Review Article

A Review on Blending of Oils and Their Functional and Nutritional Benefits

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Abstract

Vegetable oils are vital component of the daily diet and major source of fat in the diet. There are several types of vegetable oils, but no single edible oil available which has desired fatty acid profile, oxidative stability and functional property. Therefore, fats /oils needed to be modified according to their specific end use. Studies of blended oils have shown that blending balances fatty acid composition with good functional and nutritional value. Also, they exhibit desired health benefits. Recently, blended oil has gained relevance in the food industry. Thus, studies related to the blending of oils and functional and nutritional benefits of blended oil were reviewed in this review paper.

Keywords: Edible oil, Blending, Blended oils, Fatty acid composition, Oxidative stability, Functional properties, Nutritional benefits

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Introduction

Dietary fats provide desirable physical, nutritional, organoleptic properties to the food. Vegetable oils are the chief source of fat in the diet and mainly used as the cooking medium in different food preparation [1]. Fats and oils are basically triacylglycerol composed of one glycerol molecule with three fatty acids. “Fat” term is generally used for the solid fat, whereas “Oil” is used for liquid fats. Vegetable oils, in general differ in fatty acid composition. No oil by nature provides all fatty acid in optimum amounts as desired [2]. Currently, the nutritional quality of fats and oils has gained importance due to their connection in the diseases of circulatory and nervous systems. In 2015, 17.7 million deaths were described globally due to cardiovascular diseases and it projected to be 23.3 million in future (WHO, 2017), thus due to rapid growth in cardiovascular diseases, much care has been given to the consumption of fats and oil [3]. The nutritional value of edible oils depends on the fatty acid profile, degree of unsaturation, arrangement of fatty acid in triglyceride structure. According to various clinical and animal studies, it has proved that saturated fat increases the blood and plasma cholesterol level. However, monounsaturated and polyunsaturated fat reduced the level of blood and plasma cholesterol [4]. The major challenge is that the oils rich in monounsaturated and polyunsaturated fatty acids are very prone to oxidation and are less stable. Healthy and stable oil with a high functional value always is a debatable idea because of changing lifestyle and dietary pattern. To improve the stability, shelf life, utility and nutritional value, fats and oils could be modified by blending. The Blending of two or more oil with different properties is an economic way to modify fatty acid profile and physicochemical properties of the final oil blend [5]. Thus the objective of the present review is to compile all the recent researches of vegetable oil blends with special focus on the health benefit and stability of oil blends.

Need of blending of oil

Oil is an integral cooking medium of every food preparation. Apart from energy, oil also provide essential fatty acids linoleic acid (omega-6) and linolenic acid (omega -3), which cannot be synthesized in the human body and must be obtained from diet [6]. The nutritional value of edible oils depends upon the fatty acid profile, degree of unsaturation, arrangement of fatty acid in triglyceride structure. In present scenario, cardiovascular diseases (CVDs) are the major cause of morbidity and mortality in the world and saturated fat intake is directly related to CVDs, due to which consumption of healthy oil is a topic of concern [7]. According to World Health Organization (WHO, 2008) [8], the healthy oil should have following three characteristics:

- The ratio of saturated, mono and polyunsaturated should be 1:1.5:1.
- The ratio of essential fatty acid, linoleic acid (omega- 6): linolenic acid (omega - 3) should be 5- 10:1.
- Presence of antioxidants.

No fats and oil is perfect in respect to above nutritional characteristics. The fatty acid profiles of commonly consumed oils are listed in **Table 1**. Most of the oil is deficient in essential fatty acid omega -3, omega - 3 fatty acid is very beneficial for the regulation of lipid metabolism and also in the prevention of cancer and cardiovascular diseases (CVDs). The ratio of essential fatty acids, i.e. omega-6 (n-6): omega -3 (n-3) is very crucial; their unbalanced ratio leads to diabetes, atherosclerosis and obesity, high blood pressure and cancer [9]. Linseed oil is rich in omega -3 fatty acid and the blending of linseed oil with some other oil is a feasible method to obtain balanced n-6/n-3. Balanced omega-6: omega-3 was reported in the blends of linseed oil with groundnut oil [10]. Similar results were obtained by various oil blends [11]. Along with the balanced fatty acid profile, blending of oil can also result in the reduction of triacylglycerol and cholesterol levels in blood [10].

