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Storage and frying behavior of sunflower oil blended with peanut oil

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Abstract

The present study was designed to improve stability of sunflower oil by blending with peanut oil in storage as well as in frying. Mostly, the peanut oil is used for the deep frying of the French fry but it has high cost as compared other oils present in market. Therefore, cost reduction and enhanced oil stability during storage and frying, different blends were formulated (70:30, 80:20 and 90:10) of sunflower oil with peanut oil, respectively. Storage oil was varied from 0.53 to 1.70% of FFA, 1.20 to 4.22 % of acid value, 181.3 to 194.53 mg KOH/g of saponification, 1.55 to 2.53 meq/kg of peroxide, 111.2 to 167 mg/100 of iodine values and 50 to 81 µg/100g thiobarbituric acid reactive substance (TBARS) contents of oil blends. Moreover, seven consecutive frying was done in order to select one of best blends among three blends for French fry for frying. Sunflower and peanut oil blend (80:20) could be suggested is a better combination among all the treatments because moderate increased all parameters described aforementioned as compared to control except iodine value. Conclusively, addition of peanut oil in sunflower oil was better combination for the improvement of deep fry and storage stability of oil.

Key words: Blend, Food quality, Food safety, Oil frying, Oil stability

Introduction

Sunflower (Helianthus annuus L.) is one of the most important oilseed crop (Stefansson, 2007). Besides palm, soy and rapeseed oil, sunflower oil is ranking fourth with a worldwide production (FAO-STAT, 2008). In year 2008-09 sunflower seed production in Pakistan was recorded 683,000 and oil was 264.000 metric tons. The area under sunflower cultivation in 2008-09 was 1130 thousand acres which is 11.7 % of the total area where oil seed crops were cultivated (GOP, 2010). Sunflower has a great potential for meeting the ever-increasing demand for edible oil and have high oil content 400-550g/kg and rich in essential fatty acids (Nagraj, 1997) especially rich in oleic acid 14-40%, linoleic acid 48-74% (Fsaifr, 2002). Whereas, peanut (Arachis hypogea) is also an important source of oil having delicate fragrance and mixture of about 80% unsaturated fatty acid and 20% saturated fatty acid (Yoshida et al., 2005). Additionaly, oil also contains about 33.3–61.3% oleic acid and 18.5–47.5% linoleic acid (Jiang et al., 2010). High oleic sunflower oil can be also produced by traditional breeding (and by genetic modification). But the purpose of this study was to formulate the high oleic acid blend at minimum cost using indigenous oil seed crop resources.

Lipid peroxidation in fats and fatty foods not only deteriorates their quality by chemical alterations or changes, but also generates free radicals and reactive oxygen species which are supposed to be implicated in carcinogenesis, mutagenesis, inflammation, aging and cardiovascular diseases (Pezzuto and Park, 2002). Oxidative reactions limit the shelf-life of fresh and processed foodstuffs and are a serious concern in the vegetable oil and fat industry. Strongly oxidized oils could have toxic effects on human health and, therefore, these oils are not suitable for nutritive purposes because of reaction products (Kazuhisa, 2001).

Oxidative stability of sunflower oil was improved by blending with highly stable unconventional edible oils enriched with oleic acid and low in linoleic acid. By

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increasing the proportion of high oleic acid oils in sunflower oil, the linoleic acid content was decreased, and oleic acid content was amplified. Consequently, blending improved oxidative and storage stability (Mariod et al., 2005). Therefore, oil blending are gaining popularity worldwide because of their superior thermal and oxidative stability and allied nutritional benefits, as they are cheaper alternatives or substitutes to pure vegetable oils.

Throughout the frying process, oils are repeatedly used at elevated temperature in the presence of air and moisture thus causes partial conversion of oils to volatile chain-scission products, nonvolatile oxidized derivatives and dimeric, polymeric, or cyclic substances especially, polyunsaturated fatty acid in oil swiftly oxidized and decomposed and changes sensory and nutritional aspects (Orthoefer and List, 2007). During frying, total trans fats contents increase in oil as well as in the fried products (Khor and Mohd, 2008).

