International Research Journal of Biological Sciences ISSN 2278-3202
Vol. **1(6),** 68-75, October **(2012)** *I. Res. J. Biological Sci.*

Review Paper

Cancer, Heart and other Chronic Diseases: Some Preventive Measures to Control Lipid Peroxidation through Choice of Edible Oils

Sarmandal C.V.
Formerly with C.F.T.R.I., Mysore, INDIA

Available online at: www.isca.in
Received 5th April 2012, revised 11th August 2012, accepted 15th September 2012

Abstract

Peroxidation of oils and fats has been realised as a major health hazard. Importance of antioxidants has been realised. Literature indicates that i. the desirable ratio of saturated, monounsaturated and polyunsaturated fatty acids (PUFA) is 7:16:7 in edible oils and fats; ii. decreasing the ratio of ω_6/ω_3 PUFA in foods, wherever required is beneficial in reducing certain risks of cardiovascular and other diseases like cancer. Literature also showed that rats fed diets containing greater than 2.5 wt% of ghee had lower levels of serum cholesterol compared with rats fed diets contain groundnut oil. For deep fat frying, ghee (especially cow ghee) is also a good medium (like some oil blends). Refined coconut oil can also be a good medium for frying, because of its low iodine value. For better public health, following oils for blending (any 2 oils, with min. 20% of any oil) are suggested – frying oil grade I – should be blends of lower medium range I.V. oils e.g. groundnut oil, ricebran oil, palmolein oil, canola oil, below 110 I.V. sesame or sunflower oil, thoroughly refined neem seed oil, coconut oil, thoroughly refined cottonseed oil, karanja oil etc. etc. Out of two oils one could be refined oil and the other, cold pressed organically grown oil or refined oil. Frying oil grade II – should be two oil blends of – frying oil grade I (any one (80%)), and 20% of one of the following oils – soybean oil, safflower oil, sunflower oil (above 110 I.V.), sesame oil (above 110 I.V.), corn oil, or any other edible oil in the above range. Salad oil, chutney oil, table oil (which are used at ambient conditions) – above oil should contain, either – 20% of cold pressed and organically grown flax oil or walnut oil and 80% of refined soybean oil or 80% of refined canola oil. For the blends containing good amount of linolenic or higher unsaturated fatty acids (e.g. flax oil) – amount of intake recommended should be strictly followed.

For bread spread – for chocolate fat – cocoa butter 95% + 5% refined sal fat or any other suitable fat. Algal oil blends to be used only as table oils – algal oil containing ω_3 fatty acids (thoroughly refined) – 20% + 80% soybean oil refined or canola oil (refined) (subject to approval by the authorities). Forest origin oils (which have been approved by the authorities) to be used only as table oils (thoroughly refined) – 20% + 80% soybean oil or canola oil, refined (subject to approval by the authorities). Normally, any two oils blending are carried out. But in future – more than two oils blending (3, 4 or more) may be considered by many blending companies (with the approval by the authorities) to achieve the desirable fatty acids ratio. Agriculture side, for the following crops, there seems to have good scope – olive, walnut, coconut, and palm (to increase acreage / to introduce crops). Genetically improved crops for the following with introduction of higher chain length ω_3 fatty acids (present in some fish oils and algae) – flax, soybean, mustard (eurucic acid free), walnut – this may be taken up for countrywide discussion.

Kewords: Fatty acids ratio, algal oil, ω_6/ω_3 ratio in PUFA, ghee, cholesterol, fish oil, salad oil, microwave oven, vacuum fryer, blended oils.

Introduction

Edible oils and fats have several important functions. One of these is – as source of essential fatty acids. Another is – as effective heat transfer medium for cooking. One more function is to impart desirable appeal, aroma and taste to the edible product. Over the last two decades new thoughts have emerged about dietary habits and health. Peroxidation of oils and fats has been realised as a major health hazard. Importance of antioxidants has been realised. Literature indicates that the desirable ratio of saturated, monounsaturated and polyunsaturated fatty acids is 7 : 16 : 7 in edible oils and fats. A well known thumb rule for rate of chemical reactions is that for every 10°C rise in temperature, the rate of reaction doubles. So oxidation of food components will increase at a rapid rate with increase in cooking temperature. Similarly the rate of oxidation should increase with the degree of unsaturation.

Biochemistry – An Evolving Science

Although our genetic makeup and associated epigenic characteristics are important factors that contribute to disease susceptibility and to other traits, factors in a person's environment are also significant. What are these environmental factors? Perhaps the most obvious are chemicals that we eat or are exposed to in some other way. The adage "you are what you eat" has considerable validity; it applies both to substances that we ingest in significant quantities and to those we ingest in small amounts. In the study of biochemistry, we encounter vitamins and trace elements and their derivatives that play crucial roles in many processes. In many cases, the roles of these chemicals were first revealed through investigation of deficiency disorders observed in people who do not take in a sufficient quantity of a particular vitamin or trace element. Despite the fact that the more important vitamins and trace elements have been known for some time, new roles for these essential dietary factors continue to be discovered[1]

Chemicals are only one important class of environmental factors. The behaviours in which we engage also have biochemical consequences. Through physical activity we consume the calories that we take in, ensuring an appropriate balance between food intake and energy expenditure. Activities ranging from exercise to emotional responses such as fear and love may activate specific biochemical pathways, leading to changes in gene expression the release of hormones and other consequences. For example, recent discoveries reveal that high stress levels are associated with the shortening of telomeres, structures at the end of chromosomes. Genetic factors associated with a range of behavioral characteristics have been at least tentatively identified[1].

