HEALTHIER FATS AND OILS

A HEALTHIER APPROACH TO DIETARY FATS

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I. DECLERATION

We hereby declare that all the work contained within this article has been a result of extensive research carried online (due to corona pandemic) during our candidature as Bsc (Hons) Chemistry at Ramjas College and is written originally by us except for ***References*** (including research papers) given at end of this article. To the best of our knowledge, none of this article has been submitted In part or fully for any other academic purpose (degree or diploma), at any other college or university. In addition, we abide that no material contained within this article has been written or published by any other person, except for the cases where due reference has been given within the text.

II. STATEMENT OF PURPOSE

Fats and Oils are integral part of our diet and lifestyle. They are the most concentrated sources of energy, and are vital for various life processes within our body. We can obtain fats or oils from various sources, and each one of these source has a unique fat profile, leading to different effects on health (*good* or *bad*). Despite the importance of fats and oils in our diet, there is significant confusion within consumer's (or an average person) mind, as to which fats and oils are good and which are bad, and more importantly, how much good or bad they are to our health and what makes a fat or oil better or worse than the other in first place.

This article aim's on giving a scientific and logical insight towards these questions, and to clear doubts and fears about fats and oils in society. We will go through the underlying chemistry and biology of fats and oils, in most simple words possible and then some helpful dietary tips and interesting future trends towards a "*greener*" path in this field.

III. Concepts

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a. Coconut Oil
b. Olive Oil
c. Canola Oil
d. Vegetable Oil

7) Uses of Oils
   a. In cooking
   b. In other uses

8) Health and Wellbeing
   a. Healthiest cooking oil
   b. Ghee
      i. Benefits of Ghee
      ii. Is Ghee healthy?
   c. Highly Unsaturated Oils in food
      i. Guidelines
      ii. Challenges
      iii. Chemical Deterioration
      iv. Thermal Degradation
      v. Hydrolytic Rancidity
      vi. Oxidative Rancidity
   d. Antioxidants
      i. Introduction
      ii. Benefits
      iii. Disadvantages
      iv. Types
      v. Food Sources
      vi. Effect on cooking

9) Clinical Interventions
   a. Dietary Patterns
   b. Role of SFA, MUFA, and PUFA in coronary heart disease
   c. Specific Foods and Oils
   d. Public confusion about Nutrition Research and resultant Dietary Fat Recommendations

10) Conclusion

11) References
   a. Research Papers
      i. Chemistry of Oils & Fats and their Health Effects
      ii. A healthy approach to dietary fats
      iii. Challenges of Utilizing Healthy Fats in Foods
      iv. Healthful Oils
   b. Books and Manuals
   c. External Links

IV. INTRODUCTION

A. General Introduction

- *Fats and oils* are the most abundant lipids in nature. They provide energy for living organisms, insulate body organs, and transport fat-soluble vitamins through the blood.
- They are considered as essential nutrient in our diet. All fats are not bad, in fact, healthy fats are essential to manage our body systems, maintain our mental health, fight fatigue and even control weight.
- They provide us with the most concentrated source of energy along with essential fatty acids that act as precursors to important hormones, the prostaglandins. They act as carriers for many fat soluble vitamins and make our food more palatable. Healthy fats are vital for proper brain development and function as the human is nearly 60% fat.

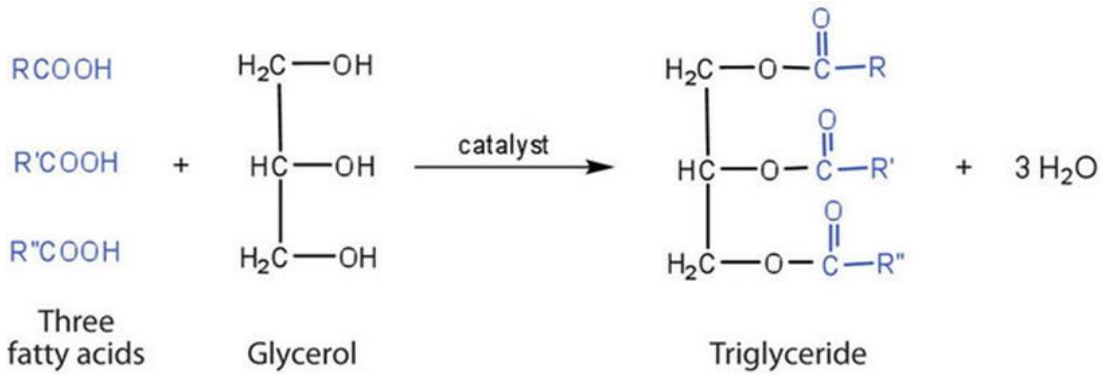
So our first task is to understand the chemistry of fat, type of fatty acids contained in fat from which we can decide which fat is good and which is bad for health.

- According to public health recommendations in 1977 in US, fat intake should be reduced to as low as 30% of calories to lower the incidence of CAD. Whereas according to current recommendations the Trans fats, saturated fats and cholesterol intake should be kept as low as possible while consuming a nutritionally adequate diet.
- This review summarizes chemistry of fats and oils along with findings and observations on the role of good fats however also discussing the harmful effects of saturated and trans fats

and the oils rich in certain kind of fats so that one can choose the right oil.

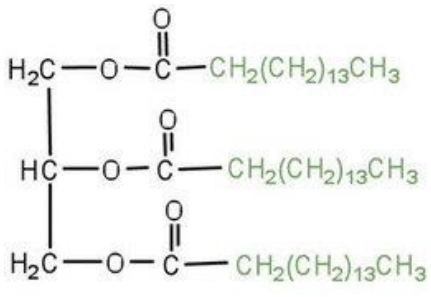
B. Chemical Introduction

Chemically, Fats and Oils are made up of ester units, composed of glycerol (a trihydroxy alcohol) esterified with three fatty acids (long chain aliphatic carboxylic acid). Hence,

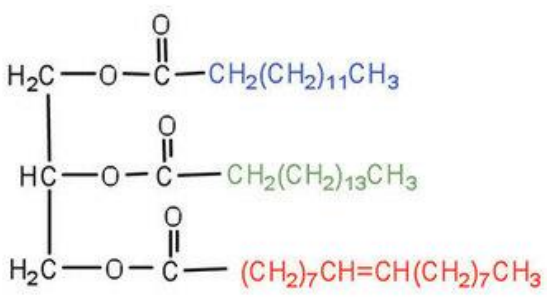


they are best known as *triglycerides* (or triacylglycerol's).

If all three OH groups on the glycerol molecule are esterified with the same fatty acid, the resulting ester is called a *simple triglyceride*. Although simple triglycerides have been synthesized in the laboratory, they rarely occur in nature. Instead, a typical triglyceride obtained from naturally



Tristearin
a simple triglyceride



a mixed triglyceride

occurring fats and oils contains two or three different fatty acid components and is thus termed a *mixed triglyceride*

A triglyceride is called a *Fat* if it is a solid at 25°C, and an *Oil* if it is a liquid at that temperature. These differences in melting points reflect differences in the degree of unsaturation and number of carbon atoms in the constituent fatty acids. Triglycerides obtained from animal sources are usually solids, while those of plant origin are generally oils. Therefore, we commonly speak of animal fats and vegetable oils.

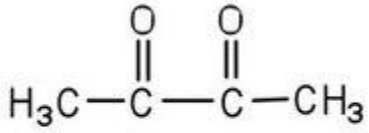
The major component of most of the fats and oils are triacylglycerol's while minor components comprise mono- and diacylglycerol's, free fatty acids, phosphatides, fat soluble vitamins such as vitamin A & D, sterols, tocopherols, fatty alcohols, carotenoids & chlorophyll etc. The levels of free fatty acids, carotenoids & chlorophyll and phosphatides are reduced during refining of oils.

No single formula can be written to represent the naturally occurring fats and oils because they are highly complex mixtures of triglycerides in which many different fatty acids are represented. The composition of any given fat or oil can vary depending on the plant or animal species it comes from as well as on dietetic and climatic factors. To cite just one example, lard from corn-fed hogs is more highly saturated than lard from peanut-fed hogs. Palmitic acid is the most abundant of the saturated fatty acids, while oleic acid is the most abundant unsaturated fatty acid.

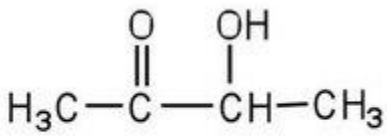
Terms such as saturated fat or unsaturated oil are often used to describe the fats or oils obtained from foods. Saturated fats contain a high proportion of saturated fatty acids, while unsaturated oils contain a high proportion of unsaturated fatty acids. The high consumption of saturated fats is a factor, along with the high consumption of cholesterol, in increased risks of heart disease.

C. PHYSICAL PROPERTIES

- Contrary to what you might expect, pure fats and oils are colorless, odorless, and tasteless. The characteristic colors, odors, and flavors that we associate with some of them are imparted by foreign substances that are lipid soluble and have been absorbed by these lipids.
- For example, the yellow color of butter is due to the presence of the pigment carotene; the taste of butter comes from two compounds diacetyl and 3-hydroxy-2-butanone produced by bacteria in the ripening cream from which the butter is made.



Diacetyl



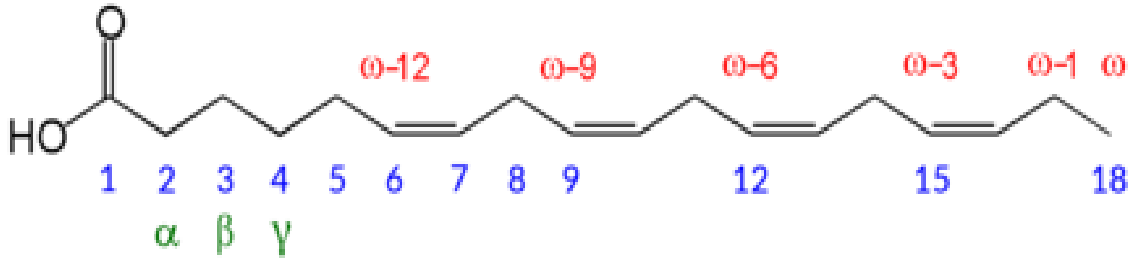
3-hydroxy-2-butanone

- Fats and oils are lighter than water, having densities of about 0.8 g/cm3.
- They are poor conductors of heat and electricity and therefore serve as excellent insulators for the body, slowing the loss of heat through the skin

V. Fatty Acids

- *Fatty acid* is a carboxylic acid with a long aliphatic chain, which is either saturated or unsaturated.
- Most naturally occurring fatty acids have an unbranched chain of an even number of carbon atoms, from 4 to 28.
- Fatty acids are usually not found in organisms in their standalone form, but instead exist as three main classes of esters: *triglycerides*, phospholipids, and cholesteryl esters.
- In any of these forms, fatty acids are both important dietary sources of fuel for animals and they are important structural components for cells.

Fatty acid structure has 2 ends, one is the –COOH end (or Δ end) and other is $-CH_3$ end (or ω end). This is represented in figure shown below…



Numbering of carbon atoms. The systematic (IUPAC) C-x numbers are in blue. The omega-minus "ω−x" labels are in red. The Greek letter labels are in green. Note that unsaturated fatty acids with a cis configuration are actually "*kinked*" rather than straight as shown here

