# NUTRITIONAL ROLES OF DIETARY FATS WITH SPECIAL REFERENCE TO PALM OIL+

*B Berra**

Fats which represent one of the most concentrated forms of energy, are normal constituents of the diet. The qualitative and quantitative aspects of fat consumption are strongly influenced by many factors: social, cultural, economic, geographical and racial. Moreover in recent years, in parallel with an increase in consumption, changes have occurred in the choice of dietary fats, as reflected by a reduction in the use of fats of animal origin and a concomitant increase in the consumption of vegetable oils with the intention of achieving better health.

*Functions of dietary fats.* From a quantitative point of view, dietary fats represent the most important source of energy, in this connection, saturated fatty acids are the best substrate for the production of ATP through ß-oxidation. However fats have additional functions which must be taken into account when considering a well-balanced diet. In fact they are the carriers of the fat soluble vitamins and a source of essential fatty acids (EFA). EFA, which include linoleic and alpha-linolenic acids, are the precursors of the eicosanoid nucleus and contribute to the regulation of membrane fluidity. The optimum ratio of linoleic to alpha-linolenic acid is still a subject of debate but there seems to be a general agreement that polyunsaturated fatty acids should account for no more than 10% of the calories from fat in the diet.

Two additional functions of dietary fats have also to be considered: 1) they add to the palatability of foods, and 2) they are involved in the regulation of the hunger centre, since they contribute to the sensation of satiety after a normal meal.

*Role of body fats.* Fats can be stored in substantial quantity in the adipose tissue and they form a major energy reservoir for the whole organism. The relevance of fatty acids as an energy source is further exemplified in the recent finding that the different composition of muscle fibre types is possibly an aetiological factor for obesity (Wade, 1990). Fatty acids are not only utilized for the production of chemical energy in the form of ATP but are also involved in thermogenesis; in fact a special intrinsic protein of the inner mitochondrial membrane is able to convey the energy derived from the electron transport chain to the production of heat. However it must be pointed out that the oxidation of fatty acids is exclusively an aerobic process. Moreover fats which are present in adipose and subcutaneous tissues constitute a physical protection for vital organs and insulate against heat losses. Finally, phospholipids and cholesterol, both from endogenous and exogenous sources, represent the building blocks of cellular membranes, natural detergents (biliary acids) and the fat transport systems (plasma lipoproteins).

*Chemical composition of palm oil.* The fatty acid composition of palm oil is as follows: palmitic 43.0% - 48.0%; stearic 4.5% - 5.5%; oleic 35.0% - 40.0%; linoleic 8.5% - 11.0% and alpha-linolenic 0.2% - 1.0% (Ia 009-NGD, 1989). Palm oil should be distinguished from palm kernel and coconut oils since its fatty acids have a lower level of saturation and it lacks fatty acids of shorter chain length, such as caprylic, lauric and myristic. For most purposes palm oil does not require hydrogenation, thus avoiding the formation of the *trans*-fatty acids and uncommon *cis*-fatty acids found in hydrogenated oils. Interestingly, about 60% of the total triglycerides of palm oil contain mono- or poly-unsaturated fatty acids in the 2-position and the percentage of diglycerides present is particularly high (Geeraert and Sandra, 1985; Mariani and Fedeli, 1985).

The composition of the sterols in palm oil is typical of a vegetable oil, *i.e.* there is a high proportion of ß-sitosterol (60.0% - 65.0%) with campesterol and stigmasterol accounting for 20% - 22% and 9% - 13% respectively, while the amount of cholesterol is negligible (Ia 990 - NGD, 1989).

*Nutritional aspects of palm oil.* Based on epidemiological and animal studies, the amount and type of dietary fats play a crucial role in determining plasma lipid concentration. A level of plasma lipid (cholesterol and/or triglycerides) is claimed to be involved in the pathogenesis of atherosclerosis, coronary heart disease (CHD) and vascular diseases. Many consensus conferences have agreed that dietary cholesterol and saturated

* Head, Department of General Physiology and Biochemistry University of Milan, Italy

+ This paper was presented at the European Palm Oil Symposium in May 1990

fatty acids affect blood cholesterol levels. Recently it was also recognized that an increase in blood triglycerides may represent a risk factor for vascular diseases.

Triglycerides and cholesterol are transported in the blood in association with phospholipids and apoproteins; this micellar arrangement constitutes the so-called lipoproteins (Scanu and Spector, 1986; Assmann, 1982).

The very low density lipoproteins (VLDL), which are synthesized in the liver, transport mainly triglycerides, while the low density lipoproteins (LDL) transport cholesterol from the liver (where it is synthesized or repacked) to the tissues; cholesterol in the form of LDL represents a risk factor for CHD (Castelli, 1986).

