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Quality of oil used to prepare French fries in Dhaka city

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Abstract

To evaluate the quality of oil used to prepare French fries, fifteen samples of three different categories were collected from Dhaka city. Using solvent extraction method, oils were extracted from the samples. Fatty acid composition, color, peroxide value (PV) and free fatty acids (FFA) of the extracted oils were analyzed. It was found that soybean oil and palm oil were used for frying purpose. Majority of the samples (60%) had peroxide value more than 10 meqO_2/kg with highest value of 17.57(±1.39) meqO_2/kg. Average color score was found 53.17(±12.73), yellow score was 17.16(±3.79) and red score was 7.2(±3.27). FFA content of the extracted oils were 0.33(±0.29) with the highest value 1.828(±0.029). Fatty acid composition revealed that palmitic acid and oleic acid were the dominant fatty acid with the highest concentration of 43.71±3.39% and 49.54 ±3.6314% respectively. *Trans* fatty acid was found in 80% of the extracted oils, most frequent trans fat was *trans* linoleic acid ($C_{18:2}$) where as *trans* oleic acid ($C_{18:1}$) was found in highest concentration 3.7020 ±0.3448. PV and *trans* fatty acids revealed that the quality of oil used in low cost shops were lower than middle and high cost shops.

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Introduction

French fries are deep-fat fried potato-based products prepared from potato strips. There is some controversy about the origin of French fries but there is no doubt that it is one of the most popular fast food in the world. Though it is not a traditional fast food, the availability of this snack even in road side vendor indicates the increasing popularity in Bangladesh.

Deep-fat frying is one of the most common techniques of food processing where foods are fried by immerging it into hot oil. Fats and oils act as effective heat transfer medium during the frying process, but a mass transfer with a significant uptake of frying oil into the fried product occurred during frying as well. At the same time loss of moisture, lipids, protein and carbohydrates also happened during this process. For instance moisture content of some potato products decreases from 80% to 50% after heating (Vitrac *et al.*, 2000). However, the main purpose of deep-fat frying is immerging the food in hot oil to minimize the loss of juice and flavor by the crisp crust as well as to introduce the roasted, fried aroma and their pleasant golden to brown color. This high temperature creates evaporation of water which moves away from food and through the surrounding oil. It is common practice that during deep-fat frying, frying fats and oils are repeatedly heated at high temperature and exposed to atmospheric oxygen and moisture at a high temperature of 150-190ºC (Krokida, *et al.*, 2001). Hence, they undergo many reactions which produces a number of degradation products such as free fatty acids (FFA), partial- and polymerized glycerides, short chain-, *trans*-, conjugated, cyclic fatty acids and further reaction products from the decomposition of hydroperoxides like aldehydes, hydroxy aldehydes and hydrocarbons have been identified from deep fat frying products. After the removal of the products from fryer after frying, a significant amount of oil is sucked into the products during cooling period. Major portion of the oil is located in the curst portion which leads to an increase of the oil content of French fries to about 10-15g/100 g oil in the finished products (Vitrac *et al.*, 2000; Bouchon *et al.*, 2003).

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Trans fatty acids (TFA) are unsaturated fatty acids which contain at least one double bond in the *trans* position. These *trans* form of fatty acids are more stable than *cis* double bonds and results from reactions where fats are heated for high temperature for long time (Moreno *et al.*, 1999). In recent years the concern with the increase intake of foods containing high TFA has grown because of the hazardous effects of these lipids on plasma lipoproteins which increase low density lipoprotein (LDL-c) and lipoprotein a(Lp[a]) levels and decrease the level of high density lipoprotein (HDL-c). This condition contribute to increase the LDL/HDL ratio which is considered as a significant sign of the risk of cardiovascular disease development (Ascherio *et al.*, 1999; Hunter, 2005). Therefore, it is necessary to reduce the amounts of dietary *trans* fat for maintaining healthy life.

