Coronary heart disease (CHD) is the leading cause of mortality all over the world; its incidence is rising rapidly, especially in developing countries, including India. Dietary factors, particularly the edible oils, play an important role in the causation, treatment, management, and prevention of CHD. Cooking oils form an integral part of Indian diets; however, one is confronted with an array of commonly marketed edible oils asserting host of health claims. Therefore, right selection of edible oil is extremely important, especially in the Indian context, where cooking methods are different then in the west. Numerous clinical trials and observational/metabolic studies among diverse populations indicate a consistent association between quality/quantity of fat intake and the CHD risk.1,2 The effect of dietary fats on plasma lipids constitutes a key link in the causal pathway that connects diet to CVD.

Edible oils have several fatty acids, which can be grouped into three classes—saturated fatty acids (SFA) (which have 3 groups, short-chain, medium-chain, and long-chain SFA), monosaturated (MUFA), and polyunsaturated (PUFA) (further subdivided into linolenic (LC or n6), alpha-linolenic (ALNA or n3) acid, and transfatty acids (TFA)), which are produced by hydrogenation of vegetable oils (Vanaspati ghee) or marine oils. Table 1 shows the approximate fatty acid composition of various edible oils.

In addition, edible oils contain several antioxidants (like tocopherols, oryzanol, carotenes, tocotrienols, etc.), phytosterols, and micronutrients.

SFA have been considered harmful, as they can increase total cholesterol (TC) and LDL cholesterol – a risk factor for atherosclerosis.3 A meta-analysis of randomized trials suggested a 17% reduction in risk of CHD in studies that reduced SFA from about 17% to about 9% of energy (RR 0.83, 95% CI 0.72–0.98). However, short- and medium-chain SFA are not harmful, as they do not affect the serum lipids.4 A randomized study in this issue of the journal has also indicated that even after 2 years of follow-up, serum lipids were not altered by coconut oil (which is rich in SFA) as compared to sunflower oil.5 A recent systemic review also suggests that SFA may not be harmful as considered earlier.6 PUFA and MUFA are other types of fatty acids that can lower LDLc and are cardioprotective.7 Jakobsen et al.7 have reported that substitution of SFA with PUFA can significantly reduce the CHD risk in a pooled analysis of 11 cohort studies. N6 (linoleic acid) and N3 (alpha-linolenic acid) are essential fatty acids required for proper functioning of the body. N6 PUFA lowers not only LDLc but can also decrease HDL, whereas N3 PUFA may lower triglycerides, blood pressure, inflammation, improve vascular function, and sudden death.8,9 N6 and N3 PUFA should be present in adequate and balanced proportion in the body because both compete for the enzymes that convert them into more active compounds. Several dietary recommendations suggest that the ratio of n6:n3 PUFA should be 5–10:1 or lower to prevent heart disease.10,11 There is evidence that in humans when omega-6 intake is kept low, plant-based omega-3 can be converted to long-chain n3 fatty acids as found in fish oils (eicosapentaenoic acid) in limited amounts. On the other hand, transfatty acids (TFA) produced by hydrogenation of vegetable fat (Vanaspati ghee) due to the undesirable effects on serum lipids are associated with an elevated risk of CHD and are considered even worse than the saturated fats.12,13 Several reviews have demonstrated that high intake of TFA was associated with increased CHD events and mortality and also possibly other chronic diseases like Alzheimer’s disease, cancer, diabetes, obesity, inflammation, depression, etc. Antioxidants present in several oils (like tocotrienols, tocopherols, oryzanol, and phytosteroles) have favorable effects on lipids and oxidative stress and can prevent heart disease.14–16