Plasma lipoproteins can be taken up from the circulation and internalized in the tissue via a receptor-mediated process; in particular LDL cholesterol can be taken up again by the liver; thereafter the sterol can be further metabolized and utilized (Goldstein and Brown, 1984). An increased production of LDL receptors, assessed by the increase in the specific messenger RNA, indicates a more efficient removal of LDL particles from the blood, and such an increase in LDL receptors is considered to reduce the risk of heart disease. On the other hand the down-regulation of LDL receptor expression induced by saturated triglycerides of animal origin (Spady and Dietschy, 1985) is considered to be detrimental in relation to CHD.

Despite its content of palmitic acid, palm oil cannot be compared to animal fats. In fact, as in other vegetable oils, the middle (2-) position of the triglycerides is mainly occupied by unsaturated fatty acids; digestion preferentially splits off the fatty acids in position 1 and 3, and therefore a high proportion of unsaturated 2-monoglycerides are absorbed from palm oil.

There is another lipoprotein (high density lipoprotein or HDL) that is engaged in the reverse transport of cholesterol from the tissue to the liver. HDL levels are inversely related to susceptibility to CHD and the same association has been demonstrated for Apo A-1, the apoprotein linked with HDL which ensures its receptor-mediated uptake by the liver (Heiss and Tyroler, 1982). Apo A-1 is thought to participate via two mechanisms in the reverse transport of cholesterol from the tissues to the liver where it is utilized or metabolized to bile acids which can be excreted. Apo A-1 can promote cholesterol efflux: 1) by facilitating its translocation from inside the cell to the plasma membrane and by acting as a signal for a specific receptor that is up-regulated by cholesterol loading (Brinton and Bierman, 1983) or 2, by displaying cofactor activity for the lecithin-cholesterol acyltransferase (LCAT) enzyme, which is responsible for almost all plasma cholesterol esterification (Fielding, 1973).

A diet in which palm oil contributed 5% by weight resulted in a significant increase in the production of the m-RNA for the LDL receptor and of apoprotein A-1 (Hayes, 1988): these data point to a beneficial effect of palm oil in reducing cardiovascular risk.

So far only a limited number of human feeding studies have been published where a diet rich in palm oil was used; in none of them was palm oil associated with a rise in serum cholesterol as compared to the starting values, when the volunteers had been eating the habitual diets (Anon., 1987).

In the control of the levels of LDL and HDL cholesterol, as well as of VLDL triglycerides, a relevant role might be attributed to the high oleic acid content of palm oil. Recent studies in fact demonstrate that oleic acid is as active as polyunsaturated fatty acids in reducing blood cholesterol (Mattson and Grundy, 1985; Zoppi, 1985; Berra and Rapelli, 1986). The effect of olive oil on serum triglyceride control has also been observed (Zoppi *et al.*, 1985).

Personally, I believe that a discussion of the nutritional properties of palm oil should not be confined to its possible effect on blood cholesterol, since there is growing evidence in the recent literature that cholesterol is not to be considered the major risk factor for CHD or vascular disease, especially in older persons (Kaiser and Morley, 1990; Anon, 1989; McNamara, 1987). According to these findings, the evaluation of palm oil should also take into consideration the following points:

1. Palm oil is readily digested, absorbed and utilized.

The digestibility of a fat depends upon the chain lengths and the nature of the fatty acids in the triglyceride molecules present. Triglycerides with low melting points are digested more rapidly; in other words the rate of hydrolysis is reduced by the presence of significant quantities of saturated fatty acids and increased by the unsaturated ones. Moreover, the presence of oleic acid in the 2 position of

2 - monoglycerides produced by hydrolysis results in a better stabilization of the digestive emulsion which can therefore penetrate more easily into the intestinal mucosa: a high percentage of palm oil triglycerides have oleic acid in the 2 position. Also, the presence of a relatively large amount of diglycerides contributes to an increase in digestibility.

Fatty acids and 2-monoglycerides are absorbed into the intestinal mucosa cells by simple diffusion; the process is reported to be facilitated by the presence in the jejunal mucosa of a protein which binds chain fatty acids (Ockner, Manning, Poppenhausen and Ho, 1972); this FABP (fatty acid binding protein) appears to have a higher affinity for unsaturated than for saturated fatty acids (Ockner and Manning, 1974). These results warrant the assumption of a very high digestibility for palm oil (Calloway and Kurtz, 1956).

2. Refined palm oil is a rich source of vitamin E and related substance (tocopherols and tocotrienols) (Meyboom and Jongenotter, 1979) which have been reported to have the following effects:

a) In a cross cultural and epidemiological study (Gey, Puska, Jordan and Moser, in press) the amount of vitamin E in plasma showed a strong inverse correlation with the age-specific mortality from ischemic heart disease (IHD). The parameter was found to be a better marker for IHD than the amount of total plasma cholesterol.

b) These substances are antiaggregatory to blood platelets *in vitro* (Steiner and Anastasi, 1975), thereby possibly reducing thrombosis *in vivo*. Moreover they promote the formation of prostacyclin, a potent vasodilatory and antithrombotic compound(Chan and Leith, 1981).

