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OILS & FATS FOR HEALTH AND NUTRITION: MYTHS AND FACTS



Dr R B N PRASAD

Academy for Science, Technology and Communication
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Academy for Science, Technology and Communication

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To conduct periodical academic enrichment programmes, with innovative projects for promotion of science and engineering, involving teachers and students, to pursue curiosity and creativity among budding scientists and to stimulate scientific temper.

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To promote temperament of Science and Technology among Youth.

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Preface



In addition to making our food delicious, oils are essential for running our body's machinery. They are a dense source of energy, providing more than twice the energy per gram compared to carbohydrates or proteins. Fats, lipids of a type known as phospholipids, form the structural framework of cell membranes, ensuring cellular integrity and regulating the transport of substances in and out of cells. Steroids, a type of lipids, are precursors for hormones like testosterone, estrogen, and cortisol, which regulate metabolism, immune response, and reproductive functions. Lipids help insulate the body to maintain its temperature and cushion vital organs against physical shocks. Lipids are necessary for the absorption of fat-soluble vitamins (A, D, E, and K), which are vital for various bodily functions. Among the countless functions of oils and fats, the myelin sheath that helps prevent leakage of current is important for most of our activities.

Despite this phenomenal importance in our survival, many fear oils and fats. They avoid eating oily, fatty (… tasty) food in the hope of clean arteries and good health. Not all oils and fats are bad. One fact I think everyone should be aware of is that there is no cholesterol in plants - no vegetarian source of cholesterol at all. Our body makes cholesterol because it needs it. It is a cause of concern only if it is more than required.

Dr. RBN Prasad, a scientist and popular science writer, elegantly explains, in this handy booklet, the good and bad of oils, different types of oils; virgin, cold pressed, refined etc and from different sources such as palm, rice barn, sesame, peanut etc. These multitude of oils, together with terms such as omega-3, omega-6, PUFAs and MUFAs surely create a slippery surface for many of us to choose what is good. This booklet walks you through this maze and should help you choose well and stay fit.

Dr. Ch. Mohan Rao
Chairman-Scientific Advisory Council, ASTC

* CSIR-Distinguished Scientist & Former Director CCMB, Hyderabad

Editor's Vision



A healthy diet consists of three major macronutrients, namely proteins, carbohydrates, and oils & fats. As an integral component of various foods, Oils and fats provide essential precursors for the formation of biological membranes, such as phospholipids and cholesterol, which are vital for building cell membranes.

Globally, about 225 million tons of oils and fats are consumed annually. In our country, the consumption is approximately 25 million tons per year, with a major share being imported.

Dr. R.B.N. Prasad, a distinguished lipid scientist who has made outstanding contributions in the field of oils and fats for over 45 years, has highlighted their importance through this booklet titled "Oils & Fats for Health and Nutrition: Myths and Facts", as part of ASTC COMMUNICATIONS.

Dr. Prasad has emphasized the significance of oils and fats in our diet and provided authentic information on the actual requirements. Oils and fats are often misunderstood, with many myths surrounding their role in health. The truth is, not all fats are bad - some are essential for a healthy body. Several videos on social media are spreading confusion about oils and fats, and Dr. Prasad has addressed many of these misconceptions in this article.

As Convenor of the Editorial Committee, I extend my sincere appreciation to Dr. R. B. N. Prasad for his meticulous efforts in bringing out this valuable resource.

Let us continue to explore, innovate, and celebrate the wonders of science together in the form of ASTC Communications

Dr. Y. Purushotham
Vice President, ASTC

Scientist-F, Centre for Materials for Electronics Technology (C-MET), Hyderabad

President's Voice



Oils and fats, though indispensable in our daily diet, are often surrounded by myths, misconceptions, and conflicting advice. This edition of the ASTC COMMUNICATIONS series, titled "Oils & Fats for Health and Nutrition: Myths and Facts," is a significant effort to dispel such confusion and present clear, evidence-based insights that empower individuals to make healthier, well-informed dietary choices.

From essential fatty acids to modern refining practices, and from the science of nutraceuticals to the importance of fortification, this publication offers practical clarity. With careful attention to Indian dietary habits and cultural nuances, it serves as a relatable and valuable guide for our diverse population.

As our Hon'ble Prime Minister has often emphasized, fostering a scientific temper, promoting holistic well-being, and encouraging people's participation approach to health are vital to building a healthy, self-reliant India. His recent appeal to reduce household edible oil consumption by 10% to combat obesity and lifestyle diseases resonates strongly with the objective of this booklet—transforming nutrition into not just a personal priority, but a national movement.

In an era overflowing with information-and often misinformation-it is both timely and essential that science-based understanding reaches every household, student, and health-conscious citizen. I am confident this publication will serve as a meaningful and trusted resource for the wider public.

I extend my sincere appreciation to Dr. R.B.N. Prasad, a distinguished expert, for his dedicated contribution, meticulous effort, and unwavering commitment to science communication.

Dr. C. Manikyamba
President, ASTC

Emeritus Scientist, CSIR-National Geophysical Research Institute (NGRI), Hyderabad

From Secretary's Desk

ASTC has been steadfast in its commitment to science popularization, fostering interdisciplinary collaborations, and inspiring young minds through diverse initiatives. Through impactful lectures, seminars, symposia, workshops, and publications, we aim to bridge the gap between scientific advancements and public understanding. Our academic initiatives seek to ignite curiosity and nurture the next generation of scientists and engineers.

