

FATS AND OILS: CHOOSE SENSIBLY

The information explosion in the science of nutrition very often creates the impression that available information is contradictory. Consequently, it is no longer easy to distinguish between fact, misinformation and fiction. The Division of Human Nutrition, Faculty of Medicine and Health Sciences, Stellenbosch University act as a reliable and independent source of nutrition information.

Fat, the nutrient

Dietary fat is an essential nutrient and source of energy required for many functions in the body. Fat is the most concentrated source of energy in the diet, and provides 37 kJ per gram compared to 17 kJ per gram from either carbohydrates or protein and 29 kJ per gram from alcohol. The contribution of fats and oils to total dietary energy intake increases with industrialisation and urbanisation. It is digested slowly and may play a role in satiety or “signals of fullness” the body receives after eating.

Functions in the body

Some fat is found in the blood and other body cells such as cell membranes, but the largest amount is stored in the fat cells as a source of available energy. These fat cells also serve to insulate the body and support and cushion vital organs. Fat is needed to carry fat-soluble vitamins.

Fats are chemically known as triglycerides. A triglyceride consists of a glycerol backbone with three fatty acids linked to the glycerol molecule. Different combinations of fatty acids are linked to the glycerol backbone.

Types of fatty acids – structure and characteristics and dietary sources

Fatty acids are classified based on whether or not the fatty acid carbon chain contains double bonds between carbon atoms or not. The fat in food does not only consist of one type of fat but it is a mixture of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). SFA contain no double bonds, MUFA contain one double bond and PUFA contain more than one double bond. PUFA are further classified based on the position of the first double bond from the methyl end of the carbon chain.

Saturated fats: SFA refers to the major SFA in our diet, namely myristic (C14), palmitic (C16) and stearic (C18), except in the case of milk and coconut oil where SFA range from butyric (C4) to stearic (C18). Animal fat such as beef and lamb fat, lard, skin from poultry, milk fat, e.g. cream, butter, cheese,

and other dairy products made from whole or low-fat (2%) milk and some vegetable fats are important sources of saturated fat in the diet. Many confectionery products, commercially prepared snacks and fried food such as convenient food or fast food can also contain high levels of saturated fats.

Some plant foods (tropical oils), such as palm oil, palm kernel oil, and coconut oil are relatively high in saturated fats. Coconut oil contains approximately 92.1% SFA, 6.2% MUFA, 1.6% PUFA. It is used as cooking oil, to make margarine and is a component of many processed foods. Palm oil is semi-solid at room temperatures. Palm oil contains several saturated and unsaturated fats in the forms of glyceryl laurate (0.1%, saturated), myristate (0.1%, saturated), palmitate (44%, saturated), stearate (5%, saturated), oleate (39%, monounsaturated), linoleate (10%, polyunsaturated), and linolenate (0.3%, polyunsaturated). Palm kernel oil and coconut oil are more saturated than palm oil. Palm oil is a common cooking ingredient in Southeast Asia and the tropical belt of Africa. Its increasing use in the commercial food industry in other parts of the world is due to its lower cost and the high oxidative stability (saturation) of the refined product when used for frying. Palm oil is often used in the food industry for deep fat frying while palm kernel oil is used extensively in the production of tea and coffee creamers.

Animal fats contain predominantly palmitic acid and stearic acid and tropical oils contain high amounts of SFAs, such lauric, palmitic and myristic acid.

Trans fats: *Trans* fats are formed by the partial hydrogenation of unsaturated fatty acids. *Cis* and *trans* are terms that refer to the arrangement of chains of carbon atoms across the double bond. In the *cis* arrangement, the chains are on the same side of the double bond, resulting in a kink. In the *trans* arrangement, the chains are on opposite sides of the double bond, and the chain is straight. *Trans* fatty acid (TFA) is the common name for unsaturated fat with *trans*-isomer fatty acid(s). The process of hydrogenation adds hydrogen atoms to unsaturated fats, eliminating double bonds and making them into partially or completely saturated fats. These more-completely saturated fats have a higher melting point, which makes them more attractive for baking, and the saturation extends their shelf-life. Cakes, commercial cookies, chips, fried chicken, breaded chicken and fish nuggets as well as salty snack foods such as popcorn, crisps and crackers made with partially hydrogenated vegetable oils, traditional vegetable shortening or hard ("stick") margarine typically contain trans fats. Trans fats occur naturally in products of animal origin, although to a limited extent. TFA are present in ruminant meat (beef) and milk fats as a result of biohydrogenation of unsaturated fatty acids in the rumen. The major TFA in ruminant meat and milk is vaccenic, with smaller amounts of other TFA. (Soft margarines are high in polyunsaturated fatty acids and typically contain no or very low levels of TFA).