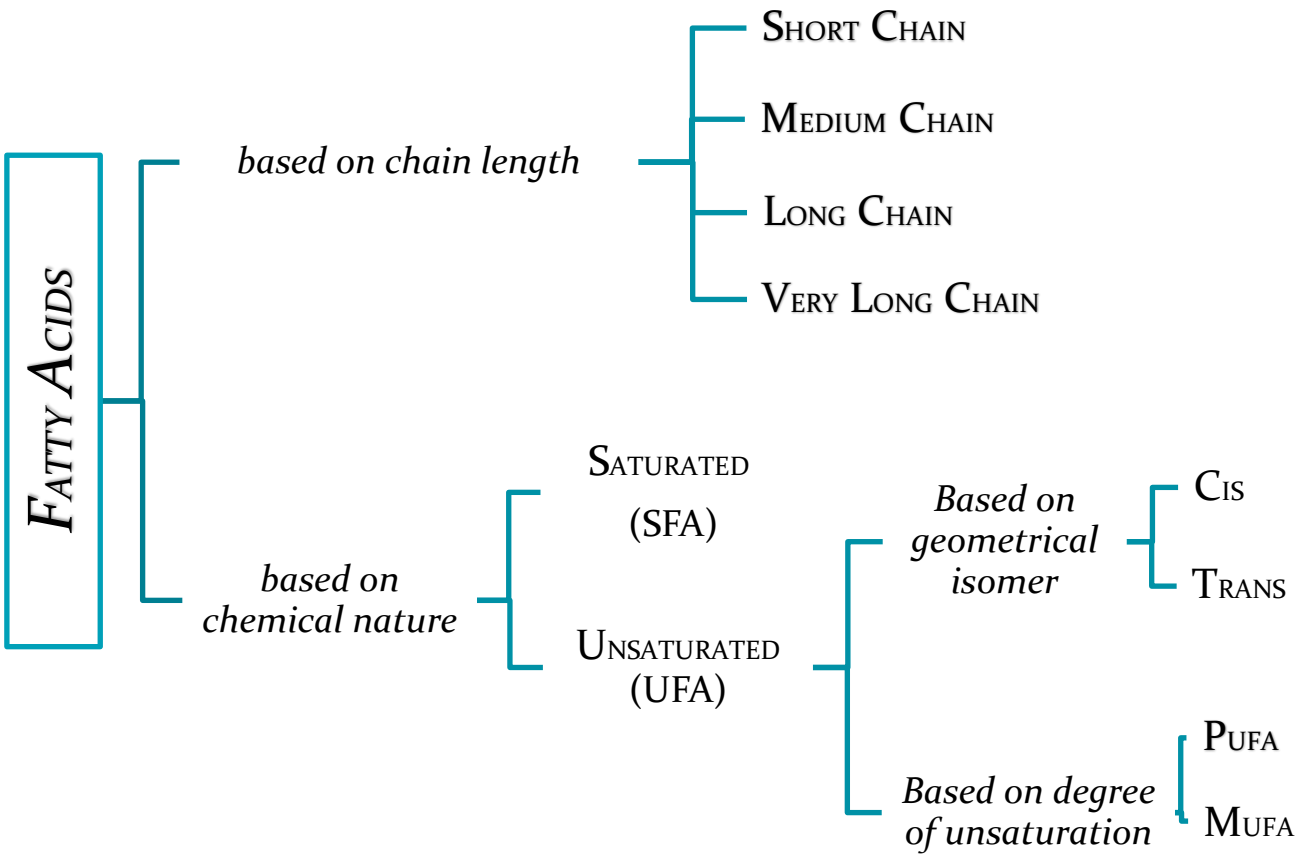
The notation $\Delta^{x, y, \cdots}$ is traditionally used to specify a fatty acid with double bonds at positions x, y, …. (The capital Greek letter "Δ" (delta) corresponds to Roman "D", for Double bond). Thus, for example, the 18-carbon linolenic acid is $\Delta^{9, 12, 15}$, meaning

that it has three double bonds between carbons 9 and 10, 12 and 13, 15 and 16.

A. Types of Fatty Acids

Fatty Acids can be classified into many classes based on various factors, like chain length, degree of saturation/ unsaturation, geometry and position of double bond, even vs odd carbon content etc.

Some main classes of fatty acids are represented in diagram below...



BASED ON CHAIN LENGTH

(a) **Small Chain Fatty Acids (SCFA) :**
SCFA are fatty acids with aliphatic tails of five or fewer carbons (e.g. butyric acid).

(b) **Medium Chain Fatty Acids (MCFA) :**
MCFA are fatty acids with aliphatic tails of 6-12 carbon atoms (e.g. carprylic acid).

(c) **Long Chain Fatty Acids (LCFA) :**
LCFA are fatty acids with aliphatic tails of 13-21 carbon atoms (e.g. palmitic acid).

(d) **Very Long Chain Fatty Acids (VLCFA) :**
VLCFA are fatty acids with aliphatic tails of 22 or more carbon atoms (e.g. cerotic acid).

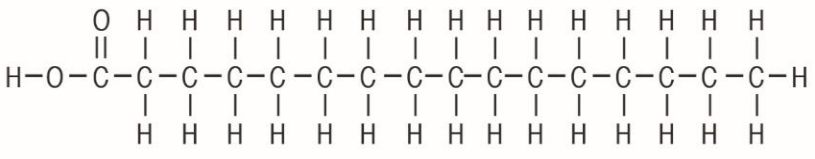
- Small and medium chain fatty acids have relatively fewer carbon-atoms in their side chain. This allows them to have higher solubility and to be directly absorbed in blood stream and metabolized for instant requirement of energy for the body. They do not affect blood cholesterol levels (neither of LDL or HDL) and serum triglyceride concentration, hence have no risks of heart related problems.

- On contrary, long and very long chain fatty acids have long side chains. Due to their large size and low solubility, they can't be absorbed directly and must be transported to liver for storage and metabolism. They contribute to blood cholesterol (mainly LDL), serum triglyceride concentration and accumulated fat in body, all of which result in various health problems.

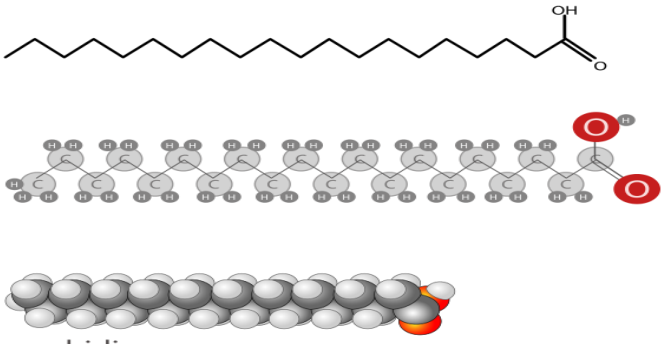
BASED ON CHEMICAL NATURE

1. SATURATED FATTY ACIDS (SFA)

- Saturated Fatty Acids (or SFA) are those fatty acids which have purely saturated aliphatic alkyl chain (i.e they do not contain C-C double bonds).
- They can all be represented by same formula $CH_3 (CH2)_n$ COOH, with only variations in "n".
- Due to their saturated alkyl side chain, they do not have bends in their structure. This fact enables them to easily stack over one another and pack closely resulting in their hard, mostly solid state.
- They usually have high melting point, and can clog up arteries when consumed in excessive amounts. They increases LDL (Low Density Lipoprotein also known as bad cholesterol) levels in blood resulting in various heart related diseases and strokes.
- They cannot be made further harder than they are in nature. The proportion of saturated fats is usually higher in those fats which exist as solid at normal room temperatures They are very stable and have good shelf life i.e. they do not readily become rancid.
- Most of the animal fats such as meat, butter, cream and cheese contain comparatively high proportion of saturated fat so should be consumed with restraint. Baked goods such as cakes, biscuits and pastries also have high amounts of saturated fat.



Palmitic Acid



Arachidic acid

Examples of saturated fatty acids

Common name	***Chemical structure***	***C:D***
Carprylic acid	$CH_3(CH_2)_6COOH$	8:0
Carpric acid	$CH_3(CH_2)_8COOH$	10:0
Lauric acid	$CH_3(CH_2)_{10}COOH$	12:0
Myristic acid	$CH_3(CH_2)_{12}COOH$	14:0
Palmitic acid	$CH_3(CH_2)_{14}COOH$	16:0
Stearuc acid	$CH_3(CH_2)_{16}COOH$	18:0
Arachidic acid	$CH_3(CH_2)_{18}COOH$	20:0
Behenic acid	$CH_3(CH_2)_{20}COOH$	22:0
Lignoceric acid	$CH_3(CH_2)_{22}COOH$	24:0
Cerotic acid	$CH_3(CH_2)_{24}COOH$	26:0

2. Unsaturated Fatty Acids (UFA)

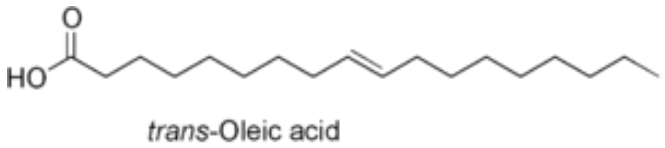
Unsaturated fatty acids have C-C double bonds in their aliphatic side chain. They can further be classified based on degree of unsaturation (number of double bonds) or based on geometry of double bond (*cis* or *trans*)

Cis–UFA

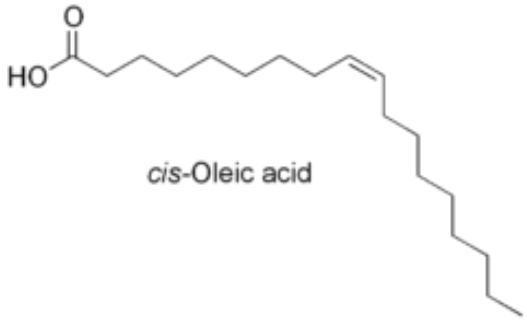
- A cis configuration means that the two hydrogen atoms adjacent to the double bond stick out on the same side of the chain.
- The rigidity of the double bond freezes its conformation and, in the case of the cis isomer, causes the chain to bend and restricts the conformational freedom of the fatty acid. The more double bonds the chain has in the cis configuration, the less flexibility it has.
- When a chain has many cis bonds, it becomes quite curved in its most accessible conformations. For example, oleic acid, with one double bond, has a "*kink*" in it, whereas linoleic acid, with two double bonds, has a more pronounced "*bend*", α-linolenic acid, with three double bonds, favors a "*hooked*" shape.
- The effect of this is that, in restricted environments, such as when fatty acids are part of a phospholipid in a lipid bilayer, or triglycerides in lipid droplets, *cis bonds limit the ability of fatty acids to be closely packed, and therefore can affect the melting temperature* of the membrane or of the fat.
- Net effect of this is a much lower melting point, soft physical state and health benefits. They are considered much healthier than their saturated or trans-counterparts and are believed to lower risks of heart diseases.

Trans–UFA

- A *trans* configuration, by contrast, means that the adjacent two hydrogen atoms lie on opposite sides of the chain. As a result, they do not cause the chain to bend much.
- These are similar in structure to their saturated counterparts, having straight aliphatic side chain, efficient stacking and close packing resulting in higher melting point.
- Heath wise, these are even more harmful then SFA's as they lower HDL (High Density Lipoprotein or good cholesterol) level in addition to increasing LDL level of blood.
- Trans fatty acid isomers can be found in fats and oils as naturally occurring or industrially produced fatty acids.
- TFA in tallow and milk fat is vaccinic acid (18:1 trans-7) which is naturally formed during bio hydrogenation and isomerization of PUFAs in rumen guts.
- TFA's can also be formed as a result of industrial catalytic hydrogenation process for hardening of oils. This is better described in *chemical reactions* section.



trans-Oleic acid



cis-Oleic acid

Comparison of the trans isomer Elaidic acid (top) and the cis isomer oleic acid (bottom)

MONO–UFA (MUFA)

- Fatty acids in this category have exactly one double bond in their hydrocarbon chain.
- They are considered as the best type of fat to eat in nutritional terms since they are comparatively stable to oxidation and the development of rancidity.
- The olive oil and rapeseed oils are the most common source of monounsaturated fatty acids.

POLY–UFA (PUFA)

- Fatty acids in this category have more than one double bond in their hydrocarbon chain.
- Due to higher degree of unsaturation as compared to MUFA, they have lower melting point and are mostly very soft or liquid at room temperature.
- They are most healthy fatty acids and at the same time, are least stable fatty acids which are highly prone to oxidation and hydrolysis (or rancidity). So they are best used in cold applications.
- The sunflower seed oil is the most common source of polyunsaturated fatty acids.

In most naturally occurring unsaturated fatty acids, each double bond has three (n-3), six (n-6), or nine (n-9) carbon atoms after it, and all double bonds have a cis configuration. Most fatty acids in the trans configuration (trans fats) are not found in nature and are the result of human processing (e.g., hydrogenation which is accompanied with isomerization of some cis-double bonds to trans). Some trans fatty acids also

occur naturally in the milk and meat of ruminants (such as cattle and sheep). They are produced, by fermentation, in the rumen of these animals. They are also found in dairy products from milk of ruminants, and may be also found in breast milk of women who obtained them from their diet.