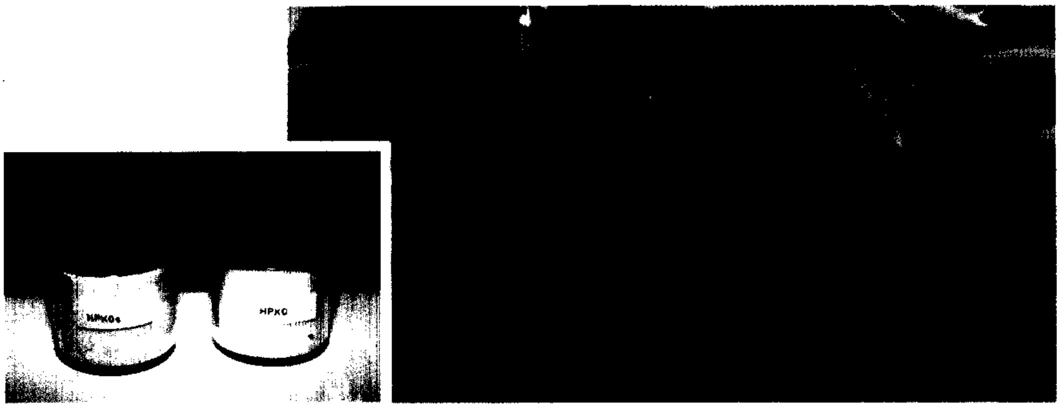
c) Vitamin E and the tocotrienols are natural antioxidants. They act as scavengers of damaging oxygen free radicals which are hypothesized to play a role in cellular ageing, atherosclerosis and cancer. This antioxidant effect is involved also in the enhancement of immunological defence mechanisms which is attributed to vitamin E and tocotrienols (Corwin and Gordon, 1982).

In addition, unrefined palm oil, which is consumed in a number of countries, is one of the richest sources of ß-carotene, which is regarded as an anti cancer agent of great promise (Ziegler, 1989).

Finally it must be pointed out that studies on the nutritional value of palm oil (as well as of many other vegetable oils) have focused mainly on the triglycerides, with relatively few investigations on the minor components—vitamin E, tocopherols, tocotrienols, carotenoids, sterols - which have potential nutritional value. They deserve further study, and in the case of palm oil seem likely to contribute to its beneficial effects.

# THE USE OF PALM PRODUCTS IN TOFFEE

*Sabariah Samsudin, Teah Yau Kun and Salmi Yati Shamsudin*



## INTRODUCTION

Toffee can be defined as being essentially like highly-cooked caramels with a harder texture. The production of toffee of good texture and taste with an attractive colour and long shelf-life is a worthwhile aim which requires some care to achieve.

Our experimental toffees were initially made from sugar, glucose and water solution boiled to a soft 'crack'; they contained only a little fat and no milk. Later, milk was added to produce toffee of a hard and 'chewy' texture.

## FORMULATION

The basic formulation for toffee developed in PORIM is as follows:

| **Ingredients** | **Weight (g)** |
|---|---|
| Granulated sugar | 75 |
| 42 DE glucose syrup | 217.5 |
| Full cream sweetened condensed milk | 147.5 |
| Fat | 60 |
| Salt | 2 |
| Water | 15 |
| Lecithin | 0.5 |

Toffee was made by the emulsification method. The ingredients were premixed and emulsified at 60°C for 15 minutes; the temperature was then increased to 123°C in 25 minutes.

## TYPES OF FAT USED IN TOFFEE

Traditionally, the fat used in toffee is butter and from the flavour standpoint this is certainly significant. Good toffee can also be made from vegetable fats with high oxidation stability and for many years the recognized 'toffee butter' was hardened palm kernel oil (Minifie, 1980). Other fats have also been used, notably hardened coconut and hardened fish oils, but there are some difficulties with carry-over of flavour.

The inclusion of fats in the formulation affects the texture by giving body to the toffee and providing chewiness, lubrication and reasonable resistance to moisture penetration and absorption.

Fats with higher melting points (35°C - 45°C) are preferred in hotter climates (Lees and Jackson, 1973). Since toffee for such climates should be harder, lower melting fats are unsuitable because the toffee produced will be greasy, mainly because of slow migration of the fat from the body of the toffee to the surface. This will increase its susceptibility to rancidity owing to the increase in exposure to the atmosphere.

A good quality toffee should contain 24% - 28% condensed milk and about 18% - 20% fat calculated as percent of raw material on the out turn. For a cheaper product the quantity of milk fat can be reduced but the eating quality will be inferior.

Several types of fats have been tried in the PORIM toffee formulation *(Table 1)*. Data on the properties of these fats are given in *Table 2.*