ASTC does not receive any regular Government funding, and it has been thriving with the event-based contributions and encouragement from major scientific organizations and committed individuals, which have been pivotal in sustaining and expanding its multifaceted programs.

Our flagship event is the Annual Convention, where we honor excellence through Lifetime Achievement Awards, Excellence Awards in Science & Technology, and Science Popularization Awards. This event draws participation from national laboratories, scientific institutions, universities, and eminent professionals across various disciplines of science and technology. We also pay tribute to the legacy of S&T luminaries through prestigious memorial lectures, ensuring their contributions continue to inspire future generations.

In our commitment to making cutting-edge science accessible, ASTC publishes concise and insightful booklets on contemporary topics. Our popular series, "ASTC Communications" serves as a platform for distilling and disseminating advancements in science and technology, thereby fostering an informed and empowered society. Two booklets titled "More Kohinoor Diamonds from India" and "The Sun and Solar Energy: Igniting the Future" were already under progress.

The third title in this series on "Oils & Fats for Health and Nutrition: Myths and Facts", authored by Dr RBN Prasad who has vast experience as an eminent Lipid Scientist and made outstanding contributions in areas of lipid chemistry and technology. He was also responsible in establishing Centre for Lipid Research with state-of-the-art facilities at CSIR-IICT. Dr Prasad was the National President of Association of Food Scientists & Technologists (India) and Oil Technologists' Association of India.

We are highly thankful to Dr Prasad whose contributions are significant in the area of popularization of science and we hope that everyone finds this booklet useful, thought-provoking, and easy to share with others.

Sri. C.L. Narasimha Rao
Secretary, ASTC

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Oils & Fats for Health and Nutrition: Myths and Facts

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Importance of Oils and Fats in our Diet

Healthy diet consists of three major macro nutrients namely proteins, carbohydrates and oils & fats. Minerals and vitamins are the micronutrients responsible for human health. In addition, water is necessary for maintaining the hydration of the body. A healthy balanced diet is important for overall health and every food ingredient is important for health. Oils and fats are energy-rich components in our daily food and provide about 9 kcal/gram whereas carbohydrates and proteins provide only 4 kcal/g.

Oil and fats are very important for the maintenance of good health. The most important property of oils in our diet is to provide desirable organoleptic properties such as flavor, aroma, texture and mouth feel. In addition, oils and fats carry, enhance and release the flavors of other food components and increase the palatability of food. Oils and fats provide precursors needed for making biological membranes such as phospholipids and cholesterol vital for making the cell membranes. Oils and fats provide essential fatty acids which are the precursors for the synthesis of prostaglandins, thromboxane, leukotrienes, lipoxin, resolvins etc. which are the building blocks for several biological compounds needed to regulate our body metabolism. Fatty acids are essential for the development of the central nervous system. Oils and fats promote healthy skin and provide shape and contour to the body. Oils and fats serve as good carriers for fat-soluble vitamins A, D, E and K. Oils and fats acts like a "cushion" and heat regulator to protect heart, liver and other vital organs. In addition, some of the oils contain potent nutraceuticals like tocopherols, tocotrienols, phytosterols, phytosteryl esters, oryzanol, squalene, lignans, beta carotene, polyphenols etc.,

In case of less consumption of oils and fats may lead to retarded growth, skin lesions, kidney and liver disorders etc. Hence, oils and fats are very important ingredients of our diet for nutrition and health and do not blame or reduce the consumption of oils and fats too much after seeing some unscientific viral videos.

Visible and Invisible Oils & Fats

Visible oils and fats are cooking oils, ghee, butter, vanaspati, margarines etc. which are being used by us in the kitchen for preparing the daily foods. Oils and fats are present as an integral component of various foods. For example, the fat content in the most cereals, millets, legumes and pulses varies from 1.5 to 3% and maize, bajra, Bengal gram and soyabean contain more content of oils. There are several high fat content food items like wet coconut (40%), dry coconut (60%), groundnuts (45%), almonds (55%), cashew (50%), walnuts (60%), pistachio (40%), papad, pickles etc. (10-30%), panner (15%) cheese, cream, white sauce, milk, ice cream (5 to 15%),

bakery items like biscuits, cakes, puffs (~15%), sweets, snacks, potato chips (30-50%), variety of snacks (15-40%), meat (~10%), egg yellow yolk (25%) etc.

According to Food Safety and Standards Authority of India (FSSAI) guidelines, nutritional facts including fat content must be mentioned on every food pack. Hence, we can calculate the invisible fat being consumed by us every day. The small amounts of invisible fat present in various foods add up to a substantial level in our daily diet.

According to NIN-Indian Council of Medical Research (NIN-ICMR) estimates, about 20 g in rural population and 50 g among urban middle-income and high-income groups may consume these invisible fats unknowingly. Hence it is necessary to consider the invisible fat intake while consuming dietary intake of visible fat.

Global Recommendations for Oils & Fats Requirement

Most of the global health organizations recommend the intake for total dietary fat (visible plus invisible fats) in adults ranges between 20 to 35% of total energy intake per day. In India, the recommended dietary guideline of NIN-ICMR for the total dietary fat intake is approximately 30% of total energy. For active individuals, the fat intake may be up to 35% of total energy intake per day. For example, if an individual consumes 2000 kcal of energy per day, then 30% of 2000 kcal i.e. 600 kcal (equivalent to approximately 65 g) must come from total fat (visible + invisible). However, after considering the invisible fat consumption, visible fats may be restricted to 20-50 g (4 to 10 tablespoon full) per person/day depending on the level of energy (calorie) requirement, which is based on physical activity and physiological status.