The geometric differences between the various types of unsaturated fatty acids, as well as between saturated and unsaturated fatty acids, play an important role in biological processes, and in the construction of biological structures (such as cell membranes)

Examples of common unsaturated fatty acids

Common name	Chemical structure	Δ^x	C:D	IUPAC	n−x
Myristoleic acid	$CH_3(CH_2)_3\mathbf{CH=CH}(CH_2)_7COOH$	*cis*-Δ^9	14:1	14:1(9)	*n*−5
Palmitoleic acid	$CH_3(CH_2)_5\mathbf{CH=CH}(CH_2)_7COOH$	*cis*-Δ^9	16:1	16:1(9)	*n*−7
Sapienic acid	$CH_3(CH_2)_8\mathbf{CH=CH}(CH_2)_4COOH$	*cis*-Δ^6	16:1	16:1(6)	*n*−10
Oleic acid	$CH_3(CH_2)_7\mathbf{CH=CH}(CH_2)_7COOH$	*cis*-Δ^9	18:1	18:1(9)	*n*−9
Elaidic acid	$CH_3(CH_2)_7\mathbf{CH=CH}(CH_2)_7COOH$	*trans*-Δ^9	18:1		*n*−9
Vaccenic acid	$CH_3(CH_2)_5\mathbf{CH=CH}(CH_2)_9COOH$	*trans*-Δ^{11}	18:1		*n*−7
Linoleic acid	$CH_3(CH_2)_4\mathbf{CH=CH}CH_2\mathbf{CH=CH}(CH_2)_7COOH$	*cis,cis*-Δ^9,Δ^{12}	18:2	18:2(9,12)	*n*−6
α-Linolenic acid	$CH_3CH_2\mathbf{CH=CH}CH_2\mathbf{CH=CH}CH_2\mathbf{CH=CH}(CH_2)_7COOH$	*cis,cis,cis* $\Delta^9,\Delta^{12},\Delta^{15}$	18:3	18:3(9,12,15)	*n*−3

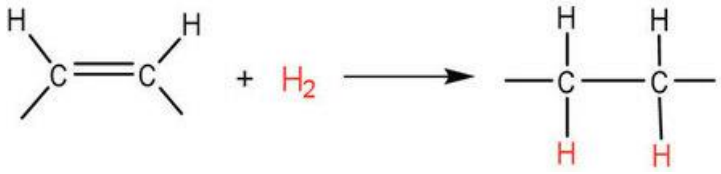
VI. Chemical Reactions

- Fats and oils can participate in a variety of chemical reactions.
- Being esters of fatty acids, they can undergo hydrolysis of ester linkage to produce constituent fatty acids. This is cause of hydrolytic rancidity.
- If fatty acid is unsaturated, it is liable to oxidation by oxygen in air. This makes highly unsaturated fats and oils less stable at high temperatures and prone to oxidative rancidity.
- Double bonds in fatty acids can also undergo hydrogenation and isomerization. This fact is widely exploited in food processing industry for hardening of oils.

Some of the common chemical reactions of fats and oils are described below…

A. Hydrogenation

- The double bonds in fats and oils having unsaturated fatty acids can undergo hydrogenation.
- Catalytic hydrogenation of polyunsaturated fatty acids in an industrial modification process applied to reduce some of the double bonds of polyunsaturated fatty acids in order to improve oxidative stability of oils and increasing their hardness.
- It is an important process in food industry and chemically, is essentially identical to the catalytic hydrogenation reaction described for alkenes.

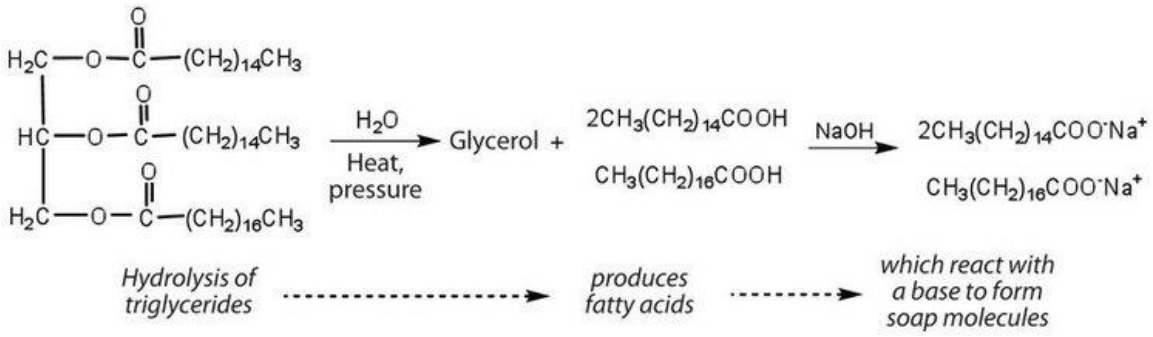


- In commercial processes, the number of double bonds that are hydrogenated is carefully controlled to produce fats with the desired consistency (soft and pliable).
- Inexpensive and abundant vegetable oils (canola, corn, and soybean) are thus transformed into margarine and cooking fats. In the preparation of margarine, for example, partially hydrogenated oils are mixed with water, salt, and nonfat dry milk, along with flavoring agents, coloring agents, and vitamins A and D, which are added to approximate the look, taste, and nutrition of butter. (Preservatives and antioxidants are also added.)
- In most commercial peanut butter, the peanut oil has been partially hydrogenated to prevent it from separating out.

Consumers could decrease the amount of saturated fat in their diet by using the *original unprocessed oils* on their foods, but most people would rather spread margarine on their toast than pour oil on it. Many people have switched from butter to margarine or vegetable oils because of concerns that saturated animal fats can raise blood cholesterol levels and result in clogged arteries. However, *during the hydrogenation of vegetable oils, an isomerization* reaction occurs that produces the *trans* fatty acids which are even more harmful than saturated counterparts. Consumers are now being advised to use polyunsaturated oils and soft or liquid margarine and reduce their total fat consumption to less than 30% of their total calorie intake each day.

B. Hydrolysis

- Fats and oils are triglycerides (or esters of glycerol and three fatty acids), hence they can be hydrolyzed in the presence of an acid, a base, or specific enzymes known as lipases.
- The hydrolysis of fats and oils in the presence of a base (or alkaline hydrolysis) is used to make soap and is called *saponification*.
- Today most soaps are prepared through the hydrolysis of triglycerides (often from tallow, coconut oil, or both) using water under high pressure and temperature [700 lb/in2 (~50 atm or 5,000 kPa) and 200°C]. Sodium carbonate or sodium hydroxide is then used to convert the fatty acids to their sodium salts (soap molecules):



Saponification of fat/oil to produce soap

C. Oxidation

- Fats and oils with unsaturated fatty acids in their triglyceride structure can undergo oxidation of double bond. This changes composition of fatty acids (and eventually fat or oil they are part of) and can produce harmfull compounds which can affect health of consumer.

- Highly unsaturated fats and oils (mainly PUFA's) are more prone to oxidation than their less unsaturated (MUFA's) or saturated counterparts.
- Oxidation can be a result of *Deep Frying* which is explained below...

Deep Frying :

- Heating oil too much (up to its smoking point) is known as deep frying, and may change the chemical composition of the oil which becomes harmful to our health when we ingest it and even inhale its fumes.
- When we heat fats and certain foods such as fatty meats at very high temperatures, or barbecuing and stir-frying on very hot surfaces, *polycyclic aromatic hydrocarbons (PAHs)* may be formed which are supposed to be carcinogenic. Advanced *Glycation End Products (AGEs)* are also formed when foods mainly meat and potato chips are browned. These chemicals are believed to be related with an enhanced risk of age-related diseases such as Alzheimer's, heart disease, stroke and cataracts.
- Also refined oils (plain olive oil, canola and sunflower) have a higher smoke point, so they can be heated to a higher temperature before beginning to burn and smoke.

D. Rancidity

Fats and oils that are in contact with moist air at room temperature eventually undergo oxidation and hydrolysis reactions that cause them to turn rancid, acquiring a characteristic disagreeable odor.

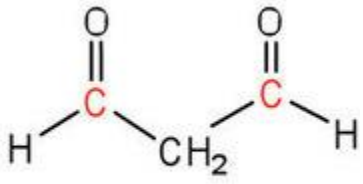
Rancidity is of two types, namely hydrolytic and oxidative rancidity as explained below..

Hydrolytic Rancidity :

- One cause of the odor is the release of volatile fatty acids by hydrolysis of the ester bonds.
- Butter, for example, releases foul-smelling butyric, caprylic, and capric acids.
- Microorganisms present in the air furnish lipases that catalyze this process.
- Hydrolytic rancidity can easily be prevented by covering the fat or oil and keeping it in a refrigerator.

Oxidative Rancidity :

- Another cause of volatile, ~CH=CH–CH_2–CH=CH~ odorous compounds is the oxidation of the unsaturated fatty acid components, particularly the readily oxidised structural unit in PUFA's such as linoleic and linolenic acid.
- One particularly offensive product, formed by the oxidative cleavage of both double bonds is *malonaldehyde*.



Malonaldehyde

- Oxidative rancidity is a major concern of the food industry, which is why food chemists are always seeking new and better antioxidants, substances added in very small amounts (0.001%–0.01%) to prevent oxidation and thus suppress oxidative rancidity.
- Antioxidants are compounds whose affinity for oxygen is greater than that of the lipids in the food. Thus they function

by preferentially depleting the supply of oxygen absorbed into the product.

- Because vitamin E has antioxidant properties, it helps reduce damage to lipids in the body, particularly to unsaturated fatty acids found in cell membrane lipids.

VII. Common Fatty Acids

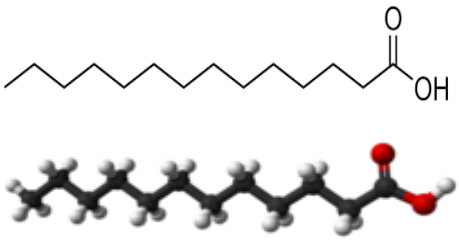
A. Lauric Acid

CLASS : medium-long chain, saturated fatty acid

LIPID NO : 12:0

FORMULA : $CH_3(CH_2)_{10}COOH$

IUPAC : dodecanoic acid



It is a bright white, powdery solid with a faint odor of bay oil or soap. The salts and esters of lauric acid are known as laurates.

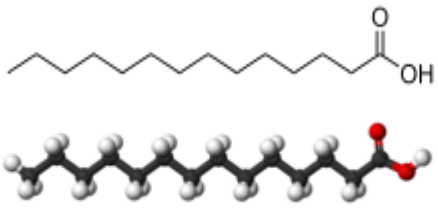
Though, in principle it is the longest medium chain fatty acid and is supposed to have no effect on blood cholesterol, it suprisingly increases blood LDL (Low Density Lipoprotein or bad cholesterol) level. Hence it is best categorized under

medium-long chain fatty acid and is considered harmfull for health..

OCCURRENCE : Lauric acid, as a component of triglycerides, comprises about half of the fatty-acid content in coconut milk, coconut oil, laurel oil, and palm kernel oil (not to be confused with palm oil) Otherwise, it is relatively uncommon. It is also found in human breast milk (6.2% of total fat), cow's milk (2.9%), and goat's milk (3.1%).

B. Myristic Acid

CLASS : long chain, saturated fatty acid
LIPID NO : 14:0
FORMULA : $CH_3(CH_2)_{12}COOH$
IUPAC : tetadecanoic acid



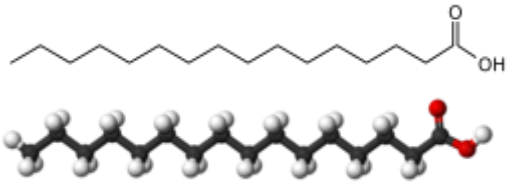
Its salts and esters are commonly referred to as myristates or tetradecanoates. It is named after the binomial name for nutmeg (Myristica fragrans), from which it was first isolated in 1841 by Lyon Playfair. It is even more harmfull than it's precessor lauric acid.

OCCURRENCE : Nutmeg butter has 75% *trimyristin*, the triglyceride of myristic acid. Besides nutmeg, myristic acid is

also found in palm kernel oil, coconut oil, butterfat, 8–14% of bovine milk, and 8.6% of breast milk as well as being a minor component of many other animal fats. It is also found in spermaceti, the crystallized fraction of oil from the sperm whale. It is also found in the rhizomes of the Iris, including Orris root. It also comprises 14.49% of the fats from the fruit of the Durian species Durio graveolens.

C. Palmitic Acid

CLASS : long chain, saturated fatty acid
LIPID NO : 16:0
FORMULA : $CH_3(CH_2)_{14}COOH$
IUPAC : hexadecanoic acid



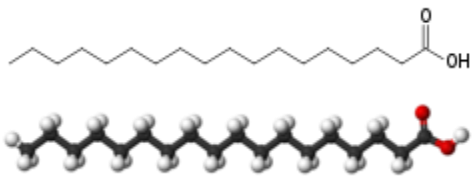
It is the most common saturated fatty acid found in animals, plants and microorganisms. *Palmitates* are the salts and esters of palmitic acid. The palmitate anion is the observed form of palmitic acid at physiologic pH (7.4).

Evidence is "convincing" that consumption of palmitic acid increases the risk of developing cardiovascular disease, based on studies indicating that it may increase LDL levels in the blood. Retinyl palmitate is a source of vitamin A added to low-fat milk to replace the vitamin content lost through the removal of milk fat. Palmitate is attached to the alcohol form of vitamin A, retinol, to make vitamin A stable in milk.

OCCURRENCE : As its name indicates, it is a major component of the oil from the fruit of oil palms (palm oil). Palmitic acid can also be found in meats, cheeses, butter, and other dairy products. Palmitic acid is naturally produced by a wide range of other plants and organisms, typically at low levels. It is naturally present in butter, cheese, milk, and meat, as well as cocoa butter, soybean oil, and sunflower oil. Karukas contain 44.90% palmitic acid. The cetyl ester of palmitic acid (cetyl palmitate) occurs in spermaceti.