Although plenty of research have been conducted on modifications of used frying fats and oils during heat treatment under different conditions, quality of oil absorbed by the fried food substrate have been much less studied. Therefore, this experiment designed to observe the quality of oil in fried products as well as to find the difference of oil quality in fried French fries from shops of different price.

Material and methods

Materials

French fries samples were collected from local shops. Based on the price of sample, shops were categorized into three groups, high cost (HC), medium cost (MC) and low cost (LC). After collecting, samples were brought to the laboratory of Oilseed and Lipid Technology Research section, Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR).

Oil extraction

In the laboratory the samples were cut into small pieces of about 1 cm^2, 400 g of samples were placed in a conical flask, 500 mL of petroleum ether (Merck, Mumbai, India) was taken into the flask, shaked well for proper mixing and kept overnight for oil extraction. The solvent with oil was then filtered through filter paper, evaporated in water bath and the extracted oils were kept in sample bottle for analysis.

Peroxide value, acid value and color estimation

Peroxide value

Peroxide value (PV) was estimated according to AOCS Official Method 965.33. Five grams (5±0.05g) of oil samples were weighed into a glass-stoppered Erlenmeyer conical flask and 30 ml of glacial acetic acid (Merck, Germany) -chloroform (RCI Labscan, Thailand) mixture in the ratio of 3:2, respectively, were added to the oil samples. Half ml saturated potassium iodide (KI) (Merck, Germany) solution was added to the solution and allowed to stand for 1 min thereafter, 30 ml of distilled water was added and titrated with 0.1 M sodium thiosulfate (Merck, Germany) solution using starch indicator until the blue color was discharged. A blank was prepared to correct the calculation. Peroxide value was calculated (Equation 1).

$$\text{Peroxide value } (\text{meq}O_2/\text{kg oil}) = \frac{(V\times M\times 1000)}{(g\ \text{test portion})} \quad \text{--------} (1)$$

where V= mL sodium thiosulfate solution (blank corrected) and M= molarity of sodium thiosulfate solution.

Free fatty acid

Free fatty acid (FFA) was measured with a slight modification of AOAC (2005). One to three gram (1-3g) of oil sample was weighed into a 250 mL conical flask and dissolved with 25 mL distilled ethanol was added. Two drops of phenolphthalein indicator were added to the flask and titrated to faint pink end point with 0.1 N potassium hydroxide (KOH) (Merck, Germany). FFA was calculated as equation 2.

$$\%\ \text{FFA (as oleic acid)} = \frac{(V\times S\times \text{molecular weight of oleic acid})}{(10\times \text{Wt of sample in gram})} \quad \text{---} (2)$$

(where V = mL of potassium hydroxide and S= the strength of potassium hydroxide)

Color

Lovibond Tintometer instrument (Model F; Solisbury, Wilts, England) was used for color measurement. The color of the extracted oils were determined by comparison with standard colored glass in a Lovibond Tintometer using 1 inch (2.54 cm) cell. Extracted oils colors were expressed as the combination of yellowness and redness of measured by the instrument using the equation 3.

$$\text{Color} = Y + 5\ R \quad \text{------------}(3)$$

(where Y= yellowness and R= redness).

Determination of fatty acid composition and trans fatty acid

Fatty acid composition of the extracted oils was determined as their methyl esters with a slight modification of method stated by Akabr *et al.* (2009). In this method, few drops of extracted fat were dissolved in petroleum ether in a test tube and methylated by using sodium methoxide (Merck, Germany) in presence of flame. The solution was then diluted with distilled water and allowed to settle for few minutes until a clear portion was visible in the upper part of the tube. The upper layer of fatty acid methyl ester (FAME) was collected and used for GC-analysis.

