RECENT ADVANCES IN PALM OIL NUTRITION

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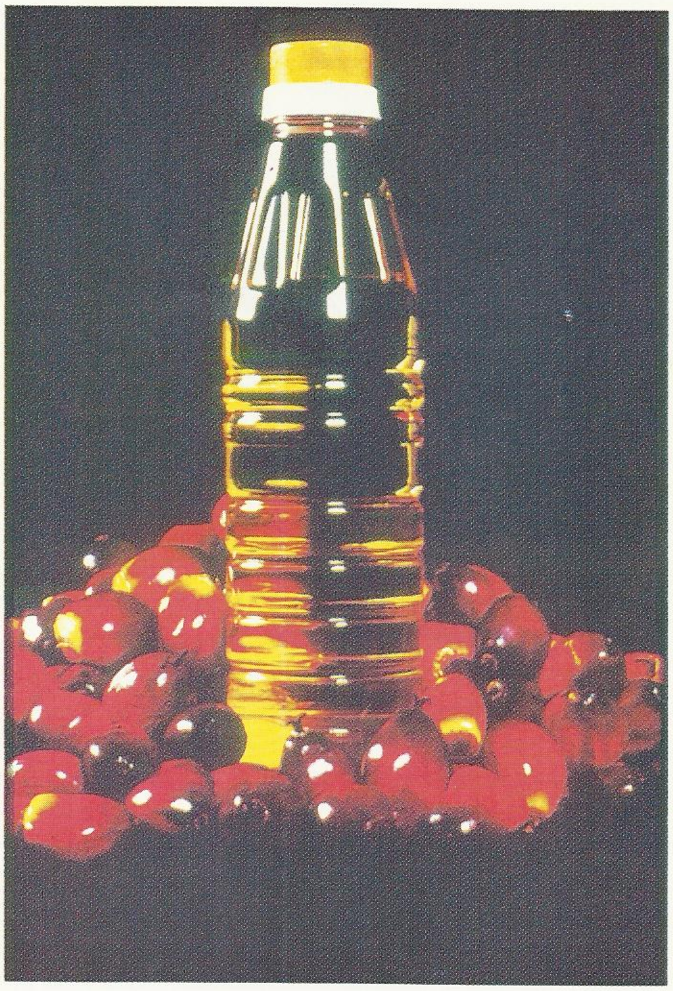
INTRODUCTION

Gone are the days when we were practically afraid to talk about the nutritional properties of palm oil. The fear then was not so much our reservation about its nutritional attributes but rather the lack of published references available in the world biomedical databases. This was significantly corrected by PORIM's concerted efforts in propagating well-defined research themes to evaluate and understand the underlying mechanisms that dictate the nutritional effects of palm oil and its fractions. To date, PORIM has commissioned a total of 97 such nutritional trials worldwide and many of the completed studies have now been published in reputed journals and indexed in the best biomedical databases making access to these important scientific findings available to anyone interested. It would also be correct to point out here that PORIM's efforts have indirectly spurred other independent research on this important food commodity recently and this is borne out by the increasing number of publications generated by various research groups not funded by PORIM. A number of recent publications on this subject are summarized in this review.

NEUTRALITY OF PALMITIC ACID GAINS MOMENTUM

Palmitic versus lauric, myristic acids in the human diet

Based on data from animal and human studies, the generally held notion that the saturated fatty acids, specifically lauric, myristic and palmitic are equally cholesterolaemic has been challenged in recent years. The challenge has been spearheaded by the group led by Prof. K.C. Hayes at the Foster Biomedical Research Laboratories, Brandeis University, in the United States of America. An early report from this laboratory showed that plasma cholesterol in their monkeys was not uniformly elevated by the different saturated fatty acids. Suprisingly, plasma total cholesterol and the atherogenic LDL-cholesterol decreased as the content of palmitic acid in the diet was increased at the expense of lauric+myristic acids. This cleary suggested that palmitic acid was not cholesterol raising as previously postulated by the classical predicative equations of Keys and Hegsted. Further studies from this laboratory using radiolabeled lipoprotein kinetics suggested that palmitic acid-rich palm oil and oleic acid-rich safflower oil had almost equivalent effects on LDL-cholesterol metabolism. A clear emergence from this study and other similar



Cooking Oil

studies was the observation that LDL receptors activity (important for the regulation of the atherogenic LDL-cholesterol) was not down-regulated by a palm oil en-