D. Stearic Acid

CLASS : long chain, saturated fatty acid
LIPID NO : 18:0
FORMULA : $CH_3(CH_2)_{16}COOH$
IUPAC : octadecanoic acid



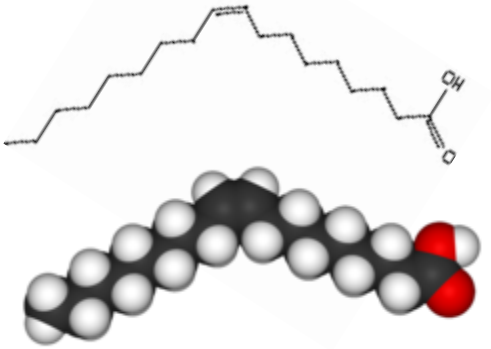
It is waxy solid and it's name comes from the Greek word στέαρ "stéar", which means tallow. The salts and esters of stearic acid are called stearates. As its ester, stearic acid is one of the most common saturated fatty acids found in nature following palmitic acid.

The triglyceride derived from three molecules of stearic acid is called stearin. It is much *healthier and most popular* saturated fatty acid, that has no effect on plasma lipids.

OCCURRENCE : Stearic acid is more abundant in animal fat (up to 30%) than in vegetable fat (typically <5%). The important exceptions are the foods cocoa butter (34%) and shea butter, where the stearic acid content (as a triglyceride) is 28–45%. Commercially, fats high in oleic acid such as palm and soy may be hydrogenated to convert oleic into stearic acid. In terms of its biosynthesis, stearic acid is produced from carbohydrates via the fatty acid synthesis machinery wherein acetyl-CoA contributes two-carbon building blocks.

E. Oleic Acid

CLASS : long chain, mono-unsaturated fatty acid (MUFA)
LIPID NO : 18:1 cis-Δ^9 (ω^9)
FORMULA : $CH_3(CH_2)_7\boldsymbol{CH}=\boldsymbol{CH}(CH_2)_7COOH$
IUPAC : cis -9 octadecenoic acid



Oleic acid is a fatty acid that occurs naturally in various animal and vegetable fats and oils. It is an odorless, colorless oil, although commercial samples may be yellowish. The name derives from the Latin word oleum, which means oil. It

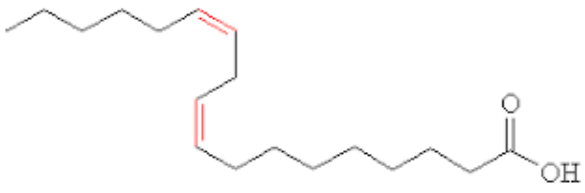
is the *most common fatty acid in nature*. The salts and esters of oleic acid are called *oleates*.

OCCURRENCE : Triglycerides of oleic acid comprise the majority of olive oil. Free oleic acid renders olive oil inedible. It also makes up 59–75% of pecan oil, 61% of canola oil, 36–67% of peanut oil, 60% of macadamia oil, 20–80% of sunflower oil, 15–20% of grape seed oil, sea buckthorn oil, 40% of sesame oil, and 14% of poppyseed oil. High oleic variants of plant sources such as sunflower (~80%) and canola oil (70%) also have been developed. It also comprises 22.18% of the fats from the fruit of the durian species, Durio graveolens. Karuka contains 52.39% oleic acid. It is abundantly present in many animal fats, constituting 37 to 56% of chicken and turkey fat, and 44-47% of lard.

It is the most abundant fatty acid in human adipose tissue, and second in abundance in human tissues overall, following palmitic acid.

F. Linoleic Acid

CLASS : long chain, poly-unsaturated fatty acid (PUFA)
LIPID NO : 18:2 cis, cis-$\Delta^{9,12}$ (ω^6)
FORMULA : $CH_3(CH_2)_4\boldsymbol{CH}=\boldsymbol{CH}CH_2\boldsymbol{CH}=\boldsymbol{CH}(CH_2)_7COOH$
IUPAC : cis -9 cis-12 octadecadienoic acid



It is a colorless or white oil that is virtually insoluble in water but soluble in many organic solvents. It is one of two *essential fatty acids* for humans, who must obtain it through their diet.

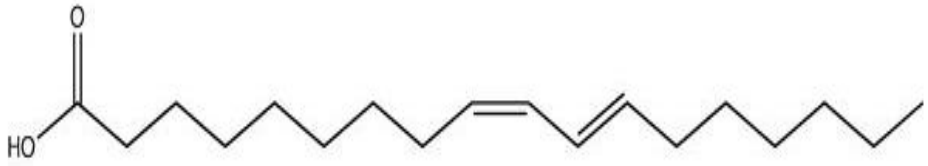
The word "linoleic" derives from the Latin linum "flax" + oleum "oil", reflecting the fact that it was first isolated from linseed oil. Salt and esters of this acid are called *linoleate*.

The consumption of linoleic acid is vital to proper health, as it is an essential fatty acid. In rats, a diet deficient in linoleate (the salt form of the acid) has been shown to cause mild skin scaling, hair loss, and poor wound healing.

OCCURRENCE : It is abundant in safflower, sunflower, corn, and comprises over half their composition by weight. It is present in medium quantities in soybean oils, sesame, and almonds. Cockroaches release oleic and linoleic acid upon death, which discourages other roaches from entering the area. This is similar to the mechanism found in ants and bees, which release oleic acid upon death.

g. Conjugated Linoleic Acids

CLASS : long chain, poly-unsaturated fatty acid (PUFA)
LIPID NO : (a) 18:2 cis/trans, cis/trans-$\Delta^{9,11}$ (ω^7)
(b) 18:2 cis/trans, cis/trans-$\Delta^{10,12}$ (ω^6)
FORMULA : (a) $CH_3(CH_2)_5\mathbf{CH}=\mathbf{CH}\text{-}\mathbf{CH}=\mathbf{CH}(CH_2)_7COOH$
(b) $CH_3(CH_2)_4\mathbf{CH}=\mathbf{CH}\text{-}\mathbf{CH}=\mathbf{CH}(CH_2)_8COOH$
IUPAC : (a) cis/trans-9 cis/trans-11 octadecadienoic acid
(b) cis/trans-10 cis/trans-12 octadecadienoic acid



CLA isomer cis-9, trans-11 (c9t11)

CLA isomer trans-10, cis-12 (t10c12)

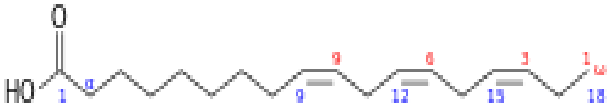
Conjugated Linoleic Acids (CLA) are a family of at least 28 positional and geometrical isomers of linoleic acid found mostly in the meat and dairy products derived from ruminants. Their two double bonds are conjugated (i.e. separated by a single bond). CLAs can be either cis-fats or trans-fats. CLA is marketed as a dietary supplement on the basis of its supposed health benefits.

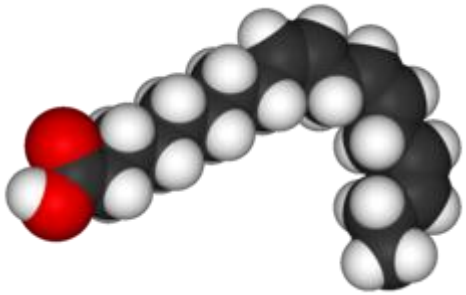
cis and trans combinations have shown that conjugated linoleic acid have been found in many clinical studies to have physiological effects such as anticarcinogenic, antiatherogenic, checking of type II diabetes, and immunomodulating properties of CLA. Conjugated linoleic acid has been observed to be quite effective to inhibit the growth and metastasis of prostate and breast cancers in some clinical studies on animals.

OCCURRENCE : Food products from grass-fed ruminants (e.g. mutton and beef) are good sources of CLA and contain much more of it than those from grain-fed animals. Eggs from chickens that have been fed CLA are also rich in CLA, and CLA in egg yolks has been shown to survive the temperatures encountered during frying. Some mushrooms, such as Agaricus bisporus and Agaricus subrufescens, are rare non-animal sources of CLA. However, dietary punicic acid—which is abundant in pomegranate seeds—is converted to the CLA rumenic acid upon absorption in rats, suggesting that non-animal sources can still effectively provide dietary CLA.

H. Alpha-Linolenic Acid

CLASS : long chain, poly-unsaturated fatty acid (PUFA)
LIPID NO : 18:3 cis, cis, cis-$\Delta^{9,\,12,\,15}$ (ω^3)
FORMULA : $CH_3CH_2\boldsymbol{CH}{=}\boldsymbol{CH}\,CH_2\boldsymbol{CH}{=}\boldsymbol{CH}CH_2\boldsymbol{CH}{=}\boldsymbol{CH}(CH_2)_7COOH$
IUPAC : cis -9 cis-12 cis-15 octadecatrienoic acid





α-Linolenic Acid (ALA), (from Greek linon, meaning flax), is an n–3, or omega-3, *essential fatty acid* like linoleic acid. α-

Linolenic acid can only be obtained by humans through their diets because the absence of the required 12- and 15-desaturase enzymes makes de novo synthesis from stearic acid impossible.

α-Linolenic acid is relatively more susceptible to oxidation and will become *rancid* more quickly than many other oils. Oxidative instability of α-linolenic acid is one reason why producers choose to partially hydrogenate oils containing α-linolenic acid, such as soybean oil. Soybeans are the largest source of edible oils in the U.S., and, as of a 2007 study, 40% of soy oil production was partially hydrogenated.

OCCURRENCE : ALA is found in many seeds and oils, including flaxseed, walnuts, chia, hemp, and many common vegetable oils. Seed oils are the richest sources of α-linolenic acid, notably those of hempseed, chia, perilla, flaxseed (linseed oil), rapeseed (canola), and soybeans. α-Linolenic acid is also obtained from the thylakoid membranes in the leaves of Pisum sativum (pea leaves).

VIII. Healthy Oils.

Overview

Many oils are available in the market but oils for cooking should be chosen on the basis of their proposed use, shelf life, the fat composition and the N-3, N- 6 ratio. However, many oils have some special components or characteristics which make them particularly useful. For e.g. for deep frying, oils with high smoke point should be selected. For healthy eating,

the plant-based cooking oils should be selected instead of butter, lard and animal fats because most of the plant-based oils contain much lower proportion of saturated fat which is harmful for our hearts and are richer in the polyunsaturated and monounsaturated fats which are beneficial for our heart health. Some of the plant based oils are discussed here…

Healthful Oils

Healthful oils are an important part of every diet. There are many types of oil to choose from, so which are the best ones for cooking, nutrition, and health benefits?

- Dietary fats play an essential role in the body. The fats in food help the body to absorb vitamins A, D, E, and K. They are also essential for brain and nerve function.
- The 2015–2020 Dietary Guidelines for Americans Trusted Source recommends adding healthful oils to the diet to help support a healthy body weight and reduce the risk of heart disease.
- There are many different oils to choose from, such as olive, coconut, canola, and vegetable oils. Each of these oils has different characteristics.
- Oils do not contain protein or carbohydrates and are not a significant source of vitamins and minerals. None of these oils contain ***trans fat***, a type that is harmful to human health.
- Oils are very high in calories and a good source of energy.
- Olive, coconut, canola, and vegetable oils each provide the same number of calories per tablespoon.

	Extra virgin olive oil, 1 tbsp	Organic virgin coconut oil, 1 tbsp	100% pure canola oil, 1 tbsp	100% pure vegetable oil, 1 tbsp
Calories	120	120	120	120
Total fat	14 g	14 g	14 g	14 g
Saturated fatty acids	2 g	13 g	1 g	2 g
Monounsaturated fatty acids	10 g	1 g	8 g	3 g
Polyunsaturated fatty acids	1.5 g	0 g	4 g	8 g

- The most significant difference between each of these four oils is their fat profile:
- Extra virgin olive oil is highest in monounsaturated fats.
- Organic virgin coconut oil contains the highest levels of saturated fats.
- Pure vegetable oil has the most polyunsaturated fatty acids per tablespoon.
- Unsaturated fats, which include monounsaturated (MUFA) and polyunsaturated (PUFA) fats, can reduce the risk of heart disease when people chose to eat them instead of saturated and *trans fats*.
- An American Heart Association (AHA) research associated saturated fats with higher levels of low-density lipoprotein (LDL) cholesterol in the blood. LDL cholesterol, which

doctors also call bad cholesterol, is a significant risk factor for cardiovascular disease.

- There is some debate among researchers about whether or not people can consider coconut oil a healthful addition to the diet.

IX. Commonly Used Oils

A. Coconut Oil

Many people believe that coconut oil is a healthful fat that benefits heart health. These claim have stimulated debate in the scientific community because of the very high levels of saturated fatty acids that coconut oil contains.

- Some commercial websites say that coconut oil behaves differently than other oils that contain high levels of saturated fats. They claim that coconut oil has similar properties as medium-chain triglycerides.
- These medium-chain fatty acids are healthful because the body digests and absorbs them more quickly than long-

chain fatty acids. This makes them a better energy source than long-chain triglycerides.