Gas chromatography analysis

Fatty acid composition and *trans* fatty acids were analyzed with Shimadzu GC-14B (Japan) series gas chromatograph equipped with flame ionization detector and fused silica capillary column (FAMEWAX, Crossbond® polyethylene glycol, 15m×0.25mm×0.25µm film thickness, Restek; Pennsylvania, USA). Splitless injection technique with nitrogen as carrier gas at a constant flow rate of 20 mL/min was used. Injector temperature was 250^{o}C, initial oven temperature was 150^{o}C and held for 5 minutes. Temperature was increased at 8^{o}C/min to 190^{o}C and then increased to 200^{o}C at a rate of 2^{o}C/min and held for 10 minutes. The fatty acids were identified by using respective fatty acid methyl ester standards (FAME mix; Sigma-Aldrich, St. Louis, Missouri, USA) and presented as relative percentage as done by the automated GC software (Class GC-10; Shimadzu; Japan).

Statistical analysis

The results presented are mean ± standard deviation obtained from the analysis of three samples. The difference between the mean value of the parameters were obtained by One-way analysis of variance (ANOVA) using SPSS 16.0 (SPSS 2007, SPSS for Windows, Chicago, Illinois, USA) statistically significant differences were reported at ($P<0.05$).

Results and discussion

A total of 15 samples of French fries collected from different part of Dhaka city were analyzed. Types and number of collected samples were: five samples from high cost brand shops; five samples from medium cost shops and five samples from road side venders which considered as low cost shops. Average oil content in French fries was found 13.50 (±2.20)% where the highest oil content was found in MC5 which was 17.39(±1.15)% and the lowest in LC2 10.33(±0.79)%.

Color value

Table I showed the color value of the extracted fats from French fries. Total color score of extracted fats was found 53.17(±12.73), yellow score was 17.16(±3.79) and red score was 7.2(±3.27). Average total color score of medium cost shop had higher value 67.17(±1.55) than the others, the highest total color was found in MC3 117.15(±5.1) followed by MC1 81.68(±4.12) and HC1 70.90(±1.05). The lowest total color score was recorded in MC2, 14.05(±0.67) followed by HC5, 20.03(±1.05) and LC5 20.88(±1.05). In this experiment yellow unit was found highest in oil sample extracted from LC4 which was 42.7(±0.61), followed by MC4 29.77 (±1.02), HC2 27.03(±0.15) and MC1 24.13(±0.10). The lowest yellow unit was found in MC5 0.97(±0.06) followed by MC2 4.2(±0.10) and MC3 9.3(±0.26). Average yellow unit was highest in Low cost shops 21.19(±0.25) followed by High cost 16.61(±0.15) and medium cost 13.67(±0.49) shops. In case of red unit, highest value observed in extracted oil from medium cost shop MC3 which was 21.57(±0.49) followed by MC1 11.53(±0.35); HC1 11.4(±0.10) and HC3 10.07(± 0.60). Besides, lowest red value found in low cost shop LC 3, 0.9(±0) followed by HC 5, 2(±0.10) and LC 1, 3(±0.10). Average red value of oil from middle cost samples 10.7(±0.20) were higher than high cost 6.69(±0.07) and low cost 4.22(±0.11) samples.

Fresh fat/oil contains light yellow color which rapidly changes to orange brown color on heating. During heating at high temperature polymerization and oxidation occurs which change the color of oil/fat (Tan *et al*., 1985). Average total color value of the extracted oils were much more higher than the total color value of soybean oil 1.50(±0.2) and palmoline 16.42(±1.03) which considered as the major cooking oil of French fries. The higher color value indicates the possibility of long time exposure of these cooking oils at high temperature for long time. Latha and Nasirullah (2014) also observed the same result who found a threefold increase in red units and fourfold increase in yellow units in rice bran oil after two hour of heating.

Peroxide value (PV)

Average PV of extracted fats was found 10.37(±2.47) meq O_2/kg whereas, the highest PV was found in LC4 oil which was 22.4(±1.66) followed by MC2 17.57(±1.39); HC5, 16.61(±2.06) and MC3 16.24(±0.98). Table I showed that average PV of oils from high cost shops French fries were significantly lower than those of low and medium cost shops. The lowest PV was found in HC2 2.40(±0.03) followed by HC3 2.53(±0.07) and HC4 5.35(±0.13). Both low cost 11.92(±1.01) and medium cost 11.67(±0.60) samples showed PV more than the cutoff point to be used as cooking oil. PV