French fries are appreciated worldwide because of their pleasant taste, flavors and crispy texture. All through the preparation of French fries, hot oil is used as frying media are used for various periods at high temperatures. Thermo-oxidative of oil heated at 185 ± 5 or 215 ± 5 ℃ were increased trans fatty acid content and total polar components was increased. Whiles, PUFA contents were decreased (Aladedunye and Przybylski, 2009). Linoleic acid content was decreased more rapid as compared with oleic acid after heating of seven hours of sunflower oil (Kowalski, 2007). The addition of oleic acid contents in the form of peanut oil in sunflower supposed to be enhance the oxidative stability because oleic acid are more stable than linoleic acid.

Present study was designed to evaluate the effect peanut oil in sunflower oil on physiochemical, storage and frying stability. Therefore, French fries were fried using these blends to evaluate the effect of selected blending ratios on replenished frying system.

Material and Methods

Sunflower, peanut and potato were procured from Ayub Agriculture Research Institute Faisalabad, Pakistan. Sunflower and peanut was stabilized by heating at 125-135℃ for 1-3 seconds to inactivate liptuase activity and oil was extracted by using Soxtech System (HT2 1045 Extraction Unit, Hoganas, Sweden) using hexane (B.P. 68℃) as solvent by following the AACC method 30-10 (AOCS, 1998). Laboratory scale refining was carried out of respective oils following the steps of degumming, neutralization, bleaching (at 90.7℃ using 1% bleaching earth) and filtration. The bleached oil was deodorized at temperatures between 245 and 257.7℃, and cooled to 45–48.7℃ (Sharif et al., 2009) in postgraduate research laboratory of National Institute of food science and technology, University of Agriculture Faisalabad, Pakistan. Moreover, blending of peanut oil with sunflower oil was done by following the scheme given in Table 1.

Table.1 **Treatments plan for blend preparation**

Treatments	Sunflower oil (%)	Peanut oil (%)
T_1	100	-
T_2	90	10
T_3	80	20
T_4	70	30

PHYSIOCHEMICAL ANALYSIS OF OIL

Physico-chemical parameters like color, flavor and odor, was determined by sensory method (Meilgaard et al., 2007) while, specific gravity, refractive index, smoke and fire point as the method was described in AOCS (2003), while, saponification value (SV), iodine value (IV), acid value (IV), free fatty acids (FFA) and peroxide value (POV) value were carried out to assess the deteriorative changes up to 7th frying of French fries (AOCS, 1998). Before frying potatoes were peeled, thoroughly washed, wiped, and cut in to uniform pieces (6.6±0.8cm long and 1.0±0.2cm thick, approximately). Samples were fried in 25g lots at a temperature of 190oC in oil blend for 6±2 min, using a Kenwood Deep Fryer (Model No. DF320 Series).

THIOBARBITURIC ACID REACTIVE SUBSTANCE (TBARS) ASSAY

Oil samples (0.2±0.005g) were precisely measured and dissolved 20mL of 1- butanol. Mixture of oil and 1-butanol (5mL) was mixed with 5mL of fresh prepared TBA reagent (200mg TBA in 100mL 1-butanol). The contents were mixed and heated in a water bath at 95oC for 120 min. The intensity of the resultant colored complex was measured at 532 nm using a spectrophotometer (CESIL CE7200). TBARS of oils samples were determined at specified intervals to evaluate the stability of peanut oil (Kirk and Sawyer, 1991).

STORAGE STABILITY

Oil analyses were conducted for its keeping quality at 0, 10, 20, and 30 days. To select the suitable oil blend with reference to storage stability different physiochemicals characteristics were determined to assess the deteriorative changes in oil blends (AOCS, 2003).

FRENCH FRIES PREPARATION EXPERIMENTS

All frying experiments were conducted in a 2 L semiprofessional thermostated deep-fryer equipped in the oil bath. Twenty French fries (60 g) were heated for 5 min at 175±1℃. Directly after frying, the French fries were cooled on an absorbing paper (MESTDAGH et al., 2005). Finally, the fried oil was collected for analysis.

