represent a sizeable percentage of the visible fat consumed in developing countries. Non-food uses are many and varied and fat-based products find their way into many areas of human life as they are renewable sources and readily biodegradable. The different sources of fats in the diets of selected countries are summarised in *Figure 1*.



Sources: ^aMead, J F C (1985). *Lipids*. Plenum press, New York.

^bFAO (1996). *FAO Food Balance Sheet*. Rome.

Figure 1. Distribution (%) of fats in the diets.

DIETARY REQUIREMENTS FOR OILS AND FATS

During most of the 20th century, awareness and concern about nutrition was focused on the problems of inadequate nutrient consumption. The normal diet of the vast majority of the world's population is deficient in fat and protein and the major nutritional problem of many developing countries is chronic energy deficiency associated with low fat intake. For example, maternal energy deficiency possibly exacerbated by very low fat intakes (<15% of energy) is one key determinant in the etiology of low birth weight. Fat free diets are frequently poorly balanced and can result in dietary insufficiencies.

According to the FAO/WHO, the minimum recommended level of fat intake is 20% of the dietary energy (Beare Rogers *et al.*, 1998). The average annual per capita consumption of fat is around 8 kg in the most populous nations of Asia as compared with 16 kg for the world and more than 40 kg for the developed countries.

At present, US national recommendations are that total fat intake be 30% or less of total energy, and saturated fat intake be less than 10% of total energy for all individuals over the age of two years (Kennedy *et al.*, 1999).

The targets in the 'Health of the Nation' (Gurr, 1998), which were for the proportion of energy from total fat to be no more than 35% and that of saturated fatty acids to be no more than 11% by the year 2005.

WHICH OIL OR FAT IS BEST

No food by itself is good or bad and there are a multitude of factors which contribute to the totality of health. When you talk of an oil being good for health, it is not only very simplistic but also ignores the many factors which contribute to health and disease. It is important to remember that humans do not always make food choices based solely on health considerations, but

also based on income, occupation, education, ethnicity, rural or urban residence, religious beliefs, nutrition knowledge, and physiologic characteristics (Kittler and Sucher, 1989).

The composition of the world disappearance of oils and fats has constantly been changing over the years. The further back we go, the larger was the share of animal fats, the demand and production of which is increasing less sharply than that for oils and fats. As animal and dairy fats are much more expensive than vegetable oils and fats, ample supplies of vegetable oils will ensure that oils and fats will continue to be more affordable.

Selection of an oil for cooking, frying, industrial frying, baking, and the manufacture of margarine and other products is not based solely on its fatty acid content, *i.e.* whether it is saturated, monounsaturated or polyunsaturated, but also depends on its applications. Generally an oil or shortening for any food formulation and processing is chosen on the following criteria: product flavour, product texture, mouth feel, after-taste, oil flavour stability, availability, cost, nutritional needs, consumer acceptance and concerns. It would be naive under these circumstances to advocate a particular oil or an oil of specific fatty acid composition for all purposes.

SHOULD SATURATED FATS BE AVOIDED?

The body has a requirement for all types of fatty acids – saturated, monounsaturated and polyunsaturated. Saturated fats can be derived both from animal and vegetable sources and their fatty acid content is variable. The primary contributors to saturated fatty acids in the US and UK are listed in *Table 1*. Palmitic acid is the second most abundant fatty acid (after oleic acid) and the most abundant saturated fatty acid in the diet in many countries. It is present in fish oils, in milk, body fat and virtually all vegetable oils. Saturated fatty acids are also major components of phospholipids in membrane lipid bilayer and can be regarded as

TABLE 1. MAIN SOURCES OF SATURATED FATS

American diet	British diet
Beef	Whole milk
Cheese	Cheese
Hamburger	Butter
Low fat milk	Biscuits, buns, pastries puddings, ice cream

essential component of the membrane structure. For proper functioning of membranes, a good combination of these three classes of fatty acids is essential.