Table I. Total yield, color, peroxide value and free fatty acid content of extracted oil samples

Sample ID	Total yield	Total color Score (Y+5R)	Yellowness (Y)	Redness (R)	Peroxide value (PV)	Free fatty acid (FFA)
LC 1	11.55(0.55 ±)	35.2(±1.05)	20.2(±0.20)	3(±0.10)	9.18(±0.32)	1.49(±0.015)
LC 2	10.33(±0.79)	58.97(±0.72)	12.97(±0.15)	9.2(±0.10)	11.44(±1.08)	0.075(±0.006)
LC 3	15.30(±0.70)	24.53(±0.90)	20.03(±0.15)	0.9(±0)	10.28(±1.30)	0.31(±0.011)
LC 4	10.83(±0.83)	71.85(±0.59)	42.7(±0.61)	5.83(±0.29)	22.4(±1.66)	0.115(±0.009)
LC 5	14.62(±0.61)	20.88(±1.05)	10.03(±0.06)	2.17(±0.06)	6.277(±0.67)	0.082(±0.003)
Average	12.43(±2.15)	42.29(±0.50)	21.19(±0.25)	4.22(±0.11)	11.92(±1.01)	0.146(±0.009)
MC 1	13.80(±0.77)	81.68(±4.12)	24.13(±0.10)	11.53(±0.35)	5.26(±0.06)	0.281(±0.009)
MC 2	15.63(±0.66)	14.05(±0.67)	4.2(±0.10)	1.97(±0.06)	17.57(±1.39)	0.049(±0.003)
MC 3	15.23(±0.77)	117.15(±5.1)	9.3(±0.26)	21.57(±0.49)	16.24(± 0.98)	0.186(±0.006)
MC 4	13.52(±0.70)	74.42(±1.35)	29.77(±1.02)	8.93(±0.06)	7.65(±0.43)	0.031(±0.003)
MC 5	17.39(±1.15)	50.82(±0.55)	0.97(±0.06)	9.97(±0.07)	11.62(±0.34)	0.361(±0.013)
Average	15.11(±1.60)	67.17(±1.55)	13.67(±0.49)	10.7(±0.20)	11.67(± 0.60)	0.182(±0.007)
HC 1	11.59(±0.64)	70.90(±1.05)	13.9(±0.10)	11.4(±0.10)	10.18(±0.35)	1.828(±0.029)
HC 2	14.44(±1.01)	62.18(±0.72)	27.03(±0.15)	7.03(±0.06)	2.40(±0.03)	0.457(±0.009)
HC 3	11.26(±0.70)	70.05(±0.91)	22.7(±0.35)	10.07(±0.60)	2.53(±0.07)	0.848(±0.023)
HC 4	12.73(±1.11)	24.85(±0.59)	10(±0.10)	2.97(±0.06)	5.35(±0.13)	0.062(±0.003)
HC 5	15.56(±0.69)	20.03(±1.05)	10.03(±0.10)	2(±0.10)	16.61(±2.06)	0.088(±0.003)
Average	13.12(±1.89)	50.06(±0.50)	16.61(±0.15)	6.69(±0.07)	7.52(±0.49)	0.657(± 0.013)
Grand average	13.50(±2.20)	53.17(±12.73)	17.16(±3.79)	7.2(±3.27)	10.37(±2.47)	0.33(±0.29)

shown in Table I revealed that majority of the extracted oils (eight samples out of 15) were below standard for cooking oil according to Bangladesh as well as FAO Standard (BDS 999:1982; BDS 909:1979; FAO/WHO 2009).

