

# Dietary Fatty Acids and Biochemistry of Coconut, Sesame, Mustard and Groundnut Oils: Comparative Healthy Aspects

Rashmi S\*

*Department of Chemistry, S.P.C. Govt. College, Ajmer, Rajasthan, India*

\***Corresponding author:** Rashmi S, Department of Chemistry, S.P.C. Govt. College, Ajmer, Rajasthan, India, E-mail: avinash\_1965@yahoo.co.in

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## Abstract

The metabolism and biochemistry related with the vegetable oils and animal fat is very interesting and significant as well. The complete metabolic oxidation of tri glycerol yields 37 kJ/g energy. Most of the energy derived from fat breakdown comes from oxidation of the constituent fatty acids. Fatty acid oxidation provides the major energy source for many human and animal tissues. In general, fats containing substantial amounts of unsaturated fatty acids, such as oleic and linoleic acids, which tend to be liquid at body temperature, are relatively easily absorbed, whereas lipids containing mostly long chain saturated fatty acids, such as palmitic and stearic acids with higher melting points are digested and absorbed more slowly. Evidences also suggests that linolenic and other  $\omega$ -3 fatty acids act by somehow competing with the metabolism of arachidonic acid (20:4 $\Delta$  9,12,15,18) the principal precursor of a class of biological regulators called Prostaglandins and Thromboxanes.

**Keywords:** Fatty Acids; Edible Oils; Coconut; Mustard; Sesam; Groundnut

## Introduction

Fats are one of the large group of organic compounds and the major energy storage form in most cells. Fats have been used by humans as edible oils and animal fat like butter because they are readily digested and utilized in the body. The chief contribution of fats and other lipids to the diet is their *energy value and also satiety value*. Fats are also acts as solvents and source for the fat-soluble vitamins such as A, D, E, K and pro vitamin A, the carotene. Fats and other lipids also contribute essential fatty acids to the diet which body cannot synthesize.

Lipids play roles in energy metabolism, as membrane constituents, thermal insulators and biological regulators. The fats and lipids are therefore important in the diet for a number of reasons.

Edible oils have significant role in diet all around the world specially, in India as Indian culture is based on idealism of well beings of all creatures of the earth [1-3].

## Natural Oil Seeds

Edible oils are related directly to the health aspects of all the people. The production of natural and real oil seeds (which contains more than 40-50% oil as per Table 1 may also contribute to the wellbeing of the people in the world through generating the employment to small farmers, small scale oil expellers and livelihood of consumers. From long time according to the environment of the local region and area, various natural oil seeds like coconut, sesame mustard and ground nut have been cultivated as a source of best fat in the different eastern countries especially in India. Literature survey also reveals that traditional and natural edible oils like coconut, mustard, groundnut and sesame are being used in cooking vegetables, deep frying and for storage purposes as pickles from a long time worldwide specially in eastern countries like India, China and Japan [2,3]. The virgin oil has been extracted through ecofriendly, cold pressing technique called 'Ghani', which extract the oil from seed at very low speed (which is an important factor to preserve the natural quality, components, specific colour, flavour and odour of the oil) at room temperature between 25-400 °C. The oil extracted through natural oil seeds of good quality with cold pressing techniques is fresh, healthy, pure, and rich in antioxidants and vitamins. These oils are more nutritious having essential fatty acids, vitamins, tocopherole, phytosterols, etc., serve better to provide maximum energy for which oils have been consumed by humans. They may easily assimilated and digested in human body and provide many benefits without causing any harmful effect on health [2-7].

According to literature of ancient Ayurveda sesame oil is the best for edible purposes and which has been used as dressing oil on freshly cooked traditional food items made by regional food grains which are very nutritious in all means, though mustard, groundnut and coconut oils are not only healthy but possess medicinal properties as well [2,3]. Whereas, Safflower oil is said to be worst for eaten as oil [2].