As per NIN-ICMR dietary guidelines, it is recommended that adult women or men with sedentary lifestyle limit daily fat intake to 20 and 30 g of visible fat (cooking oil) respectively. Adult men with moderate and heavy physical activity may consume visible fat up to 40 g and 50 g respectively, while adult women with moderate and heavy physical activity may consume up to 30 g and 40 g respectively. After considering these general guidelines, on average not more than 27-30 g visible fat (cooking oil) is required for a 2000 Kcal diet/day. Hence, about 800 to 900 g of cooking oil per person per month will be more than sufficient for a 2000 Kcal diet/day.

Indian Scenario of Oils & Fats

Globally about 225 million tons of oils and fats are being consumed. In India the

consumption of oils is about 25 million tons per year and out of this about 65% of oils are being imported. Table 1 provides the consumption patterns of edible oils in India.

Table 1: Edible Oil Consumption Pattern in India (2023-24)

Oil	Quantity (MMT)	%Share
Palm	9.4	37.6
Soya	5.3	21.2
Rape/Mustard	3.4	13.6
Sunflower	2.9	11.6
Rice Bran	1.2	4.8
Cottonseed	1.1	4.4
Groundnut	0.8	3.2
Sesame, Safflower Coconut, Olive etc.	0.9	3.6

Nomenclature of Oils based on Processing Methodologies

Oils and fats are available in the market with different descriptions like kachi ghani oil, expelled oil, double filtered oil, cold pressed oil, virgin oil, refined oil etc. All these forms of oils and fats are permitted by FSSAI with appropriate specifications. Hence all these oils and fats are safe, and one can consume any of these oils and fats. However, one must make sure that these oils and fats are selling with FSSAI licence number and conforming to the standards prescribed by FSSAI for the specified edible oils on the respective label. A brief description is provided for different types of processing of oils and fats for human consumption.

Kachi ghani mustard oil: Mustard oil means the oil expressed from clean mustard seeds and the oil may be labelled as Kachi Ghani, if the content of natural isothiocyanate in the oil is not less than 0.20 % by weight.

Cold pressed oil: Cold pressed oils are obtained without altering the oil, by expelling or pressing without the application of heat. They may have been purified by settling, filtering, and centrifuging. Generally, oils containing higher amounts of poly unsaturated fatty acids are extracted using cold pressing process. Examples include safflower, linseed/flax seed oils etc.

Virgin oil: Virgin oils are obtained, without altering the nature of the oil, by expelling or pressing, with the application of heat. They may have been purified by washing with water, settling, filtering and centrifuging. Examples include virgin olive oil, virgin coconut oil etc.

Solvent-extracted oil: Solvent extracted oil means any vegetable oil or fat obtained from oil-bearing material by the process of extraction by a solvent (normally food grade hexane). Solvent extracted oils and fats must be consumed only after refining.

Refined oil: Refined vegetable oil means any vegetable oil or fat which is obtained by expression or solvent extraction of vegetable oil bearing materials, deacidified with alkali and/or physical refining and/or by miscella refining using permitted food grade solvents and/or degumming using phosphoric/citric acid and any suitable food grade enzyme, followed by bleaching with adsorbent earth and/or activated carbon or both of them and deodorized with steam under vacuum. No other chemical agent is permitted. All refined oils that conform to FSSAI standards are safe for health.

Why is Refining Necessary for Some Oils? Does the Industry use Toxic Chemicals for Refining?

As mentioned above, all the solvent extracted oils must be refined before human consumption. As per FSSAI guidelines, cottonseed oil, mahua oil, rice bran oil, kokum fats, mango kernel fats, dhupa fat and phulwara fat must be refined before human consumption for the removal of the antinutritional or unsafe substances.

Some of the common oils like groundnut, sesame, coconut, sunflower, mustard, safflower oils which are extracted using expelling technique can be consumed without refining. However, in some cases, even expelled oils may contain some impurities or toxic substances like aflatoxin or higher amounts of free fatty acids which adversely affect safety, flavor, odor and appearance of oil and it is advisable to refine such oils for making them safer. In some cases, like soybean oil, even useful components like phospholipids (in lecithin form) must be removed from the crude oils as they may create some problems like foaming during further refining steps or during cooking the food. After refining, oils will become safer, more palatable and stable against rancidity upon storage.