PV is one of the most commonly used chemical test to assess the quality of fats and oils. It is an indication of level of deterioration of oil. PV of common refined vegetable oils are generally low which increases in storage at high temperature and during cooking at high temperature (Zahir, 2017). During frying the producer add fresh oil with the existing oil in the pan and continue frying, at the end of the day they cool down the oil and keep it to fry products in the next day, which may increase the PV of the extracted oil. The same observation was also described by Clark and Serbia (1991) who found the oxygen solubility increase in the oil when the oil cools down from the frying temperature, which causes higher deterioration of oils than continuous heating. Yilmaz and Aydeniz (2011) found peroxide value 12.74±2.23 in frying oil collected from fast food restaurant. Latha and Nasirullah (2014) observed gradual increase of PV in rice bran oil up to 2.9 meqO_2/Kg during heating at frying temperature for 6 hours. This observation also supports the statement of Tabee *et al.* (2008a) who found PV of different oils around 5.5 after 6 hours of heating at 180±5˚C. In this study, the higher PV of oils indicates long time exposure of these oils to heat at higher temperature.

Free fatty acid (FFA)

Free Fatty Acid (FFA) is another important parameter used for the evaluation of suitability of frying oils for human consumption. Oil quality has an inverse relationship with the free fatty acid content. Generally, fatty acids are found in the triglycerol form which hydrolyzes in the presence of water to form these acids. During frying the formation is facilitated by

Table II. Saturated fatty acid compositions of oils extracted from French fries (% w/w)

Shop Code	$C_{12:0}$	$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	Other SFA	Total SFA
LC 1	0.181±0.010	0.860±0.067	40.110±0.828	3.986±0.292	0.300±0.041	ND	45.436±0.62
LC 2	0.210 ±0.017	0.822±0.010	39.560±2.704	1.174±0.525	0.287±0.009	ND	42.053±3.266
LC 3	ND	0.890±0.118	43.712±3.387	4.012±0.980	ND	ND	48.614±4.485
LC 4	ND	ND	11.894±2.352	2.643±0.323	ND	ND	14.537±2.673
LC 5	0.178 ±0.024	0.794±0.024	36.702±2.915	2.543±0.426	0.244±0.124	ND	40.461±2.287
MC 1	0.154±0.017	0.829±0.121	39.099±2.536	3.696±0.284	0.198±0.040	ND	43.977±2.076
MC 2	ND	ND	14.076±1.445	1.931±0.682	ND	ND	16.007±0.764
MC 3	0.18 ±0.020	0.864±0.107	39.857±3.971	0.626±0.118	0.300±0.021	0.068±0.008	41.896±4.245
MC 4	ND	0.068±0.014	12.775±1.950	2.590 ±0.28	0.346±0.032	0.927±0.045	16.705±2.320
MC 5	ND	ND	12.367±2.237	3.748±0.954	0.268±0.001	ND	16.382±1.284
HC 1	ND	0.138±0.006	13.215±0.251	1.843±0.084	0.438±0.012	0.258±0.003	15.891±0.176
HC 2	0.135 ±0.009	0.536±0.022	29.215±2.684	3.998±0.918	0.327±0.071	ND	34.210±1.692
HC 3	0.342 ±0.044	0.867±0.062	37.035±2.665	1.613±0.286	ND	ND	39.857±2.376
HC 4	0.219 ±0.041	0.12 ±0.014	39.986±3.211	1.296±0.456	ND	ND	41.621±2.705
HC 5	ND	0.12 ±0.014	12.779±0.706	1.382±0.064	0.105±0.009	ND	19.386±0.747

Table III. Unsaturated fatty acid compositions of oils extracted from French fries (% w/w)