Metabolism: Basic Concepts and Design: How does a cell extract energy and reducing power from its environment? How does a cell synthesize the building blocks of its macromolecules and then the macromolecules themselves? These processes are carried out by a highly integrated network of chemical reactions that are collectively known as metabolism or intermediary metabolism. General principles and motifs of metabolism – i. Fuels are degraded and large molecules are constructed step by step in a series of linked reactions called metabolic pathways; ii. An energy currency common to all life forms, adenosine triphosphate (ATP), links energy – releasing pathways with energy – requiring pathways; iii. The oxidation of carbon fuels powers the formation of ATP[3].

Energy from foodstuffs is extracted in three stages: Hans Krebs described three stages in the generation of energy from the oxidation of food stuffs. In the first stage, large molecules in food are broken down into smaller units. This process is digestion. Proteins are hydrolyzed to their 20 different amino acids, polysaccharides are hydrolyzed to simple sugars such as glucose and fats are hydrolyzed to glycerol and fatty acids. The degradation products are then absorbed by the cells of the intestine and distributed throughout the body. This stage is strictly a preparation stage. No useful energy is captured in this phase[4].

In the second stage, these numerous small molecules are degraded to a few simple units that play a central role in metabolism. In fact most of them – sugars, fatty acids, glycerol and several amino acids – are converted into the acetyl unit of acetyl COA. Some ATP is generated in this stage, but the amount is small compared with that obtained in the third stage[4].

In the third stage, ATP is produced from the complete oxidation of the acetyl unit of acetyl COA. The third stage consists of the citric acid cycle and oxidative phosphorylation, which are the final common pathways in the oxidation of fuel molecules. Acetyl COA brings acetyl units into the citric acid cycle (also called the tricarboxylic acid (TCA) cycle or Kreb's cycle), where they are completely oxidized to CO_2. Four pairs of electrons are transferred (three to NAD^+ and one to FAD) for each acetyl group that is oxidized. Then a proton gradient is generated as electrons flow from the reduced forms of these carriers to O_2, and this gradient is used to synthesize ATP[4].

Desirable ratio of Saturated, Monounsaturated and Polyunsaurated Fatty Acids in the Deit: By reducing intakes of animal fats and gradually reducing intakes of trans fatty acids, a one third reduction in cholesterol – raising fatty acids seems practical, from 12% to 7 – 8% of total energy intake. The intake of polyunsaturated fatty acids should not exceed current intakes, about 7% of total energy. Although further research is needed to determine a recommended ratio of oleic acid to carbohydrates, on the basis of the relatively low rates of coronary artery disease and cancer in both the mediterranean region (where oleic acid intake is high at the expense of carbohydrates) and in populations consuming low – fat, high carbohydrates diets, a reasonable compromise is a diet in which total fat is about 30% of energy, allowing for an intake of oleic – acid of 15 – 16% of total energy[5-7].

Changes in Repeatedly Heated Oils during Deep Fat Frying

To assess the stability of oils during repeated frying, refined groundnut oil, raw groundnut oil, and refined groundnut oil blended with raw sesame oil in the ratio 3: 1 v/v which was used for deep frying at regular intervals were investigated. The oils were examined for % triglycerides, % di- and mono – glycerides, % free fatty acids, UV spectrum of triglycerides, diglycerides and mono – glycerides at regular intervals. Glyceride composition revealed that as frying progressed degradation of triglycerides increased. The values for triglycerides for samples A, B and C were found to be between 93.0 to 79.1, 93.2 to 79.6 and 93.0 to 80% respectively. Effect of natural antioxidants like tocopherols and sesamol present in groundnut oil and sesame oil have been studied. No significant change in free fatty acids content was noticed. Ultra violet spectrum of triglycerides and mixture of diglycerides and monoglycerides have shown a strong absorption at 242 nm and a weak absorption at 270 nm indicating the likely presence of conjugated ene-one system generated after deep frying. Incorporation of sesame oil in refined groundnut oil retarted the progress of oxidation[8].