Table 1 Fatty acid profile of commonly used vegetable oils [12]

Vegetable oil	Fatty acid composition (%)				Essential fatty acid (%)		
	SFA	MUFA	PUFA	PUFA/SFA	n-6	n-3	n-6/n-3
Coconut oil	90.84	7.24	1.90	0.02	2	-	-
Corn oil	16.60	33.67	49.74	3	49	1	64.15
Cottonseed oil	28.17	19.66	52.16	1.85	51	0.35	146.7
Groundnut oil	19.27	53.77	26.96	1.40	27	-	-
Mustard oil	5.73	66.98	27.28	4.76	16	11	1.33
Palm olein	44.84	43.62	11.54	0.26	11	1	37.43
Rice bran oil	23.63	43.71	32.66	1.38	32	1	54.30
Safflower oil	9.19	14.04	76.78	8.39	76.58	0.13	631.59
Soybean oil	15.90	24.77	59.33	3.73	54.17	5.16	10.5
Sunflower oil	11.39	25.92	62.69	5.51	62.69	-	-

Unsaturated fatty acids rich oils are good for human health as compared to saturated fatty acids, but they are highly unstable at high temperature and easily undergo oxidation. These vegetable oils have very limited use in cooking and processing due to low stability and melting point. Thus, blending is commonly used practice to achieve stable oil with the ideal fatty acid profile. In a recent investigation, different rice bran oil blends were prepared with traditional oils and it was found that rice bran oil & groundnut oil blend (70:30) and rice bran & olive oil blend (70:30) are more stable than all other blends [13]. The Blending of traditional oil with cold pressed oil could also provide a stable oil blend [14]. Cold pressing of seeds is a method of oil extraction without heat treatment or chemical treatments and without the losses of natural antioxidants [15]. Various researchers have given similar or different blends for improving oxidative stability of oil [16-18]. Sensory acceptability of potato chips fried in blend of palm oil with sesame oil at 50:50 is more acceptable than chips fried in sesame oil only [19]. Natural antioxidants rich minor oils (Refined red palmolein, Rice Bran Oil and Sesame oil) lowered the rate of oxidation during storage and frying, when blended with the major vegetable oils (Groundnut oil and Sunflower oil) [20].

Recently the demand of confectionery, bakery, shortening and margarine products have increased. Mostly hydrogenated fat is used for plastic and bakery fat due to its plasticity, spreadability and texture properties. However, hydrogenated fats contain *Trans* fats, which are harmful for human health [21]. Henceforth, blending of fats and oils could be a better alternative for hydrogenated fat, as these oil blends do not form trans-fat and possess similar properties like commercial products [22-24]. Blending of oil is now becoming a common and economical practice in food industry [25]. Overall, the main aim of oil blending is to obtain desirable characteristics of different oils in single oil and to formulate oil which has balanced fatty acid profile, high stability, rich in bioactive compounds, beneficial for human health with high functionality and industrial value.

Oxidative stability of blended oils

Oil undergoes various chemical reactions, including oxidation, hydrolysis, and polymerization during frying temperature and can form various volatiles and non-volatiles compounds which are undesirable for human health and it also affect the quality of fried food [26]. Saturated oils are less prone to oxidation as compared to unsaturated oils and thus more stable, but consumption of these oils is related to CVDs. Hence it is required to encourage the consumption of oils that have low SFA content, but are stable under frying conditions. This can be achieved by blending of oils [27]. For example, some oils like olive oil and soybean are good for human consumption, but due to their high content of unsaturated fatty acid they are unstable at cooking temperature [28]. Thus balancing fatty acid profile of these oils can be achieved by blending with saturated oils like palm oil and coconut oil. Some high oleic - oils such as olive or canola oil are suitable for frying, but their cost is on the higher side, so these oils can be blended with high linolenic acid rich oil like soybean or corn oil to achieve a good and low cost frying oil [29, 30]. In an

investigation it was reported that blending of natural antioxidants rich (β-carotene, tocopherols, oryzanol and lignans) minor oils (red palm olein, refined rice bran oil, unrefined sesame oil and unrefined coconut oil) with groundnut oil and sunflower oil may lower the rate of oxidation during storage and frying [20]. The quality parameters of frying oil include color, viscosity, free fatty acid, smoke point, iodine value, total polar material, peroxide value, foaming properties [31-33].