The phospholipids in the gray matter of the brain are rich in saturated fatty acids. The phospholipids of the lining lung surfactant lipids are esterified entirely with palmitic acid, without which the lungs would collapse during expiration. Palmitic acid is also an important structural storage lipid in man and is preferentially oxidized as a source of energy by the body. Despite the fact that saturated fatty acids have been vilified for their cholesterolemic effects, a recent study in the USA found that men with the highest intakes of saturated fatty acids had the lowest incidence of stroke when followed for 20 years (Gillman *et al.*, 1997).

DO SATURATED FATS LEAD TO HIGH CHOLESTEROL LEVELS?

Variations in the ratio of polyunsaturated to saturated fatty acids (P:S) is well established as a mediator of serum cholesterol concentrations. Energy adjusted total and LDL-cholesterol levels increased significantly with higher intakes of total fat, saturated fat and cholesterol and concomitant decreases in dietary fibre intake.

Those not familiar with recent developments in lipid nutrition generally think of saturated fatty acids in terms of their alleged capacity to raise blood cholesterol. Unfortunately, they have been conditioned to the fact that the major factor in raising cholesterol is saturated fats and so become oblivious to the reality, that there are many factors which can affect cholesterol levels.

The effects of dietary fats/oils on serum lipids and lipoproteins generally reflect the collective influence of multiple fatty acids in the diet or food. Normal mixed diet contains many components that influence blood cholesterol level in either direction.

The way in which fatty acids are distributed in a triacylglycerol may also influence plasma cholesterol, irrespective of the overall composition of the fatty acids.

Dietary fat intake, and especially intake of saturated fat, is weakly related to a person's level of blood cholesterol. No regional differences in the intake of saturated fats was seen in the UK despite regional differences in CHD mortality rates (Gurr, 1998).

ALL SATURATED FATTY ACIDS ARE NOT EQUIVALENT IN THEIR CHOLESTROLEMIC EFFECTS

Different saturated fatty acids are by no means equivalent in terms of their influence on blood cholesterol levels. Metabolic studies suggest that saturated fatty acids differ in their effects on blood lipids and lipoprotein concentrations. The different effects of specific saturated fats on plasma lipids and lipoproteins imply that that these fats may have different effects on the risk of CHD.

The medium and short chain fatty acids with less than 10 carbon atoms are handled by the body more like carbohydrates than fats and have no effect on plasma cholesterol concentrations.

Current evidence suggests that myristic acid (C14:0) found in milk fat, butter, coconut oil, and palm kernel oil has the highest potency for raising total and LDL-cholesterol levels. This is directly related to its ability to down-regulate LDL-receptor activity in humans. Dietary cholesterol raises plasma LDL concentration by a somewhat similar mechanism.

Recent evidence suggests that palmitic acid (C16:0), the most abundant saturated fatty acid in the human diet is also neutral.

This neutrality is however subject to the make up of the host and to a large extent on the total amount of fat calories consumed.

Stearic acid (C18:0) has long been postulated to be a neutral fatty acid. Even though stearic acid is comparable to oleic acid in its cholesterolemic effects, it may lower HDL-C and increase lipoprotein Lp(a) concentrations (Hu *et al.*, 1999).

Further, different hypercholesterolemic fatty acids have different thresholds at which they exert an effect on plasma cholesterol, which are dependent on the concentration of linoleic acid and cholesterol in the diet and the initial plasma LDL-cholesterol concentration (Khosla and Sundram, 1996).

PALM OIL AS A SAFE, HEALTHY AND VERSATILE OIL

Palm oil is a major edible oil in many parts of the world and an important source of dietary fats. Palm oil contains a balanced proportion of the different classes of fatty acids and is rich in the fat soluble vitamins E (tocopherols and tocotrienols) and the carotenoids which are important precursors of vitamin A. In addition, these minor components have antioxidant functions. In addition to enhancing the palatability of food, fats including palm oil make a significant contribution to the energy needs of man (Chandrasekharan *et al.*, 2000).

