Perspectives on the use of seed oils in the South African diet

The debate and the evidence in the literature on the importance of the type of fat in the diet continues to elicit interest, and hopefully better understanding. Opperman et al[1] addressed the suggestion made in *The Real Meal Revolution*[2] that seed oils are toxic, high in trans fat and genetically modified in this issue of the SAJCN. The authors concluded in their findings that South African seed oils, i.e. sunflower oil, olive oil and canola oil are of good quality and safe for human consumption, based on their fatty acid composition, i.e. trans-fatty acid content, peroxide and conjugated diene levels. They further concluded that oil crops are not genetically modified.[1]

The chemical and health properties of any fat or oil in the diet depend on the individual fatty acid composition of that specific fat or oil. Each fat and oil is classified according to the main proportions of saturated fatty acids (SFAs), i.e. mainly lauric, myristic, palmitic and stearic acids; monounsaturated fatty acids (MUFAs), mainly oleic acid; and/or of polyunsaturated fatty acids (PUFAs) from the omega-6 (n-6) (linoleic or arachidonic acid) and omega-3 (n-3) family [α-linolenic acid, eicosapentaenoic acid (EPA), docosapentaenoic (DPA) and docosahexaenoic acid (DHA)], as well as of the trans-fatty acids present.[3] The impact of dietary fat and oil on health and disease is now also better understood as certain fatty acids are essential nutrients involved in important physiological processes, including brain development and functioning. They can also reduce the risk of the development of nutrition-related non-communicable diseases.[4] These health and disease states are mainly influenced by the individual fatty acid composition of the fats and oils consumed. The degree of saturation and the total amount and ratio of n-6 to n-3 fatty acids in the diet are of the essence.[5-7]

The fact that it was concluded following a recent meta-analysis of prospective epidemiological studies that there was no significant evidence that SFAs are associated with an increased risk of coronary heart disease[8] should be seen in context, and interpreted in the light of the fact that the replacement of SFAs with PUFAs lowers the risk of cardiovascular disease in both prospective cohort studies[9] and randomised controlled trials.[10] Limiting SFA intake should always be considered in the context of the nutrient that replaces it. Furthermore, the use of the term "PUFAs" in lipid science has become too broad and non-specific, as the quality or type of dietary fat or oil is mainly determined by the proportions of PUFA it contains from both the n-6 and n-3 series.

Seed oils remain an important source of the essential fatty acids, linoleic acid (C18:2 n-6) and α-linolenic acid (C18:3 n-3), which humans cannot synthesise, but which are vital for human well-being.[11] Cellular membranes consist of a lipid bilayer, composed mainly of phospholipids, which consist of a polar head group and two fatty acids. The PUFAs and long-chain PUFAs in phospholipids determine the membrane's fluidity, which, in turn, facilitates functions such as cell signalling of all cell types and phagocytosis in immune cells. Mostly the long-chain PUFAs are also important precursors for the formation of hormone-like substances which influence and regulate key physiological functions, ranging from blood pressure, vessel stiffness and relaxation, thrombotic aggregation and fibrinolytic activity, to inflammatory responses and leukocyte migration.[11-13] Omega-6 PUFAs are generally regarded as precursors of pro-inflammatory metabolites, which signal for the start of inflammation, and n-3 PUFAs as precursors for metabolites with anti-inflammatory properties, which on the other hand facilitate the termination of inflammation.[14,15] Both these functions are vital for human health,[4] and thus balancing the intake of n-6 and n-3 PUFAs is essential.[4,14] Furthermore, evidence that dietary SFAs also switch on proinflammatory mechanisms is accumulating.[4,16] Thus, the evidence of the health benefits gained when including PUFAs in a balanced way in the diet [n-6 (5-8% energy) and n-3 (1-2% energy)] and of keeping SFAs less than 10%, is, on balance, convincing.[14,17]

Although the conversion of essential fatty acids to longer-chain metabolites is not very effective in humans, an adequate intake of essential fatty acids during the life cycle remains important on its own merit, and as a contributor towards long-chain PUFA status. This might be even more important in the South African context, as recent data in the South African leg of the Prospective Urban Rural Epidemiology (PURE) study showed that dietary α-linolenic acid and its final long-chain product in plasma, DHA, correlated stronger than dietary DHA and plasma DHA.[18] The population studied consisted of 1 950 apparently healthy, migration-stable subjects (aged 35-70 years) from a sample of 6 000 randomly selected households in rural and urban areas in North West province of South Africa. These data may indicate that the conversion of essential fatty acids to longer-chain metabolites are more effective in this population than in others,[18] and that seed oils remain a key source of essential fatty acids in the various levels of the food chain. Furthermore, as correctly indicated by Opperman et al,[1] seed oils are excellent sources of vitamin E, which, among other functions, protect the fatty acids in membranes from oxidation.[19]

Therefore, there is no evidence to support the premise that seed oils are toxic or unhealthy due to their fatty acid composition, as stated in The Real Meal Revolution,[2] but rather what is of importance is how we use these oils in food preparation and processing, a point on which there remains a need to educate the consumer. Food preparation methods and oil storage conditions should be considered, and oils that contain vital fatty acids but which are sensitive to heat should be added to salad dressings and sauces, or could contribute to a healthy diet in the form of spreads and margarine.