Unsaturated Fats: Unsaturated fats consist of monounsaturated and polyunsaturated fats.

Monounsaturated: MUFA refers to the major monounsaturated fatty acid in Western diets, which is oleic acid (C18:1n-9). MUFA are present in vegetables, vegetable oils, nuts, seed oils, as well as in meat, chicken and dairy products. Oleic acid is present in high amounts in olive oil, canola oil, high-

oleic sunflower oil, and other mid- and high oleic vegetable oils, peanuts, pistachios, almonds, and avocados.

Polyunsaturated: PUFA refers to the major PUFA in our diet, which includes mainly linoleic acid (LA) (C18:2n-6), a lower proportion of alpha-linolenic acid (ALA) (C18:3n-3), and depending on seafood intake a variable but relatively low proportion of long chain PUFA such as arachidonic acid (AA), Eicosapentaenoic acid (EPA), Docosapentanoic Acid (DPA) and Docosahexaenoic Acid (DHA).

PUFA are found in vegetable oils (soybean oil, corn oil and safflower oil), fish, especially oily fish (salmon, mackerel, herring, trout, sardines and snoek), and most nuts and seeds. ALA can be converted by the body into EPA and DHA, but only about 2 - 10% is converted. The human body cannot synthesize ALA and linoleic acid (LA), an omega-6 fatty acid, making it essential fatty acids since it needs to be obtained from dietary sources.

Functions of essential fatty acids

Essential fatty acids are required for maintaining healthy skin, regulating cholesterol metabolism, and as a precursor of prostaglandins, hormone-like substances that regulate many body processes. Long-chain PUFA consists of about 20 percent of the brain's dry weight and is critical for healthy brain development and function.

Examples of Polyunsaturated and Monounsaturated Fatty Acids and Important Food Sources

Unsaturated Fatty Acids	Name	Abbr.	Food Source [#]
Omega-3	Alpha-linolenic acid	ALA	Walnuts, flaxseed oil, soybean, and canola oil
	Eicosapentaenoic acid	EPA	Oily fish* and fish oils
	Docosahexaenoic acid	DHA	Oily fish* and fish oils and algal oils
Omega-6	Linoleic acid	LA	Corn-, safflower-, soybean-, cottonseed-, and sunflower oils
	Gamma-linolenic acid	GLA	Evening primrose oil, borage oil, and black current seed oil ^{##}
	Arachidonic acid	AA	Meat, poultry, and eggs, fish
MUFA	Oleic Acid	OA	Olive oil, canola oil, nuts

Not a representation of all sources;

These are not really 'food sources' but consumed as supplements.

* Examples of oily fish include snoek, sardines, butterfish, herring, salmon and mackerel

Abbr. = abbreviation

The quantity and quality of fat is important in the diet ~ Why?

Chronic diseases of lifestyle (also called non-communicable diseases) are a group of diseases that develop as a result of long term exposure to risk factors such as unhealthy diets, smoking and lack of exercise. It is now generally accepted that not only obesity [body mass index (BMI) > 30 kg/m²], but also overweight (BMI > 24.9 kg/m²), increases the risk of a number of major chronic diseases or conditions including insulin resistance, hyperlipidaemia, hypertension and stroke, type 2 diabetes, cardiovascular disease, as well as cancers of some sites. Genetic, social, and environmental factors over the course of life influence the prevalence of weight gain, overweight, and obesity. High energy diets are probably a cause of weight gain, overweight, and obesity by promoting excess energy intake.

Total energy intake should be balanced between energy intake and expenditure, to achieve and maintain a healthy body weight. The quantity of fat in the daily eating plan is an important factor contributing to total energy intake. The quality of fat in the diet is important as some fats have a positive impact on normal growth and development, brain function, and others may influence blood cholesterol levels negatively and could thus contribute to the development of coronary heart disease and stroke.

Focus on: Dietary Fat and Obesity

Overweight and obesity are specific risk factors for developing hypertension, diabetes and heart disease. There is also a strong indication that obesity is associated with osteoarthritis and a number of cancers.

Energy density describes the amount of energy per unit weight of foods or diets. Energy-dense foods are usually high in fats or oils, and / or refined or processed starches and added sugars. Convenient or fast foods, sweets and snacks such as chocolates and confectionery are examples of high energy-dense foods. The energy density of meat depends on the amount of fat it contains and how it is prepared. High energy-dense foods are probably a cause of weight gain, overweight, and obesity, particularly when large portion sizes are consumed regularly and results in an overall increased energy intake.