Oil	Total % of Oil content	Saturated unsaturated	Mono unsaturated	Poly unsaturated
Coconut	57-75	91 (medium and short chain fatty acids)	8	1
Groundnut	47-55	20	54	26
Mustard	43	6	73	21
Sesame	50	14	46	40
Cotton seed	35	34	26	40
Palm	-	80 (long chain fatty acids)	13	7
Safflower	20-30	11	13	76
RiceBran	-	25	38	37
Soyabean	18	15	25	60
Sunflower	48-53	8	34	58

**Table 1:** Percentage fatty acid composition of commonly used oils [6]

Name of oil	8:0	10:0	12:0	14:0	16:0	16:1	18:0	18:1	18:2	18:3	others
Coconut	2.5	4.7	50.6	21.6	9.1	—	2.7	7.0	1.8	—	—
Ground Nut	—	—	—	—	10	—	4	61	18	—	C20– C24–7 %
Mustard	—	—	—	—	2	—	1	25	18	10	20:1–10 %
Sesame	—	—	—	—	8	—	4	45	41	—	—
Soyabean	—	—	—	—	12	—	4	24	51	9	—
Sunflower	—	—	—	—	—	14	—	14	72	—	—

**Table 2:** Major component acid (% wt.) of vegetable oils investigated [3,4,8]

## Refined Oils and adverse health effects

It is a well-known fact that soybean, sunflower, ricebran and safflower oils are extracted through different new technologies involving solvent extractions, bleaching, refinement etc. by the use of number of harmful chemicals like isopropanol, hexane, methanol, KOH, NaOH, fuller's earth, clay, hydrosol solvents etc., at very high temperature or pressure, which may remain in traces after the treatment. The antioxidants and other vitamins have been added in these oils afterwards.

Rancidity and reversion are found to be the main problem in use of vegetable oils, which are caused due to tendency of unsaturated fatty acids to oxidize [3,4]. Literature survey reveals that oil containing more polyunsaturation reacts more rapidly with air and rancidity and reversion like phenomenon takes place readily. It may also be noted that edible oil is treated at high temperature during frying and cooking food items or stored for long period as pickles mostly. Some other reactions like oxidative polymerization and hydrogenation can occur during their thermal abuse and long storage [3,4,7,8]. In-depth scientific studies of edible oils indicate that these new oils extracted by solvents, refined, bleached and treated with number of chemicals are only undesirable but are harmful for health, especially in Indian cuisine where oils are mostly used for frying and pickle [7].

A perusal of Table 1 and 2 and literature survey suggest that oils with a higher percentage of polyunsaturated fatty acids (PUFA) such as soybean, sunflower and safflower (highest content of PUFA present) lower both harmful LDL cholesterol and useful HDL cholesterol. On the other hand edible oils rich in monounsaturated fatty acids such as olive, mustard, groundnut, and sesame lower harmful LDL cholesterol level without affecting useful HDL cholesterol and hence are better for balancing cholesterol profiles [3-9]. Oxidation products present in abused frying fats and oils are the compounds most suspected of impairing the nutritional properties of the oils or involving adverse physiological effects [10-16].

The recent studies on their health implications include those related to their fate and those focused on their effects in metabolic pathways and the most prevalent diseases [17,18].

Moreover, additional cholesterol-reducing properties are likely to come from the natural plant sterols and stanols contained in oils extracted without heat or solvents [3,19]. Sesame contains 594mg/100g of soluble phytosterols while groundnut contains 247mg/100g and olive oil 210mg/100g. Soya and corn oils also contain phytosterols when raw (380mg/100g and 580mg/100g respectively), but since these latter need solvent or heat for extraction, the sterols are invariably lost in processing [19].

The natural oils such as mustard, peanut and sesame are stable non-drying or semi-drying oils with a low tendency to oxidize in the light. In their natural form they contain antioxidants which prevent rancidity and reversion (development of 'off' odors). In contrast, soybean and safflower oil are drying oils while sunflower oil is a semidrying oil. Thus, due to a higher percentage of PUFAs they are prone to oxidation in the presence of light, temperature, air and metal. In cooking, since edible oils are mainly used for frying in which oil is subjected to light, high temperature and contact with air and metal, such oils are harmful to health [3]. In the last few years these native edible oils have been supplanted by introducing recent oils such as palm, soybean, sunflower, ricebran and safflower which have never been used in any part for traditional nutritious food of local region in world and India.