STATISTICAL ANALYSIS

Results obtained from research of storage and frying stability of oils blends were analysed for statistical significance by two way analysis of variance (ANOVA) and difference among treatments were established

according to least-squared difference test by using the Statistic 8.1 Program (Analytical Software).

Results and Discussion

Physiochemical parameters:

The physical property of sunflower and peanut oil is described in Table 2. Specific gravity of both oils was 0.91, while, specific gravity of oils (sunflower and peanut oil) increased with the increase of frying time. Moreover, refractive index of the blends was varied as the consequence of peanut oil addition in sunflower oil. Whereas, smoke point of peanut oil was 231℃ and sunflower oil was 227℃ (Table 2). Smoke point was directly proportional with the percentage addition of peanut oil in sunflower oil. Peanut oil has comparatively high smoke and fire point which also indicates its stability for deep-frying purposes. Selection of the comparative better blends of sunflower oil with peanut oil for the frying of French fries has been done on the bases of oils physiochemical properties.

Means obtained from all physiochemical parameters for the purpose to find out best formulation or blend on the bases of their storage stability as compared to sunflower oil (control). It is deducted that the sunflower oil has more stability with 20% peanut oil as compared to others blends. Because this ratio of the peanut oil possibly adjust the ratio of monounsaturated and polyunsaturated fatty acid which showed stable during storage and frying Therefore, aforementioned blend was selected for frying purposes and for further investigations.

Table 2. Physical parameters of sunflower, peanut oil and their different blends

Para meters	Sunflower oil	Peanut oil	T_2	T_3	T_4
Specific gravity (25 ℃, mg/mL)	0.91	0.91	0.91	0.91	0.91
Refractive Index (n_D, 40 ℃)	1.46	1.42	1.45	1.44	1.43
Smoke point	227℃	231℃	227℃	228℃	230℃
Fire point	266℃	346℃	270℃	275℃	279℃

Free fatty acid (FFA) content is one of the most important indicators of oil deterioration. The data pertaining FFA of oil blends during storage are shown in (Table 3). The FFA was ranges from 1.18 to 1.99% in control, followed by T4 (0.93 to 1.63%), T2 (1.17 to 1.58%), and T3 (0.61 to 1.33%) during storage period (0 to 30days) at ambient temperature. Free fatty acid has positive correlation with storage time (Fig. 1b) and number of frying had considerable ($p < 0.05$) enhanced in FFA production in oil. The FFA were increased from 0.75 to 2.18% in T2 (peanut oil 20% + sunflower oil 80%) and 0.65 to 1.27 in control. Similarly, prepared blend had acid value 1.46% for control, followed by T2 (2.08%) and T3 (1.2%). After thirty days, acid value was increased up to 4.20% (control), followed by T3 (3.2%).

Table 3. Free fatty acid, acid and iodine value of different treatments of sunflower and peanut oil blends formulations during storage

Treatments /storage days	0 day	10 days	20 days	30 days	Mean
Free fatty acid (%)					
T_1	0.55	0.77	1.8	2.01	1.28^{a}
T_2	0.54	0.73	1.3	1.7	1.06^{b}
T_3	0.55	0.71	1.2	1.5	0.99^{c}
T_4	0.53	0.74	1.3	1.6	1.04^{bc}
Mean	0.54^{d}	0.74^{c}	1.4^{b}	1.70^{a}	1.09
Acid value (%)					
T_1	1.76	3.23	3.8	4.2	3.17^{a}
T_2	1.78	2.59	3.01	3.44	2.78^{b}
T_3	1.20	1.80	2.60	3.21	2.20^{d}
T_4	1.40	2.20	2.87	3.80	2.56^{c}
Means	1.53^{d}	2.4^{c}	3.06^{b}	3.66^{a}	2.68
Iodine value (mg/100g)					
T_1	167.0	165.1	162.7	160.2	163.76^{a}
T_2	135.6	133.4	130.7	129.7	132.35^{b}
T_3	119.7	118.7	114.7	111.2	116.08^{d}
T_4	127.4	125.6	123.7	115.2	122.48^{c}
Means	137.43^{a}	135.7^{b}	132.95^{c}	129.07^{d}	133.79