Only non-toxic chemicals are permitted for refining oils. FSSAI and other global agencies permit several processing aids for the refining of oils. Hence, refined oils are totally safe to use as cooking oil. Globally or in India, more than 85% of the oils consumed is refined oil. Most of the nutritional components like tocopherols, tocotrienols, phytosterols, oryzanol lignans etc. are retained in reasonably higher quantities during refining. ***Hence, do not believe unscientific viral videos which propagate refined oils as unsafe.***

Significance of Essential Fatty Acids

Two known essential fatty acids (EFA) are linoleic acid (LA, omega-6) and alpha linolenic acid (ALA, omega-3), which are the basic Poly Unsaturated Fatty Acids (PUFA). The nomenclature is based on the position of the first double bond from the methyl end of the fatty acid molecule. If it comes on the 6th carbon atom it is called omega-6 PUFA and if it is on 3rd carbon atom, then it is omega-3 PUFA. As mentioned earlier, EFAs are not synthesized by the body, and we must provide them through diet as the role of these PUFA is very crucial in the synthesis of biologically important lipids in the body. EFAs are the components of cell membranes, structural elements of gonads and mitochondrial membrane. They are required for brain growth and development, healthy vision and for preventing fatty liver formation. EFAs are precursors of eicosanoids. EFAs perform cardio protective role by lowering serum cholesterol and increasing HDL levels. Deficiency of EFAs may cause cardiovascular diseases, diabetes, cancer, age-related functional decline, retarded growth in children, reduced fertility, pathologic changes in the skin etc. Omega 3 PUFA generates 3 series prostaglandins and 5 series leukotrienes which have anti-inflammatory activity. On the other hand, omega 6 PUFA generates 2 series of prostaglandins and 4 series of leukotrienes which are pro-inflammatory in nature. Therefore, it is recommended that an ideal ratio of omega-3 and omega-6 fatty acids to be in the range of 1:5 to 1:10 for maintaining good health.

Most of us consume plenty of omega-6 fatty acid, but not enough omega-3 fatty acid. Due to the low content of ALA and high content of LA in common edible oils, omega-6 to omega-3 ratio is quite high. A very high ratio promotes the pathogenesis of many diseases, including cardiovascular disease, cancer, and inflammatory and autoimmune diseases. Increased levels of omega-3 PUFA may lower the incidence of many chronic diseases that involve inflammatory processes. Hence, it is preferable to take at least 1 g per day of ALA either as supplement in capsule form (like flax seed oil or chia seed oil) or in the form of omega-3 fatty acid containing oil.

Nutraceuticals Present in Oils and Fats

The major components of oils and fats are triglycerides and in addition, they contain several minor nutritional constituents like phytosterols, tocopherols, carotenoids, oryzanol, polyphenols, lignans etc. with biological and health functions (Table 2). For example, rice bran oil contains oryzanol, which has potent hypocholesterolemic activity and due to this reason, rice bran oil is known as heart oil. Rice bran oil and palm oils contain most potent tocotrienols in addition to

tocopherols. Sesame oil contains sesamin, sesamolin, and sesamol, which are known as lignans with several biological and health functions including antioxidant activity. Olive oil contains poly phenols with good antioxidant property. Value of oils enhance with the presence of the nutraceuticals in addition to balanced fatty acid profile and the following table provides the information about the nutritional components present in various oils and their biological and health functions.

Table 2: Nutritional Components Present in Edible Oils

Nutritional Component	Oil	Biological and Health Function
Sterols (Phytosterols)	All Oils	Hypocholesterolemic
Tocopherols (Vitamin E)	All Oils	Vitamin, Antioxidant
Tocotrienols (Vitamin E)	Palm, Rice bran	Vitamin, Antioxidant
Oryzanol	Rice bran	Hypocholesterolemic, Antioxidant
Sesamin, Sesamolin, Sesamol	Sesame	Antioxidant, Hypocholesterolemic & Anti-inflammatory activities.
Hydroxytyrosol, Phenolic acids	Olive	Antioxidant

Fatty Acid Composition of Individual Oils

Oils and fats contain three types of fatty acids namely Saturated fatty acids (SFA) Monounsaturated fatty acids (MUFA) and Polyunsaturated fatty acids (PUFA). SFAs raise blood cholesterol and LDL cholesterol (bad cholesterol). MUFA lowers blood cholesterol and lowers LDL cholesterol. PUFAs are further classified into omega 6 and omega 3 fatty acids. The basic PUFA namely linoleic acid (omega-6) and linolenic acids (omega-3) are known as essential fatty acids since these cannot be synthesized in the body and must be provided along with the diet. PUFAs can reduce the levels of plasma cholesterol and thereby provide some protection against cardiovascular diseases. Generally, oils and fats are characterized based on the fatty acid composition. Table 3 provides a general idea about the common edible oils.

Global (World Health Organization, WHO) and National (NIN-Indian Council of Medical Research, NIN-ICMR) Health Organizations recommend that SFA intake should not exceed 8-10% of total energy. The intake of PUFA should be 8-10% of energy intake. The remaining 8-10% of fat calories can be derived from MUFA. According to FAO/WHO Guidelines, replacing SFA with PUFA or MUFA decreases LDL cholesterol concentration and the total/HDL cholesterol ratio. So, it is advisable to increase the consumption of MUFA or PUFA content by decreasing

Table 3: Fatty Acid Composition (wt%) of Common Edible Oils (Approximately Averaged Figures)

Edible Oil	SFA	MUFA	PUFA		Remarks
			Omega-6	Omega-3	
Optimum Level [a]	**<28***	**>33-43**	**>28-33**	**>4****	
Coconut	92	6	2	0	SFA-Rich Oil
Palmolein	40	50	10	0	SFA/MUFA-Rich Oils
Olive	20	70	10	0	MUFA-Rich Oils
Groundnut	20	50	30	0	
Rice bran	20	45	33	2	
Sesame	16	42	42	0	MUFA/PUFA-Rich Oils
Sunflower	10	25	65	0	PUFA (Omega-6)-Rich Oils
Safflower	10	15	75	0	
Cottonseed	25	30	45	0	
Corn	15	30	54	1	
Soybean	14	24	55	7	PUFA (Omega 6 &3)-Rich Oils
Mustard	6	68	16	10	MUFA & Omega-3-Rich Oils
Canola	6	62	22	10	
Rapeseed	8	62	20	10	
Linseed	10	20	15	55	PUFA (Omega 3)-Rich Oils
Chia seed	10	10	20	60	