Healthy active adults should aim to consume diets high in vegetables and fruit, legumes and wholegrain cereals in order to maintain a healthy body weight and to ensure optimal nutrient intake. Consuming more than 35 percent of energy from fats generally increases saturated fat intake and may make it more difficult to avoid consuming excess energy.

Focus on: Dietary Fat and Coronary Heart Disease (CHD)

The association between dietary fat and CHD has been extensively studied. Dyslipidaemia is defined as a clinically significant change in the circulating lipids and lipoproteins predisposing to CHD and related disorders. In practice the most important and common form of dyslipidaemia is hypercholesterolaemia. Coronary heart disease occurs when the arteries that supply blood to the heart muscle (the coronary arteries) become hardened and narrowed. The arteries harden and narrow because of build up of fatty deposits (atheroma) in the cells lining the wall of the coronary arteries. This build up is known as atherosclerosis.

Diets high in saturated fatty acids and *trans* fatty acids increase low-density lipoprotein (LDL) cholesterol levels, one of the risk factors of CHD. Not all saturated fatty acids increase LDL cholesterol. Lauric (C12:0), myristic (C14:0) and palmitic (C16:0) acids increase LDL cholesterol whereas stearic (C18:0) has no effect. There is convincing evidence that replacing SFA with PUFA decreases the risk of CVD. When polyunsaturated fats replace saturated fats in the diet, this could help to reduce blood cholesterol concentrations and thus lower the risk of CVD. A similar but lesser effect is achieved by replacing SFA with monounsaturated fatty acids (MUFA).

In view of the positive linear relationship among dietary saturated fat, LDL cholesterol, and cardiovascular disease (CVD) risk, saturated fat should be limited to less than 10% of total energy intake in order to prevent CVD. For those at risk of cardiovascular disease the intake should be less than 7% of energy.

Fish intake and fish oil have been associated with decreased risk of CVD. Healthy individuals should aim to eat a variety of oily fish at least twice a week. Adults with documented CHD are advised to consume ~1 g of EPA and DHA per day, preferably from oily fish, although EPA and DHA supplements could be considered. For individuals with hypertriglyceridemia, 2 to 4 g of EPA and DHA per day, provided as capsules, are recommended but only under the supervision of their medical practitioner.

Dietary fat goals to prevent chronic diseases

Recent evidence indicates that diets with adequate energy providing less than 30% of energy from fat are sufficient to promote normal growth and normal sexual maturation, but protect against chronic diseases of lifestyle. Most of the fat in the diet should come from foods that are sources of PUFA and/or MUFA such-as fish, nuts, and vegetable oils.

Dietary factor	South African Goal (% of total energy, unless otherwise stated)
Total fat	Up to 30% of energy intake
Saturated fatty acids	<10% of energy <7% for those at risk of cardiovascular disease
Polyunsaturated fatty acids (PUFAs)	6 – 10%
n-6 Polyunsaturated fatty acids (PUFAs)	5 – 8%
n-3 Polyunsaturated fatty acids (PUFAs)	1 - 2%
Trans fatty acids	<1%
Monounsaturated fatty acids (MUFAs)	By difference*

*MUFA = Total fat – SFA-PUFA-TFAs. Therefore, the MUFA intake resulting may cover a wide range depending on the total fat intake and dietary fatty acid pattern.

Omega 3 fatty acids: The Institute of Medicine (IOM) recommends an adequate intake level of ALA at 1.6 grams/day and 1.1 grams/day for men and women (excluding those who are pregnant and lactating), respectively. EPA and DHA can contribute up to 10 percent of the total intake of ALA. There has been increased understanding of the importance of n-3 fatty acids in reducing CVD risk, in neurological function and pregnancy outcome, and in inflammatory and immune disorders. Consensus on the ideal ratio of n-6:n3 has not yet been reached.

What does this mean? - How much and what type of fat per day?

The development of the South African Food Based Dietary Guidelines was a joint initiative between the Nutrition Society, Association for Dietetics in South Africa, Medical Research Council, food industry and the Department of Health (DOH). These guidelines advise that fats should be eaten sparingly.