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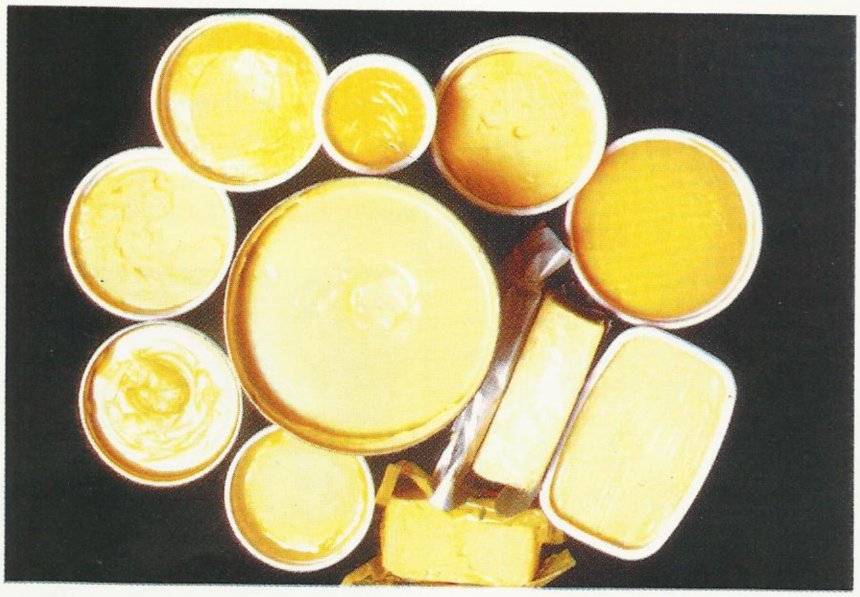
riched diet. It soon became apparent that myristic acid (occurring mainly in coconut oil, butterfat and palm kernel oil) is the single most potent cholesterol elevating saturated fatty acid in the diet. These studies also gave birth to the concept of a 'threshold' level for polyunsaturated linoleic acid. Unlike previous arguments in the literature, it was postulated that a maximum of 5% - 7% energy as linoleic acid in the diet was optimum for maintenance of a preferred plasma cholesterol-lipoprotein balance (Hayes and Khosla, 1992).

The results from these animal studies have now been tested in several human clinical trials thereby giving greater credence to the neutrality of palmitic acid. Sundram *et al.* (1994) undertook a direct comparison of palmitic acid versus a lauric + myristic acid combination in 18 healthy male volunteers fed controlled diets for four week durations. The hypothesis tested was that the selective exchange of dietary palmitic acid for lauric+myristic acids would produce lower plasma cholesterol concentrations in normo cholesterolaemic individuals, thereby proving that the saturated fatty acids are not uniform in their cholesterolaemic effects. The lauric+myristic acids enriched diet resulted in significantly higher total and LDL-cholesterol than the palmitic acid enriched (palm olein) diet. An independent human study by Schwab *et al.* (1995) evaluated the effect of diets differentiated by either lauric or palmitic acids but with the content of myristic acid held at a low but constant level. There were no differences in the concentration of serum total or lipoprotein cholesterol, apolipoproteins or Lp(a) between the diets. This therefore suggests that it is myristic acid that renders diets cholesterolaemic. A third study from Scandinavia (Tholstrup *et al.*, 1994) also reported similar effects in healthy humans. They demonstrated that substitution of palmitic acid for a lauric-myristic acids enriched diet resulted in significantly elevated serum total and LDL cholesterol levels in their subjects. The above human studies were successful in demonstrating that the different saturated fatty acids are not uniform in their effects on plasma cholesterol levels and that myristic acid is the most potent cholesterol raising saturated fatty acid.



Margarine

Palmitic versus oleic acid in the human diet

Fats in the human diet are distributed as saturated, monounsaturated and polyunsaturated fatty acids. Monounsaturated fatty acids have gained prominence as a preferred fatty acid component in the diet. This has been due to several epidemiological and clinical observations that populations consuming a reasonably high amount of the monounsaturated fatty acids are apparently protected against the onset of coronary heart disease. Hence, the desire of many to incorporate Mediterranean type fatty acids in the diet, in this case predominated by olive oil rich in oleic acid. Apart from olive oil, canola, rapeseed, sunflowerseed and safflowerseed oils are rich in oleic acid. It would be in the interest of the reader to remember that the oleic acid content of palm olein is in excess of 45% of its composition. This can be further increased by double fractionation during processing or by breeding new varieties of oil palm having an oleic acid composition almost similar to that of olive oil. Nutritionally, there is little doubt about the benefits of a diet high in monounsaturated oleic acid but the question of how much is optimum remains a mystery for now. The answer to this may, at least in part, lie in human studies evaluating palm olein against monounsaturated olive and canola oils.

The average Malaysian diet containing 25% energy as fat is predominantly cooked with palm olein. This was the basis of a human study in healthy Malaysian volunteers fed controlled diets and cooked almost entirely with either palm olein or olive oil (Ng *et al.*, 1992). Thirty-three subjects were initially challenged with a coconut oil-rich diet for four weeks and subsequently assigned to either a palm olein rich or olive oil-rich diet for six week durations. The coconut oil diet significantly raised all lipid and lipoprotein parameters. Subsequent one-to-one exchange between the palm olein and olive oil diets resulted in identical serum total, LDL and HDL cholesterol in the volunteers. This was in spite of the observation that the palm olein diet had almost 21% more palmitic acid and 22% less oleic acid than the olive oil diet.