Blending of different vegetable oil can also improve the content of antioxidant and bioactive lipids and these antioxidants and bioactive components are also improving the stability of vegetable oils [31]. On comparing the oxidative stability and radical scavenging activity of soybean oil with its blends (sea buckthorn oil, camellia oil, rice bran oil, sesame oil and peanut oil), it was found that soybean oil blends were more stable then soy bean oil [5]. A mixture of rice bran oil and soybean oil improves oxidative stability of soybean oil and retard the rancidity in fried product during storage [34]. Blending of seinat seed oil with peanut oil improved the stability and tocopherols content [35]. The blend of palm olein and canola oil suffered minimum losses of antioxidant and polyunsaturated fatty acid (PUFA) during repeated frying [36]. Coconut oil blends with sunflower and rice bran oil showed less peroxide formation and greater oxidative stability than the individual oils [37]. A blend of canola and olive oil in the ratio 80: 20 with 20% palm olein is suitable for deep frying [38]. Some recent researches on stable oil blends and their suitable ratio have summarized in **Table 2**.

Table 2 Recent studies on stable oil blends and their ratios

Oil Blend	References
Virgin olive oil : Soybean oil or sunflower (20:80)	[31]
Palm olein : Canola oil (50:50)	[36]
Palm olein : Sesame oil (50:50)	[19]
Rice bran oil : Palm olein (80:20 and 70:30)	[33]
Rice bran oil : Olive oil (70:30)	[13]
Palm oil : Extra virgin olive oil (80:20)	[38]
Palm oil : Canola oil (50:50)	[39]
Sunflower oil : Palm oil (65:35)	[40]
Sunflower oil :Black cumin oil (80:20)	[41]
Tiger nut oil : Sunflower oil (20:80 to 50:50)	[32]
Moringa oleifera oil: Soya bean oil (80:20)	[42]
Camellia oil: Soya bean oil (60:40 and 50:50)	[43]
Extra virgin olive oil : Sesame oil (80:20)	[44]
Canola oil : palm oil (30:70)	[45]

Health benefits of oil blending

Several researchers have reported that blending of oil enhanced their nutritional and functional properties and lead to various health effects [46]. As we have already discussed the parameters of healthy oil given by WHO. Along with essential fatty acids, oil should have a good amount of bioactive lipids, antioxidant compounds and high stability. To achieve ideal fatty acid combination traditional oil could also be blended with unconventional oils [47]. The blending of oils is a common practice to formulate a new vegetable oil with desirable health benefits. Many researches revealed that suitable oil blends reduced the serum and liver level of cholesterol and triacylglycerol [48-50]. The interesterification of soybean oil and sunflower oil with ethyl behenate resulted in the formation of two low calorie structured lipids, which showed the hypocholesterolemic effect in rats and rabbits [51]. Umesha & Naidu (2012) carried out an experiment by feeding rats with blends of n- 3 rich Garden cress seeds oil with commonly consumed n-6 PUFA rich vegetable oils (sunflower oil, sesame oil and rice bran oil) and the result showed the reduction in Total cholesterol (TC), Triglyceride (TG), LDL-C levels [52]. Blends of coconut oil with other commonly consumed vegetable oils improved amount of monounsaturated, polyunsaturated and total tocopherols [37]. Blends of soybean oil with other oils (rice bran oil, sesame oil, sea buckthorn oil, camellia oil and peanut oil) provide important antioxidants and bioactive compounds, which are beneficial for the prevention of chronic diseases [22]. Blending of coconut oil with rice bran oil and sesame oil enhanced PUFAs/SAFAs ratio of 0.8-1.0 and also showed a hypolipidemic effect [46].

Application of oil blends in food industry

The blending of oils is used to obtain desirable physical and chemical properties in order to improve their functional role in bakery products and food industry. Bakery and confectionery fats have certain desirable physicochemical