Shop Name	Palmitoleic acid ($C_{16:1}$)	Oleic acid ($C_{18:1}$)	Linoleic acid ($C_{18:2}$)	Linolenic acid ($C_{18:3}$)	Eicosenoic acid ($C_{20:1}$)	Total USFA
LC 1	0.115±0.001	44.253±0.875	9.686±0.561	0.161±0.008	0.122±0.012	54.570±1.481
LC 2	0.601±0.099	42.644±2.299	11.708±0.712	0.355±0.713	0.123±0.009	57.95±2.186
LC 3	ND	42.108 ±1.95	8.479±0.863	ND	ND	51.386 ±2.525
LC 4	ND	24.019±1.305	54.177±1.748	4.542 ±0.255	ND	85.463±2.673
LC 5	0.131±0.022	45.805±3.949	12.715±1.590	0.362±0.004	0.1492±0.002	59.540±2.287
MC 1	0.899±0.170	43.597±3.255	11.238±1.00	0.290±0.034	ND	56.024±2.076
MC 2	ND	29.832±2.660	49.887±2.479	4.274±0.944	ND	83.993±0.764
MC 3	0.263±0.014	42.440±4.094	11.057±0.736	0.321±0.01	0.136±0.014	58.105 ±3.776
MC 4	ND	36.430±3.337	42.466±2.284	2.804±0.51	0.073±0.007	83.295±1.741
MC 5	ND	24.364±1.255	51.72±3.252	4.704±0.525	ND	86.618±1.284
HC 1	0.512±0.079	34.137±2.310	43.131±2.288	3.57 ±0.393	0.203±0.004	84.109±0.176
HC 2	0.425±0.036	37.511±3.096	23.081±1.100	2.298±0.15	0.154±0.009	65.79±1.692
HC 3	ND	49.539±3.631	9.872±1.240	0.731±0.017	ND	60.143±2.376
HC 4	ND	46.567±1.769	10.208±0.867	0.501±0.11	ND	57.48±2.742
HC 5	0.246±0.017	30.335±2.160	49.241±1.766	4.797±0.39	ND	85.614±0.747

ND = Not Detected

an increased rate of hydrolysis. Table I shows the percent (%) FFA of the extracted oil as oleic acid. FFA content of the extracted oil ranged from 1.828% to 0.031%. The highest FFA content was found in a sample of high cost shop (HC1) 1.828(±0.029) followed by LC1 1.49(±0.015) and HC3 0.848(±0.023), where as the lowest FFA content was found in MC4 sample 0.031(±0.003). Average FFA content was also found higher in high cost samples 0.657(±0.013) than Medium cost sample and 0.182(±0.007) and low cost sample 0.146(±0.009). The FFA content of common cooking oil are generally low for instance palm olein 0.15%, rice bran oil - 0.08%, soybean oil - 0.05%, rapeseed oil 0.04% which increase over time and exposure to high temperature (Chen, 2012). The high level of FFA percentage of oils extracted from French fries indicates the lower quality of the used oil that may caused by long time exposure of these cooking oils to high temperature. This statement also supported by the findings of Tabee *et al.*, 2009, who observed a linear increase in FFA formation with time and the FFA concentration doubled after 5 frying operation.

Fatty acid composition

Saturated fatty acid (SFA): Table II shows the saturated fatty acid composition of the extracted oils from French fries collected from different shops in Dhaka city. SFA found in extracted oils were lauric acid ($C_{12:0}$), myristic acid ($C_{14:0}$), palmitic acid ($C_{16:0}$), stearic acid ($C_{18:0}$), and arachidic acid ($C_{20:0}$). SFA occupy 48.614±4.485 % to 14.537±2.673% of total fatty acids. Most abundant saturated fatty acid found was palmitic acid (43.712%-11.894%), followed by stearic acid (4.012 %-0.626%). Highest content of palmitic acid 43.712 ±3.387, stearic acid 4.012 ±0.980 and total SFA 48.614 ±4.485 were found in samples from low cost (LC3) shop, whereas lowest palmitic acid and stearic acid were found in LC4 and MC3 shops respectively. Myristic acid was found in 80% of the sample but the concentration was below 1% of the total SFA. Lauric acid and arachidonic acid were found in trace amount in 53% and 67% of the samples respectively.

In this study, it is found that palmitic acid ($C_{16:0}$) was the dominant fatty acid in 60% of the extracted oils, which indicate that majority of the French fries were cooked by palm oil as the major ingredient of palm oil is palmitic acid. From the table it is found that 80% of low cost shops, 60% of medium cost shop and 40% of high cost shops used palm oil. Tabee *et al.*, (2008b) described that palm oil is most commonly used for the preparation of fried potato products, which also support the finding of the present study.

