

Omega-3: Fish versus Flax

A major review published in the *British Medical Journal* (Hooper *et al.*, 2006) supports the view that pollutants in fish, such as mercury, dioxins and polychlorinated biphenyls, may cancel out the beneficial effects of the 'good' omega-3 fats they contain.

The good news is there are perfectly safe plant sources of omega-3 that can benefit health. Many studies, including a joint report by the World Health Organisation and Food and Agriculture Organisation show that ALA has a protective effect against heart disease. This benefits the environment as well; flax is a sustainable crop whereas fish are not. (For more information, see the VVF's *Fishing for Facts* fact sheet.)

Recent studies suggest that the ratio of omega-6 to omega-3 fatty acids is more important than the amounts of individual fatty acids consumed. Recent changes in the diet, as we have moved away from whole foods towards refined foods rich in processed vegetable oils, have increased our intake of omega-6 fats. This has increased the ratio of omega-6 to omega-3 fats in the diet, which may have a detrimental effect on the rate of conversion of ALA to EPA and DHA.

Most people eating a Western diet need to limit the amount of omega-6 essential fats in their diet and increase the amount of omega-3. This can be achieved by reducing the use of omega-6 rich sunflower, safflower and corn oils and increasing the use of omega-3 rich flaxseed and rapeseed oils.

Cutting down on dietary cholesterol (avoiding eggs, meat and dairy products), avoiding or cutting down on processed foods, and avoiding foods containing hydrogenated vegetable oils (listed on the packaging) will help your body make best use of the omega-3 from plant foods.

Also avoid or reduce fried foods, alcohol, caffeine, sugar, smoking and stress. Make sure that you get all the minerals you require including zinc – found in pulses, wholegrains (eg brown rice, wholemeal bread etc), nuts and seeds – and chromium, found in nuts, wholegrains and brewer's yeast.

One teaspoon of flaxseed oil or one-and-a-half tablespoons of ground flaxseed should provide most people with sufficient omega-3 fats (see Table 5). These fats are easily damaged by light or heat so try and keep these foods refrigerated and use them cold, for example on cold vegetable/rice/pasta salads and so on.

Summary

- Reduce your intake of saturated fat, dietary cholesterol, and trans-unsaturated fatty acids
- Avoid products containing hydrogenated fats or oils (listed on the packaging)
- Avoid butter, cream, whole milk and tropical oils as they are especially rich in cholesterol-raising saturated fats
- If you are genetically prone to hypercholesterolaemia then it is particularly important for you to restrict dietary cholesterol, which is found in all animal products
- Improve the balance of omega-6 to omega-3 in your diet by reducing omega-6 oils (sunflower, corn oil) and increasing omega-3s (flax, rapeseed)
- Pollutants in fish may cancel out the beneficial effects of the 'good' omega-3 fats they contain
- ALA (from plant foods) can be converted into EPA and DHA, and has a protective effect against heart disease
- Cutting down on dietary cholesterol (eggs, meat and dairy products), processed foods, and hydrogenated vegetable oils will help your body to make best use of the omega-3 from plant foods
- Also avoid or reduce fried foods, alcohol, caffeine, sugar, smoking and stress
- Increase the consumption of foods rich in fibre, including wholegrains, fruit and vegetables

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Chewing the Fat

How a plant-based diet provides all the essential fats you need – and why animal fats are particularly detrimental to health

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What is Fat and Why Do We Need It?

Of the four main classes of food, fat is the most energy dense. It contains more than twice as many calories (kilocalories) weight-for-weight as protein or carbohydrate (see Table 1). It is a good source of energy, both for immediate use and for laying down a storage depot (adipose tissue) for use when food intake is reduced.

Table 1: The Energy Content of the Main Classes of Food (Macronutrients)

	Energy per gram in kilocalories
Fat	8.8
Protein	4.06
Carbohydrate	3.8
Alcohol	7.1

Fat in the diet helps the body to absorb fat-soluble vitamins (A, D, E and K). It is a source of the essential fatty acids that the body cannot make itself. Fat also provides insulation, protects the body's vital organs and acts as a shock absorber.

Fat's more technical name is 'lipid' – a term that includes both fats and oils. Nominally, fats are solid at room temperature, oils are liquid, and dense brittle fats are called waxes.