Studies indicate that olive oil intake can confer various health benefits in addition to reduced CHD risk.17 A randomized controlled intervention by Covas et al.19 has demonstrated that in olive oil, apart from monounsaturated fatty acids, its polyphenolic compounds confer beneficial effects on plasma lipid concentrations and bring about linear reduction in oxidative stress markers. However, the main limitation is that olive oil does not have ideal N6 N3 ratio and may not be suitable for Indian cooking. Mustard oil is considered healthy edible oil because it is low in SFA, high in MUFA and PUFA, specially alpha-linolenic acid, and a good n6:n3 ratio (6:5). It is also available in nonrefined (cold compressed) form and is relatively stable during cooking at high temperatures. Several studies also suggest that mustard oil may be associated with lower CHD risk as compared to other oils. A multicentre epidemiologic study by Rastogi et al.10 reported 71% reduction in CHD risk among individuals using mustard oil for frying as compared to sunflower oil (RR 0.29, 95% CI 0.13–0.64). Another double-blind RCT has demonstrated that in acute MI patients using mustard oil, there was reduction in arrhythmias, heart failure, and angina.20 Based on earlier studies in rats, there was a concern regarding high erucic acid content of mustard oil21; however, later studies showed that in rats there is an inefficient activation of erucic acid to erucyl-CoA coupled with lowered activity of triglyceride lipase and enzymes associated with β-oxidation of erucic acid, which possibly contribute to the accumulation and retention of cardiac lipids. Other species, including humans, have not demonstrated to have such toxic effects. Low erucic acid rapeseed oil (canola), by virtue of its ideal
Table 1
Approximate fatty acid composition of visible fats (g/100 g).

|            | SFA | MUFA | LA | ALNA | LA/ALNA |
|------------|-----|------|----|------|---------|
|            | Short chain | Medium chain | Long chain |       |         |
| Coconut    | 14  | 63   | 12 | 7    | 2       | <0.5    | 4       |
| Palm kernel| 7   | 65   | 10 | 15   | 2       | <0.5    | 4       |
| Rice bran  | 3   | 44   | 44 | 32   | 2       | 0.5     | 4       |
| Olive      | nd  | 1    | 17 | 6    | 10      | <0.5    | 20      |
| Groundnut  | nd  | 1    | 17 | 37   | 10      | <0.5    | 20      |
| Rapeseed   | nd  | 1    | 17 | 32   | 4       | 1       | 42      |
| Cotton seed| nd  | 1    | 17 | 22   | 41      | 35.5    | 12      |
| Corn       | nd  | 12   | 17 | 32   | 55      | 1       | 55      |
| Sunflower  | nd  | 13   | 17 | 27   | 60      | <0.5    | 120     |
| Safflower  | nd  | 13   | 17 | 17   | 70      | <0.5    | 140     |
| Soybean    | nd  | 15   | 17 | 27   | 53      | 5       | 11      |

nd, not detected; SFA, saturated fatty acids; MUFA, mono saturated fatty acid; LA, linolenic acid; ALNA, alpha linolenic acid.

a Transfatty acids (ghee 23%, vanaspati 53%).

b Modified from Ghafoorunissa.1

LA/ALNA ratio, has also been found to exert cardioprotective effects.22 **Flaxseed oil**, though a rich source of ALNA, is not commonly consumed; however, blending it with other edible oils is a good strategy to increase ALNA intakes.

1. Indian cooking conditions

Indian cooking conditions subject oil to very high temperatures, like in deep frying during which the oil temperatures can go above 170 °C. It has been demonstrated that certain oils, especially refined oils with high PUFAs, can degrade easily to toxic components like free radicals, transfats, melondialdehyde (MDA), etc., which are potentially mutagenic and atherogenic.23 Repeated frying of the oil can further damage the oil and produce more toxic components that are highly harmful to the heart. An Indian study has demonstrated that TFA content of oil samples drawn for the halwais, who use same oil for repeated frying, have high TFA.24 It is also preferable to avoid refined oils and use cold-pressed or extra virgin oils. Refined oils are purified oils from oil cakes using highly intense mechanical and chemical [solvent extraction] processes to extract the oil from the seeds and vegetables products. The crushed seeds are heated repeatedly to high temperatures up to 270 °C in a steam bath for deodorization and to start the oil extraction process. These high temperatures can result in loss of antioxidants (like tocopherols) and sterols, produce free radicals and TFA, and polymeric components, which are potentially atherogenic and mutagenic. Oils high in saturated fats like ghee/coconut are ideal for deep-frying, as they are more stable.