How to eat fats sparingly? Practical hints to limit fat and to eat the recommended amount and a variety of healthy fats:

Dietary goal	Food based dietary guidelines to achieve dietary goals
<p>Total fat</p> <p>Limit total fat intake to ~ 30% of total energy *</p>	<p>Limit the intake of fatty foods such as fatty meat, pies and fried chips.</p> <p>Apply healthy cooking methods and avoid adding fat to food while cooking: Steam, grill, boil and bake food to avoid frying and adding of fat to food or recipes.</p> <p>Avoid or limit convenient foods, fast food and restaurant meals to special occasions.</p> <p>Read food labels and choose products with less than 3g fat per 100g edible portion where possible.</p> <p>Eat at least 5-6 portions of fresh, frozen or canned vegetables and fruit without added fat and sugar per day.</p> <p>Eat 6-12 portions of low fat high fibre grains and starches, without added fat and sugar, per day.</p>
<p>Saturated fatty acids</p> <p>< 10% of total energy</p>	<p>Choose only lean meat cuts and chicken without the skin. Limit portions to about 60-90 g per day. Eat oily fish or low fat white fish instead of red meat, chicken or pork twice a week.</p> <p>Choose leaner meat cuts such as fillet and remove all visible fat before cooking.</p> <p>Limit the intake of organ meat and offal to small portions and special occasions.</p> <p>Read product label and try to choose products low in saturated fat (\leq 1.5 g per 100 g).</p> <p>Avoid or limit processed meat such as polony, vienna sausages or salami.</p>

	<p>Eat legumes and dishes made from dried beans instead of meat regularly.</p> <p>Choose fat free (preferably) or low fat dairy products. Limit the intake of hard cheeses such as cheddar and gouda to 2-3 times a week. Keep portions small. Opt for reduced fat cheeses or cottage cheese.</p> <p>Eat soft margarine, high in PUFA, in tubs sparingly instead of butter. Opt for light or reduced oil options.</p> <p>Avoid confectionary products and sweets made with palm kernel oil, coconut oil, butterfat or peanut oil.</p> <p>Use liquid plant oils instead of solid fats in recipes or in food preparation (preferably cook without fat where possible).</p>
<p>Trans fatty acids</p> <p>< 1%</p>	<p>Read product labels and choose products free or virtually free (≤ 0.1 g per 100 g) of trans fatty acids. Limit the intake of snacks and confectionary products unless the label indicates that the product is free or virtually free of trans fatty acids.</p> <p>Always opt for soft type margarine, high in PUFA, in tubs and avoid hard (brick) margarines.</p>
<p>n-6 Polyunsaturated fatty acids (PUFAs)</p> <p>5 - 8% of total energy</p>	<p>Choose a variety of liquid plant oils such as sunflower oil, grape seed, corn oil, sesame oil, salad dressings and soft margarines made from these oils to add taste and palatability to meals where necessary.</p> <p>Always use fats and oils in small amounts. Depending on the total energy content of the diet, this translates to about 3 – 9 portions – including the monounsaturated fatty acids – see below (1 portion = 5 ml margarine or 5 ml oil), provided that the background diet comprises of low fat or medium fat meat, fat free or low fat dairy products and has a low fat content in general.</p>
<p>n -3 Polyunsaturated fatty acids (PUFAs)</p> <p>1 - 2%</p>	<p>Eat oily fish regularly to increase the intake of omega 3 fatty acids in the diet. Substitute red meat with salmon, mackerel, snoek, trout, sardines and pilchards at least two-three times per week.</p> <p>Read product labels. Products enriched or fortified with omega 3 fatty acids such as eggs and milk is available in food stores.</p>

<p>Monounsaturated fatty acids (MUFAs)</p> <p>By difference -Please see PUFAs quantities also</p>	<p>Replace saturated fatty acids with monounsaturated plant oils where possible. Choose olive oil or canola oil or high oleic sunflower oil (1 portion = 5 ml margarine or 5 ml oil) to add variety, taste and palatability to meals. Opt for avocado and / or peanut butter on sandwiches instead of saturated fat sources such as hard cheeses, processed meat or butter. Avocado (1 portion = ~ 1/8thavocado) nuts (1 portion =5 large or 10 small) and olives (1 portion = 8 - 10) can be enjoyed in moderation.</p>
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*Healthy active adults consuming diets high in vegetables and fruit, legumes and wholegrain cereals may sustain a fat intake of up 35 – 40% of total energy intake, provided that energy balance is maintained, without the risk of weight gain. The majority of the fat should come from plant oils, which are excellent sources of PUFAs and MUFAs.