The amount of monounsaturated content (25 and 61%) Table 2, as isomers and absence of conjugated double bonds in mustard and groundnut are another important criteria for establishing their stability upon deep-frying. The content of octadienoic acid (Linoleic) amounted to 51% in Soyabean & 72% in Sunflower whereas only 18% in mustard and groundnut. Besides this the content octadecatrienoic acid (Linolenic) was 9% in soyabean oil whereas the trienes were totally absent in other oils. The contents of octadecenoic, hexadecenoic (Mono unsaturated) and saturated fatty acids were 24, 28, 45% and 16, 0, 12% in soyabean, sunflower and sesame respectively [4,11-14]. The higher amount of polyunsaturated fatty acid present in refined soyabean and sunflower oils make these oils more susceptible to oxidative polymerization under frying conditions. Previous, studies by various scientists show that the rate of cyclization, branching and polymerization of fatty acids is faster at higher temperature of frying than at lower temperatures [11-18]. The results of various studies also suggest that antioxidants are almost ineffective in retarding the degree of polymerization in soyabean and sunflower at frying temperature. Studies of various parameters also suggest that the decrease in the iodine value of oil could be due to the constant destruction of double bonds with the development of polymeric fractions [4,7,20,21]. Soyabean oil because of more methylene interrupted unsaturated groups provides more active centers for conjugation which in turn facilitate the formation of polymers [3,4].

The peroxide value of the frying oil increases indicative of degree of deterioration and was also observed by many scientists [3,4,20,21]. All the above results indicate and suggest a higher degree of deterioration due to presence of higher poly unsaturation in conjugation and ineffectiveness of antioxidants at higher temperatures in refined soyabean, sunflower and safflower oils. Some chain cleavage products from fatty acids disturbs endothelial cells and induces several genotoxic effects in hepatocytes and lymphocytes [13,14]. Soyabean, sunflower and safflower are prone to be more susceptible towards oxidation during frying and longer storage, thus found to be more harmful for cooking at high temperature [8,20,21]. In Western countries rancidity and reversion of refined oils such as soybean oil were initially remedied by hydrogenation. More recently, with growing evidence of the harmfulness of trans-fatty acids, rancidity and reversion are increasingly being prevented by the addition of antioxidants [15,16]. However, according to studies conducted on soybean oil by V.K. Tyagi and Pramod Kumar at Kanpur, deterioration of nutritional quality at high frying temperatures is rapid and added antioxidants are almost ineffective at retarding this [20,21].

## Best Sources and Healthy Aspects

Sources of energy are very significant as food has been eaten to provide energy to the body. If the source selection is not proper, it may cause disease which needs remedy. Natural, bio diversified, locally grown oil seeds may be chosen as best source of energy. These oil seeds have good balance of saturated fatty acids, monounsaturated fatty acids, poly unsaturated and essential fatty acids with many other natural nutraceuticals which are responsible for their stability and healthy aspects.

Vegetarians can easily fulfill the need of essential fatty acids, n-6/n-3 ratio and ALNA( $\alpha$ -linolenic acids) by using ALNA rich edible oil like yellow Indian mustard as the cooking medium and also by increasing the intake of ALNA rich foods such as coconut, sesame, mustard, and groundnut oils freshly extracted through cold pressing method in the diet [22-26].