**Blending of oils** combines the potency of two/more edible oils; it offers a balance of fatty acids and antioxidants, and this approach is used to enhance the oxidative and thermal stability of oils. A blend of rice bran oil and safflower oil (70:30) with added antioxidants reportedly improved several lipid parameters and certain inflammatory markers.25 Study by Gillingham et al.26 has indicated that canola, or in blend with flaxseed oil, effectively reduced serum TC and LDL-c. Moreover, the canola–flaxseed oil blend further reduced plasma E-selecitin by targeting the inflammation and atherogenic pathways. Therefore, supplementation of commonly consumed fats with canola–flaxseed oil or similar blends is a viable option to achieve dietary recommendations, as well as target the CVD risk factors.

2. Conclusions

In the global context, Indian cooking conditions differ greatly, since the oils are often subjected to rather high temperatures, as stir-frying is a routine process in every curry or other similar preparations. As a result, exposure to high temperatures not only destroys antioxidants like vitamin E and β-carotene but also produces toxic compounds that may potentially be mutagenic and atherogenic. It is advisable to avoid refined oils, since during the refining process, oils are heated to high temperatures resulting in their degradation and generation of toxic substances. Refined oils, particularly high in PUFAs, degrade easily and therefore, should be avoided for frying. On the contrary, oils high in saturated fats (like ghee/coconut oil) can be used for Indian cooking, as they are comparatively stable during frying. Earlier, oils high in SFA were considered harmful since they increase LDL-c but recent studies indicate that oils high in short/medium-chain SFA (like coconut oil) have not demonstrated adverse health effects. Mustard and rapeseed oils – due to their favorable LA/ALA ratio, low SFA, and high MUFA content along with their relative stability during cooking – can be a preferred choice, particularly mustard oil in its nonrefined (cold-pressed) form. In fact epidemiologic studies among Indians do suggest that mustard oil consumption can reduce the risk of CHD. Further, appropriate blending of edible oils (such as rice bran and safflower oil; coconut and safflower oil; canola and flaxseed oil) also appears to be a good option to reduce the plasma lipids, inflammation and, thus, the CHD risk.