Fried foods are one of the major items in Indian dishes. Frying oils used in the preparation of fried foods are exposed to elevated temperatures in the presence of moisture. Under these conditions number of changes takes place like hydrolysis, oxidation, themolysis and polymerisation. As these reactions proceed, they trigger formation of volatile and non – volatile decomposition products which have an effect on the flavour, colour and texture of fried foods, as well as the life of the frying oil. The decomposition products and the rate of their formation vary with the nature of the fat used, the surface volume ratio, the excess of air, the nature of fried food, and interval of heating. Experiments have shown that the rate of oxidative deterioration is accelerated by an increase in temperature and increase in degree of unsaturation[8-13].

In India, about fifty percent of the edible oils are used for frying purpose. Oil is subjected to heat treatment (180°C), cooling and again heating to above temperature repeatedly in an open atmosphere. Hence, to assess the stability of oils to repeated heating, refined groundnut oil, raw groundnut oil and refined groundnut oil blended with raw sesame oil were selected. Raw groundnut oil and sesame oil contain natural antioxidants like tocopherols and sesamol respectively. This study was aimed to measure their effect on the stability of oils to repeated heating with refined groundnut oil as control[8,14-16].

Prolonged heating of oils at the high temperature occurs during frying. In the presence of moisture and oxygen released from foods causes oxidation of the oil to a range of volatile carboxyls, hydroxy acids, keto acids and epoxy acids. Many factors affect the rate of deterioration of fat used for frying. Physical methods of estimation of deterioration include viscosity, smoke point, foam height, colour, refractive index, UV absorption, IR spectroscopy and dielectric constant. Chemical tests which can be used are free fatty acids, iodine value, active oxygen method, carbonyls, anisidine value, non – urea adduct forming acids, insoluble oxidized acids and total polar compounds[8,17,18].

It can be concluded that three oils namely, refined groundnut oil, raw groundnut oil and mixture of refined groundnut oil and raw sesame oil selected for frying studies showed that refined groundnut oil was least stable and mixture of refined groundnut oil and sesame oil was most stable during frying. This may be attributed due to the potential antioxidant nature of sesamol present in sesame oil. However, raw groundnut oil showed moderate stability as expected. This also indicates that addition of raw sesame oil into refined groundnut oil had a very good protective effect as far as control of autoxidation is concerned but had not much role to play for protecting the glycerides against thermolysis. However, oxi-compounds produced during autoxidation are much more toxic than mono and diglycerides produced during thermolysis. Hence, sesame oil can be advised to be added to refined groundnut oil which will protect the frying oil from autoxidation[8,19].

Comparative Induction Periods of Oxidation during Autoxidation of few Oil Blends Balanced in Fatty Acids

Epidemiological, clinical and biochemical studies performed during last three decades in some countries suggest that decreasing the ratio of ω_6/ω_3 PUFA in foods, wherever required, is beneficial in reducing certain risks of cardiovascular and other diseases, like cancer. Nutrition experts have suggested a ω_6/ω_3 fatty acids ratio of 2 or below while keeping the intake of linoleic acid at 3 – 4 energy %. First, the fatty acid composition (FAC) by gas liquid chromatography (GLC) was determined of the individual commercial oils used for blending. Secondly, the following oils were blended and the FAC determined, and then the saturated : monounsaturated : polyunsaturated (SMP) ratio and C 18 : 2/C 18 : 3 ratio was calculated – i. Refined Rice Bran Oil (RRBO), and Cold pressed unrefined Flax Oil (FO) (Blend); ii. Refined Palm Olein Oil (RPO): FO (Blend), iii. Unrefined Coconut Oil: FO (Blend). Two of the blends had C 18: 2/C 18:3 ratio of less than 1 and one of the blends had C 18: 2/C 18:3 ratio of less than 3. Comparative induction periods of RPO, FO and the blends similar to mentioned earlier, were measured. The comparative rate of oxidation was followed by weighing small samples daily of RPO, FO and the blends – keeping the samples in oven for the entire period and taking out daily for a short time for weighing. The induction periods varied and the induction period of one of the blends was satisfactory and the flavour of this blend was better than the remaining blends. The blend may be suitable for ambient temperature use[20].

Essential Faffy Acids (Poly–Unsaturated Fatty Acids)

The term ‘essential fatty acid’ (EFA) also known as polyunsaturated fatty acids (PUFA) was introduced by Burr and Burr in 1930 for linoleic acid. They found it to be essential for the growth and health of young albino rats fed on a fat-free diet. They found it to be effective in curing fat deficiency syndrome in albino rats. Later Turpeinen reported that arachidonic acid was highly effective in promoting growth of rats on a fat – free diet. Other workers reported that γ-linolenic acid and linolenic acid can promote growth in albino rats fed on a fat – free diet but the dermal symptoms were cured by linoleic, γ-linolenic and arachidonic and not by linolenic acid. Thus, there are two groups of essential fatty acids: Linoleic acid group and Linolenic acid group. The different essential fatty acids belonging to these two groups are given in table 3 [21].

