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Investigation of edible oil quality in fast food restaurants in Erbil city

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Abstract

The study aimed to assess the quality of fried oil in Erbil City. Therefore, fried oils and fats from 10 fast-food restaurants in Erbil were randomly collected. Frying process as well as fried oils was submitted into evaluation, by determining some physicochemical characteristics namely p-Ansisidne value (pAV), lodine value (IV), Peroxide value (PV), Acid value (AV) and fatty acids profile using GC MS as well as Refractive index and viscosity. Results indicated that the majority of restaurants used sunflower oil most commonly as a frying medium, potato (French fries) among the fried foods, steel utensils and gas as a heating source. In addition, frying temperatures ranged from 150 to 217°C, and they replenished oil instead of changing it at the end of the working shift or day. The highest AV was in sample one 1.3 and lowest in sample five 0.3 (mg KOH/g). Also, highest PV, IV and pAV was 9.5(mEq/kg oil), 144(g/100g oil) and 65 the lowest was 0.3 (mEq/kg oil), 51 (g/100g oil) and 9 respectively. Regarding refractive index was between 1.40 to 1.47. The data also showed that the fresh fats and oils (controls) seem to be within the Iraqi guideline specification. High AV indicated that fried oil had exceeded the standard specification. Viscosity (cP) of discorded oil noticeably increased with increasing frying time. The results of GC-MS showed that the highest fatty acid percentage of palmetic, stearic, oleic, and linoleic 49.25, 3.85, 46.44 and 61.41, respectively

Keywords: Oil quality, physiochemical properties, fast food restaurants health risks.

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Introduction

One of the most common methods used for preparation of food IS frying. In particular, it is used in the preparation of fast food including sandwiches, French fries and falafel [1]. These are quickly prepared and served utilizing highly energized cooking method to improve palatability as a result of frying and fat absorption. In Iraqi-Kurdistan like any other developing country as a consequence of life style and eating behaviour changes, opening new fast foods brands and increasing the number of working women , the consumption of fast foods are steadily rising [2].

The cooking methods particularly frying, types of oil and utensils type can affect the physical and chemical changes of edible oil during frying [3]. Deep-fat frying is a complex physicochemical proceeding which is concurrently influenced with several factors for example time, temperature, frying oil and fried substance character, stable or periodic heating, fryer model, filters application and supplement of oil. Several changes including oxidation and hydrolysis and/or polymerization could take place when edible oils are fried repeatedly or continuously and using high temperature with the existence of moisture and oxygen. This decomposition can pose adverse impact on some sensorial attributes more likely colour and flavour. However, the antioxidant and frying condition can decide on the fried oil stability [4].

Among the oils used in deep frying are sunflower oil, hydrogenated oils, palm oil, soybean oil, corn oil, and safflower oil. It is worth noting that the oil or fat used in frying provides many nutritional elements, including fat-soluble vitamins as well as essential fatty acids and energy. However, the use incorrect leads to negative consequences for the oil used and thus for the consumer’s health, such as obesity and arteriosclerosis [5].Fried foods absorb a large percentage of oil, and then oxidized oil becomes an essential part of consumer food, and may affect health. Therefore, modern research focuses on deep frying to find out the changes that occur to foods and frying oil during exposure to high temperatures, as well as to know the health effects of these changes on the consumer. The frequent utilize of oil for preparing food by frying in centres food supply, restaurants and confectionaries is the problematic issue by many nutritionist and environmental and food safety issues and considered as the serious threat to the community health[6].Therefore, it is recommended that the by authorities would have regular monitoring and inspection in such food preparing places must be done. This is to identify risk factors created during the processing and frying foods. On the other hand, it is believed that the food operators, restaurants, fast food restaurants handle edible inappropriately through deep frying for a long period of time or reusing fried oil that imposes serious health risk on consumers[7].

This The purpose of this study therefore was assessing the general characterizations of fried oil (i.e. temperature, time, using utensils…etc.) as well as assessing physiochemical properties changes of deep fried oil used in fast food restaurant in Erbil-city of Kurdistan-Iraq.

Materials and Methods

2.1 Sample collection:

The collection of frying oil samples was done from ten fast food restaurants in Erbil city. The restaurants were randomly selected. The quantity oil samples were 50 ml taken from the used fryer directly and placed in clean and dark glass bottles. The bottles were then cooled down, sealed and coded and stored in the fridge for further analysis. The information about the, types of oil used, type of the fryer, temperature, time of replacing oil were taken from the restaurant owners and checked by the authors. All the analyses were done with tri plicate and the samples were compared, and the results were subjected to statistical analysis to compare all the treatments. Due to the diversity of the samples and their different sources, a sample of unprocessed oil or fat was taken from each restaurant to be used as control samples for each restaurant individually and specifically.

2.2. Acid value

Oil sample hydrolytic changes were evaluated using standard titration protocol and the values representing the acid values [8].