References

1. Ghafoorunissa. Dietary lipids and heart disease – the Indian context. Nutr Med J Indiu. 1994;7(6):270–276.
2. Hu FB, Stampfer MJ, Manson JE, et al. Dietary fat intake and the risk of coronary heart disease in women. N Engl J Med. 1997;337(21):1491–1499.
3. Hooper L, Martin N, Abdelhamid A, Davey Smith G. Reduction in saturated fat intake for cardiovascular disease. Cochrane Database Syst Rev. 2015;6:CD011737.
4. Bach AC, Babayan VK. Medium-chain triglycerides: an update. Am J Clin Nutr. 1982;36:950–962.
5. Vijay Kumar M, Vasudevan D, Sundaram KR, Matthew N. A randomized study of coconut oil versus sunflower oil on cardiovascular risk factors in patients with stable coronary heart disease. Indian Heart J. 2016;68:321–327.
6. De Souza RJ, Mente A, Maroileauu A, et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. BMJ. 2015;351:h3978. http://dx.doi.org/10.1136/bmj3978.
7. Jakobsen MU, O’Reilly EJ, Heitmann BL, et al. Major types of dietary fat and risk of coronary heart disease: a pooled analysis of 11 cohort studies. Am J Clin Nutr. 2009;89:1425–1432.
8. Ristin-Medic D, Vucic V, Takic M, Karacic I, Gilibetic M. Polynsaturated fatty acid in health and disease. J Serb Chem Soc. 2013;78:1269–1289.
9. Ghafoorunissa. Vani A, Laxmi R, et al. Effects of dietary alpha-linolenic acid from blended oils on biochemical indices of coronary heart disease in Indians. Lipids. 2002;37(11):1077–1086.
10. ICMR, Nutrient Requirements and Recommended Dietary Allowances for Indians – A Report of the Expert Group of the Indian Council of Medical Research. Hyderabad, India: National Institute of Nutrition; 2010:90–111.
11. AO/WHO. Fats and Fatty Acids in Human Nutrition Report of an Expert Consultation. FAO. 2010.
12. Booker C, Ji M. Tran’s fatty acids and cardiovascular health: translation of the evidence based. Nutr Metab Cardiovas Dis. 2008;18:448–456.
13. Mozaffarian D, Rao A, Willett WC. Health effects of trans-fatty acids: experimental and observational evidence. Eur J Clin Nutr. 2009;63(2):55–521.
14. Cicero AF, Gaddi A. Rice bran oil and gamma-oryzanol in the treatment of hyperlipoproteinemias and other conditions. Phytother Res. 2001;15(4):277–286.
15. Budin SB, Othman F, Louis SR, Bakar MA, Das S, Mohamed J. The effects of palm oil tocotrienol-rich fraction supplementation on biochemical parameters, oxidative stress and the vascular wall of streptozotocin-induced diabetic rats. Clinics (Sao Paulo). 2009;64(3):235–244.
16. Dermonty I, Ras RT, van der Knaap HC, et al. Continuous dose–response relationship of the LDL-cholesterol-lowering effect of phytosterol intake. J Nutr. 2009;139(2):271–284.
17. Stark AH, Madar Z. Olive oil as a functional food: epidemiology and nutritional approaches. Nutr Rev. 2002;60:170–176.
18. Covas MI, Nyssonen K, Poulsen HE, et al. The effect of polyphenols in olive oil on heart disease risk factors: a randomized trial. Ann Intern Med. 2006;145(5):333–341.
19. Rastogi T, Reddy KS, Vaz M, et al. Diet and risk of ischemic heart disease in India. Ann J Clin Nutr. 2004;79(4):582–592.
20. Singh RB, Niaz MA, Sharma JP, et al. Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: the Indian experiment of infarct survival-4. Cardiovasc Drugs Ther. 1997;11(3):485–491.
21. Chariton KM, Corner AH, Davey K, et al. Cardiac lesions in rats fed rapeseed oils. Can J Comp Med. 1975;39:261–269.
22. Lin I, Allemekinders H, Dansby A, et al. Evidence of health benefits of canola oil. Nutr Rev. 2013;71(6):370–385.
23. Fullana A, Carbonell-Barrachina AA, Sidhu S. Volatile aldehyde emissions from heated cooking oils. J Sci Food Agric. 2004;84:2015–2021.
24. Jain A, Passi SJ, Pant KK. Estimation of trans-fatty acid content of fat/oil samples in use for frying the food items: a study in an urban slum of Delhi. J Prev Cardiol. 2015;4(3):706–715.
25. Upadya H, Devaraju CJ, Joshi SR. Anti-inflammatory properties of blended edible oil with synergistic antioxidants. Indian J Endocrinol Metab. 2015;19(4):511–519.
26. Gillingham LG, Gustafson JA, Han SY, Jassal DS, Jones PJH. High-oleic rapeseed (canola) and flaxseed oils modulate serum lipids and inflammatory biomarkers in hypercholesterolaemic subjects. Br J Nutr. 2011;105:417–427.

S.C. Manchanda*
Senior Consultant Cardiologist, Sir Ganga Ram Hospital, New Delhi, India

Santosh Jain Passi
Public Health Nutrition Consultant; Former Director, Institute of Home Economics, University of Delhi, India

*Corresponding author
E-mail address: doctormanchanda@yahoo.com (S.C. Manchanda).

Available online 19 May 2016