- However, coconut oil contains mostly Lauric acid, which acts like a long-chain triglyceride and does not have the same healthful benefits as medium-chain triglycerides.
- Evidence suggests that replacing coconut oil with oils that contain a higher level of unsaturated fats may reduce risk factors for cardiovascular disease.
- In two studies on the effects of coconut oil vs. vegetable oil, researchers observed that coconut oil increased the levels of LDL cholesterol in comparison with safflower oil and olive oil.
- Another study shows that coconut oil raises HDL cholesterol, which doctors call good cholesterol, compared with butter and olive oil.
- However, in light of the overall research to date, the AHA advice against people consuming saturated fats, such as coconut oil. Further research is needed to know the true effects of coconut oil on health.

B. Olive Oil

- Olive oil has a more favourable fatty acid profile. Olive oil has a very high level of monounsaturated fats.
- Olive oil mainly contains oleic acid, with smaller amounts of linoleic acid and palmitic acid.
- In a clinical trial known as *PREDIMED*, researchers observed lower rates of cardiovascular problems, which include heart attack, stroke, and death from heart disease, in people following the Mediterranean diet with either extra virgin olive oil or nuts, as opposed to a control diet.

- As long as olive oil is not heated, the *antioxidant* properties in the oil are higher than those of vitamin E. The antioxidant effects may provide protection from oxidative stress in a person's body. Reducing this type of biological stress can slow down or prevent tumour cells from growing or developing.

Cooking with olive oil

- Olive oil remains stable even when people heat it to high temperatures because of these antioxidants.
- Also, when heated to a high temperature for a long time, extra virgin olive oil releases a lower amount of unhealthful compounds compared with canola and vegetable oils. This is because the high levels of monounsaturated fats are more stable in high heat.

C. CANOLA OIL

- Canola oil also has low levels of saturated fatty acids and high levels of unsaturated fats.
- A group of researchers from the Department of Food Science and Human Nutritional Sciences in Manitoba, Canada, reviewed the evidence for the health benefits of canola oil.
- Their results demonstrate Trusted Source that people who follow diets they based on canola oil had lower total cholesterol levels compared with those consuming a typical Western diet high in saturated fatty acids.
- The researchers suggest that the canola oil could reduce LDL cholesterol levels by an average of 17 percent Trusted Source when they compared it with that of the typical Western diet.

Cooking with canola oil

- When people expose canola oil to high heat for long periods, a chemical reaction occurs that releases potentially unhealthful compounds.
- To safely use canola oil, people can use it to quickly sauté vegetables, meat, or meat alternatives, making sure that the oil does not get too hot.

D. VEGETABLE OIL

- Manufacturers make vegetable oil from oilseeds, legumes, nuts, or the flesh of some fruits.
- Vegetable oil contains the highest levels of polyunsaturated fats compared with olive, coconut, and canola oil.
- Partially hydrogenated vegetable oils contain *trans fats*. Trans fats are unsaturated fatty acids with a different chemical structure. Clinical trials consistently report on the adverse effects of trans fats on risk factors for cardiovascular disease.
- Trans fats are in a variety of processed foods such as margarine, baked goods, and deep-fried foods. Because of the dangers health experts associate with eating trans fats, manufacturers must include the trans fats content on food labels.

Vegetable oil in cooking

- Similarly to canola oil, vegetable oils are not stable when people use them at high temperatures.
- Vegetable oils have low levels of antioxidants and can release potentially harmful compounds when heated.

Researchers have linked these compounds with various forms *of cancer, Alzheimer' s, and Parkinson's disease.*

X. Uses of Oils

A. In Cooking

- Since the properties of each oil are different, each oil has its unique uses in cooking.
- People can use olive, coconut, canola, and vegetable oil when sautéing. Coconut oil works well in baked goods.
- People can use vegetable oil for frying and making mayonnaise, salad dressings, and sauces.
- Extra virgin olive oil has the most versatile flavour compared with other oils. It can be grassy, peppery, or fruity, depending on the olives.
- People can use extra virgin olive oil in vinaigrettes and as a finishing drizzle over a final dish.

B. In Other User

- Olive oil has a long history of use in hair and skin products. The anti-inflammatory effects of olive oil may help in wound healing.
- The high levels of linoleic acid in vegetable oil make it a suitable ingredient in skin products. Linoleic acid can improve skin hydration and reinforce the skin barrier.

- Researchers have observed that coconut oil may help control symptoms of skin rashes in children. It may also help speed up wound healing and help the skin repair itself.

XI. Health and Wellbeing

A. Healthiest Cooking Oil

Oils are all packed with fat and calories, but their chemistry – and effect on our health – can be very different.

Cooking oils are a kitchen staple. But there's a lot of conflicting information regarding how healthy each of them are. With so many on the shelves – from coconut to olive, vegetable to canola, avocado to rapeseed oil – how do we know which ones to use, and if we should be avoiding any altogether?

Oils used for cooking tend to get their name from the nut, seeds, fruits, plants or cereals they're extracted from, either by methods of crushing, pressing, or processing. They're characterized by their high fat content, including saturated fat, monounsaturated and polyunsaturated fatty acids.
In recent years, coconut oil, which is around 90% saturated fat, has become the latest trendy "superfood". It's been hailed as a superfood (including that it's less likely to be stored in the body as fat and more likely to be expended as energy) – but one Harvard University epidemiologist calls it "pure poison".

- Olive oil, which is made by crushing olives and separating the oil from their pulp, is renowned for being the healthiest of plant oils.
- Some research has found that extra virgin olive oil is associated with the most health benefits.
- Experts advise opting for an oil lower in saturated fat, and higher in other types of fats that are healthier in moderation.
- *The message isn't to add lots of oil because we think it's good for us, because that's just adding lots of calories – Alice Lichtenstein.*
- According to one Harvard professor, coconut oil, is actually like '***pure poison***'**.** Karin Michels, a professor of epidemiology at Harvard who delivered a speech in Freiburg, Germany, coconut oil "is one of the worst foods you can eat". A diet high in the white stuff could mean you're getting way too much saturated fat, which can eventually put a strain on your internal organs.
- Now we're no strangers to being told the food we're eating is actually killing us. Remember when we found out that bacon causes cancer? Or that red wine isn't good for us

after all? And it was only last week we found out that - despite years of being told otherwise - low-carb diets can actually shorten your life.

- Of course, Prof Michels is far from the first person to point out that **coconut oil = loads of saturated fat = bad.**
- In 2005 - 13 years ago - the World Health Organization had already included coconut oil in its list of foods you should 'restrict your use of' if you didn't want to have a heart attack. And as far back as the 90s, in fact, there was a health scare in the US when a study claimed that cinema popcorn was much fattier than people realized - because it was being popped in (surprise!) coconut oil**.**
- At the same time, however, it has been wholeheartedly marketed to us as a health food.
- According to the American Heart Association last year, about 72% of the US public believed coconut oil was healthy even though, at that point, only 37% of nutritionists agreed.
- A lot of this disconnect, they said, was down to clever marketing campaigns from coconut oil companies who paint it as a healthy alternative to butter and vegetable oil, as well as endorsements from celebrities like Gwyneth – who has not only advocated eating it, but also moisturizing your face with it, putting it in your hair, and, arm, **using it as lubricant.**
- Using coconut oil as a moisturizer and as hair oil are common beauty practices in countries including India (although we're not sure about the lube) – a fact which may have contributed to the oil's holistic, healthy image.

B. GHEE

- Ghee is a type of clarified butter used in the cuisines of India and the Middle East. Traditionally, it's made by gently heating cow's-milk butter until its water content evaporates and its milk solids can be skimmed and strained away, leaving behind only the liquid fat.
- "Clarified butter is very similar [to ghee], but it's sometimes made using high heat, whereas ghee is simmered at 100 degrees or less," says Chandradhar Dwivedi, a distinguished professor emeritus of pharmacology at South Dakota State University.

Benefits of Ghee

- Ghee is a source of vitamin E, vitamin A, antioxidants and other organic compounds, many of which would be broken down or destroyed if boiled at higher temperature.
- Ghee is also a component of Ayurveda, a roughly 6,000-year-old form of complementary medicine that is still

widely practiced in India and elsewhere. “Ghee is used as a vehicle for herbal medication

- “The thought process was that ghee is sacred, and when given with medicine, you get both the medical benefit and a spiritual benefit.”
- Setting aside the spiritual aspects, eating fat-rich foods like ghee can increase the “bioavailability” and absorption of some healthy vitamins and minerals. By cooking or eating vegetables or other healthy foods along with ghee, your body may have access to more of their nutrients, he says. Ghee also tastes good, he adds, and so it can make some healthy but unappetizing foods more palatable.

Is Ghee Healthy?

- Well, it’s a type of fat. And until recently, dietary fats had a universally bad reputation. Fat is a calorie-dense macronutrient, so eating all types of fatty foods was thought to promote weight gain and obesity. Ghee and other types of butter are also high in saturated fat, which was long associated with heart disease..
- But the thinking on fat has shifted. Far from promoting obesity, many forms of dietary fat—foods like olive oil and avocado—are now considered hunger-satisfying additions to a healthy diet. While experts still disagree about saturated fat, some no longer consider it to be an obvious health risk.
- “The more research I’ve done, the more total saturated fat seems relatively neutral neither good nor bad for your heart,” says Dariush Mozaffarian, a cardiologist and

professor of nutrition at Tufts University. “Dairy fat, for example, doesn’t seem to be linked to heart disease or diabetes, and even seems to be protective against diabetes,” he adds.

- This viewpoint is in line with some recent studies tying the consumption of some saturated-fat-rich foods to health benefits. Also, a 2016 review on butter found “relatively small or neutral” links between its consumption and heart disease or diabetes.
- “There was concern that consuming saturated fatty acids was not good for you and that it could increase the risk of coronary artery disease,” Dwivedi says. “So people were very concerned and [were avoiding] saturated fat, including ghee.”
- In an effort to understand the heart-health risks of ghee, Dwivedi conducted several studies on rats. (While animal research doesn’t necessarily translate to people, Dwivedi’s work is some of the only published research looking specifically at ghee.) Among healthy animals, he found that packing their diets with up to 10% ghee did not lead to elevated levels of harmful cholesterol or other markers of heart disease. On the other hand, when examining a species of inbred rat with a genetic predisposition for various disease, eating a ghee-heavy diet increased their blood’s levels of unhealthy cholesterol and triglycerides.
- “In nutritional research, rats tend to be a good experimental model for humans,” he says. “Our findings suggest that consuming ghee up to 10% of the diet will not increase the risk of heart diseases, but for those

predisposed because of family or genetic factors, 10% may be harmful."

- There's not much hard evidence to suggest that ghee is healthier than other forms of butter. "Claims of special health-giving properties of ghee are unsubstantiated," says Dr. Rosalind Coleman, a professor of nutrition at the University Of North Carolina Gillings School Of Public Health.
- Coleman says that ghee, which does not include milk solids, may be easier to digest for adults who are lactose intolerant. Ghee also has a higher smoke point than plain butter, which may make it healthier for cooking, she says. But the same is true of clarified butter. "The actual kinds of fats are the same in butter and ghee, so moderate use of both would be recommended," she adds.
- All this suggests that if you're healthy and looking to add more fat to your diet, ghee may be a fine option. But there's not strong evidence to suggest that ghee is a "superfood" that should replace other cooking fats in your diet.

C. Highly Unsatrated Oils in Food

Guidelines:-

The Dietary Guidelines for Americans not only recommends decreased consumption of solid fats but also replacement of solid fats with liquid oils. This recommendation can be very helpful for fats used in cooking (e.g., butter vs. olive oil), but as mentioned above, liquid oils

will often not produce the desirable textural properties of products such as cookies, pastry, confectionaries, ice cream, and whipped cream. The Dietary Guidelines for Americans also recommends increased consumption of fish containing omega-3 (ω-3) FAs due to their benefits to heart health.

Challenges:-

The challenge of incorporating polyunsaturated oils and ω-3 FAs into foods is their susceptibility to oxidative deterioration (rancidity), resulting in changes in both negative alteration in food quality and nutrition. This is especially true of ω-3 FAs that not only oxidize quickly but also have oxidation products which humans can detect at concentrations as low at 1 μg/L . Therefore, food manufacturers must not only be concerned about how the physical properties of fats and oils affect foods but also the chemical stability of these nutritionally beneficial lipids. If lipids are not protected from oxidation, the resulting rancidity will prevent their consumption, thus decreasing their health benefits.

Chemical Deterioration

Lipids can chemically degrade by numerous mechanisms to negatively affect food quality, including thermal degradation, hydrolytic rancidity, and oxidative rancidity.

Thermal Degradation

Thermal heating of oils causes TGs to hydrolyze into FFAs and glycerol, which can volatilize and cause oil to smoke. Smoke points decrease with increasing FFA concentrations.

