# Dietary Fats and Inflamation: Some Recent Developments

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## INTRODUCTION

In the past six decades, a number of epidemiological studies have shown a clear association between certain dietary fatty acids and the risk of cardiovascular disease. A 2% increase in energy intake from partially hydrogenated fats or *trans* fatty acids is associated with a 23% increase in the incidence of cardiovascular heart disease. Replacement of saturated or *cis* unsaturated fatty acids with *trans* fatty acids has been shown to raise low-density lipoprotein (LDL) cholesterol concentrations, reduce high-density lipoprotein (HDL) cholesterol concentrations, and increase the total:HDL cholesterol ratio (Mensink *et al*., 2003; Mozaffarian *et al*., 2004). High blood levels of *trans* fatty acids have also been shown to have a more pronounced adverse effect on the lipid profile and other cardiovascular disease risk markers, and are more strongly associated with the incidence of cardiovascular heart disease than saturated fatty acids (SFA) (Willett, 2006; Mozaffarian and Clarke, 2009).

The increasing use of artificially produced *trans* fats in foods drew grave concern from the public, and led to stricter regulatory measures globally. Consequently, the United States Food and Drug Administration put out a mandatory '*trans* fatty acids' labelling on packaged food products, effective from 1 January 2006, and this prompted food manufacturers to find alternatives to the use of commercially hydrogenated vegetable oils in formulating bakery products, and in margarines and fried foods. The consumption of partially hydrogenated vegetable oils in western countries has reduced tremendously after the mandatory labelling of '*trans* fatty acids'. Consumers in developed countries have become more aware of the health hazards of *trans* fatty acids.

However, Asian countries such as Iran have also reported high consumption of partially hydrogenated vegetable oils (>75%). The *trans* fatty acids content of partially hydrogenated vegetable oils used in Iranian households is 25%-35%, and up to 50% in the food industries (Mozaffarian *et al*., 2007). The energy intake from *trans* fatty acids in Iranians is 12.5% of energy total calorie intake (Mozaffarian *et al*., 2007).

In India, vanaspati is a typical blend of partially hydrogenated vegetable oils which contains up to 40% of *trans* fatty acids (Ghafoorunissa, 2008). Vanaspati is a substitute for animal ghee commonly used for home cooking, in bakeries, and in the preparation of commercially fried and processed foods. In north India, the maximum consumption of vanaspati can be up to 20 g per person per day (Ghafoorunissa, 2008). The formulation of partially hydrogenated vegetable oils may vary between different countries (L'Abbe *et al*., 2009). Palm oil, which is widely used in Southeast Asian countries, is a natural replacement for commercially-produced hydrogenated vegetable oils.

## DIETARY FATS AND INFLAMMATION

Currently, there is emerging evidence that suggests that certain dietary fatty acids may have a direct role in the modulation of cardiovascular disease risk above and beyond that associated with changes in blood lipids. A number

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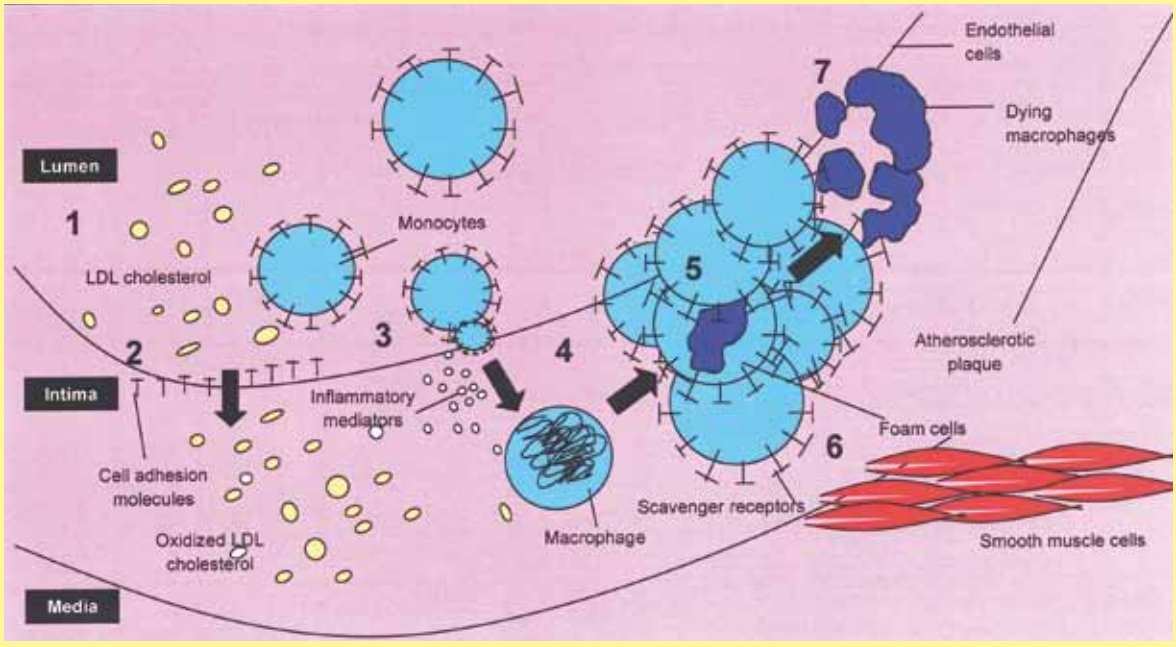
of pro-inflammatory markers, such as the acute phase reactant, high sensitivity C-reactive protein (hsCRP), and pro-inflammatory cytokines, such as interleukin-6 (IL-6), interleukin-1β (IL-1β), tumour necrosis factor-α (TNF-α), and interleukin-8 (IL-8), were found to be present in the atherosclerotic plaque, and these can predict cardiovascular heart disease risk. The hsCRP and cytokines are proteins found in the blood, the levels of which rise in response to inflammation. The process of inflammation is illustrated in *Figure 1*.