Physico–Chemical Characteristics of Selected Vegetable Oil Blends for use as Health Oils: Palm, rice bran and sesame oils were blended with groundnut, mustard and sunflower oils in the ratios of 20:80 and 20:20:20: 40, w/w to exploit the nutritional potential and associated benefits of natural antioxidants present in them. Physico – chemical characteristics, antioxidants content (β – carotene, tocopherols, oryzanol, sesamin, sesamolin) and fatty acid composition of oils and oil blends were studied by standard methods, including HPLC analysis. Results indicated that the oil blends did not show many changes in their physico – chemical characteristics, fatty acid composition and natural antioxidants compared to the original oils used for the preparation of oil blends. This study has shown the feasibility of use of oil blends for getting natural antioxidants enriched vegetable oil blends which may be termed as health oils[22].

Raw (red) palm oil of edible quality is one of the richest sources of carotenes (500 – 700 ppm), with β – carotene, the precursor of vitamin A, predominating more than 65 per cent. It is also a good natural source of vitamin E, i.e., the tocopherols and tocotrienols (800 – 900 ppm), which act as natural antioxidants. Tocopherols are of biological and nutritional significance primarily because of their physiological role as antioxidants and claimed to be free radical scavengers. Rice bran oil is used as premium edible oil in Japan, Korea, China, Taiwan and Thailand and is considered to be important edible oil due to the presence of balanced amounts of saturated and unsaturated fatty acids and certain nutritionally and medicinally important minor constituents such as tocopherols, tocotrienols, sterols and oryzanol. It is considered as “Health oil” in Japan due to its excellent hypolipidemic activity. Sesame oil contains phenolic antioxidants, such as sesamin and sesamolin. These natural antioxidants are known to scavenge the free radicals produced at tissue level lipid peroxidation and thus they play a very vital protective role against cellular damage, ageing and degenerative diseases like cataract, atherosclerosis and cancer[22-30].

Results and Discussion

Above literature indicates that a ratio of 7:16:7 of saturated: monounsaturated: polyunsaturated fatty acids in the diet will suffice.

Literature survey indicates that incorporation of sesame oil in refined ground nut oil retarded the progress of oxidation. This may be attributed to the potential antioxidant nature of seasamol in sesame oil.

Literature indicates that epidemiological, clinical and biochemical studies performed during last four decades in some countries suggested that decreasing the ratio of ω_6 / ω_3 PUFA in foods, wherever required, is beneficial in reducing certain risks of cardiovascular and other diseases like cancer. Nutrition experts have suggested a ω_6 / ω_3 fatty acids ratio of 2 or below while keeping the intake of linoleic acid at 3 – 4 energy %. Sarmandal C.V., had studied comparative induction periods of oxidation during autoxidation of few oil blends balanced in fatty acids. First, the fatty acid composition (FAC) by gas liquid chromatography (GLC) was determined of the individual commercial oils used for blending. Secondly, the following oils were blended and the FAC determined, and then the saturated: monounsaturated: polyunsaturated (SMP) ratio and C 18:2 / C 18:3 ratio was calculated – i. Refined rice bran oil (PRBO), and cold pressed unrefined flax oil (FO) (BLEND); ii. Refined palm.

Table-1
Cooking Oils, Nuts and Oilseeds (S: M: P as Wt. % of Total Fat)

	Saturated	Mono unsaturated as weight percent (%) of Total Fat.	Poly unsaturated of % Total Fat.
Canola Oil	7	59	29
Corn Oil	13	24	59
Olive Oil	13	74	8
Sunflower Oil	10.3	19.5	65.7
Soybean Oil	15	24	58
Coconut Oil	92	6	2
Almonds (Dry, Roasted)	9	65	21
Cashews (Dry, Roasted)	20	59	17
Macdamia (Dry, Roasted)	15	79	2
Peanuts (Dry, Roasted)	14	50	31
Flaxseed (Ground)	8	23	65
Sesame Seed	14	22	57
Walnuts (Dry, Roasted)	9	23	63
Soybean	14	22	57
Sunflower	11	19	66

Table-2
Percent Calories Supplied by Carbohydrates, Fats and Proteins in Average Diets

Diet	Percent calories provided in the diet by		
	Carbohydrates	Proteins	Fats
Adults			
Western diets	40 – 55	15 – 20	30 – 40
India and other developing countries :			
Adults :			
Well – to – do class	40 – 55	15 – 20	30 – 40
Middle income groups	65 – 75	10 – 15	15 – 20
Low income groups	79 – 85	10 – 15	5 – 6
Infants	35 – 45	15 – 20	40 – 50
Children	50 – 65	15 – 20	20 – 30

Table-3
Biological Activities of Essential Fatty Acids[21]

Fatty Acid	Growth effect	Cure of dermal symptoms
Linoleic family		
Linoleic acid (C 18 : 2)	+	+
γ-Linolenic Acid (C 18 : 3)	+	+
Arachidonic acid (C 20 : 4)	+	+
Linolenic family		
Linolenic acid (C 18 : 3)	+	0
Eicosapentaeonic acid (C 20 : 5)	+	0
Decosahexaenoic acid (22 : 6	+	0

Fatty Acid Composition of Rice Bran Oil: 14 : 0 = 0.40 , 16 : 0 = 20.60, 18 : 0 = 2.00, 18 : 1 = 44.50, 18 : 2 = 29.10, 18 : 3 = 1.20, 20 : 0 = 0.90, 20 : 1 = 0.80, 22 : 0 = 0.50[22].