Lipids in the diet can come from both plants and animals. Plants most often store their oils in seeds, such as nuts, sunflower seeds, soya beans and corn; and sometimes in fruits, eg avocados, olives and coconuts. Animals most commonly store fat within their muscles (commonly called marbling fat), between their muscles, under their skin and around their gut area.

Lipids in the diet are largely made up of molecules called fatty acids, attached to the molecule glycerol. Three fatty acids combine with one molecule of glycerol to form 'triglycerides'. The fatty acids can be of three major types – saturated, monounsaturated and polyunsaturated, depending on how many double bonds they contain.

A certain type of unsaturated fatty acid – trans-unsaturated, or 'trans fatty acids' – is often considered separately because of its ill effects on health, and because it is largely created by the manufacturing process.

The human body cannot function without some fat, but it is eating the right kind of fat that is vital in terms of our overall health. According to the Committee on Medical Aspects of Food Policy, most people should aim to get no more than 10 per cent (and preferably less than seven per cent) of their total calorie intake from saturated fat. Less than 10 per cent of calories should come from polyunsaturated fat. The 10 per cent figure for polyunsaturates includes one to two per cent of calories from omega-3 fats (Department of Health, 1991). Less than one per cent of calories – and preferably none – should come from trans fatty acids.

Table 2: The Main Sources of Fat in the Human Diet

Source of Fat	Examples	Type of Fat
Milk fat	Milk, yoghurt, cream, butter and cheese	Almost inevitably highly saturated (typically 50 to 65 per cent saturated)
Meat fat	Meat (poultry and red meat), meat products (such as sausages and burgers), cooking fats of animal origin such as lard	Tends to be highly saturated (typically 27 to 44 per cent of fat is saturated)
Fatty fish	Mackerel, herring, trout and salmon (typically 17 to 25 per cent of fat is saturated)	Relatively low in saturated fats
Seeds	Seeds, nuts, vegetable and nut oils and soft margarines	Relatively low in 'bad' saturated fats and high in 'good' polyunsaturated fats (except tropical oils such as coconut and palm oil). Typically eight to 25 per cent of fat is saturated

Table 2 summarises the main sources of fat in the human diet. Any food that contains any of these products as an ingredient will also contain fat.

Dietary Cholesterol

Cholesterol is a soft, waxy substance found in the bloodstream and in all the body's cells. It is used to form cell membranes and some hormones. However, a high level of cholesterol in the blood (hypercholesterolaemia) is a major risk factor for heart disease.

Cholesterol and other fats have to be transported to and from the cells by special carriers called lipoproteins. Two of particular note are low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

LDL is the major cholesterol carrier in the blood. Too much LDL cholesterol in the blood can lead to the build up of fatty deposits (plaques) on the inside walls of the arteries. Plaques can clog the arteries feeding the heart and brain (atherosclerosis); hence LDL is termed 'bad' cholesterol. Lower levels of LDL cholesterol reflect a lower risk of heart disease.

HDL, on the other hand, tends to carry cholesterol away from the arteries and back to the liver, where it is eliminated from the body. A high HDL level seems to protect against heart disease, hence HDL cholesterol is termed 'good' cholesterol.

Cholesterol comes from two main sources. The body produces approximately 1,000 milligrams per day. Animal products also

contain cholesterol, especially egg yolks, meat, poultry, shellfish and whole- and reduced-fat milk and dairy. One small grilled skinless chicken breast contains 94 milligrams of cholesterol (FSA, 2002), whereas foods from all plants (every type of fruit and vegetable, pulses, (peas, beans and lentils) wholegrains, nuts and seeds) are cholesterol-free.

Humans have no need for dietary cholesterol as the body can manufacture all that it requires. The American Heart Association recommends that people limit their average daily cholesterol intake to no more than 300 milligrams (AHA, 2008).

High intakes of dietary cholesterol increase harmful LDL cholesterol (Grundy and Denke, 1990) which can increase the risk of heart disease. If you are genetically prone to hypercholesterolaemia then it is especially important to restrict dietary cholesterol, which is found in all animal products. High-quality proteins from vegetable sources such as pulses are good substitutes for animal sources of protein. For more information, see the VVF guide, *Have a Heart*.

