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Changes of Quality Parameters of Soybean Oil in Deep Fat Frying: A Review

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Abstract—*Deep fat frying is the prime cooking technology used in house hold cooking, restaurants, street vendors, etc worldwide. It is preferred because it cooks food faster than other methods. Also it adds pleasant smell of flavor, texture, crispness and even colour to the food. To do so, soybean oil is the most widely used and India is its leading consumer.*

The main objective of this article is to highlight the various reviewed literature/studies published to ascertain the quality deterioration of soybean oil due to application of high temperature during deep fat frying. Soybean oil consists of 16g of saturated fats, 23g of mono-unsaturated fats and 58g of poly-unsaturated fats per 100g. It is likely that soybean oil composition deteriorates much faster than any other vegetable oil at elevated temperatures. In deep fat frying the temperature elevates nearly to 200°c resulting in various chemical changes in oil. To avoid losses the deep fat fryer in restaurants and street vendors re-uses the same oil for several times. Based on published literatures, the prolonged exploitation of same oil for several times in elevated temperatures in presence of oxygen and moisture causes hydrolysis, oxidation and polymerization reactions that counts in increase of free fatty acid content, peroxide value, total polar compounds, viscosity, foam and even haze, etc. Use of such type of chemically deteriorated oil in deep fat frying can cause serious health hazards further more it also imparts hazy smell to the food. To avoid health hazards PFA specified some important factors for soybean oil such as refractometer reading should be 61.7 to 69.5 at 40°c, saponification value 189 to 195, iodine value 120- 141 and free fatty acid content must not exceed 1.25%.

Present study is devoted on reducing the hazardous components by using various means of adsorbents on published literatures.

Keywords: *deep fat frying, soybean oil, free fatty acid, peroxide, total polar compounds*

1. INTRODUCTION

Indian sub-continent is well known worldwide for its numerous fried products of street vendors. In every small town nearly 20-50 streets vendors can be found and metro cities counts goes to 100. Despite of its unhygienic conditions starting from cooking environment to cooked product people throng to have a taste. Deep fat frying is the common Technology of cooking for street vendors. This method is adopted because it cooks food much faster than other method of cooking. In deep frying the food undergoes various pleasing changes caramelization and maillard reaction turns them to golden and brown colours provide crispiness and desirable flavors.[4,21]

In deep frying the oil is subjected to high temperature nearing to 200°C. In the process oil undergoes thermal oxidation, Polymerization and hydrolysis resulting in decomposition that affects the products adversely [33]**.** The presence of air and water further accelerates the deterioration of frying oil [8]. Soybean oil is one of the best recommended oil for deep fat frying. It contains high amount of mono-unsaturated fatty acids, which is desirable for health benefits**.** In international market as reported by solvent extraction association India (SEAI)**,** soybean oil trade is 22.85% among the edible oils and India's share of import is 3rd largest, according to 2007- 2008 data. According to the consumption rate one can assume that most of the street vendors of Indian market use soybean oil for cooking purposes.

The physicochemical and functional properties of the component of fried food and oil are inter- related [19]. To avoid losses the street vendors repeatedly uses the same oil for several times. This over exploitation of soybean oil affects both physical and chemical properties of oil. Almost all volatile compounds are lost and the non-volatile compounds are degraded [10]. Direct use of soybean oil for deep frying makes the soybean oil unstable even under ambient conditions because of presence of significant amount of linolenic acid [2]**.** Linolenic acid is one of the most prone to thermal oxidation.

2. SOYBEAN OIL

Soybean oil is a vegetable oil which is being produced by extraction from the seed of soybean (*glycine max*). It consists of 16g of saturated fats, 23g of mono-unsaturated fats and 58g of poly-unsaturated fats per 100g of soybean oil [22]. This oil is considered best frying oil because of presence of high level of fatty acid moreover it has high smoke point of 460°F (210°C) [32]which is higher than any other vegetable oil. Based on physiochemical tests and antioxidant assay soybean oil is the most suitable frying oil. The parfried soybean oil shows

highest anti-oxidant value [23]. The table 1.0 below shows the composition of soybean oil.

Table 1: Composition of soybean oil

Soy Fatty Acid		Structure	%
Unsaturated	Palmitic	CH3(CH2)14COOH	11
	Stearic	CH3(CH2)16COOCH3	4
Saturated	Oleic	CH3(CH2)7CH=CH(CH2)7COOCH3	26
	Linoleic	CH3(CH2CH=CH)2(CH2)7COOCH3	52
	Linolenic	CH3(CH2CH=CH)3(CH2)7COOCH3	7

Soybean oil production is 38.79 Mt in the 2008/2009-crop season which is one of major vegetable oil production of the world. India is the third largest consumer of soybean oil in the world.