Fatty Acid Composition of GNO (Groundnut Oil): 14: 0 = 0.10, 16 : 0 = 15.40, 18 : 0 = 3.00, 18 : 1 = 41.90, 18 : 2 = 33.40, 20 : 0 = 1.50, 20 : 1 = 0.90, 20 : 2 = 3.40, 24 : 0 = 0.40[22].

Fatty Acid Composition (FAC) of PO (Palm Olein Oil): Above composition of P.O. was used for the calculation of FAC mentioned in conclusions – P.O. proposed by the preparation method used by Khatoon Sakina (and not the commercial P.O.) 14 : 0 = 0.70, 16 : 0 = 40.50, 16 : 1 = 0.10, 18 : 0 = 1.50, 18 : 1 = 41.40, 18 : 2 = 13.20, 18 : 3 = 0.30, 20 : 0 = 0.40, 20 : 1 = 1.40, 22.0 = 0.50[22].

Preparation Method of Refined Palm Olein – (The fatty acid composition of P.O. The above method has been mentioned for preparing P.O.): Palm olein used in that study was fractionated from crude red palm oil. Palm oil was heated to 50 ± 2°c for 20 min. and held at room temp (27 ± 2°C) for 8 hours. Palm olein fraction (44%) was separated from palm stearin (66%) by centrifugation at 6000 r.p.m. for 20 min. Then the palm olein was refined by treatment with sodium hydroxide followed by washing with hot water to get refined palm olein which has retained the β - chrotene present in crude plam oil.
Olein Oil (RPO): FO BLEND, Unrefined coconut oil: FO (BLEND). Two of the blends had C 18:2 / C 18:3 ratio of less than 1 and one of the blend had C18:2 / C18:3 ratio of less than 3. Comparative induction periods of RPO, FO and the blends similar to mentioned earlier, were measured. The comparative rate of oxidation was followed by weighing small samples daily of RPO, FO and the blends- keeping the samples in oven for the entire period and taking out daily for a short time for weighing. Flavour of the samples was also noted[20].

Above work has given the vision for all India, especially the rural sector that good research can be carried out just with minimum facility of a good oven and a good balance (even a cheap old type (non electronic)) will be O.K. Hundreds of oil blends can be tested and antioxidant properties of herbs and spices can be tested. In big cities, the work can be carried out with the help of robotics technology.

Another vision is – in the linseed growing areas – the farmers can take each day some amount of linseed to the nearby ghani and get extracted the oil. This oil can be mixed with any one of the other available oils mentioned earlier (RRBO, coconut, RPO) in such a proportion that the 18: 2 to 18: 3 ratio will be about 2. This blend can be used with chutney. Alternatively the ghani owner can daily prepare the fresh blend and sell it for a small, medium or large scale industry. Sophisticated packaging set up will be required.

Literature indicates that raw (red) palm oil of edible quality is one of the richest sources of carotenes (500 – 700 ppm), with β

– carotene, the precursor of vitamin A, predominating more than 65 percent. It is also a good natural source of vitamin E, i.e. the tocopherols and tocotrienols (800 – 900 ppm) which act as natural antioxidants. Tocopherols are of biological and nutritional significance primarily because of their physiological role as antioxidants and claimed to be free radical scavengers[22,24,26,31].

Per acre palm oil production is far more than any other oil seed. If it is organically cultivated, unrefined oil can be used. The author has worked on laboratory scale processing of palm fruit – to extract palm oil and palm kernel oil. Palm oil was extracted using Carver hydraulic press (unpublished data). So, the farmers can extract oil on their farm itself and use the oil without refining, if they have cultivated organically.

Literature indicates that rice bran oil is used as premium edible oil in Japan, Korea, China, Taiwan and Thailand and is considered to be important edible oil due to the presence of balanced amounts of saturated and unsaturated fatty acids and certain nutritionally and medicinally important minor constituents such as tocopherols, tocotrienols, sterols and oryzanol. It is considered as “Health Oil” in Japan due to its excellent hypolipidemic activity[15,22,23,26,29,30,31].

Operation rice bran oil is successful due to the efforts of Technology mission on oilseeds and pulses (T.M.O.P.) (just like the “Green Revolution” and the “Operation Flood” (for milk) was successful). There was a time when almost all the rice bran oil produced in the country was used for soap making (during early seventees). But due to the efforts of T.M.O.P. (Govt. of India) and institutions like C.F.T.R.I., Mysore, I.I.C.T., Hyderabad, and some other institutes and the solvent extraction industry and the rice milling industry, trade and farmers; the oil is now edible in India. There is immense scope to increase the production, as day by day production of good quality rice is going to increase. Sesame oil contains phenolic antioxidants, such as sesamin and sesamolin[22,25].