A second but independent comparison of palm olein versus olive oil was performed in Australia recently (Choudhury *et al.*, 1995). Twenty-one healthy free living volunteers who normally consumed a typical high fat Australian-type diet were initially conditioned to a low fat diet. To this was added the test oils, palm olein and olive oil in the form of spreads, frying fat and bakery fat such that approximately 30% energy from fats was available during the experimental dietary periods. As a result, energy intake from oleic acid during the olive oil period was 1.6 times that during the palm olein period. Conversely, energy derived from palmitic acid during the olive oil period was half that during the plam olein period. Theoretically, these differences in oleic and palmitic acid consumption levels should have resulted in significant differences in the volunteers' blood cholesterol levels. However, under the experimental conditions plasma total and LDL cholesterol were again identical with the two test oils.

In another Malaysian study (Sundram *et al.*, 1995), resident male volunteers were fed diets supplying approximately 31% energy as fat derived from palm olein (high palmitic acid), canola oil (high oleic acid), or an American Heart Association Step 1 diet (equal amounts of saturates, monounsaturates and polyunsaturates). The palm olein and canola oil diets represented a direct exchange of 7% energy between palmitic acid for oleic+linoleic acids. The expected differences in plasma cholesterol levels again did not materialize since the diets resulted in identical lipid and lipoprotein cholesterol levels.

The above human studies clearly demonstrated that in a 30% fat energy dietary environment the lipidaemic effects of palm olein are comparable to those of monounsaturated olive and canola oils although their fatty acid compositions differ significantly. Indeed, the 45% oleic acid content in palm olein was generally found to by hypocholesterolaemic and comparable to the higher content (70%) of oleic acid in olive and canola oils. This helps to emphasize the neutrality of palmitic acid, especially in a low fat dietary environment.

Towards an optimum balance of LDL/HDL cholesterol ratio

The American Heart Association (AHA), in an attempt to lower the incidence and mortality from coronary heart disease in the American population, has recommended a modified diet low in fat. Popularly known as the AHA Step I diet, the recommendations include a maximum fat consumption of 30% energy in which the saturates, monounsaturates and polyunsaturates are distributed in an equal ratio of 1:1:1. Unfortunately, no single edible oil or fat can effectively contribute this desired ratio of fatty acids. However, it is enlightening to note that this AHA blend can be easily prepared by a blend of palm olein, soya bean oil and canola oil. Such a palm-based AHA blend was recently evaluated in humans (Sundram *et al.*, 1995). The AHA blend did not affect serum total and LDL-cholesterol in comparison to a palm olein or canola enriched diet. However, the AHA blend caused a significant 17% increase in the beneficial HDL cholesterol and thereby altered the LDL/HDL cholesterol ratio beneficially. This led the authors to hypothesise that an optimal LDL/HDL ratio may depend on an appropriate balance between the saturates and polyunsaturates in the diet and that the saturates in the form of palmitic acid from palm oil/olein appear more desirable. Considering that every unit increase in the HDL-cholesterol level is deemed beneficial, the incorporation of high levels of palm olein to achieve an AHA type blend could foster better protection against the onset of coronary heart disease.

Positional distribution of palm triglyceride fatty acids and their nutritional implications

Dietary fats and oils differ in their distribution of fatty acids within the triglyceride molecules. Depending on their positional distribution, it has been postulated that lipoprotein concentration and distribution may be influenced. Typically, triglycerides are absorbed in the intestine after hydrolysis to monoglycerides and fatty acids. They are then resynthesized into triglycerides and secreted in the chylomicrons which largely retain the original fatty acid in the 2-positon. Palmitic acid in palm oil is predominantly esterified in the one and three positions of the triglyceride. This is also true for most other vegetable oils. On the other hand, in most animal fats and especially in lard (pork fat), palmitic acid occupies the 2-position.

Two recently published studies have attempted to elucidate the nutritional properties of palm oil on the basis of its triglyceride fatty acid distribution. In their rat study, Renaud *et al.* (1995) suggested that palm oil was not thrombogenic as might be expected from its fatty acid composition due to the majority of its saturates being esterified in the one and three positions. Indeed, when palm oil was interesterified and palmitic acid largely repositioned in the 2-position (as occurs naturally in lard) a higher thrombogenicity of the interesterified fat was evident. Zock *et al.* (1995) examined the effect of palm oil and enzymatically modified palm oil in 60 subjects. Their natural palm oil had 82% of the palmitic acid attached to the one and three positions whereas the enzymatically modified palm oil had only 35% palmitic acid attached to the one and three positions. With the enzymatically modified palm oil diet, a nonsignificant increase in total and LDL-cholesterol was recorded. Although they concluded that such modification of palm oil does not confer any advantage to cholesterol metabolism, its effects on other nutritional parameters, especially the thrombogenic factors, may need further examination.

CONCLUSION

The studies quoted above provide strong and credible evidence for the nutritional wholesomeness of palm oil and its fractions. The growth in the trade and consumption of palm oil has also been matched by increasing interests in understanding its physical, chemical and nutritional properties. This trend is expected to continue and the reader can expect more information on the health aspects of palm oil and its fractions in the near future.

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