## Sesame

Sesame has been considered to be an important and best edible oil seed from ancient times, not only because of its high oil content, but also because of its resistance to oxidative deterioration and its number of medicinal effects [2]. This oil has been used in India as fresh and raw in different traditional dishes in many states like Rajasthan, Gujrat, Madhyapradesh, etc. The studies on the antioxidative constituents in sesame seed and oil revealed four lignanphenols. Among them sesamol and sesaminol antioxidants, Sesaminol was also found in high concentration in unroasted sesame oil. In this connection, it has been found that large amounts of sesamol are produced from sesamol during frying process and contribute to the stability of fried food [25]. Further, recent studies also support the Neurological role benefits in regulation of blood pressure of sesame oil [26,27]. The important antioxidants sesaminol, sesamol, sesamin and sesamin maintain the fats including Low Density Lipoproteins (LDL) which cause arteriosclerosis and are believed to promote the integrity of body tissues. These antioxidant lignans have shown hypocholesterolemic and immunomodulatory effect [28,29]. Vitamin E, a fat soluble antioxidant, protects the body from harmful oxidizing compounds. Sesame seed oil contains gamma tocopherols along with sesaminol and sesamin which possess Vitamin E like activity [28]. Application of sesame oil with turmeric powder in milk on the facial skin, makes it smooth, soft removing pimples [29].

Sesame oil is known for its healing properties and has a reputation as a sedative in Tibetan medicine and also used for millennia in Chinese system of medicine [29-31]. In ayurveda, sesame is known to cure Tridoshas [2,29]. During Abhyanga, a form of massage,

the oil is rubbed externally on the skin to improve energy flow and help free the body from impurities. In ayurveda, sesame oil is regarded as an anti-bacterial mouthwash and it can also be applied to nostrils to relieve anxiety and insomnia. The pain associated with premenstrual syndrome (PMS) can be overcome by applying the oil on to the abdomen region [30,31].

According to traditional system of medicines, sesame is known to cure bleeding dysentery, burns, ear pain, headache and impotency.

For pharmaceutical applications, sesame oil is used as a solvent for intramuscular injections and has nutritive, demulcent, and emollient properties and as a laxative. It was used to cure toothaches and gum diseases in 4<sup>th</sup> century. It is also used for the treatment of blurred vision, dizziness and headaches. The oil is more efficient than isotonic chloride solution in curing nasal mucosa dryness due to winter. The high polyunsaturated fat content in oil reduces cholesterol. Sesame oil has been used by Indians as an antibacterial mouthwash, to relieve anxiety and insomnia. Malignant melanoma growth was selectively inhibited due to the presence of large amount of linoleate in triglyceride form in sesame oil [32]. The antioxidant and health promoting property of sesame lignans (sesamin and sesamol) increases both hepatic mitochondrial and peroxisomal fatty acid oxidation rate. Consumption of sesame seed increases plasma gamma-tocopherol and enhances vitamin-E activity which can prevent cancer and heart disease. Sesame seed contains cephalin which has hemostat activity. Fibres from sesame are used as an antidiabetic, antitumor, antiulcer, cancer preventive and cardioprotective [32].

Sesame oil contains Mg, Cu, Ca, Fe, Zn and vitamins B6 which are very useful metals and vitamins Copper provides relief for rheumatoid, arthritis, Mg supports vascular and respiratory health calcium helps prevent colon cancer phytic acid present in seed to protect colon cancer, osteoporosis, migraine and PMS. Zn promotes bone health. Sesame contains high quality protein (25%) and is rich in Methionine [essential Amino acid] and seed is highly beneficial in the treatment of Piles [32-36].

## Coconut

The coconut oil also very good for human health. Recent studies about coconut oil suggest that due to presence of short chain fatty acids as major components and lauric acid is the most prominent medium chain fatty acid MCFA along with natural antioxidants such as vitamin E and polyphenols present in the coconut oil (*Cocos nucifera* L.), oral supplementation with coconut oil combined with exercise training improved impaired BRS and reduced oxidative stress in SHR [37]. Other study shows that the lauric acid MCFA digested easily and converted into energy in the liver directly. This makes MCFAs do not take part in the synthesis of cholesterol or deposit fat in body. Many scientists Valente, *et al.* showed that MCFAs in coconut oil can control overweight condition for women. On the other hand, antibacterial ability of MCFAs is one of the remarkable abilities which are concerned by many authors [38].