[a]Based on the recommendations of Global Health Organizations (WHO/FAO and NIN-ICMR)
**Recommended to decrease further; **Linolenic acid (omega-3) to consume minimum 1 g per day*

SFA. In the above Table, the first row provides the optimum level of fatty acids required as per these recommendations when converted into absolute values. Interestingly, no single vegetable oil can meet all the nutritional and dietetic requirements. As seen in the above table individual oils are either SFA-rich or MUFA-rich or PUFA-rich or do not contain omega 3 fatty acid. The following are the attributes of all the major edible oils.

- **Coconut oil** contains medium chain saturated fatty acids that are easily metabolized. However, it contains less amounts of MUFA and PUFA. Hence, if someone consumes only coconut oil without any other source of oil for MUFA and PUFA, it may not be good for their health in the long run.

- **Palmolein oil** is rich in SFA and MUFA with lower content of PUFA. Some viral videos propagate that palm oil is not a healthy oil, which is not correct. Palm oil is a safe oil to consume and there is no scientific evidence for adverse health effects. Palmolein contains tocopherols and tocotrienols which are natural antioxidants. Palmolein may be consumed along with PUFA-rich oils like soybean, sunflower and safflower. Soybean oil may be blended with palmolein in 1:1 ratio for getting optimum fatty acid ratio including the required omega 6 to omega 3 ratio.
- **Olive oil** is rich in MUFA that helps lower LDL Cholesterol. However, olive oil contains lower amounts of PUFA. Olive oil contains polyphenols which are natural antioxidants. If someone consumes only olive oil without any other source of oil for PUFA, it may not be good for their health in the long run. Hence, olive oil may be consumed along with PUFA-rich oil like sunflower oil, soybean oil etc.
- **Groundnut oil** contains MUFA and omega-6 PUFA that helps lower plasma cholesterol. This oil contains reasonable amounts of SFA and does not contain omega-3 fatty acid. Hence minimum 1 g of omega 3 fatty acid must be consumed per day in addition to this. Groundnut oil contains tocopherols which are natural antioxidants. Double filtered groundnut oil may have the contamination of aflatoxins if spoiled groundnuts are taken for extraction. Refined oil is free of aflatoxins, but refined oil does not have the characteristic flavor of groundnut oil.
- **Rice bran oil (RBO)** contains MUFA and omega-6 PUFA that helps lower plasma cholesterol and is known as heart friendly oil. This oil contains reasonable amounts of SFA and contains 1-2% of omega-3 fatty acid. As this omega-3 fatty acid may not be sufficient, it is preferable to take minimum 1 g of omega 3 fatty acid per day in addition to this. RBO contains both tocopherols and tocotrienols. RBO also contains oryzanol which has hypocholesterolemic activity and several other health benefits. Hence, RBO is one of the healthiest oils for health and nutrition.
- **Safflower oil, Cottonseed oil, Sunflower oil and Corn oils** are rich in PUFA (omega-6 fatty acid, Linoleic acid) that help lower plasma cholesterol. These oils contain lower amounts of MUFA. However, these oils do not contain omega-3 fatty acid (ALA). Hence minimum 1 g of omega 3 fatty acid must be consumed per day in addition to these oils. Cottonseed and Sunflower Oils contain higher content of tocopherols which are natural antioxidants.
- **Sesame oil** contains equal proportions of MUFA and PUFA that helps lower plasma cholesterol. This oil contains reasonable amounts of SFA and does not

contain omega-3 fatty acid. Hence a minimum of 1 g of omega 3 fatty acid must be consumed per day in addition to this oil. Sesame oil contains lignans and tocopherols which are natural antioxidants. Lignans possess hypocholesterolemic and anti-inflammatory activities. Due to the strong antioxidant property, sesame oil is being used in long storage pickles extensively. Sesame oil or combination with any other oil is also a good oil for cooking purposes.

- **Mustard oil** contains erucic acid (long chain MUFA) in major quantities and lower amounts of omega-6 fatty acids. This oil contains omega-3 fatty acid (Alpha linolenic acid), which is an essential fatty acid that contributes to the maintenance of normal blood cholesterol. Mustard oil also contains tocopherols which are natural antioxidants. In addition, mustard oil contains allyl isothiocyanate, which has a characteristic flavor liked by some regions of the country.
- **Canola and rape seed oils** contain MUFA in major quantities and omega-3 in good quantities which help lowering of plasma cholesterol. However, they contain lower amounts of omega-6 PUFA and SFA. Hence, these oils may be blended with SFA rich or omega-6 rich oils for balancing all the fatty acids.
- **Soybean oil** contains good amounts of omega-6 fatty acid (linoleic acid) and omega-3 fatty acid (alpha linolenic acid) which help in lowering plasma cholesterol. This oil contains lower contents of SFA and MUFA. Soybean oil also contains tocopherols which are natural antioxidants. This oil may be consumed by blending with palmolein to get optimum fatty acid profile.
- **Linseed/flax seed and Chia seed oils** are rich in omega-3 fatty Acid (Alpha linolenic acid) that contributes to the maintenance of normal blood cholesterol. Due to higher amounts of omega-3 fatty acid, these oils are not useful as cooking oils. Both the oils are permitted by FSSAI to add to the blended oils upto 5% as a source of omega-3 fatty acid. As mentioned above, these oils are the best oils to consume to supplement omega-3 fatty acids in daily food, in case the regularly consumed oils do not contain omega-3 fatty acids. Consumption of minimum of 2 g of either flax seed or Chia seed oils provides about 1 g of alpha linolenic acid (omega-3), which is sufficient for general health and nutrition.