This means that unrefined oils (e.g., olive oil), which have not gone through the neutralization step of refining and thus have high FFA concentrations, have lower smoke points and may not be suitable for frying.

Optimal frying temperatures are ~180°C. Unrefined oils such as extra-virgin olive oil have a smoke point of 191°C, which means that it could be used for frying. However, if this oil is used for prolonged frying and FFAs increase, the smoke point can decrease to the frying temperature. This creates a problem because thermal degradation of frying oils can produce *acrolein*, a potentially toxic compound. In addition, the smoke point is followed by the flash point, and if the oil is heated too long it could catch on fire.

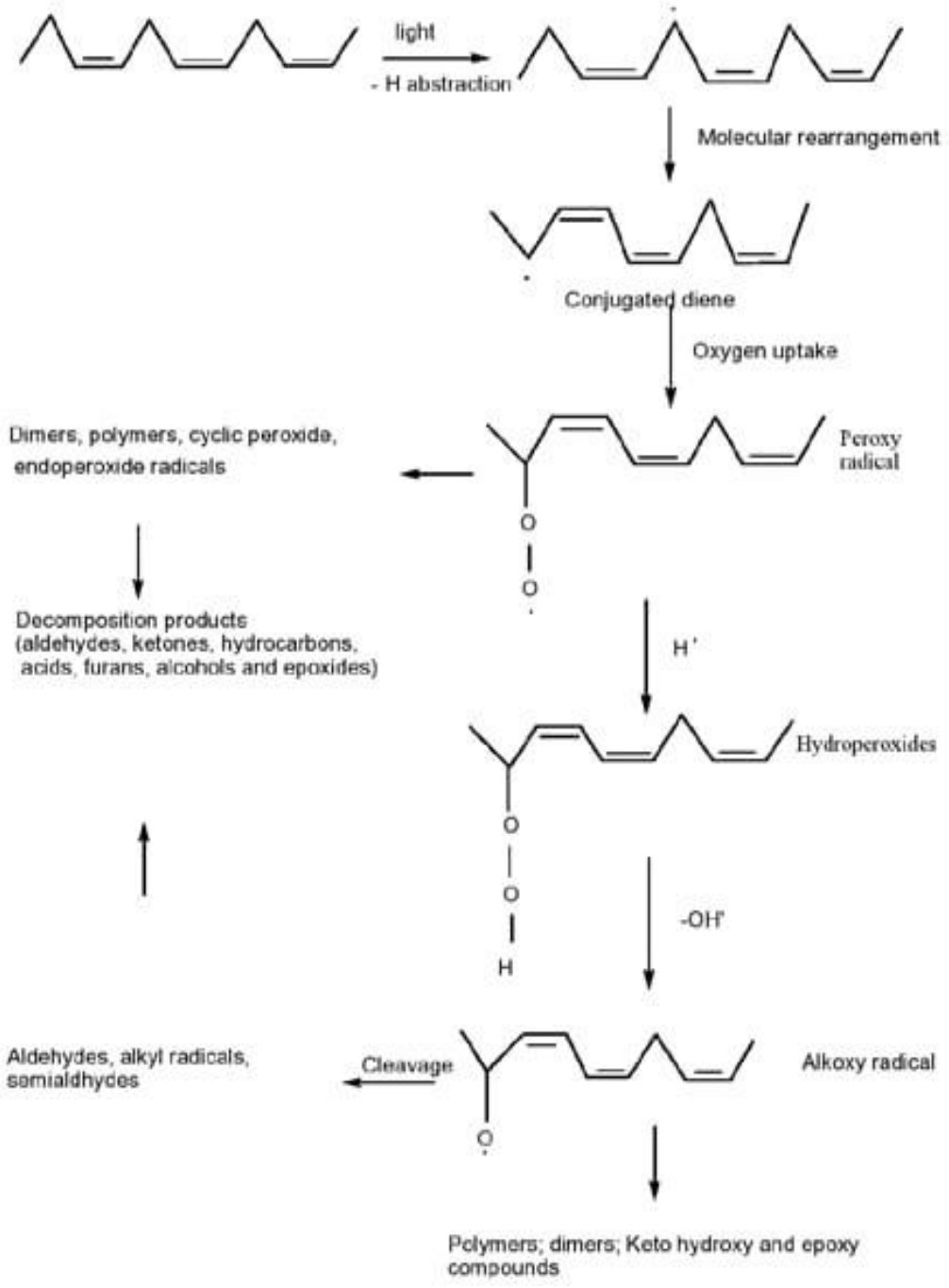
Hydrolytic Rancidity:-

Lipid oxidation is a free radical chain reaction between unsaturated fats and oxygen. Free radicals are highly reactive molecules that have unpaired electrons. These unpaired electrons seek an electron pair, thus promoting reactions such as addition, transfer, and scission. Lipid radicals can react with the unpaired electrons in oxygen, resulting in the addition of oxygen onto the FA to form *peroxyl radicals*. The peroxyl radical can then abstract a hydrogen from one unsaturated FA and transfer the radical to another FA, thus resulting in the formation of lipid hydroperoxides. The hydroperoxides are susceptible to decomposition by light and metals to form alkoxyl radicals. These alkoxyl radicals are very high in energy, allowing them

to promote the scission of FAs into low-molecular-weight volatile compounds that produce rancid off-flavors and aromas.

Oxidative Rancidity:-

The susceptibility of oils and foods to lipid oxidation is influenced by numerous factors. Probably the most important factor is the chemical structure of the FAs and in particular the number, position, and geometry of double bonds. Saturated lipids are much more stable to oxidation than unsaturated lipids, which makes them desirable in foods very susceptible to oxidation such as frying oils .Double bonds increase the susceptibility of FAs to oxidation, with an increasing number of double bonds increasing oxidative susceptibility.



Lipid oxidation is often referred to as auto-oxidation because it can be a self-propagating reaction. However, the reality is that most foods contain pro-oxidants that can be the primary drivers of oxidation, thus increasing reaction rates

and changing kinetics such that auto-oxidation is often only a minor component of the cause of rancidity.

D. Antioxidants

Introduction-

They are sometimes called "free-radical scavengers."

- The sources of antioxidants can be natural or artificial. Certain plant-based foods are thought to be rich in antioxidants. Plant-based antioxidants are a kind of phytonutrient, or plant-based nutrient.
- The body also produces some antioxidants, known as endogenous antioxidants. Antioxidants that come from outside the body are called exogenous.
- Free radicals are waste substances produced by cells as the body processes food and reacts to the environment. If the body cannot process and remove free radicals efficiently, oxidative stress can result. This can harm cells and body function. Free radicals are also known as reactive oxygen species (ROS).
- Factors that increase the production of free radicals in the body can be internal, such as inflammation, or external, for example, pollution, UV exposure, and cigarette smoke.
- Oxidative stress has been linked to heart diseases, cancer, arthritis, stroke, respiratory diseases, immune deficiency, emphysema, Parkinson's disease, and other inflammatory or ischemic conditions.
- Antioxidants are said to help neutralize free radicals in our bodies, and this is thought to boost overall health.

Benefits

Antioxidants can protect against the cell damage that free radicals cause, known as oxidative stress.
Activities and processes that can lead to oxidative stress, like…

- mitochondrial activity
- excessive exercise
- tissue trauma, due to inflammation and injury
- ischemia and reperfusion damage
- consumption of certain foods, especially refined and processed foods, trans fats, artificial sweeteners, and certain dyes and additives
- environmental pollution
- radiation
- exposure to chemicals, such as pesticides and drugs, including chemotherapy
- industrial solvents
- ozone
- Such activities and exposures can result in cell damage:

Disadvantages

- This, in turn, may lead to an excessive release of free iron or copper ions an activation of phagocytes, a type of white blood cell with a role in fighting infection
- An increase in enzymes that generate free radicals
- A disruption of electron transport chains
- All these can result in oxidative stress.
- The damage caused by oxidative stress has been linked to cancer, atherosclerosis, and vision loss. It is thought that the

free radicals cause changes in the cells that lead to these and possibly other conditions.

- An intake of antioxidants is believed to reduce these risks.
- Antioxidants act as radical scavenger, hydrogen donor, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist, and metal-chelating agents.
- Other research has indicated that antioxidant supplements may help reduce vision loss due to age-related macular degeneration in older people.
- Overall, however, there is a lack of evidence that a higher intake of specific antioxidants can reduce the risk of disease. In most cases, results have tended to show no benefit, or a detrimental effect, or they have been conflicting.

Types

- There are thought to be hundreds and possibly thousands of substances that can act as antioxidants. Each has its own role and can interact with others to help the body work effectively.
- "Antioxidant" is not really the name of a substance, but rather it describes what a range of substances can do.
- Examples of antioxidants that come from outside the body include:
  - vitamin A
  - vitamin C
  - vitamin E
  - beta-carotene
  - lycopene
  - lutein

- selenium
- manganese
- zeaxanthin

Flavonoids, flavones, catechins, polyphenols, and phytoestrogens are all types of antioxidants and phytonutrients, and they are all found in plant-based foods.

Each antioxidant serves a different function and is not interchangeable with another. This is why it is important to have a varied diet.

Food Sources

- The best sources of antioxidants are plant-based foods, especially fruits and vegetables.
- Foods that are particularly high in antioxidants are often referred to as a "superfood" or "functional food."
- To obtain some specific antioxidants, try to include the following in your diet:
  - **Vitamin A**: Dairy produce, eggs, and liver
  - **Vitamin C**: Most fruits and vegetables, especially berries, oranges, and bell peppers
  - **Vitamin E**: Nuts and seeds, sunflower and other vegetable oils, and green, leafy vegetables
  - **Beta-carotene**: Brightly coloured fruits and vegetables, such as carrots, peas, spinach, and mangoes
  - **Lycopene**: Pink and red fruits and vegetables, including tomatoes and watermelon
  - **Lutein**: Green, leafy vegetables, corn, papaya, and oranges

- **Selenium**: Rice, corn, wheat, and other whole grains, as well as nuts, eggs, cheese, and legumes

- Foods with rich, vibrant colors often contain the most antioxidants.
- The following foods are good sources of antioxidants. Click on each one to find out more about their health benefits and nutritional information:

  - blueberries
  - apples
  - broccoli
  - spinach
  - lentils

Effect on Cooking

- Cooking particular foods can either increase or decrease antioxidant levels.
- Lycopene is the antioxidant that gives tomatoes their rich red colour. When tomatoes are heat-treated, the lycopene becomes more bio-available (easier for our bodies to process and use).
- However, studies have shown that cauliflower, peas, and zucchini lose much of their antioxidant activity in the cooking process. Keep in mind that the important thing is eating a variety of antioxidant-rich foods, cooked and raw.

XII. Clinical Interventions

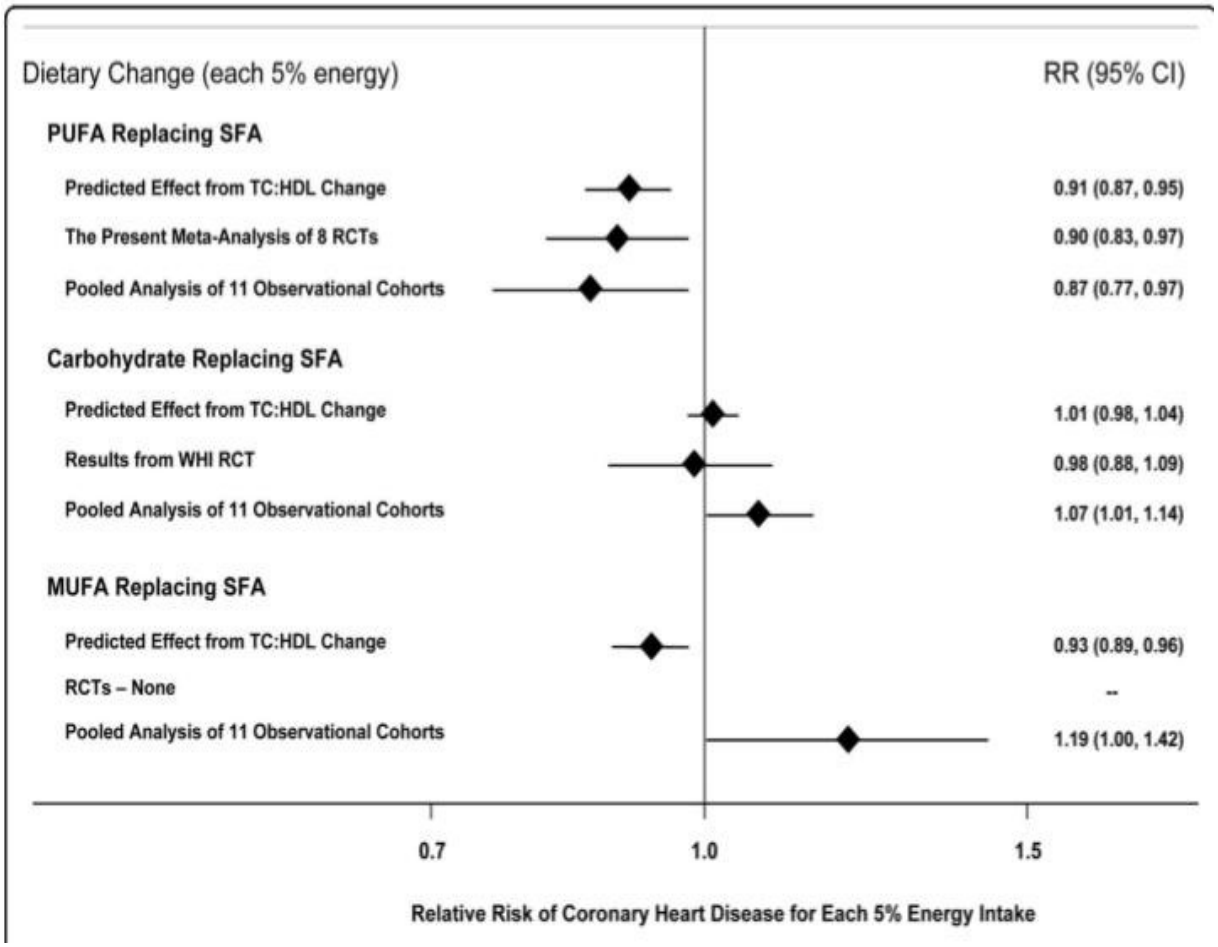
A. Dietary Patterns

Recent clinical evidence also supports the hypothesis that including plant and seafood sources of PUFA and MUFA in the diet improves cardio-metabolic risk factors.