3. DEEP FAT FRYING

Deep fat frying is a frying technology of food by immersing the food as a whole into the hot oil [9,15]. This technology is adopted world-wide and is the major frying technology used in food processing industries, street vendors, restaurant and household cooking. It cooks food must faster as compared to other cooking processes. The frying oil act as a heat transfer medium [7] Besides it also provides pleasing organolaptic characteristics to the food such as smell, flavor, crispness, texture, etc. during frying the hot oil evaporates the moisture content of the food and replaces the void spaces within [25]. The temperature provided in the process is 160°C to 180°C and sometimes it may rise up to 200°C. Deep fat frying can be classified into two categories atmospheric frying and vacuum frying [11]. Two processes of heat transfer takes place simultaneously during frying, convection which takes place in oil and conduction from oil to food and within food [13]. The rate of conductive heat transfer depends on the thermal properties of the food including thermal conductivity, thermal diffusivity, specific heat and density. These properties changes randomly during frying [6]. During deep fat frying mass transfer takes place between moisture removal and oil uptake by the food. The amount of oil uptake by the food product being fried is directly proportional to the moisture removed from the food [25]. It also helps food maintain the physical structure. It is a rapid cooking technology hence street vendors accept it as prime method of cooking food but the presence of high fat content in the food might result in health concerns [35]. Besides it also produces mutagenic substances [14,3]**.** Deep fat frying changes the physic-chemical properties of oil [5]**.** It is used both commercially and domestically to produce fried food products of desirable texture and flavour at high temperature regimes with high heat transfer rates and rapid cooking [9].

4. EFFECT OF FRYING IN OIL QUALITY

In deep fat frying oil is subjected to nearly 200°C for several minutes. To avoid losses the street vendors re-uses the same oil for several cycles. This action deteriorates the quality of oil in all aspects both physical as well as chemicals. Initially oil degradation can be determined with naked eyes. Continuous exposure of oil in high elevated temperature changes the colour of oil from light yellow to orange brown. Oil darkening during frying is the most visible change taking place and can be used as a parameter to indicate the quality of frying oil [36]. With the change in colour of oil one can understand the change in density and viscosity index of oil. The sole reason for both the case is the repeated use of same oil at high temperature for several times. Density of oil increases with an increase in the number of use of same oil [16]. The increase density results in increase of viscosity due to formation of high molecular weight polymer. Viscosity of soybean oil increases from 35 to 43 mPaS after 48 hours of vacuum frying [28]**.** Viscosity of soybean oil increased from 46.7 cP to 79.9 cP [31]**.**

Various chemical reactions takes place during frying at elevated temperatures, oxidation, hydrolysis, polymerization and fission [17,20]. Due to these reactions the components such as Free Fatty Acid (FFA) level, Para-oxide Value, Total Polar Compounds (TPC), Iodine value, Saponification value increases which are harmful aspects to human health. As according to PFA soybean oil should have refractometer reading of 61.7 to 69.5 at 40°C, Saponification value of 189 to 195, Iodine value 120 to 141 and FFA content maximum of 1.25% for healthy food processing. But in contrary the value goes on increasing with the increase in number of cycles of frying times. FFA levels of in use oils ranges widely from 0.25 to 3.99%. This indicates that triacyl glycerol components were undergoing hydrolytic degradation. Para-oxide value is an important parameter to access oil quality. Frying vegetable oil should have a Para-oxide value less than 2 meq/kg [24]. TPC analysis is also a method to access the useability of oil [18] 25% to 27% TPC should be considered as unuseable oil [34]**.** With the increase in number of cycles of frying oil becomes rancid. It can be considered rancid at a Para-oxide value above 10 meq/kg oil [12]**.** Lipid oxidation and hydrolytic reactions accelerates the oil deterioration [26,27]**.** The data below is provided to specify the increase in TPC % in soybean oil as per studied by S.M. Abdulkarim et al

Table1.1: Changes in characteristics of soybean oil during frying of banana

Frying days	TPC %
0	4.7±0.6
1	10.03±0.9
2	16.6±0.8
3	24.4±1.0
4	28.5±0.7
5	32.4±0.7
6	35.3±0.1

5. CONCLUSION

Vegetable oil degradation on elevated temperature processing is a complex issue. Based on various references the change of oil takes place both physically and chemically. Increase in haze counts in physical change and increase in FFA count, Para-oxide value, TPC, Iodine Value, Saponification value counts in chemical change. Those changes are undesirable for human health. Soybean oil one of the finest vegetable cooking oil having health benefits turns into health hazardious after being subjected to high temperature during deep fat frying.

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