These natural antioxidants are known to scavenge the free radicals produced at tissue level lipid peroxidation and thus they play a very vital protective role against cellular damage, ageing and degenerative diseases like cataract, atherosclerosis and cancer[22,25,28,29,30,31].

Conclusion

Edible oils and fats have several important functions. One of these is – as source of essential fatty acids. Peroxidation of oils and fats has been realized as a major health hazard. Importance of antioxidants has been realized. Literature indicates that i. the desirable ratio of saturated, monounsaturated and polyunsaturated fatty acids (PUFA) is 7:16:7 in edible oils and fats; ii; epidemiological, clinical and biochemical studies performed during last four decades in some countries suggested that – decreasing the ratio of ω_6/ω_3 PUFA in foods, wherever required is beneficial in reducing certain risks of cardiovascular and other diseases like cnacer. Nutrition experts have suggested a ω_6/ω_3 ratio of 2 or below while keeping the intake of linoleic acid at 3-4 energy%.

Ayurvedic literatures ascribe numerous beneficial properties to ghee. Because of its many healing effects, it is one of the most important foods. Literature indicates that ghee as fat for deep frying has its smoke point as 250°C, which is well above typical cooking temperature of around 200°C and above that of most vegetable oils. Literature also showed that rats fed diets containing greater than 2.5 wt% of ghee had lower levels of serum cholesterol compared with rats fed diets containing groundnut oil. But ghee is costly, so it seems very probable that the cost can be offset by following some modern processes for cooking, e.g. microwave cooking and spraying melted ghee after cooking, using pressure cooker and spraying melted ghee after cooking, using continuous steam cooker and spraying ghee after cooking.

For deep fat frying ghee (especially cow ghee) is also a good medium (like some oil blends). Now low cholesterol ghee is also available commercially. One of the important points about ghee is that its iodine value is quite low compared to common oils, except coconut oil.

Refined coconut oil can also be a good medium for frying, because of its low iodine value, provided epidemiological / animal studies should have shown the prepared product to be good.

For better public health, following blends of oils are suggested – frying oil grade I – should be blends of lower medium range I.V. oils e.g. groundnut oil, ricebran oil, palmolein oil, canola oil, below 110 I.V. sesame or sunflower oil, thoroughly refined neemseed oil, coconut oil, thoroughly refined cottonseed oil, karanja oil etc. etc. Out of two oils one could be refined oil and the other, cold pressed organically grown oil or refined oil. Frying oil grade II – should be two oil blends of – frying oil grade I (any one (80%)), and 20% of one of the following oils – soybean oil, safflower oil, sunflower oil (above 110 I.V.), sesame oil (above 110 I.V.), corn oil, or any other edible oil in the above range. Salad oil, chutney oil, table oil (which are used at ambient conditions) – above oil should contain, either – 20% of cold pressed and organically grown flax oil or walnut oil and 80% of refined soybean oil or 80% of refined canola oil. Second grade ambient temperature use oils should contain 80% of higher I.V. oil e.g. soy oil and 20% of a medium range I.V. oil e.g. ricebran oil. For bakery fat, blends of palm stearin and coconut oil will be O.K. Palm stearin could be unrefined, if from organically grown plant.

For bread spread – zero cholesterol butter or blends of palm stearin and coconut oil. For chocolate fat – cocoa butter 95% + 5% refined sal fat or any other suitable fat. Literature indicates that the forest origin fat – dhupa fat is a semi greenish yellow, or nearly white fat, having faint pleasant odour. Literature indicates that – acetone fractionation of dhupa fat gives 75% yield of stearin which is used with palm mid fraction for preparing cocoa butter substitute. Non veg. oils to be used only as table oils – fish oils (those particular species fish oils which contain good amount of ω3 fatty acids) containing ω_3 fatty acids (thoroughly refined) – 20% + 80% soybean oil refined or canola oil (refined) (subject to approval by the authorities). Algal oil blends to be used only as table oils – algal oil containing ω_3 fatty acids (thoroughly refined) – 20% + 80% soybean oil refined or canola oil (refined) (subject to approval by the authorities). Forest origin oils (which have been approved by the authorities) to be used only as table oils (thoroughly refined) – 20% + 80% soybean oil or canola oil, refined (subject to approval by the authorities).