- Mediterranean diets generally derive a relatively high proportion of calories from fat (typically 35–40% of kcal or more) with much of the fat calories coming from plant and vegetable oils sources of MUFA.
- Mediterranean-type diets commonly emphasize consumption of fruits, vegetables, legumes, fish, nuts, and olive oil.
- In the *Prevención con Dieta Mediterránea* (PREDIMED) trial, 7447 persons were counseled to consume a Mediterranean diet supplemented with extra-virgin olive oil (50 g/day), a Mediterranean diet supplemented with mixed nuts (30 g/day; 15 g of walnuts and 7.5 g of almonds and 7.5 g of hazelnuts), or a control diet reduced in dietary fat .
- After a mean follow-up of 4.8 years, consumption of a Mediterranean diet supplemented with either extra-virgin olive oil or nuts resulted in a 30% reduction in risk of myocardial infarction, stroke, or death (hazard ratio: 0.70; 95% CI: 0.54, 0.92 and hazard ratio: 0.72; 95% CI: 0.54, 0.96) .
- The Dietary Approaches to Stop Hypertension (DASH) dietary pattern is also beneficial for reducing CVD risk. The original DASH diet emphasized vegetables, fruits, whole grains, low-fat dairy products, poultry, fish, and nuts while

limiting sweets and red meats, and was generally higher in carbohydrates and lower in total fats.

- At the end of the eight-week dietary intervention, systolic and diastolic blood pressure were significantly reduced by 5.5 and 3.0 mmHg compared to the control diet.
- Consumption of the DASH diet also resulted in lower total cholesterol, LDL-C, and HDL-C levels with no changes in triglycerides or total cholesterol: HDL-C ratio.
- As a follow up to the DASH trial, the Optimal Macronutrient Intake Trial to Prevent Heart Disease (Omni Heart) was conducted to compare high-carbohydrate, high-protein, or high-MUFA versions of the original DASH diet.
- Participants with prehypertension or stage 1 hypertension were fed for 6-week periods in a 3- period randomized crossover trial.
- While all diets improved blood pressure and LDL compared to baseline, the diets that replaced saturated fat with protein or especially vegetable unsaturated fats (principally olive oil) resulted in greater improvements in CVD risk factors compared to the carbohydrate-rich diet.
- Accordingly, the 2015 Scientific Report of the Dietary Guidelines Advisory Committee concluded, *"A healthy diet can be achieved in multiple ways and preferably with a wide variety of foods and beverages."*

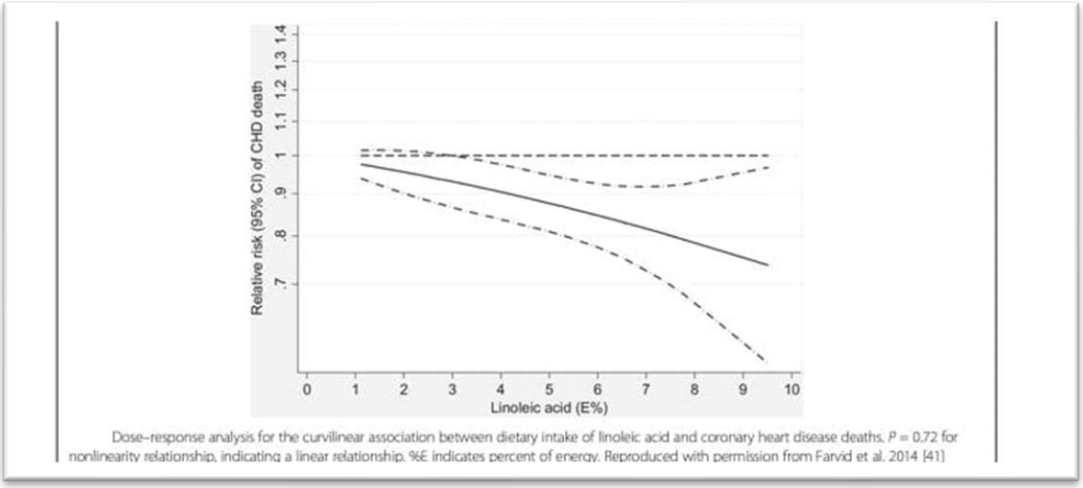


B. Role of SFA, MUFA and PUFA in coronary Heart Disease

- *Saturated and monounsaturated* fatty acids are synthesized in the body for energetic, physiological, and structural functions, and they are present in many foods.
- For example, palmitic acid, the major saturated fatty acid in the diet, is synthesized in the liver from starch and sugar via de novo lipogenesis, and it is the predominant fatty acid present in dairy and meats.

- Due to the positive linear relationship between total saturated fat intake and LDL-C concentrations, the recommendation is to limit saturated fat to <10% of calories
- However, the role of saturated fat in heart disease is complex because of the heterogeneous biological effects of the different saturated fatty acids and the diversity of food sources.
- Moreover, conclusions are complicated by dietary substitutions underscoring the importance of considering the replacement nutrient.
- Ecological and migration studies including the seminal Seven Countries Study by Ancel Keys have found strong positive correlations between saturated fat intake and CHD rates.
- Studies have consistently found that higher trans fat intake is associated with elevated risk of coronary heart disease. the effects of dietary saturated fat on coronary heart disease risk are less consistent.
- A 2010 meta-analysis of prospective cohort studies by Siri-Tarino et al. found no relationship between total saturated fat and risk of coronary heart disease.
- Similarly, a 2014 meta-analysis by Chowdhury et al. found no significant relationship between total saturated fat or total polyunsaturated fat consumption and risk of CHD.
- Based on all the evidence, the 2015 Dietary Guidelines Advisory Committee concluded that replacing saturated fat with total carbohydrates does not reduce risk of CVD.
- In cohort studies modeling specific replacement nutrients, there is consistent evidence that polyunsaturated fatty acids are the most beneficial replacement nutrient for CVD risk reduction as compared to either saturated fat or total carbohydrate.

- In a recent analysis, Li, et al. found that replacing saturated fat with high quality carbohydrates such as whole grains was associated with lower risk of CHD, but replacing saturated fat by total carbohydrates or refined starch/ added sugars was not associated with CHD risk.
- Further research is needed to better determine how different approaches to food processing, technology, stability/oxidation, and breeding/engineering of plants or animals may alter the overall health effects of PUFA and MUFAs.



Dose–response analysis for the curvilinear association between dietary intake of linoleic acid and coronary heart disease deaths. $P = 0.72$ for nonlinearity relationship, indicating a linear relationship. %E indicates percent of energy. Reproduced with permission from Farvid et al. 2014 [41]

C. Specific Foods and Oils

Several studies have examined the potential benefits of incorporating specific foods and oils on cardio metabolic risk factors.

- As described above, PREDIMED demonstrated reductions in CVD events with either mixed nuts or extra-virgin olive oil.

- A systematic review and meta-analysis examined the relationship between nut consumption and blood lipid levels. A total of 61 trails totaling 2582 unique participants provided nuts to participants for durations ranging from 3 to 26 weeks.
- Compared with controls, each daily serving of nuts lowered LDL-cholesterol (–4.8 mg/dl; 95% CI: -5.5, –4.2).
- These results complement previous findings from a pooled analysis of intervention trials examining the relationship between nut consumption and blood lipid levels.
- Twenty-five trials comprising 583 participants were included. Interventions were at least 3 weeks in duration and nut consumption was the only dietary intervention.
- Nut consumption (average 67 g/day) significantly reduced total cholesterol, LDL-C, and total cholesterol to HDL-C ratio.
- Both studies are in agreement with the large body of epidemiological evidence showing an association between increased nut consumption and decreased risk of CHD.
- Olive oil is the main fat source in the Mediterranean diet, and it is believed to confer some of the cardio-protective benefits of the diet.
- Olive oil is high in MUFAs and contains phenolic compounds, which have antioxidant and anti-inflammatory properties.
- Short-term clinical trials in healthy men have observed small increases in HDL-C, decreases in triglycerides, and reductions in systolic blood pressure with olive oil supplementation.
- Oxidative stress markers decreased with increasing polyphenol content of the olive oil. These studies complement a previous observational study, which found an

inverse association between olive oil consumption and both systolic and diastolic blood pressure.

- In addition, the results are consistent with a study conducted with Nurses' Health Study and Nurses' Health Study II data that showed that substituting olive oil for stick margarine, butter, or mayonnaise was associated with a modestly lower risk of type 2 diabetes in women.
- *The Canola Oil Multi-center Intervention Trial (COMIT)* sought to determine the effects of different oil blends with varying levels of n-9 MUFA, n-6 PUFA, and n-3 PUFA on biomarkers of coronary heart disease risk Participants were fed a controlled weight maintenance diet supplemented with one of 5 liquid vegetable oil treatments in a randomized crossover design. Treatments included…
    - Conventional canola oil (Canola; n-9 rich),
    - High-oleic acid canola oil with docosahexaenoic acid (Canola DHA; n-9 and n-3 rich),
    - A blend of corn and safflower oil (25:75) (CornSaff; n-6 rich),
    - A blend of flax and safflower oils (60:40) (FlaxSaff; n-6 and short chain n-3 rich), or
    - High-oleic acid canola oil (Canola-Oleic; highest in n-9).
- All treatments lowered total cholesterol and LDL-C.
- The Canola DHA blend significantly increased HDL-C, lowered triglycerides. The Canola DHA blend had the greatest systolic and diastolic pressure-lowering effect.
- All treatments lowered the Framingham 10-year coronary heart disease risk score; the Canola DHA treatment decreased it the most.

D. Public confusion about Nutrition Research and resultant Dietary Fat Recommendations

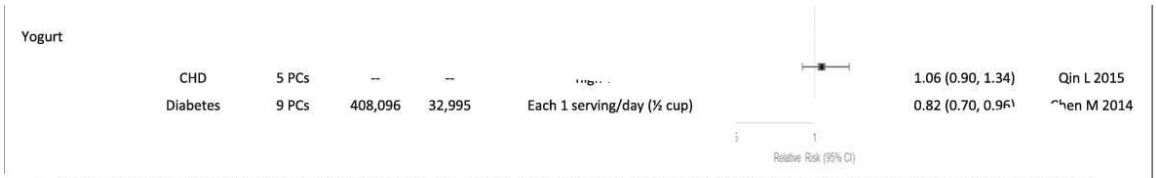
As a case-study, the science on dietary fat and cardiovascular disease is complicated, therefore research communications and dietary recommendations should be made that accurately interpret the complexity of the evidence. When asked about information provided by governments, experts, food companies, and the media regarding the role of fats in a healthful diet, 64% of consumers were confused and felt that the information provided was contradictory.

- The term fat is particularly confusing because 90% of survey respondents associate something negative with fat. Most people, especially women, associate fat intake with obesity while older men are more likely to associate it with heart health.
- In a recent poll of Americans, nearly 70% believed they should limit their fat intake to control their weight and reduce their risk of heart disease.
- Survey results suggest that most consumers believe that their fat intake should be as low as possible and that fat is not needed for a healthy diet.
- Despite consumer perceptions, research supports the use of higher-fat diets such as Mediterranean-style diets for weight loss and reducing CVD risk. Indeed, excess consumption of calories has greater effects on weight and energy balance than the amount and type of fat consumed.
- While the public is very aware of total dietary fat, they do not have a good understanding of the importance of fat

quality or of the different sources of dietary fat. Pizza, grain-based desserts, and chicken and chicken mixed dishes are among the tops sources of various fats in the diet of the U.S. population. This reflects high levels of consumption of these items by consumers.