The quality and the safety of edible oils have been areas of interest for many years, and has been researched widely.[20-22] Some issues, such as trans-fat content, lipid oxidation and genetic modification, apply to all edible oils. However, the toxicity of erucic acid, a fatty acid found in concentrations too high for human consumption in oil from older cultivars of rapeseed, applies only to rapeseed and canola oil. Canola, which is rapeseed that has a low erucic fatty acid content (< 2.2%), was cultivated with plant breeding techniques from older rapeseed varieties and is safe for human consumption. This was carried out so as to derive benefit from this seed oil's favourable fatty acid composition [55% of MUFA (oleic acid), 25% linoleic acid, 10% α-linolenic acid and only 4% SFA].[23] Therefore, canola is not genetically modified, and neither is the canola, olive or sunflower plants used for oil production in South Africa, as discussed by Opperman et al.[1]

The natural trans-fat content of seed oils is almost negligible.[1,3,24] However, during the refining of oils, and depending on the applied deodorisation conditions, trans-fatty acids can be formed, but generally, the total trans-fat content remains below 1%,[25] as also confirmed for several brands of South African olive, sunflower and canola oils by Opperman et al.[1] The trans-fat content of oil may also increase when used for an excessive time at high frying temperatures,[26] but the formation of trans-fat during frying is highly dependent on the type of oil used, temperature, total frying time, and how often the oil is replaced or replenished.[3,27] Nonetheless, the use of partially hydrogenated oils used mainly by the food industry is still recognised as the main source of trans-fat in the human diet. The good news is that partially hydrogenated oils is currently being replaced by other means of improving fat characteristics of industrially produced food, such as the blending of different oils.[3] Furthermore, most countries, including South Africa, have now enacted legislation to greatly reduce and soon forbid the presence of trans-fat, and thus the use of partially hydrogenated oils, in commercially prepared foods, owing to their detrimental health effects.[28-30]

Opperman et al[1] made a valuable contribution by measuring oxidation products and the fatty acid composition of newly purchased South African canola, olive and sunflower oils.[1] However, a limitation of the study was that it did not include the effects that household storage conditions and food preparation, such as frying, may have had on these oils. Autoxidation of edible oils by heat, air[20] and light[31] is generally a problem, and is enhanced by the presence of free fatty acids, monoacylglycerol and diacylglycerols, metals such as iron, and thermally oxidised compounds.[20] Furthermore, as lipid oxidation takes place primarily at the oil and air interface, oils should be stored closed in a cool, dark place as they may oxidise faster once opened. However, it should also be born in mind that seed and vegetable oils inherently contain antioxidants, most importantly tocopherols[32,33] and phenolic compounds,[22,34] which inhibit lipid oxidation and keep the oils stable during storage and heating. Currently, food scientists are also investigating the addition of natural antioxidants, such as rosemary extract, as well as using the biofilms of these antioxidants to create active packaging to prevent the lipid oxidation of oils and oil-containing foods.[35-38] Refining (degumming, neutralisation and bleaching) of oils generally improves their stability and increase their smoking point, i.e. the temperature at which an oil starts to burn and smoke.[25] Thus, refined oils are more suitable for heat applications, such as frying, than their unrefined counterparts. Nevertheless, refining reduces the antioxidant capacity of oils. For example, up to 30% of tocopherols are lost during the deodorisation step.[39] Thus, cold-pressed oils retain their health benefits and have a long shelf life stability owing to the presence of more natural antioxidants. They also generally have a lower smoking point,[22] and are therefore more suitable for moderate or cold temperature uses. Olive oil is an exception, and performs well at high temperatures because of its high content of phenolic compounds.[21,40]

The fatty acid composition of an oil, particularly the degree of unsaturation, further increases susceptibility to lipid oxidation.[20,32] Under frying conditions, even more so in shallow than deep frying,[41] a large number of volatile and non-volatile compounds are produced (conjugated dienes, peroxides, alcohols and carbonyls), of which a number exhibit carcinogenic, mutagenic and genotoxic properties.[42] The thermal stability of frying oils, which increases with the degree of saturation and antioxidant content, is another important criterion in the selection of a frying medium.[3] Increasingly, fast food industries use palm oil, which has a high degree of saturation (50% SFA, 42% oleic and 12% linoleic acid) and has been proven to be extremely stable while frying food.[3,43] Thus, it is not possible to expect oils used in frying to be able to adhere to the joint FAO/WHO recommended ratios of SFA, MUFA and PUFA,[6] and at the same time provide better oxidative stability during frying.[3] Furthermore, frequent fried food consumption was associated with risk of incident type 2 diabetes mellitus in two large cohort studies and are therefore not one of the best ways to prepare food.[44] Therefore, the daily diet should provide the right fatty acid ratio, and cannot be supplied by oils suitable for frying only.

Thus, it is crucial to educate the consumer that the choice of an oil depends on the food preparation or processing method used. To crucify seed oils because they contain n-6 fatty acids that are more pro-inflammatory than others is limiting, and is certainly not supported by current evidence. Some of these seed oils under discussion contain a well balanced n-6 to n-3 fatty acid ratio (canola oil), or contribute substantially to n-6 fatty acid intake, i.e. sunflower oil. The balance of n-6 to n-3 intake should be the emphasis and focus in consumer educational messages, and the practice of consuming different sources of n-3 fatty acid in the diet should also be encouraged. This is sound and accepted practice. To advise consumers to replace seed oils with SFA because of their so-called unfavourable composition is unjustified. As with any dietary intake guidelines, educating the consumer to make the right choices remains a priority, as the type of fat and oil consumed can have a major impact on long-term health and quality of life.

Marius Smuts, PhD(Biochemistry), RNT(SA), Professor in Nutrition;
Linda Malan, PhD(Nutrition), Senior Lecturer
Centre of Excellence for Nutrition, Faculty of Health Sciences,
North-West University, Potchefstroom, South Africa
E-mail: marius.smuts@nwu.ac.za

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