Despite this important contribution to the diet, reports occasionally appear in the media, particularly in the fringe health press, which cast a negative light on palm oil, asserting that palm oil consumption may not be desirable under certain circumstances. These alleged associations are often based on anecdotal information rather than on sound, peer reviewed scientific research.

Dietary recommendations in Malaysia and elsewhere advice a general reduction in fat intake and in particular a reduction in saturates, especially for those at risk for heart disease. Some fats and oils are often singled out in this advice. This may lead to the

assumption that a direct link has been shown between palm oil consumption and heart disease, but this is not the case. It is a strange paradox that the general public opinion of palm oil focuses often on the negative and seldom applauds the many positive attributes. Palm oil has an important role to play as part of a healthy balanced diet.

Scientists at MPOB have reviewed a large number of studies comparing the influence on blood lipids of diets containing palm oil with an otherwise identical, isocaloric diet containing other oils. Their findings showed no differences in plasma lipids due to palm oil. Epidemiological studies conducted in Nigeria failed to find any correlation between the consumption of palm oil and the incidence of coronary heart disease. Palm oil consumption is not directly linked to cardiovascular disease. In fact, palm oil contains components which may exert a beneficial effect in prevention.

CHOLESTEROL SHOULD NOT BE PERCEIVED AS A HARMFUL SUBSTANCE

Cholesterol has a number of important biological functions. It is a constituent of cell membranes, including the nervous tissue and brain. It is also essential for the function of cellular membranes and the structure and function of lipoprotein particles. It is necessary for formation of steroid hormones (including the sex hormones - estrogens and testosterone), bile acids (necessary for digestion and absorption of fats and the fat soluble vitamins) and vitamin D. Cholesterol is a product of animal metabolism and all vegetable oils are relatively cholesterol free. More cholesterol is synthesized by the body than is taken normally in the diet.

THE MULTIFACTORIAL ETIOLOGY OF CORONARY HEART DISEASE

It is well recognized that many inherited and environmental factors interact to affect predisposition to the development of CHD. Of some 100 risk factors that pave the way

for CHD, many are genetic or environmental components that interact with the genes. Risk factors only explain 50% of cardiac cases. Elevated plasma cholesterol level (non-familial) is *one* of the modifiable risk factors. However, high cholesterol level is by no means the only causative factor for CHD. At any given level of hypercholesterolemia, there is considerable variation in the expression of the disease.

TRANS FATTY ACIDS – A NEW RISK FACTOR FOR HEART DISEASE?

Trans fatty acids are unnatural isomers formed during the hydrogenation of polyunsaturated oils. They have been associated with adverse changes in serum lipoproteins and coronary heart disease. The relative importance of *trans* fatty acids as a risk factor for CHD varies with the consumption of hydrogenated fats (Ascherio *et al.*, 1999).

DIETARY MODIFICATIONS FOR LOWERING BLOOD CHOLESTEROL LEVELS

There is a plethora of recommendations on diets to lower cholesterol levels. However, a meta-analysis using 19 trials showed that the effects of the various diets are less than expected. A study of more than 11 000 subjects for more than 13 years carried out by the Imperial Cancer Research Fund at Oxford concluded that the difference in heart disease levels between meat eaters and vegetarians is statistically insignificant. Dietary trials to try to prevent death in men who already had a heart attack has not proved effective. In men who have not had a heart attack, the results were very poor. In fact, in two trials there were an excess of deaths due to dietary intervention? Risk factors are not diet related but self inflicted or inherited (Timms, 1999). The general public show a considerable degree of indifference to coronary heart disease, despite possessing a reasonable level of knowledge of the risks involved. This is true even among patients (Shepherd, 1998).

Patients need to be reassured that the blood cholesterol level is only one variable

in the highly complex equation that determines how long and how well we live. While it is important to effectively retain or develop low risk behaviours in populations, it is equally important to reduce barriers engendered by social, economic and political patterns that inhibit the compression of CVD mortality and morbidity (Smith, 1991).