White meat (poultry, rabbit)							
	CVD death	5 PCs	1,197,805	31,535	Each 1 serving/day (100 g)	1.00 (0.87, 1.15)	Abete I 2014
Total Dairy							
	CHD	10 PCs	253,260	8,792	high vs low	0.94 (0.82, 1.07)	Qin L 2015
	Stroke	16 PCs	764,635	28,138	high vs low	0.88 (0.82, 0.94)	Hu D 2014
	Diabetes	14 PCs	459,790	35,863	Each 1 serving/day	0.98 (0.96, 1.01)	Chen M 2014
Milk							
	CHD	6 PCs	259,162	4,391	Each 1 serving/day (200 ml)	1.00 (0.96, 1.04)	Soedamah-Muthu S 2011
	Stroke	9 PCs	525,609	22,382	high vs low	0.91 (0.82, 1.01	Hu D 2014
	Diabetes	7 PCs	167,982	15,149	Each 1 serving/day (200 g)	0.87 (0.72, 1.04)	Aune D 2013
Cheese							
	CHD	7 PCs	--	--	high vs low	0.84 (0.71, 1.00)	Qin L 2015
	Stroke	5 PCs	282,439	9,919	high vs low	0.94 (0.89, 0.995)	Hu D 2014
	Diabetes	8 PCs	242,960	17,620	Each 1 serving/day (50 g)	0.92 (0.86, 0.99)	Aune D 2013
Butter							
	CHD	5 PCs	--	--	high vs low	1.02 (0.88, 1.20)	Qin L 2015
	Stroke	3 PCs	173,853	5,299	high vs low	0.95 (0.85, 1.07)	Hu D 2014
Yogurt							

	Endpoint	No. of studies	No. of subjects	No. of events	Unit	RR	Reference
Nuts and seeds							
	CHD death	5 PCs, 1 RCT	206,114	6,749	Each 4 servings/week (4 oz [113 g])	0.76 (0.69, 0.84)	Afshin A 2014
	Nonfatal CHD	3 PCs, 1 RCT	141, 390	4,280	Each 4 servings/week (4 oz [113 g])	0.78 (0.67, 0.92)	Afshin A 2014
	Diabetes	5 PC, 1 RCT	230,216	13,308	Each 4 servings/week (4 oz [113 g])	0.87 (0.81, 0.94)	Afshin A 2014
Fish							
	CHD Death	12 PCs	282,075	4,195	2-4 servings/week vs. ≤3 servings/month	0.79 (0.67, 0.92)	Zheng J 2012
	Stroke	8 PCs	394,958	16,890	≥ 5 vs. 1 serving/week	0.88 (0.81, 0.96)	Chowdhury R 2012
	Diabetes	13 PCs	481,489	20,830	Each 1 serving/day (100 g)	1.12 (0.94, 1.34)	Wu J 2012
Unprocessed red meats							
	CVD death	13 PCs	1,070,215	24,241	high vs low	1.12 (0.95, 1.33)	Abete I 2014
	Stroke	5 PCs	239,251	9,593	Each 1 serving/day (100 g)	1.13 (1.03, 1.23)	Chen G 2013
	Diabetes	9 PCs	447,333	28,206	Each 1 serving/day (100 g)	1.19 (1.04, 1.37)	Pan A 2011
Processed red meats							
	CVD death	6 PCs	1,186,761	35,537	Each 1 serving/day (50 g)	1.24 (1.09, 1.40)	Abete I 2014
	Stroke	5 PCs	239,251	9,593	Each 1 serving/day (50 g)	1.11 (1.02, 1.20)	Chen G 2013
	Diabetes	8 PCs	372,391	26,234	Each 1 serving/day (50 g)	1.51 (1.25, 1.83)	Pan A 2011



* Meta-analyses of foods and coronary heart disease, stroke, and diabetes mellitus. BMI indicates body mass index; CHD, coronary heart disease; CI, confidence interval; CVD, cardiovascular disease; PC, prospective cohort; RCT, randomized clinical trial; and RR, relative risk. Adapted with permission from Circulation [74]

How should scientists communicate about fat in order to clear up the confusion?

Simple, easily understood messages focused on overall dietary patterns and foods rather than single nutrients are important.

- As dietary guidance is shifting away from total fat reduction and instead emphasizing types of foods and overall dietary patterns, we should stop using low-fat terminology and instead talk about healthy foods. "How to" messages should inform the public of specific foods that are sources of "healthy fats".
- Focusing on total diet quality and food patterns provides easily actionable messages for consumers rather than talking about percentages of specific fats.
- Consumer confusion about nutrition messages can also result from conflicting headlines in the media, for example related to insufficient subject expertise by journalists; limited communication skills, availability, or willingness to be interviewed of nutrition scientists; or a need for eye-catching headlines in the fast-paced world of modern media.
- While it is crucial to present new studies in the context of the existing body of evidence, limited media space and consumer attention work against this. Indeed, new studies rarely negate previous findings or alter fundamental

paradigms, but rather add new information to what was known before.

- It is the responsibility of both scientists and the media to ensure that new results are accurately reported in appropriate context.
- In order to help the population achieve a healthy diet, communication will be needed on multiple levels including individual advice, media communication, and the development of programs and services at institutions such as schools, workplaces, and healthcare systems.

XIII. Conclusion

- ✓ A healthful, high-quality diet requires dietary fats. Oils provide beneficial fatty acids. The different oils we discuss in this article have different fatty acid profiles.
- ✓ Choosing oils with a higher level of unsaturated fatty acids may provide the best health benefits. People should be aware of the different cooking methods that may change the healthful properties of oils.
- ✓ People also use different oils on their skin because this helps to hydrate and repair the skin barrier.
- ✓ Nutritional recommendations for dietary fats and oils continue to evolve as we learn more about the impact of FAs on health. However, most nutritional organizations agree that the consumption of saturated fats should be decreased and polyunsaturated fats and ω-3 FA consumption should be increased.
- ✓ In addition, polyunsaturated oils and ω-3 FAs are very susceptible to oxidation, leading to development of off-

flavors, loss of nutrients, and formation of potentially toxic compounds. Therefore, the substitution of highly unsaturated fats for solids fats could have negative nutritional consequences unless technologies are utilized to prevent their oxidation.

- ✓ These challenges, along with the removal of hydrogenated fats from the food supply, are driving food manufacturers to utilize oils high in MUFAs because these FAs have higher melting points and are more stable against oxidation.
- ✓ MUFAs tend to be neutral with regard to heart health so this change in fat source could lead to further unintended consequences in consumer health.

XIV. References

A. Research Papers

1. *Chemistry of Oils & Fats and their Health Effects*

AUTHOR:

Rummi Devi Saini (*Chemistry Department, SMDRSD College Pathankot, Pathankot, 145001, India*).

PUBLISHER:

International Journal of Chemical Engineering Research.
ISSN 0975-6442 Volume 9, Number 1 (2017), pp. 105-119,

http://www.ripublication.com

LINK

https://www.ripublication.com/ijcher17/ijcherv9n1_09.pdf

SYNOPSIS:

- ✓ In terms of overall health benefits, extra virgin olive oil and canola oil are the best choices.
- ✓ Although extra virgin olive oil does contain saturated fat (only around 12 per cent), it is one of the few unrefined oils. This means that the antioxidants present in the original fruit are retained because the oil is extracted by machine only and not refined with chemicals or other means that can remove the goodness from the oil.
- ✓ While most canola oil products are refined and don't contain many antioxidants, they have the advantage of having even less saturated fat than olive oil (around eight per cent).
- ✓ A daily amount of these oils recommended is about two to three tablespoons which would be perfectly in keeping with a healthy balanced diet and even a weight-loss rule.
- ✓ For cold dishes i.e. with salads and breads use of extra virgin olive oil is recommended in order to take advantage of the flavors and antioxidants. Refined oils such as canola, sunflower and plain olive oil are r recommended for cooking i.e. casseroling, sautéing and stir-frying and peanut oil and other flavored oils such as sesame, macadamia are suggested to be used in dishes that demand certain flavors.
- ✓ Meanwhile, tropical oils, such as palm, cottonseed and coconut, should be limited because they are naturally more saturated.
- ✓ It is generally recommended that to achieve best health benefits, oils rich in *PUFA should be used in combination with those rich in MUFA* like olive oil, mustard oil or groundnut oil.

2. *A healthy approach to dietary fats: Understanding the science and taking action to reduce consumer confusion*

AUTHORS:

- Ann G. Liu1
- Nikki A. Ford2
- Frank B. Hu3

- Kathleen M. Zelman4
- Dariush Mozaffarian5
- Penny M. Kris-Etherton6.

PUBLISHER:

Liu et al. Nutrition Journal (2017) 16:53 DOI 10.1186/s12937-017-0271-4

LINK

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5577766

SYNOPSIS:

- ✓ Consumers are often confused about nutrition research findings and recommendations. As content experts, it is essential that nutrition scientists communicate effectively.
- ✓ A case-study of the history of dietary fat science and recommendations is presented, summarizing presentations from an Experimental Biology Symposium that addressed techniques for effective scientific communication and used the scientific discourse of public understanding of dietary fats and health as an example of challenges in scientific communication.
- ✓ Decades of dietary recommendations have focused on balancing calorie intake and energy expenditure and decreasing fat. Reducing saturated fat has been a cornerstone of dietary recommendations for cardiovascular disease (CVD) risk reduction. However, evidence from observational studies and randomized clinical trials demonstrates that replacing saturated fat with carbohydrates, specifically refined, has no benefit on CVD risk, while substituting polyunsaturated fats for either saturated fat or carbohydrate reduces risk.
- ✓ A significant body of research supports the unique health benefits of dietary patterns and foods that contain plant and marine sources of unsaturated fats. Yet, after decades of focus on low-fat diets, many consumers, food manufacturers, and restauranteurs remain confused about the role of dietary fats on disease risk and sources of healthy fats.

- ✓ Shifting dietary recommendations to focus on food-based dietary patterns would facilitate translation to the public and potentially remedy widespread misperceptions about what constitutes a healthful dietary pattern.

3. *Challenges of Utilizing Healthy Fats in Foods*

AUTHORS:

- Samantha A Vieira
- David Julian McClements
- Eric A Decker

PUBLISHER:

American Society of Nutrition (ASN)
An International Review Journal

LINK

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4424769/

SYNOPSIS:

- ✓ Over the past few decades, the Dietary Guidelines for Americans has consistently recommended that consumers decrease consumption of saturated fatty acids due to the correlation of saturated fatty acid intake with coronary artery disease.
- ✓ This recommendation has not been easy to achieve because saturated fatty acids play an important role in the quality, shelf life, and acceptability of foods. This is because solid fats are critical to producing desirable textures (e.g., creaminess, lubrication, and melt-away properties) and are important in the structure of foods such as frozen desserts, baked goods, and confectionary products.
- ✓ One might expect that with these consistent recommendations to limit the consumption of solid fats, our diet would have shifted more toward the use of highly unsaturated oils.
- ✓ However, replacement of saturated fats with unsaturated oils is limited by their susceptibility to oxidative rancidity, which decreases

product shelf life, causes destruction of vitamins, and forms potentially toxic compounds.

- ✓ This article has summarized the fundamental chemical and physical properties in fats and how these properties affect food texture, structure, flavor, and susceptibility to degradation. The current sources of solid fats have been reviewed and potential replacements for solid fats were discussed.

4. *Healthful Oils*

AUTHORS:

- Jessica Caporuscio, Pharm.D
- Katherine Marengo LDN, R.D

PUBLISHER:

Medical News Today, March 30, 2019

LINK

https://www.medicalnewstoday.com/articles/324844

SYNOPSIS:

- ✓ Healthful oils are an important part of every diet. There are many types of oil to choose from, so which are the best ones for cooking, nutrition, and health benefits?
- ✓ Dietary fats play an essential role in the body. The fats in food help the body to absorb vitamins A, D, E, and K. They are also essential for brain and nerve function.
- ✓ The 2015–2020 Dietary Guidelines for Americans Trusted Source recommends adding healthful oils to the diet to help support a healthy body weight and reduce the risk of heart disease.
- ✓ There are many different oils to choose from, such as olive, coconut, canola, and vegetable oils. Each of these oils has different characteristics.

- ✓ In this article, we summarized the properties of olive oil, coconut oil, canola oil, and vegetable oil for nutrition and cooking, plus any adverse effects, and their overall health benefits

B. Books and Manuals

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C. External Links

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- https://chem.libretexts.org/Bookshelves/Introductory_Chemistry/Book%3A_The_Basics_of_GOB_Chemistry_(Ball_et_al.)/17%3A_Lipids/17.02%3A_Fats_and_Oils
- https://en.m.wikipedia.org/wiki/Fatty_acid