Future multi institute projects – i. Tailor made lypases in protein engineering departments; ii. Plant lypase extraction, especially from ricebran to be used for interesterification; iii. Plant breeding to phase out present variety mustard oil (which contains sizable amount of eurucic acid) and to cultivate canola like plant in India; iv. As 'white revolution' has taken place in India, and the second 'white revolution' is underway, it is not only essential but a must for national preventive health to carry out more and more animal and human feeding studies on cow milk, buffalo milk, camel milk, goat milk, ghee, milk sweets, etc. General studies on 'post food processing animal feeding' are also desirable; v. Epidemiological studies (like conducted in Japan, which gave 40 years data and a good boost to the theory that ω_6/ω_3 fatty acids ratio should be around 2 in the human diet, should be carried out in India for different diets and different oils consumptions; vi. Certain varieties of fishes are considered as a good source of ω_3 fatty acids – but the fish eats sea algae and derives ω_3 fatty acid from it. Moreover the only ω_3 acceptable to vegans is algae. So farmers should be encouraged to grow algae. Even low rain fed small piece of land will be sufficient for it; vii. Certain studies on various antioxidants are amenable to Robotics as daily only weighing of samples is to be carried out and hundreds of antioxidants (natural or otherwise) can be tested by this method; viii. Feeding studies on products fried in hydrogenated coconut oil is desirable.

Prediction of Sat.: Mono.:: Poly.: Fatty Acids Percentages for Certain Blends: Based on table 1 and the fatty acid composition of RBO (rice bran oil), fatty acid composition of GNO (groundnut oil) and fatty acid composition of PO (Palmolein)[5,10]. For blends of two or more than two oils – Blend 1 – RBO: SOY: GNO: 80: 10: 10.

A ratio of sat. mono: poly somewhat comparable to the ratio of 7 : 16 : 7 will be there and some amount of ω_3 fatty acids and oryazanol will be there.

For 2 Oil Blends – RBO: SOY: 80: 20: A ratio of sat: mono: poly, somewhat comparable to the ratio of 7: 16: 7 will be there and some amount of ω_3 fatty acid and oryazanol will be there.

For 3 oil blends: GNO: PO: Soy: ← ((all major oils) – These are all major oils). 40: 50: 10

A ratio of sat: mono: poly, somewhat comparable to the ratio of 7: 16: 7 will be there and some amount of ω_3 fatty acid will be there.

For 4 oil blends: Coconut oil (thoroughly refined): GNO: PO: Soy:: 10 : 40 : 40 : 10

Coconut oil can also be used in the blend. It will increase the percentage of saturated fatty acids and decrease the percentage of mono and polyunsaturated fatty acids when compared to the previous blend but as coconut oil fatty acids consists mainly of lauric acid; it will have its own advantage.

References

1. Berg Jeremy M., Tymoczko John L., Stryer Lubert, Gregory J. and Gatto Jr., Biochemistry : An Evolving Science in Biochemistry, International 7th, edition, Freeman and company, New York, U.S.A., 1–5, 20–21 **(2012)**
2. Berg Jeremy M., Tymoczko John L., Stryer Lubert, Gregory J. and Gatto Jr., Lipids and Cell Membranes in Biochemistry, International 7th, edition, Freeman and company, New York, U.S.A., 379–380 **(2012)**
3. Berg Jeremy M., Tymoczko John L., Stryer Lubert, Gregory J. and Gatto Jr., Metabolism : Basic Concepts and Design in Biochemistry, International 7th, edition, Freeman and company, New York, U.S.A., 443–444 **(2012)**
4. Berg Jeremy M., Tymoczko John L., Stryer Lubert, Gregory J. and Gatto Jr., Metabolism : Basic Concepts and Design in Biochemistry, International 7th, edition, Freeman and company, New York, U.S.A., 453–454 **(2012)**
5. Grundy Scott M., What is the desirable ratio of saturated, polyunsaturated, and monounsaturated fatty acids in the diet?, *American Journal of Clinical Nutrition*, 66 (Suppl), 988S – 990S, **(1997)**
6. Grundy S.M., Comparison of Monounsaturated Fatty Acids and Carbohydrates for Lowering Plasma Cholesterol, *New England J. Med.,* **314,** 745 – 8 **(1986)**
7. Mattson F.H. and Grundy S.M., Comparison of Effects of Dietary Saturated, Monounsaturated and Polyunsaturated Fatty Acids on Plasma Lipids and Lipoproteins in man, *J Lipid Research,* **26,** 194–202, **(1985)**

8. Nasirullah, Sarmandal C.V. and Gopalkrishna A.G., Changes in Repeatedly heated oils, during deep fat frying, *Journal of Oil Tech. Asso. of India*, **30(1),** 10–13 **(1998)**

9. Frankel R.N., Warner K. and Moultan S.R., Effect of Hydrogenation and Additives on cooking oil performance of soybean oil, *Journal of American Oil Chemists' Society,* **62,** 1354 **(1985)**

10. Stevensen S.G.M., Genser Vaisey and Eskin N.A.M., Quality control in the use of deep frying oils; *Journal of American Oil Chemists' Society,* **61,** 1102 **(1984)**

11. Gere A., Study of some factors affecting frying fat deterioration, *Fette Seifen Anstri.,* **85,** 18 **(1983)**

12. Fritsch C.W., Measurement of frying fat deterioration : A Brief Review, *Journal of American Oil Chemists' Society,* **58,** 272–274 **(1981)**