It is worth noting that there is declining death rates due to CHD in all developed countries regardless of serum cholesterol, obesity, *etc.* (the so called risk factors not changing). Each dietary factor must not be looked in isolation. It is wrong to look at each individual component of the diet, rather than diet as a whole. Diet is just one of the risk factors. With less than 25% due to diet, a very careful study is needed to separate effect of an individual dietary component.

FATTY ACID COMPOSITION OF COCONUT OIL, PALM OIL AND LARD IS NOT THE SAME

Palm oil is often confused with palm kernel and coconut oils. A recent article in an automobile club magazine even thought that it was similar to lard? The fatty acid composition of the above three oils/fat are not the same as evident from *Table 2* (Firestone, 1999). Lard being of animal origin contains significant amounts of cholesterol. They differ in their cholesterolemic effects.

OVERWEIGHT - AN EMERGING PROBLEM

The prevalence of obesity increased from 12.0% in 1991 to 17.9 % in 1998 in the US. Obesity increased in men and women and across all sociodemographic groups with the highest increase among the youngest ages and higher education levels (Kennedy, 1999; Mokdad *et al.*, 1999). Obesity is ultimately an issue of positive energy imbalance. This is an artifact of increasing energy consumption. Obesity is associated with an increased risk of numerous chronic diseases. The prevalence of comorbidity for the following conditions was high among the obese: type

TABLE 2. FATTY ACID COMPOSITION OF SELECTED OILS/FAT

Fatty acid	Lard	Coconut	Palm kernel oil	Palm oil
6:0		0- 0.6	0- 0.8	
8:0		4.6- 9.4	1.9- 6.2	
10:0		5.5- 7.8	2.6- 5.0	
12:0	<0.5	45.1-50.3	40-55	0-0.4
14:0	0.5-2.5	16.8-20.6	14-18	0.5-2.0
16:0	20-32	7.7-10.2	6.5-10.3	40-48
18:0	5-24	2.3-3.5	1.3-3.0	3.5-6.5
18:1	35-62	5.4-9.9	12-21	36-44
18:2	3-16	0.8-2.1	1-3.5	6.5-12
Cholesterol	950 mg kg ⁻¹	ns	ns	ns

11 diabetes mellitus, gall bladder disease, coronary heart disease, high blood cholesterol level, high blood pressure and osteoarthritis.

An handout on 'Management of Overweight' distributed to patients in Malaysia by a premier health institution lists the following as fats to be avoided: butter, suet, dripping, palm oil, lard, margarine and hydrogenated fats. Obviously this page has been lifted out from some archaic text that rightfully should be confined to the archives. The practice of using suet and drippings is insignificant and a thing of the past and has long been discontinued in Malaysia. Overweight is a problem of energy imbalance. All fats yield the same amount of energy on oxidation. As such, the quantity of any fat is more important than the quality of specific fats. The message is obviously flawed. It is pertinent to note that recent evidence suggests that palm oil has less tendency towards promoting adiposity in animals fed an excess of fats.

HIGH FAT REGIMES ARE NOT HEALTHY

Eating too much of anything is bad. More has not always meant better. Oils and fats are not bad if consumed in moderation. The implication that high intakes of dietary fat are associated with disease has produced a perception of fat in the consumer's mind that is anything but positive. Consequently, almost any food that contains fat, regardless

of what other nourishment it provides, has been labelled as 'bad for you'. This situation has no doubt influenced consumer's perceptions of fats and oils.

The average diet in industrialized countries consists of 40%-45% fat calories (Scrimshaw, 1998) and this is the main reason why heart disease is the number one killer in the United States (Mokdad *et al.*, 1999). Many fat reduction campaigns and programmes have been developed during the past 20 years to help Americans reduce their fat intake. Consensus on the need to reduce dietary fat was not reached until the 1980s. Reduction of fat has received significant attention both from public health authorities and the media. In recent years, the recommendations have changed from 'avoid too much fat' to 'choose a diet low in fat, saturated fat, and cholesterol'.