A few human intervention studies demonstrate that *trans* fatty acids increased circulating inflammatory markers, such as IL-6, E-selectin, and hsCRP, more than other fatty acids (Han *et al*., 2002; Baer *et al*., 2004). These fatty acids are thought to alter the expression and adherence of the circulating inflammatory markers to endothelium. However, the underlying mechanisms involved are not yet fully understood. It is possible that susceptibility to oxidation could play a role. Inflammation accelerates the atherogenic effects of oxidized lipoproteins, but the mechanisms involved are not clearly defined. There is no conclusive information concerning the interplay of fats on a wide array of inflammatory markers, and the interaction of inflammatory markers with blood lipids.

## PALM OIL AND INFLAMMATORY MARKERS

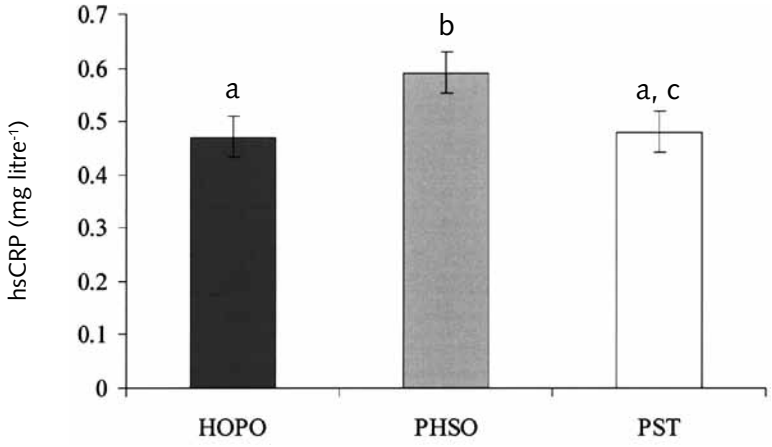
To our knowledge, no study has been reported on the consumption of partially hydrogenated vegetable oil and its relation to low grade inflammation in an Asian population. Particular interest may exist for developing countries where partially hydrogenated vegetable oils are commonly used as cooking oil and represent an inexpensive source of dietary fats. The Nutririton Group of the Malaysian Palm Oil Board (MPOB) recently conducted a five-week human dietary intervention to compare the effects of a high oleic vegetable oil with that of a partially hydrogenated, and an unhydrogenated and more saturated, vegetable oils on serum inflammatory markers and blood lipids using a randomised, crossover design.

The study conducted by Teng *et al.* (Teng *et al*., 2010) demonstrated that the PHSO (a *trans* fatty acid-rich) diet increased hsCRP




Note: 1=LDL from the circulation enters the arterial wall where it is oxidized and begins to accumulate. 2=Oxidized LDL cholesterol, for example, facilitates the release and attachment of other pro-inflammatory markers such as, hsCRP, cytokines and cell adhesion molecules (CAM) to endothelial wall. 3=Monocytes migrate into the arterial wall, and chemokines are also secreted. 4=Monocytes mature into macrophages and bind to oxidized lipoproteins. 5=The lipid-laden macrophages amplify the inflammatory processes by recruiting more pro-inflammatory cytokines and growth receptors. 6=Foam cells secrete pro-inflammatory cytokines and other factors which exacerbate the inflammatory process. 7=Foam cells, dead macrophages, lipids and smooth muscle cells accumulate to form a fatty streak and resulting in atherosclerotic plaques.

*Figure 1. Inflammatiory process involved in atheroslcerosis.*




Note: HOPO = high oleic palm olein; PHSO = partially hydrogenated soyabean oil; PST = palm stearin; hsCRP = high sensitivity C-reactive protein. Values are LSMeans ± SEM. All data were analysed by mixed model ANCOVA with baseline values as covariates. [a,b]Bars bearing values with different letters are significantly different from one another at $P < 0.05$.

*Figure 2. Effects of the three diets on serum hsCRP in the study subjects (n = 41) participating in a 5-week dietary intervention.*

when compared with the PST (an unhydrogenated saturated fat), and the HOPO (high oleic palm olein) enriched diets (*Figure 2*). Epidemiological and clinical studies indicate that *trans* fatty acids are associated with an increase in hsCRP, IL-6, and TNF-α, in both healthy and hypercholesterolemic subjects (Han *et al*., 2002; Mozaffarian *et al*., 2004). Studies have reported that a high *trans* fatty acid diet increased hsCRP, IL-6 and E-selectin, but an oleic acid-enriched diet decreased hsCRP and IL-6 (Baer *et al*., 2004; Mensink, 2008). Consistent with these findings are those of our present study which shows that a diet high in *trans* fatty acids (*i.e*., the partially hydrogenated soyabean oil) increases hsCRP concentrations more than the one with a semi-saturated fat (*i.e.,* the palm stearin), or the one with a high oleic palm olein. Thus, in addition to the hypercholesterolemic effect, *trans* fatty acids may trigger a pro-inflammatory cascade.

## CONCLUSION

The study conducted by MPOB demonstrates that the use of vegetable oils in their natural state might be preferred over one that has undergone the process of hydrogenation. Hence, high oleic palm olein may serve as a suitable cooking oil due to its beneficial effect on blood lipids and inflammatory markers.

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