How to Choose an Edible Oil with Optimum Fatty Acid Composition?

It is very clear from the above information that no single oil provides the balanced fatty acid composition. Even though some oils like rice bran and groundnut provide balanced amounts of SFA, MUFA and omega-6 PUFA, we need to supplement with some other oil for getting omega-3 PUFA. Hence, one must choose combination of oils to fulfil these specifications, while considering the invisible fats being taken by individuals in their daily diet. Today, on every pouch of oil, the fatty acid content of SFA, MUFA and PUFA is available and based on that data, we can choose our own combination of oils for getting the balanced composition of fatty acids. Hence, one must choose combination of oils to fulfil these specifications, while considering the invisible fats being taken by individuals in their daily diet.

In this context, NIN-ICMR provided some recommendations for obtaining appropriate oil blends for getting optimum levels of fatty acid compositions. The following are some of such combinations of oils.

Oil containing Linoleic acid (LA) + oil containing both LA and Alpha Linolenic acid (ALA)

- Groundnut / Sesame / Rice bran / Cottonseed + Canola
- Groundnut / Sesame / Rice bran / Cottonseed + Soyabean
- Groundnut / Sesame / Rice bran / Cotton seed + Mustard
- Palmolein + Soyabean
- Safflower / Sunflower + Palmolein + Mustard

Oil containing high LA + oil containing moderate or low LA

- Sunflower / Safflower + Palmolein / Olive
- Safflower / Sunflower + Groundnut / Sesame/ Rice bran / cottonseed

The above suggested blends are only indicative, and one can be prepared on their own, based on individual taste and preference after purchasing required pouches of oils. FSSAI also allows blending of two vegetable oils in the name of multi-sourced oils (one oil must be at least 20%) and very recently, third oil namely flax seed oil or chia seed oil is also allowed up to 5% to supplement omega-3 fatty acid and to maintain ideal ratio of omega-3 to omega-6 in the blend. We can also select one of these blends from the market based on the nutritional information provided on the pouch.

Importance of EPA and DHA in Health and Disease

Omega-3 fatty acid ALA gets converted (biosynthesized) into long chain omega-3 PUFAs (LC-PUFAs) namely docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) in the body. However, these conversion processes are not so efficient and hence, supplementation of LC-PUFAs is necessary for maintaining good health particularly for the prevention of cardiovascular diseases. EPA and DHA are required for many cell membrane functions, known to reduce the risk of clot formation in the blood. Increased intake of EPA and DHA decreases the occurrence and progression of mammary, prostate, and intestinal tumors. DHA and EPA are potent anti-inflammatories. EPA and DHA levels may be beneficial to diabetic patients, especially those with elevated serum triglycerides with respect to risk of CHD. EPA and DHA required for hormone production, to protect immune system, for healthy vision, for healthy cell growth across all life stages. They help in brain development in the growing fetus and young children as well as brain function in addition to several biological functions in the body. Preterm infants fed formulas with DHA significantly improved measures of visual function compared to preterm infants fed DHA-free formulas. DHA and EPA are readily available from fish and algal oils.

FAO/WHO and ISSFAL guidelines recommended the following quantities of omega-3 PUFAs: Minimum 1 g per day of ALA (Higher level upto 3 to 4 g) and 0.25 to 0.5g per day of EPA and DHA. (higher level of 2g/day recommended for secondary prevention of CHD). Several companies are selling omega-3 fatty acids in capsule form, and we can buy these supplements through online also. It is essential to include DHA and arachidonic acid (ARA) in the infant formulae/milk substitutes to mimic contents of fat and fatty acids in human milk. In situations where breast milk intake is low, the level of fat, LA, ALA, ARA and DHA in complementary foods should be increased to achieve the recommended intakes

Metabolism of Oils and Fats in the Body

Triglycerides, the major components of oils and fats, are metabolized in the gastrointestinal tract where hydrolyzing enzymes (fat splitting enzymes) play a role in the hydrolysis of oils and fats. The hydrolyzed products are then absorbed from intestinal epithelial cells and reassembled to form chylomicrons. The various lipids are then transported in the form of lipoproteins. The short and medium chain fatty acids are transported via portal system to liver where it is mostly utilized for energy production through β oxidation. The long chain fatty acids traverse through a lymphatic system and are sent to the liver where it is further metabolized. The various lipids then reassemble Very Low-Density Lipoproteins

(VLDL) which enter the mainstream and are transported to various organs to meet their lipid requirements. During its passage VLDL is acted upon by lipoprotein lipase and hormone sensitive lipase giving Intermediate Density Lipoproteins (IDL) followed by Low Density Lipoproteins (LDL). These lipoproteins are major cholesterol carriers in plasma. These remnants then return to the liver where they are taken in by a specific receptor and further metabolized in the liver. Similarly, another group of lipoproteins called High Density Lipoproteins (HDL) which is also metabolized in a similar fashion. While cholesterol with LDL fraction is considered bad cholesterol because over a period it gets deposited in the arteries leading to atherosclerotic plaques, one of the leading causes for heart diseases. The cholesterol associated with HDL fraction is called good cholesterol because it is coming out of the tissues. Therefore, one needs to measure not only total cholesterol but also the ratio of LDL/HDL cholesterol to assess risk factors for lifestyle diseases like cardiovascular diseases (CVD). Hence, lower LDL levels and higher HDL levels are preferred to reduce the risk factors for CVD.