Saturated Fatty Acids

We have no nutritional need for saturated and monounsaturated fats as the body can make them. Diets high in saturated fat and calories raise blood cholesterol levels and contribute to cardiovascular disease, diabetes and some cancers. Saturated fat has 10 times the cholesterol-raising power of dietary cholesterol (Enas *et al.*, 2003). Furthermore, foods high in saturated fat generally contain substantial amounts of dietary cholesterol. Reducing total and saturated fat intakes could also lower the risk of breast cancer (see VVF report, *One in Nine*).

Table 3 illustrates the major sources of saturated fats in the UK national diet.

Not all saturated fatty acids have the same effects. Those which raise cholesterol the most are lauric acid, myristic acid, and palmitic acid, which are found in meat, dairy products, eggs and tropical oils. These three fatty acids account for 60 to 70 per cent of the saturated fat in Western diets.

Myristic acid is the most powerful cholesterol-raising saturated fatty acid (Kris-Etherton *et al.*, 1997). The major dietary sources of myristic acid are butter, cream, whole milk and tropical oils. Milk fat (from dairy cows) contains eight to 14 per cent myristic acid. Coconut and palm oils contain up to 18 per cent (German *et al.*, 2004).

Palmitic acid is the most common fatty acid in the human diet. It is the main saturated fatty acid in animal fats (including red meats, poultry and eggs) and in palm oil.

Lauric acid is the least harmful of these three saturated fats, with around one-third less cholesterol-raising power than palmitic acid. It is the main saturated fatty acid in coconut and palm kernel oils (they contain around 48 per cent) (Grundy, 1986; Renaud and Delorgel, 1989; Katan *et al.*, 1995).

As tropical oils such as coconut and palm do not feature heavily in our typical national diet, they do not contribute significantly to average national saturated fat intake (FSA/Department of Health, 2003). However, coconut is the main source of energy for certain Polynesian populations. The habitual diets of the toll dwellers from both Pukapuka and Tokelau are high in saturated fat (primarily from coconut) but low in dietary cholesterol (found only in animal products) and sucrose (sugar).

Tokelauans take in many more calories from coconut than the Pukapukans (63 per cent compared with 34 per cent) and therefore have higher intakes of saturated fat. As might be

Table 3: Where Saturated Fat Comes From

Source of Saturated Fat	% Contribution to Saturated Fat Intake
Milk and milk products of which	24
Whole milk	4
Semi-skimmed milk	5
Cheese (including cottage cheese)	10
Meat and meat products of which	22
Bacon and ham	2
Beef, veal and dishes	4
Lamb and dishes	1
Pork and dishes	1
Coated turkey and chicken	1
Chicken, turkey and dishes	3
Burgers and kebabs	2
Sausages	3
Meat pies and pastries	4
Other	1
Cereals and cereal products of which	18
Pizza	2
White bread	1
Biscuits	4
Buns, cakes and pastries	4
Fat spreads of which	11
Butter	6
Margarines	1
Polunsaturated reduced fat spreads (60-80%)	1
Reduced fat spreads (60-80% fat)	2
Low-fat spreads (40% fat or less)	1
Potatoes and savoury snacks of which	7
Chips	3
Other fried or roast potatoes	1
Savoury snacks	3
Chocolate confectionery	5

expected, Tokelauans have higher blood cholesterol levels. However, cardiovascular disease – the build up of lipids and other cells on the artery wall – is still surprisingly rare in both populations (Prior *et al.*, 1981).

This apparent paradox might be explained by coconut's fibre content. Coconut is a good source of soluble and insoluble dietary fibre which have cholesterol-lowering powers. Coconut flakes (rather than coconut oil) have been found to lower harmful (LDL) cholesterol levels (Trinidad *et al.*, 2004). Of course, processing coconut in order to produce coconut oil does strip away the protective fibre.

Conversely, the leading sources of harmful saturated fats in the British national diet – namely dairy products and meat – contain no protective, cholesterol-lowering fibre (FSA, 2002; FSA/Department of Health, 2003). As perhaps would be expected, cardiovascular disease is a common finding in people who consume the modern Western diet. For more information, see VVF fact sheet, *Plant-based Diets and Cardiovascular Disease*.

Trans-unsaturated Fatty Acids

Trans fatty acids have also been shown to increase the risk of heart disease by raising harmful (LDL) cholesterol levels and lowering protective (HDL) cholesterol levels. Their combined effect on LDL and HDL cholesterol is twice that of saturated fatty acids (Mensink and Katan, 1990).