properties like melting point, solid fat content (SFC), polymorphic form and spread ability; these characteristics depend on the end use of final product [59]. Partial hydrogenation is also a method to obtain bakery fat, but during hydrogenation *Trans* fats are also produced, which are harmful for human health and leads to cardiovascular diseases, breast cancer, colon cancer, diabetes and obesity [60-63]. Thus, the structured lipid produced by the various oil blends is a method to obtain *Trans* free bakery fats [64-67]. Such as the blend of high oleic sunflower oil and fully hydrogenated Crambe abyssinica oil in the ratio 60:40 and 50:50 have significant use in bakery and confectionery fat [68]. The blend of 50% stearin and 50% patawa oil showed the suitable melting point, SFC, plasticity and consistency at refrigeration temperature as desirable for the food industry [69]. Cocoa butter is a major ingredient for confectionery fat. Cocoa butter equivalent, an alternative to cocoa butter, were prepared by using a blend of 1,3-dipalmitoyl- 2-oleoyl-glycerol (POP) rich fats with fats rich in 1,3-distearoyl-2-oleoyl-glycerol (SOS) [70,71]. Blend of palm mid-fraction (PMF), palm stearin (POs) and olive oil (OO) could be used as manufacturing shortening and cocoa butter substitutes with improved features than individual oil [66]. In another investigation, it was reported that interesterified blends of lard and soybean oil could be used as a substitute for human milk fat. As the modified blend showed similar physical and chemical properties as human milk fat [67]. Application of various oil blends has summarized in **Table 4**.

Table 3 Health effects of different oil blends

Blends	Health effects	Model system	References
Garden cress oil: Sunflower oil or Rice bran oil or Sesame oil (50:50 or 60:40 or 60:40)	Hypocholesterolemic effect	Wister rats	[52]
Garden cress oil: Sunflower oil or Rice bran oil or Sesame oil. (50:50 or 60:40 or 60:40)	Improvement in the antioxidant status and activity of antioxidant enzymes	Wister rats	[53]
Coconut oil: Rice bran oil or Sesame oil (20:80 or 22:78)	Antithrombotic and Hypolipidemic effect	Wister rats	[54]
Olive oil: Soybean or Sunflower oil (70:30 or 86:14)	Hypolipidemic effect	Hamster	[48]
Groundnut oil: linseed oil (50:50)	Hypocholesterolemic and hypotriglyceridemic effects	Rats	[10]
Coconut oil : Tiger nut oil (70:30)	Hypolipidemic effect	Albino rats	[49]
Coconut oil: Soybean or Sunflower Oil (50:50)	Hypolipidemic effect	Weanling rats	[50]
Canola oil: Palm oil (80:20)	Serum n-3 fatty acids proportion improved	Goats	[55]
Rice bran oil : Sunflower oil (80:20)	Hypolipidemic effect	Human	[56]
Rice bran oil : Olive oil (70:30)	Hypocholesterolemic and hypotensive effect	Human	[57]
Soy Oil: Extra virgin olive oil: Fully hydrogenated Crambe oil (45:45:10)	Anti-obesity and hypocholestrolemic effect	Human	[58]

Table 4 Application of different oil blends

Blends	Application	References
Rapeseed oil: fish oil : lard (70:20:10)	Fat base for cookies	[24]
Cotton seed : palm oil (75:25)	Trans free Cookies production	[21]
Palm stearin: Acer truncatum oil : palm kernel oil (50:40:10, 60:30:10, 60:20:20)	Trans free Margarine fats	[72]
Palm mid-fraction: palm stearin: olive oil (16.7:66.7:16.7)	Trans free shortening	[66]
Palm olein : Moringa oleifera oil (50:50)	Vanaspati substitute	[73]
palm stearin: mango or sal fats (70:30, 80:20)	Trans free plastic fats	[74]
Palm stearin fractionate: fish oil (2:1)	Human milk fat substitute	[75]
High oleic sunflower oil: mixture of ethyl palmitate and ethyl stearate	Cocoa butter equivalent	[71]
Ethyl behenate: sunflower or soya bean oil	Low calorie fat	[51]
High oleic sunflower oil: fully hydrogenated Crambe abyssinica oil (60:40, 50:50)	Low calorie fat	[68]

Conclusion

Fats and oils are the basic ingredient of various food formulations. Vegetable oils lack certain essential characteristics in their natural form. It has been proven that consumption of fats and oils are related to cardiovascular diseases and obesity. Hence, there is need of healthy and stable oil in day today life. Blending is a simple, feasible and economical method to alter the physicochemical and nutritional properties of the oil in a good way. Presently, it has become a common practice in the food industry. Many studies have proven that it is an economical and acceptable method to provide oil with balanced fatty acid profile, greater stability and also improved content of antioxidant and bioactive compounds.

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