The results given in Fig. 1b elucidated that there was a significant increase in acid value with the increase in number of frying. The acid value ranged from 1.63 to 4.40 mg/ KOH/100g for peanut oil and 1.20 to 4.10 mg /KOH/100g for sunflower oil. The acid value found to be significantly high in peanut oil blend comparatively (Przybylyski, 1999). The FFA content results due to hydrolysis of triglyceride as well as further decomposition of hydroperoxides (Gopala et al., 2005).

Fatty acids composition of oil had major effect in stability and quality of fried products during frying (Warner 2003), as compared with other naturally occurring minor constituents present in oil. Significant enhancement of FFA with frying time and temperature of frying oil was recorded by Tyagi and Vasishtha (1996), in potato chips and chicken nuggets due to hydrolysis (Goburdhun and Jhurre, 1995).

The acid value was quality indicators in oil/fat since it determines the extent of gylcerides have been decomposed by the lipase enzyme (Kirk and Sawyer, 1991). According to the finding of Anyasor et al. (2009) acid value of refined peanut vegetable oil in Nigeria range from 1.46 to 4.49%.

Iodine value: The iodine value ranged from 167.03mg/100g oil in control (T1), whereas, 135.60 for T2 (10% peanut oil + 90% sunflower oil), 127.40 (T3) for 30% peanut oil + 70% sunflower oil was observed. After storage period (30 days), the iodine value remained 160.20mg for control (T1) followed by T2 (129.70mg) and 111.20mg/100 g oil in T4 (Table 3). In general, all single and interaction effects of independent variables significantly ($p < 0.05$) affected by blends formulation and storage period. The finding of present study is aligned with the earlier studies, iodine value varied from (15 to 15mg/100g) in vegetable oil (Hsu and Chung, 2002).

The iodine value was decreased 127.73 to 120.57mg/100g for peanut oil blends (T2; peanut oil 20% + sunflower oil 80%) and 166.67 to 160.50mg/100g for control (sunflower) throughout in seven successive frying (Fig. 1c). NASIRULLAH (2001) findings reveal the refined soybean and rice bran oil blends decrease iodine value when subjected to frying.

Peroxide value: The peroxides were produced in oil blends at 0 day (1.60 meq/kg) in control and 1.94 meq/kg for T2 and 1.633 meq/kg for T3. The peroxide value exploited in Table 4, peroxide production was increased as the frying repeated numerous times. It was cleared from Fig. 1d peroxides were increased from 1.66 to 2.85meq/Kg in control (sunflower oil) and 1.65 to 2.95meq/Kg in peanut oil blend (T2).

Peroxide undergoes cleavage to produce aldehydes, ketones and acids responsible for off flavor (Sereewatthanawut et al., 2011; Shin et al., 1997). The better stability of blend as compared to control may be because of the presence of high vitamin E contents and less polyunsaturated contents in peanut oil. Ata-U- Rehman et al. (2006) reported that the peroxide value increased sunflower oil during storage without antioxidant supplementation. Moreover, peanut oil also contain the phytosterols about 207 mg/100g likes β-sitosterol and resveratrol having antioxidant and nutraceutical properties (ABIDI, 2001). It also contains valuable quantity of antioxidant fresh oil in 100 g has 15.69 µg of α-tocopherol and 15.91 µg of γ-tocopherol, whereas, total tocopherol contents was varied from 22.4 to 23.9mg/100g of oil (Shin et al., 2009).