Gram for gram, trans fats are even more strongly linked to heart disease than saturated fats. A review of trans fats' effects on health found them to be associated with a two-and-a-half to tenfold

higher risk of heart disease than saturated fats (Stender and Dyerberg, 2004). No safe limits of trans fat consumption have been identified (Murray, 2005).

Trans fatty acids are often found in processed foods. An industrial process known as hydrogenation is often used to convert liquid vegetable oils to solid or semi-solid fats, such as those present in margarine. The final product of this process is called hydrogenated vegetable oil, or hydrogenated fat. It is used in some biscuits, cakes, pastry, margarine and many processed foods. Foods that contain hydrogenated vegetable oil (which is always declared in the ingredients list) are likely to contain trans fats. By avoiding products containing hydrogenated fats or oils the trans fat content of a plant-based diet can be kept desirably low.

Low levels of trans fatty acids are also found naturally in dairy products, lamb and beef fat. This is because small amounts of trans fats are produced in the gastrointestinal tract of ruminant animals (Murray, 2005).



Table 4: Plant Sources of EFAs

Adapted from VVF scientific report, *Fishing for Facts*

Food (serving size)	Omega-3 (g) (ALA)	Omega-6 (g) (LA)
Oils		
Flaxseed (linseed) oil, 1 tbsp	8.0	2.2
Rapeseed (canola) oil, 1 tbsp	1.3	2.8
Walnut oil, 1 tbsp	1.4	7.2
Soya oil, 1 tbsp	0.9	6.9
Wheat germ oil	0.9	7.5
Nuts and seeds		
Flaxseeds (linseeds), ground, 2 tbsp	3.2	0.8
Walnuts, 2 tbsp	1.0	5.4
Vegetables, fruits and pulses		
Soya beans, cooked, 1 cup	1.1	7.8
Tofu, firm, ½ cup	0.7	5.0
Tofu, medium, ½ cup	0.4	2.9
Soya milk, 1 cup	0.4	2.9
Berries, 1 cup	0.2	0.2
Peas, ½ cup	0.2	0.2
Legumes, ½ cup	0.05	0.05
Green leafy vegetables (broccoli, kale, Brussels sprouts, leeks, spinach, Chinese greens, salad greens) 1 cup raw or ½ cup cooked		
	0.1	0.03
Grains		
Oat germ, 2 tbsp	0.2	1.6
Wheat germ, 2 tbsp	0.1	0.8

Note: 1 cup = 112g

Essential Fatty Acids

The fats which are essential to the diet are linoleic acid (from the omega-6 family of fatty acids) and alpha-linolenic acid (omega-3 family). Dietary sources of these essential fatty acids, or EFAs, are listed in Table 4. Seed oils such as flax (linseed), rapeseed (canola) and walnut oil are rich sources of EFAs as are seeds and nuts themselves (Buttriss, 1999). Green leafy vegetables are also a source (Pereira *et al.*, 2001).

Polyunsaturated fatty acids have many important functions in the body. They have a structural function in cell membranes; can aid the retina and other organs, including the brain and skin; are involved in regulating the transport, breakdown and excretion of cholesterol; and are precursors of prostaglandins, thromboxane and leukotrienes, which regulate many body processes including inflammation and blood clotting.

There are at least three important fatty acids in the omega-3 family: ALA, EPA and DHA. ALA can be obtained from flaxseed (linseed) oil, walnuts, rapeseed, soya beans and green leafy vegetables (although the latter do not contain much as they are generally very low in fat) (see Table 4). EPA and DHA – which are required for brain function – can only be obtained from marine sources, namely oily fish and some species of algae. However, ALA can be converted into EPA and DHA in the body.

Likewise, LA, found in sunflower, corn, walnut and soya oils, can be converted into other important polyunsaturated fatty acids in the omega-6 family, such as arachidonic acid.

Table 5: Recommended Daily Intake of Omega-3 Fats for Adults

Omega-3 fatty acids	1 daily portion is...
Flaxseed (linseed) oil	1 teaspoon
Ground flaxseed (linseed)	1½ tablespoons
Hempseed oil	1 tablespoon
Rapeseed oil	1½ tablespoons
Walnuts	8 halves/28g/1oz
Hempseed	5 tablespoons