Cholesterol and Trans Fatty Acids in Oils & Fats

Vegetable oils do not contain cholesterol. Only animal fats contain cholesterol. However, saturated fatty acids have the capability to accelerate the metabolism of cholesterol. Due to this reason, global health organizations recommend comparatively reducing the consumption of saturated fatty acids.

Trans fatty acids form during partial hydrogenation of vegetable oils to produce vanaspati, margarine, bakery fats etc. and also during high temperature refining. Trans fatty acids are double edged sword in their action as they elevate LDL cholesterol and lower HDL cholesterol levels which are not favorable for cardiac health. TFA consumption alters lipid profile, endothelial dysfunction, decreases insulin sensitivity and increases risk of diabetes, breast cancer, colon cancer, preeclampsia, disorders of nervous systems and vision in infants. Considering the negative aspects of trans fatty acids linked with several diseases, FSSAI has taken a decision to reduce the trans fatty acids to less than 2% in oils and food products with effect from 1st January 2022 as per the direction of WHO. Hence, at present there may not be any food product sold in the country containing trans fatty acids with more than 2% (in the oils and fats used in the food). However, we must look at the nutritional information on the label for trans-fat content before consumption any packed food. FSSAI also permitted the manufacturers to claim zero trans content, in case the trans fatty acid is less than 1% in the oils used for the preparation of foods.

Are Loose Oils Safe to Use?

Loose edible oils could be adulterated, and it is advised not to buy loose edible oils and consume only packed edible oils selling with FSSAI license number. Sale of loose edible oils is banned by Governments in most of the states.

Precautions During Frying of Oils and Fats

Repeated heating or deep frying of oils and fats for long hours results in oxidation of polyunsaturated fatty acids leading to the generation of compounds which are harmful and toxic and may increase the risk of cardiovascular diseases and cancer. Oils containing high amounts of saturated fatty acids such as coconut oil, palmolein etc. or high amount of mono-unsaturated fatty acid containing oils such as groundnut oil, refined rice bran oil, high oleic sunflower etc. are preferable for frying. The Food Safety and Standards Authority of India (FSSAI) regulations state that used vegetable oil or fat exceeding 25% total polar content is not safe for consumption and should not be used for further frying and this is a general guideline for the food industry for frying oils. However, at household level, oils once used for frying should be filtered and may be used for curry preparation. The same oil should be avoided to use for frying again. Such oils should be consumed in a day or two and storing used oils for a long time should be avoided, as the rate of deterioration is high in such oils.

Fortification of Oils and Milk with Vitamin A and D

Oils and fats are good carriers for the fat-soluble vitamins like A and D. Hence, FSSAI has permitted to fortify cooking oils and milk with both Vitamin A and D vitamins. All the manufacturers who are fortifying the oils or milk with Vitamin A and D exhibit F+ logo on their pouches. As most of the population is suffering from Vitamin A and D deficiency, it is advisable to consume fortified oils and milk.

Useful Tips for the Consumption of Oils and Fats

- **Don't believe unscientific claims:** Exaggerated claims like prevention of heart attacks, diabetes etc. are not allowed by either Codex or any Other Country-specific regulatory agency like FSSAI. Hence, one must be very cautious about the misleading and exaggerated claims for oils and fats being publicized by the manufacturers.
- **Oils are not everything for health:** Oils certainly help to maintain our health. However, the overall health depends on balanced diet including healthy oils, physical activity, controlling stress etc. Don't believe that one quality food

ingredient takes care our total health. World Health Organization propagates for reduced sugar, reduced trans/saturated fat and reduced salt for good health.