The original impetus for recommendations to reduce dietary fat intake arose from studies that assessed the relationship between diet and cardiovascular disease. A diet that is low in saturated fatty acids, *trans* fatty acids, cholesterol and relatively high in unsaturated fatty acids gives the best lipoprotein pattern. National dietary guidelines in most industrialized countries recommend that intakes of total fat and saturated fatty acids be reduced (Porter *et al.*, 1998).

Current dietary guidelines are to reduce absolute fat intake and not to compensate it with concomitant increase in carbohydrate

intake. Dietary data indicate that while fat as a percentage of total calories is declining, actual amount by weight has increased and total calorie intake is increasing (Kennedy *et al.*, 1999). Palm oil is not a major contributor to fat intake in those countries where fat intakes are a cause for concern.

FAT DOGMAS THIN ON EVIDENCE

A very small minority of people hold strong and atypical views about the appropriate composition of the human diet which prevent them from viewing emerging oils like palm oil as a healthy oil, despite its important contribution as an edible oil. In putting their case across in the media, they sometimes draw upon any information they can find, regardless of whether it is anecdotal or unsound. As a consequence, articles occasionally appear in certain publications portraying the supposedly adverse effects of palm oil. Many of the alleged associations are so obscure that they have often not even been investigated in a scientific manner. For this, we must also not forget the many interest groups that can influence the process.

Very often unqualified statements like 'saturated fats are bad for your health, because they raise your blood cholesterol levels and polyunsaturated fats are good for your health, and that they may even help to lower your blood cholesterol level' are irresponsibly propounded. These are not only simplistic but also ignore the extensive body of published information that documents our current understanding of the effects of fatty acids.

The oils and fats industry together with their products are highly competitive and the major players in the industry invest significantly in marketing activities, involving advertising, development and maintenance of distribution network, shelf space and packaging to create brand awareness and loyalty with a view to garner market share. Sometime subtle strategies are adopted for competition and to increase their respective market share and in this process, it is not unusual for exaggerated and unre-

alistic claims to be disguised as expert opinion and cleverly weaved into the story.

CONCLUSION

As responsible scientists, we are perturbed at times when the wrong messages are conveyed to the public targeting specific oils and fats. The role of oils and fats must be seen in perspective with other dietary components and diet in turn with other environmental factors. The focus on overall diet quality is often lost in the national obsession with lowering fat intakes. It would be a mistake to equate all low fat diets with nutritionally optimal diets. While macronutrients such as total fat and saturated fatty acids clearly deserve attention, other aspects of the diet cannot be overlooked. Focussing on individual items of food or getting obsessed with isolated risk factors distracts one from pursuing an holistic approach in promoting health. There are signs that the priority placed on the fat message in particular has overshadowed the larger goal of overall healthful lifestyle.

Science is evolutionary and there has been a better understanding of oils and fats and their effects on health and disease over the years (Chandrasekharan, 1999). Many concepts and studies published in journals and promoted vigorously often do not stand the test of time and are eventually rendered irrelevant by new studies, whereas some are flatly contradicted. It makes sense that dietary recommendations and perceptions about oils and fats have to change with time and the emerging evidence. This is very relevant for the emerging oils like palm oil. In this regard, the media has a responsible role to play in consumer education by raising awareness and understanding.

It is reiterated that fats play an important role in the health of the body and the key is what kind and how much you eat. We must not only help consumers recognize misinformation but also have an intensive campaign to educate them to interpret the claims and the competing interest behind the issue and assist them in making informed choices.

Consumers prefer information on what they should eat rather than what they should not eat. Lifestyles strongly influence health or illness. We have to promote lifestyles that enhance health and to reduce those that damage health. Recommendations for a change in lifestyle habits, particularly dietary habits must have a solid scientific foundation.