Literature survey reveals that coconut oil also showed potential neuroprotective effects [39]. The potential neuroprotective effects of virgin coconut oil (VCO) on inflammasome and oxidative stress in Alzheimer's model has also been reported by scientists [40]. Recently, virgin coconut oil (VCO) has been growing in popularity due to its potential Cardioprotective Effects. The chemical properties and the manufacturing process of VCO make this oil healthier than its copra-derived counterpart [41].

## Groundnut (Peanut)

Ground nuts and its oil are a good source possessing 30 essential nutrients and phyto nutrients like niacin, fiber, folate, Mg, Mn and P and vitamin E 25% protein antioxidant polyphenols called p-coumaric acid – roasting can increase peanuts p-coumaric acid levels, boosting their overall antioxidant content by as much as 22%. They are significant source of resveratrol and co-enzyme Q.10 Resveratrol anti-oxidant is a chemical studied for potential antiaging effects and also associated with reduced cardiovascular disease and reduce cancer risk [42-44].

## Mustard

Similarly mustard seeds and its oil are also possess very good nutritional value as well as medicinal values. Number of scientific studies and Charak Samhita and Sushrut Samhita (Indian Ayurvedic Literature) suggest that the Glucosinolates, essential fatty acids like linoleic acid ((A) and  $\alpha$  - linoleic acid (alna), antioxidants etc. are required by the body and should be taken from external sources from food or from supplements. The genus *Brassica* consist of 150 species which are cultivated as oil seed crops or as vegetables and fodder crops. Black mustard is used more as a condiment. *B. Juncea* or Indian mustard is used as a condiment or as an oil seed. The chemical composition of the spices documented shows that they contain fat, nitrogenous substances, fiber, volatile, oil and isothiocyanates and related compounds. Protective effect against carcinogens probably due to isothiocyanate content which by virtue of its potent effect and enzymes, enhances solubilization and elimination of carcinogens [2,45].

Benzyl isothiocyanates and indole 3- carbinol, which are present in cruciferous vegetables in high amounts induce the conjugating system and are more effective inhibitors. The antimutagenic effects of mustard were also assessed by various scientists [46]. Mustard (*B. campestris*) and sesame are considered anti carcinogenic based on cyto toxic and tissue culture studies. Thus the plant kingdom and dietary substances appear to open up new fields of investigation in cancer research.

Studies related to n-6/n-3 ratio and ALNA(alpha linolenic acid) were done by various methods on untreated (raw state) oils whereas traditional cooking processes the oil is treated at high temperature atleast once and the composition of the oils containing higher PUFA value distorted due to uptake of oxygen and various chemical reactions [45-48].

## Conclusion

Coconut, sesame, mustard (rapeseed) and groundnut (peanut) are natural oil seeds with highest content of naturally stable healthy oil. They are stable naturally due to presence of abundant amount of natural antioxidants. All these oils have a lesser tendency to oxidize and deteriorate in presence of sunlight, temperature, air and metal which prevents them from rancidity & reversion, while refined soyabean and safflower oils are drying oils and sunflower oil is semi drying. Due to higher percentage of polyunsaturated fatty acids (PUFA) and presence of double bond they have greater tendency to oxidize in presence of sunlight, temperature, air and metal. Coconut, mustard, groundnut and til (Sesame) oils are easy to process at small scale decentralized levels with eco-friendly and health friendly technologies. The oil extracted through cold pressing technologies is fresh, nutritious, unadulterated and with natural flavour of taste. Other oils have being extracted by using hydrocarbon solvents such as Hexane, The other processes like bleaching and refinement also include number of hazardous chemicals. In the process of refining using alkaline solution, bleaching and finally de-odorizing process, most of the useful lecithin, tocopherols, vitamins and phytosterols are removed during various treatments given to the oils. Thus, it may be emphasis that the selection of the oil in the diet should be done carefully.

In fact, greater reliance on a natural means of protection from a disease rather than chemoprevention appears to be a more promising approach towards human beings all over the world.

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