Unsaturated fatty acid (USFA): Unsaturated fatty acids (USFAs) comprises 86.618±1.284% to 51.386±2.525% of the total extracted fats and the USFAs were palmitoleic acid ($C_{16:1}$), oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$), linolenic acid ($C_{18:3}$), eicosenoic acid ($C_{20:1}$). oleic acid and linoleic acid were found as the major USFAs in the samples with the

Table IV. Trans fatty acid composition of oils extracted from French fries

Shop Name	*Trans* oleic acid ($C_{18:1}$)	*Trans* linoleic acid ($C_{18:2}$)	*Trans* linolenic acid ($C_{18:3}$)	Total *Trans*
LC 1	ND	0.21±0.021	0.024±0.003	0.234±0.018
LC 2	2.308±0.675	0.207±0.005	ND	2.514±0.680
LC 3	0.798±0.024	ND	ND	0.798±0.024
LC 4	ND	1.258±0.251	1.467±0.082	2.725±0.310
LC 5	ND	0.377±0.055	ND	0.377±0.055
MC 1	ND	ND	ND	ND
MC 2	ND	ND	ND	ND
MC 3	3.702±0.345	0.186±0.004	ND	3.888±0.349
MC 4	0.749±0.052	0.136±0.021	0.552±0.145	1.437±0.078
MC 5	ND	1.137±0.118	1.688±0.075	2.823±0.192
HC 1	ND	1.252±0.407	1.302±0.153	2.554±0.456
HC 2	1.135±0.109	0.624±0.0273	0.560±0.004	2.320±0.138
HC 3	ND	ND	ND	ND
HC 4	0.204±0.003	ND	ND	0.204±0.003
HC 5	0.265±0.023	ND	0.73±0.04	0.995±0.021

ND = Not Detected

concentration of 49.539 ±3.631% to 24.019±1.305% and 54.177±1.748% to 8.479±0.863% respectively. In oils extracted from shop LC4, MC2, MC4, MC5, HC1 and HC5, linoleic acid ($C_{18:2}$) was found in concentration around 50%. This is a strong evidence of using soybean oil as cooking medium of these French fries.

Table (IV) shows the composition of *trans* fatty acid in extracted oils, which reveals that majority of the samples have at least one or more TFA. No TFA was found in oils extracted from MC1, MC2 and HC3 where as MC4 and HC2 contained all the *trans* forms of oleic acid, linoleic acid and linolenic acid. Most common TFA found in the oils was *trans* linoleic acid (linoelaidic acid), which was found in 60% of the samples. On the other hand, *trans* oleic acid (elaidic acid) was found in highest concentration 3.702±0.345 in MC3 sample.

Though most naturally occurring fatty acid double bonds show a *cis* configuration, TFA are found in a good number of refined fats and oils in trace level whcih increased by partial hydrogenation of fats (Destaillats *et al.*, 2002). Phuong and Siwarutt (2013) found an increase of TFA concentration in palm olein from 0.22% to 0.36% in first 5 days at 180°C, where as some experiments showed opposite results. Przybylski and Aladedunye (2012)observed that common frying process at about 170-180°C do not increase the TFA content to a high extent. Tsuzuki *et al.* (2010) found no change in concentration of TFAs in six vegetable oils, including cooking oil like canola oil, corn oil, rice bran oil, safflower oil, and sesame oil after four hour of heating. In this experiment, it was found that 80% of the extracted oil contained *trans* fat, 40% of the oils had *trans* fat more than 2%, which indicates the health risk of the consumers who ingest French fries on regular basis.

Conclusion

Fatty acid composition showed that the frying medium of 60% of the French fries were palm oil and for 40% case, the medium was soybean oil. No significant difference has found among the three different price groups for free fatty acid (FFA) color value, saturated datty acid (SFA), mono unsaturated fatty acid (MUFA), poly unsaturated fatty acid (PUFA) and *trans* fat. peroxide value (PV) of oils extracted from high cost shops' French fries is significantly lower than low cost and medium cost shops' French fries.

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