How to cook with fat – always keep in mind that less is better

It is always best to use alternative cooking methods such as baking, steaming, boiling and grilling to avoid adding fats and oils to food and recipes. Recipes and foods that require frying and deep fat frying should be limited and preferably only be eaten on special occasions and in small quantities. Polyunsaturated and monounsaturated liquid vegetable and seeds oils such as sunflower, canola and olive oil should be used for cooking. **A variety of these can be selected based on cost, personal preference and flavour.**

The smoke point of cooking oil refers to the temperature at which oil begins to break down to glycerol and free fatty acids and marks the beginning of both flavour and nutritional degradation. It is therefore an important consideration when selecting oil for frying, with the smoke point of the specific oil dictating its maximum unstable temperature and therefore its possible applications. For instance, since deep fat frying is a high temperature process, it requires a fat with a high smoke point.

The more refined an oil, the higher the smoke point. Refining removes the impurities that can cause the oil to smoke, therefore unrefined oils such as cold pressed oils should rather be used for milder applications and not for frying. The longer the oil is exposed to heat, the lower its smoke point becomes. Fresher oil will have a higher smoke point than the very same oil after it has been heated in a deep-fryer for several hours. Presence of food particles also decreases the smoke point of oil. Aldehydes, compounds that form when oil cools down, are a concern. Precautions should be taken to avoid temperatures > 190° C and the repeated use of frying oil should be limited to 5 – 10 cycles (also depending on the food being fried). Migration of the food components into the oil during frying due to leaching from the food can significantly alter the quality and the composition of the oil. All food particles should be removed from oil before reusing it.

How to use oils and fats

Type of fat or oil	Smoking point*	Frying	Cooking/Baking	Salad dressing	Bread spread
Avocado	250°C	√	√	√	X
Sunflower oil	246 °C	√	√	√	X
Canola oil	246 °C	√	√	√	X
Soybean oil	241 °C	√	√	√	X
Grape seed oil	204 °C	√	√	√	X
Olive oil (Refined)	225°C	√	√	√	X
Peanut oil	231°C	√	√	√	X
Corn oil	236°C	√	√	√	X
Sesame oil (Semi-refined)	232 °C	√	√	√	X
Palm oil	230°C	√	√	√	X
Olive oil (Virgin)	215 °C	√	√	√	X
Olive Oil (Extra Virgin)	190°C	X	√	√	X
Sesame oil (Unrefined)	177 °C	X	√	√	X
Soft type margarine, high in PUFA or MUFA	150 – 160 °C	X	√	X	√
Butter	150 °C	X	√	X	√

*The values shown in the above table must be taken as approximate, and are not suitable for accurate or scientific use.

Choose for unsaturated vegetable oils: Oils / fats are ranked in terms of their SFA content from lowest to highest.

Type of fat or oil	Composition of the total fatty acid content*		
	SFA%	MUFA%	PUFA%
Canola oil	6%	62%	32%
Sunflower oil	11%	20%	69%
Grape seed oil	12%	17%	71%
Olive Oil (Extra Virgin)	14%	73%	11%
Olive oil (Virgin)	14%	73%	11%
Olive Oil (Refined)	14%	73%	11%
Sesame oil (Unrefined)	14%	43%	43%
Sesame oil (Semi-refined)	14%	43%	43%
Soybean oil	15%	24%	61%
Peanut oil	18%	49%	33%
Margarine, soft	20%	47%	33%
Avocado	20%	70%	10%
Palm oil	52%	38%	10%
Butter	66%	30%	4%
Margarine, hard	80%	14%	6%
Coconut oil	92%	6%	2%

*The values shown in the above table must be taken as approximate due to differences in analytical methods used.

In conclusion

Healthy individuals should aim to initiate a healthy lifestyle and dietary habits. To attain a healthy lifestyle one needs to address eating habits, activity levels and lifestyle habits such as smoking. It is important to maintain ideal body weight. Total energy intake should be balanced between energy intake and expenditure, to achieve and maintain a healthy body weight. Dietary fat is an essential nutrient and source of energy required for many functions in the body. The quantity of fat in the daily eating plan is an important factor contributing to total energy intake and the quality of fat in the diet is important and have health implications. Fats and oils should be eaten sparingly. Total fat intake should not exceed 30% and saturated fat should be limited to less than 10% of total energy intake. Most of the fat in the diet should come from foods that are sources of PUFA and / or MUFA such-as fish, nuts, and vegetable oils. A general recommendation is to follow a dietary pattern predominantly based on whole foods (fruits and vegetables, whole grains, nuts, seeds, legumes, other dietary fibre sources and oily fish) with a relatively lower intake of energy dense processed and fried foods, and sugar sweetened beverages; and to avoid consumption of large portion sizes. Moderate consumption of dairy products and lean meats and poultry is recommended.

For further, personalized and more detailed information, please contact a dietitian registered with the Health Professions Council of South Africa.

References from the scientific literature used to compile this document are available on request.

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