REFERENCES

- ASCHERIO, A; KATAN, M B; ZOCC, P L; STAMPFER, M J and WILLET, W C (1999). *Trans fatty acids and coronary heart disease. New England Journal of Medicine, 340:1994-1998.*
- BEARE ROGERS, J; GHAFOORNIS, O; KORVER, O; ROCQUELIN, G; KALYANA SUNDRAM and UAUY, R (1998). Dietary fat in developing countries. *Food and Nutrition Bulletin, 19:251-267.*
- CHANDRASEKHARAN, N and YUSOF, B (1998). Food and nutrition misinformation and its implications. *Proceedings of the Malaysian Science and Technology Congress 98.* COSTAM, Kuala Lumpur. p.38
- CHANDRASEKHARAN, N (1999). Changing concepts in lipid nutrition in health and disease. *Medical J. Malaysia, 54: 408-428.*
- CHANDRASEKHARAN, N; KALYANA SUNDRAM and YUSOF BASIRON (2000). Changing nutritional and health perspectives on palm oil. *Brunei International Medical Journal, 2:417-427.*
- FIRESTONE, D (1999). Physical and chemical characteristics of oils, fats, and waxes. AOCs Press, Champaign, Ill, USA. 146pp.
- GILLMAN, M W; CUPPLES, L A; MILLEN, B E; ELLISON, R C and WOLF, P A (1997). Inverse association of dietary fat with development of ischaemic stroke in men. *Journal of the American Medical Association, 278:2145-2150.*
- GURR, M I (1998). Changes in coronary heart disease and its 'risk factors': paradox or not. *Lipid Technology, 6:133-134.*
- GURR, M I (1999). *Fats in Human Nutrition.* Malaysian Palm Oil Promotion Council, Kuala Lumpur. 70pp.
- HU, F B; STAMPFER, M J; MANSON, J E; SCHERZO, A; COLDITZ, G A; SPEIZER, F E; HENNEKENS, C H and WILLET, C W (1999). Dietary saturated fats and their food sources in relation to the risk of coronary heart disease in women. *American Journal of Clinical Nutrition, 70:1001-1008.*
- KENNEDY, E T; BOWERSON, S A and POWELL, R (1999). Dietary fat intake in the US population. *J. Amer Coll Nutrition, 18:207-212.*
- KHOSLA, P and SUNDRAM, K (1996). Effects of dietary fatty acids on plasma cholesterol. *Progress in Lipid Research, 35:93-132.*
- KITTLER, P G and SUCHER, K (1989). *Food and Culture in America: A Nutrition Handbook.* Van Nostrand Reinhold, New York. 180pp.
- LICHTENSTEIN, A H; KENNEDY, E; BARRIER, P; DANFORD, D and ERNST, N D (1998). Dietary fat consumption and health. *Nutrition Reviews, 56:S3-S28.*
- MOKDAD, A H; SERDULA, M K; DIETZ, W H; BOWMAN, B A; MARKS, J S and KOPLAN, J P (1999). The spread of obesity epidemic in the United States 1991-1998. *Journal of the American Medical Association, 282:1519-1522.*
- MORGAN, A (1998). Improving public understanding. *Journal of the National Cancer Institute, 90:194-99.*
- PORTER, D; KRIS-ETHERTON, P; BORRA, S and ERWIN, M C (1998). Educating consumers regarding choices for fat reduction. *Nutr Reviews, 56:S75-S100.*
- SCRIMSHAW, N S (1998). Energy requirements and the role of fat, protein and carbohydrate as energy sources. *Lipid Technology, 10:105-110.*

SHEPHERD, J (1998). New evidence, new guidelines. *Atherosclerosis*, 137:S117-S123.

SMITH, R (1991). *The Cholesterol Conspiracy*. Warren H Green Inc. St. Louis, USA. 136pp.

TIMMS, R (1999). Personal communication based on seminar 'A critical appraisal of the role of lipids in heart disease' given at the AGM of the SCI Oils & Fats Group on 10 June 1999.