Saponification. The saponification value from oil blends ranges from 182.93mgKOH/100g in (T1) control, for 188.40mgKOH/100g (T2) to186.57mgKOH/100g (T3) in control and blends oil. At 30 day T2 had high value of 194.53mgKOH/g and minimum value of T3 had 190.23 mgKOH/100g (Table 4). The present results shows similar trend as described by earlier investigations of other scientists. According ANYASOR et al. (2009), saponification value of peanut oil was found 188.195mg KOH/g-210.1 mg KOH/g and 129.03mgKOH/g respectively. Fig. 1e evident of alteration in saponification value as the number of frying increased. As for peanut oil blend, it ranged from 186.27 to 205.40mg.KOH/g, and control 182.60 to 208.50mg KOH/100g. The saponification value augmented progressively till 13th frying irrespective to the variation in the blend ratio (Petukhov et al. 1999). Warner (2003) concluded that during potato chips frying in corn oil, sunflower oil, soybean and canola oil, the higher oleic acid oils remained more stable as the time and number of frying cycle increased and the present results are concordant with these findings.

Table 4. Peroxide, sponification values and TBARS of different treatments of sunflower and peanut oil blends formulations during storage.

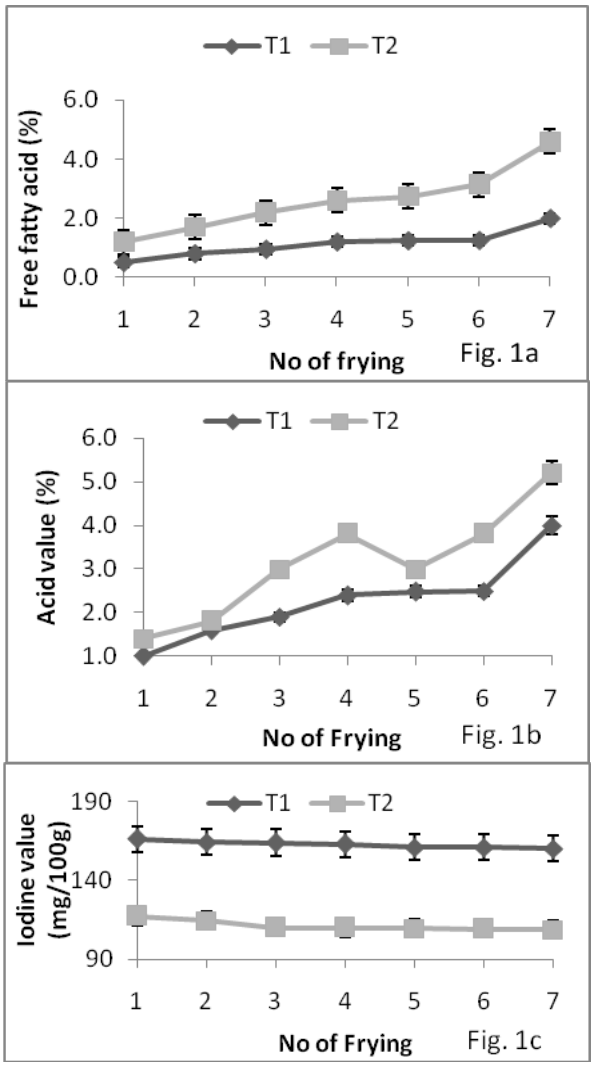
Peroxide value (meq/kg)					
Treatments /storage days	**0 day**	**10 days**	**20 days**	**30 days**	**Mean**
T_1	1.60	2.23	2.4	2.53	2.27^{a}
T_2	1.58	1.82	2.03	2.33	2.07^{b}
T_3	1.55	1.75	1.83	1.92	1.76^{d}
T_4	1.57	1.86	1.95	2.13	1.91^{c}
Mean	1.58^{d}	1.94^{c}	2.10^{b}	2.30^{a}	1.97
Sponification value (mg KOH/g)					
T_1	182.93	186.25	188.27	193.73	187.795^{a}
T_2	182.4	184.5	190.73	194.53	188.04^{b}
T_3	181.3	188.27	189.9	191.23	187.675^{bc}
T_4	182.57	187.33	189.73	192.13	187.94^{bc}
Means	182.57^{a}	187.33^{b}	189.73^{bc}	192.13^{c}	187.94
TBARS (µg/100g)					
T_1	53	61	75	81	67.5^{a}
T_2	50	60	72	80	65.5^{b}
T_3	52	56	65	71	61.0^{c}
T_4	51	55	60	65	57.75^{d}
Means	51.5^{a}	58^{b}	68^{c}	74.25^{d}	62.93