- **No cholesterol:** Cholesterol is found only in animal-source foods. No plant-based oil contains cholesterol and hence do not believe that some oils contain cholesterol, and some do not contain cholesterol.
- **How much cooking oil is required per day:** About 25 to 30 g oil per day per person is sufficient as we are consuming some invisible fats in the form of natural and processed foods.
- **Balanced fatty acid profile:** SFA (less than 20%), MUFA (more than 40%) and PUFA (more than 30%) balance is very important while selecting the oil. About 4% omega-3 fatty acid is also necessary for getting a minimum of 1 g of omega-3 fatty acid (ALA) per day. As no oil exhibits balanced fatty acids, it is advisable to consume a combination of oils to obtain the balanced fatty acids.
- **Importance of omega-3 fatty acid:** Most of the oils do not contain omega-3 fatty acids. Hence, ALA-rich oil like linseed (flax seed) or chia oil may be added upto 5% in the oils which do not contain omega-3 to obtain at least 1 to 2 g of ALA. Flax seed oil capsules may be consumed everyday as a source of ALA. Flax seed or chia seed powder may also be consumed upto 5 to 10 g every day in a suitable form like pickle powder to get about 1 to 2 g of ALA. Few walnuts may be consumed to get some omega-3 fatty acid (>60% oil with 15% ALA).
- **NIN-ICMR Dietary Guidelines:** Use Oils and fats in moderation; Using a diverse variety of oilseeds, nuts and whole grains, provides a balance of all fatty acids especially to meet daily needs essential fatty acids
- **Rice Bran Oil:** Rice Bran Oil has a close balance of fatty acids except ALA (omega 3). Hence a minimum of 1 g of omega 3 fatty acid must be consumed per day in addition to rice bran oil. Rice bran oil is known as heart friendly oil as it contains nutraceuticals like oryzanol, tocotrienols etc. This is a good oil to blend with any other oils for getting the benefit of the nutraceuticals present in it.
- **Sesame Oil:** Sesame Oil contains both MUFA and PUFA in about 40% quantities. Hence minimum 1 g of omega 3 fatty acid must be consumed per day in addition to this. Sesame oil is known for its high oxidative stability as it contains nutraceuticals like lignans, tocopherols etc. This oil is good for pickles and cooking purpose. Rice bran oil and sesame oils in a ratio of 4:1 may be a good combination for health and nutrition along with 1 to 2 g of omega 3 fatty per day.

- **Soya bean Oil:** Soybean oil contains omega-3 fatty acid but does not have the balance of SFA and MUFA. Hence, soybean oil may be blended with SFA rich oils like palmolein or MUFA-rich oils like olive oil for getting optimum fatty acid ratio including omega-3.
- **Palm oil is not Toxic:** Even though there is lot of negative propaganda on palm oil, there is no scientific evidence to link palm oil with lifestyle diseases. Meta-analysis of several clinical trials indicated that palm oil did not show any significant impact on pro-inflammatory markers and conventional risk factors for cardiovascular diseases. Hence, Palm oil is a safe oil and do not believe viral videos blaming this oil. In addition to the soybean oil combination, one can blend palmolein with omega-6 fatty acid rich oils like sunflower and safflower oils. However, a minimum of 1 g of omega 3 fatty acid must be consumed per day in addition to this combination.
- **Importance of Long Chain PUFAs:** The long chain PUFAs of n-3 (DHA and EPA) are essential during growth and development. It is advisable to consume fish oil or Algal Oil capsules every day to get about 250 mg of EPA and DHA to maintain good health.
- **Frying Tips:** Do not fry oil too much. Avoid eating roadside fried foods

Further Reading

1. Dietary Guidelines for Indians-2024, ICMR-Indian Institute of Nutrition, Hyderabad
2. Dietary Guidelines for Indians - A Manual, ICMR-Indian Institute of Nutrition, Hyderabad, 2011.
3. Report of the Joint FAO/WHO Expert Consultation on Fats and Fatty Acids in Human Nutrition, FAO Food and Nutrition Paper 91, Food and Agriculture Organization of The United Nations Rome, 2010
4. Fats, Oils and Fat Emulsions, Chapter 2.2., Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011, Food Safety and Standards Authority of India (FSSAI)
5. Recommended Dietary Reference Intakes, Nutritional Goals and Dietary Guidelines for fat and Fatty Acids: A Systematic Review, Javier Aranceta and Carmen Pe´rez-Rodrigo, British Journal of Nutrition (2012), 107, S8–S22



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About Author



Dr R B N Prasad

Dr R B N Prasad was the former Chief Scientist and Head of Centre for Lipid Research at CSIR-Indian Institute of Chemical Technology, Hyderabad. Dr Prasad is a highly distinguished Lipid Scientist and made outstanding contribution in areas of lipid chemistry and technology for over 45 years. Under Dr Prasad's leadership, CSIR-IICT established Centre for Lipid Research with state of art facilities for dedicated research in oils, fats and allied products. The most significant bioprocess developed by Dr Prasad's group transformed the rice bran oil refining industry and today more than 85% of rice bran oil produced in the country is adopting this technology to produce high-quality rice bran oil. Most of his research contributions have been useful for modernization of Indian vegetable oil and allied product industry leading to national prosperity. Dr Prasad has to his credit over 275 original research papers in reputed scientific journals, 22 book chapters and about 70 Indian and international patents in addition to transfer of several technologies to industries.

Dr Prasad is presently Member of Trans Fat Elimination Technical Advisory Board of World Health Organization. Dr Prasad was the Chairperson of Scientific Panel on Oils and Fats, and Member of Scientific Committee of Food Safety and Standards Authority of India (FSSAI). He contributed significantly for the Indian Mission on trans-fat reduction in the food sector. He is part of several expert committees of CSIR, BIRAC, DBT, DST etc. Dr Prasad was the National President of Association of Food Scientist & Technologists (India) and Oil Technologists' Association of India.

Dr Prasad received several awards and notable among them are: VASVIK Industrial Research Award, Technology Development Board's National Award for Best Commercialized Indigenous Technology, CSIR Technology Award, BHU Centennial Award and Industry Medal Award of Biotech Research Society of India etc., Dr Prasad is Fellow of Telangana Akademy of Sciences, AP Academy of Sciences, Royal Society of Chemistry (UK), Biotech Research Society of India, Indian Society of Oilseed Research etc. He is presently Associate Editor of Journal of Food Science & Technology (Springer). Dr Prasad's contributions are also significant for the popularization of science. E-mail: rbnprasad@gmail.com Mobile: 9440802789