13. Chang S.S., Peterson R.J. and Ho C.T., Chemical Reactions involved in the deep fat frying of foods, *Journal of American Oil Chemists' Society,* **55,** 718–727 **(1978)**

14. Directorate of Vanaspati, Vegetable Oils and Fats, Ministry of Civil Supplies, consumer affairs and public distribution, Govt. of India, *News Bulletin, Vegetable Oil Products,* **1(1),** 12 **(1996)**

15. O'Connor T.P., Roebuck B.C., Peterson F.J., Lokesh B.R., Kinsella J.E. and Campbell T.C., Effect of dietary omega – 3 and omega – 6 fatty acids on development of azaserine – induced preneoplastic lesions in Rat Pancreas, *Journal of National Cancer Institute,* **81,** 858 **(1989)**

16. Mukhopadhyay S. and Bhattacharya D.K., Detection of rice bran and sesame oil by TLC of antioxidant, *J. Oil Tech Assoc. of India,* **12,** 22 **(1980)**

17. Jacobson G.A., Quality Control in Deep fat frying operations, *Food Technology,* **45,** 72 **(1991)**

18. Varela G., Bender A.E. and Martan I.D., Frying of Foods, Ellis Horwood Series in Food Science and Technology England, 142, 167 **(1988)**

19. Kajimoto G.H., Yoshida and Shibanora, A role of tocopherol on the heat stability of vegetable oils, *Nippon Eiyo, Shokurya Gakkaishi* **38**, 30 **(1985)**

20. Sarmandal C.V., Comparative Induction periods of Oxidation during Autoxidation of Few Oil Blends Balanced in Fatty Acids, paper presented during International symposium, Building leadership skills in food and nutrition essential for national development, 23–25 **(2006)**

21. Swaminathan M., Essential Fatty Acids (Poly Unsaturated Fatty Acids) In Advanced Text Book on Food and Nutrition, Bappco Book, **1,** 145 **(2008)**

22. Khatoon Sakina, Hemavathy J., Sarmandal C.V. and Gopalkrishna A.G., Physico Chemical Characteristics of Selected Vegetable Oil Blends for use as Health oils, *JOTAI,* **35(2),** 63–68 **(2003)**

23. Gopal Krishna A.G., Khatoon Sakina, Shiela P.M., Sarmandal C.V., Indira T.N. and Mishra Arvind, Effect of Refining of crude rice bran oil on the retention of oryzanol in the refined oil, *Journal of American oil chemists' society*, **78**, 127 **(2001)**

24. Singhal S.C. and Ratray J.B.M., Modern Technology in the Oils and Fats Industry (Book), Oil Technologists' Association of India, New Delhi **(2000)**

25. Handoo S.K. and Sharma K.P., The fats and oils, in – Singhal S.C. and Ratray J.B.M., Modern tech. in the oils and fats industry (book), oil technologists' association of India, New Delhi, 1 **(2000)**

26. ONG A.S.H., Chi W.S.S. and Choo Y.M., New technologies in the palm oil industry, production of carotenoids and tocols, in – Singhal S.C. and Ratray J.B.M., Modern tech. in the oils and fats industry (book), oil tech. association of India, New Delhi, 99 **(2000)**

27. Ripple M.O., Henry W.F., Schwarze S.R., Wilding G. and Weindruch R., Effect of Antioxidants on androgen induced AP-1 and NF – KappaB DNA – binding activity in prostate carcinoma cells, *Journal of National Cancer Institute*, **91,** 1227 **(1999)**

28. Kumpulainen J.T. and Salonen J.T., The Proceedings of the Second International Conference on Natural Antioxidants and Anticarcinogens in Nutrition, *Health and Disease*, 24 **(1999)**

29. Kinsella J.E., Lokesh B.R. and Stone R.A., Dietary n – 3 polyunsaturated fatty acids and amelioration of cardiovascular disease : possible mechanisms, *American Journal of Clinical Nutrition,* **52,** 1 **(1990)**

30. Lokesh B.R., Black J.M. and Kinsella J.E., The suppression of Eicosanoid synthesis by peritoneal macrophages is influenced by the ratio of dietary docosahexanoic acid to linoleic acid, *LIPIDS,* **24,** 589 **(1989)**

31. Shahidi F. and Wansundara P.K.J.P.D., Phenolic Antioxidants, In – *CRC Critical reviews in food Science and Nutrition,* **32,** 67 **(1992)**

32. Wikipedia, Monounsaturated Fat **(2011)**

33. Swaminathan M., Nutritional aspects of Carbohydrates In Advanced Text Book on Food and Nutrition, Bappco, Book, **1,** 123 **(2008)**

34. Swaminathan M., Formation of Fat from Carbohydrates In Advanced Text Book on Food and Nutrition, Bappco, Book, **1,** 166–167 **(2008)**

35. Varela G., Bender A.E. and Martan I.D., Frying of Foods, Ellis Horwood Series in Food Science and Technology, England, 52 **(1988)**