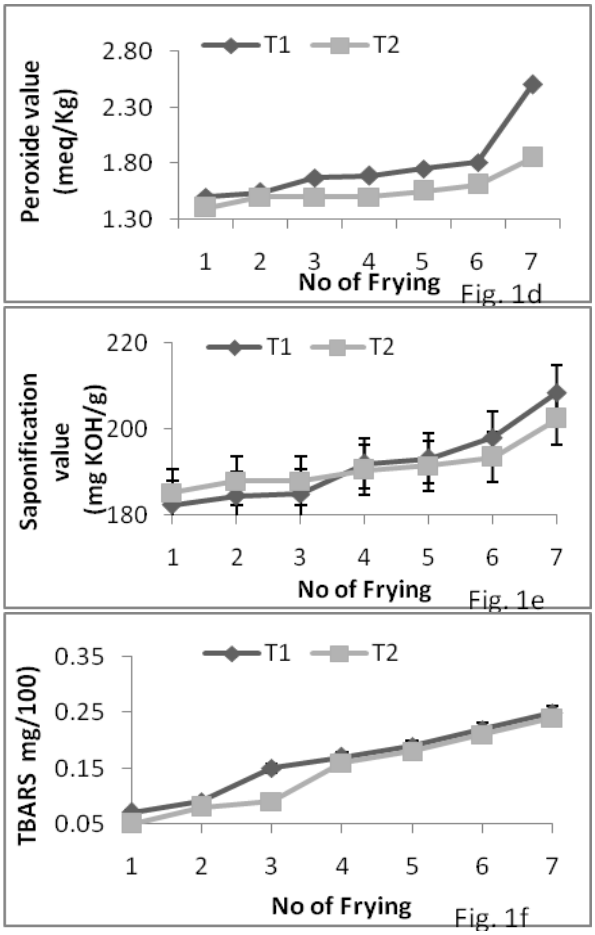
THIOBARBITURIC ACID REACTIVE SUBSTANCE (TBARS)

TBA involves with aldehydes to produce a chromatogen, (alkanals, alkadienals and alkenals) and is expressed in mg malondehyde/kg sample. Table 4 showed the TBARS generated during storage in control (T1) 60 µg/kg to 90 µg/kg followed by T3 as 40 to 70 µg/kg and least in T2 (30 to 60 µg/kg) from 0 to 30 days. Goburdhun and Jhurre (1995) purposed that TBA test was undertaken to characterize the structure of the red adduct 2:1 thiobarbituric acid (TBA). Malonaldehyde involved in the evaluation of oxidative rancidity in fats and oils during their ware house storage as the number of day's increases there was pronounced increase in the quantity. The results further indicated that there was a linear relationship between the number of frying and thiobarbituric acid value (Fig. 1f). The TBA value increases from 70µg/kg to 250µg/kg in control sample while 50 to 240 µg/kg in T2. It is suggested

from results that T2 blend is relative steady for the production of TBARS during the frying. Eisenmenger et al. (2004) reported that the TBARS was the most sensitive to detect linolenic and linoleic acid oxidation products. Gopala (2005) investigated TBARS in fried potato ranges from 2.07 to 2.41 mg/kg.

Figure 1. Free fatty acid (Fig. 1a), acid (Fig. 1b), iodine (Fig. 1c), peroxidate (Fig. 1d), sponification matter (Fig. 1e) and TBARS value (Fig. 1f) of different blends of sunflower with peanut oil selected blends for frying of control (T1) and sunflower oil 80% and 20% peanut oil (T2).





Conclusion

In the nutshell, Peanut oil is the potential source for improving sunflower oil stability and self life by modified behavior of oil and reduced its deterioration. So it is suggested that peanut oil blend (peanut oil 20% + sunflower oil 80%) can produce good quality French fry and proves a useful addition in the domain of oil special reference to it frying behavior.

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