2.3. Peroxide value

Oil samples peroxide value was determined following the official method of AOAC method [9].

2.4.p-anisidine level (p-AV)

p-AV was evaluated according to official protocol recommended method [10]

2.5. The iodine value (IV)

The IV represents the unsaturation level oil expressed as the mg of I2 which is absorbed by 100 g of unsaturated oils. IV was determined following the standard method in ISO [11]

2.6. The refraction index (RI)

The oil RI was assessed by determining the bending index of light, refractometrically. A digital type of refractometer was utilized to assess the refractive index room temperature following the official method of [12].

2.7. Viscosity measurement

Viscosity of oil samples was determined using Brookfield standard protocol [13].

2.8. Fatty Acid composition

The composition fatty acid was determined at the University of Ilam /Iran using gas chromatography (GC), using the fatty acid methyl ester (FAME) according to AOAC Official method [14].

2.9. The total oxidation (Totox) value calculation

Totox was calculated following equation below [15]

The total oxidation= 2 peroxide value + p-anisidine value

2.10. Statistical analysis

Statistical analysis was performed utilizing SPSS (Statistical Package for the Social Sciences v. 21.0, IBM). Complete Randomized Design (Posthoc=Duncan Alpha) test was used for the comparison between different variables categories. $P < 0.05$was set as statistically significant level.

Results and dissection. The results in Table 1 indicated that the majority restaurants (90%) replenish fresh oil to the old oil. Furthermore, it was found that majority of the restaurants use sunflower oil. Steel vessel fryer was the most used (70%). The majority (90%) of fast food restaurants change the oil one daily basis. The highest temperature used was 217°C and the lowest was 140°C. The majority of the restaurants change the oil daily and some never change instead they add over oil and one change once every two weeks. The peroxide value (PV) (Table 2) is the initial oxidation level of fats and oils where the peroxides are generated. Fresh oils Oxidative factors have shown a statistically significant difference in PV between them. It is shown in (Table 2) the average quantity of peroxide levels in the oils utilized in restaurants in Erbil. Among all studied oil samples, peroxide values were lower than the permissible limit in 10 samples. However, sample one limit exceeded of codex maximum level (10 meqO2/kg) [16]. Freshly used oils should have a PV less than 1 mEq/kg oil, a value of PV of exceeding 10 mEq/kg oil is considered as rejected [16].

Table 1. General frying condition of oil samples collected

Sample No.	Temp °C	Fried product	Fryer type	Heating source	Amount of oil	Oil replenish	Oil Exchange duration
1	185	Potato finger	Steel	Burner /gas system	20 L	Yes	15 days
2	175	Falafel	Steel	Burner /gas	4L	Yes	
3	174	Eggplant	Steel	Burner /gas	4L	Yes	
4	200	Potato finger	Steel	Electric heater	12L	No	
5	140	Potato finger	steel	Burner /gas	4L		Daily
6	150	Finger + Falafel	Aluminum	Burner /gas		Yes	Daily
7	200	Finger + Falafel	Aluminum	Burner /gas		Yes	Daily
8	217	Falafel +Eggplant	steel	Burner /gas	3 L	Yes	No
9	160	Falafel	Aluminum	Burner /gas	8L	No	Change
10	165	Potato finger	steel	Heater electric	25L	Yes	Three days

[1] stated that the lowest and highest peroxide values in oil samples were calculated to be 1.1 and 9.50 meq/kg, from palm sample 7 and sunflower sample 1 respectively. It is clear that none of the fried samples exceeded PV above the standard limit. Peroxide is the initial product that is generated post fats and oils oxidation of. It can have adverse consequence on human well-being and may contribute to different diseases such as allergies, cardiovascular diseases, various cancers and obesity [17].

The AV of the fried oil seems to be increasing from 0.28 to 1.37 in 1, 0.39 to 1.37 in 9 and 0.33 to 0.87 in 5. These samples are for fried potato fingers, and they have a higher values comparing to the rest of the samples. The reason may be due to the existence of high moisture content in the potato fingers, and it is one of the factors for increasing hydrolysis and increasing the acid value. However, The AV is still within the range. Previous study has stated that the AV of fried oil should be less than 2.5 [18]. It is well documented that water can enhance the triacylglycerol's decomposition generate a combination of acylglycerols, FFA and glycerol [19]. The higher the hydrolysis results from higher water content of oils.

Table 2. The Chemical testes of fried oil sample taken from the restaurants

Sample No.	Samples type	Peroxide value mEq/kg	Iodine value (mg/100g)	Acidity value (mg KOH/g)	Anisidine value (mol/kg)	Totox**
		Mean SD	Mean SD	Mean SD	Mean SD	
1	Control Used	2.53±0.030l 9.50±0.250a*	118.0±1.0g 106.0±3.0 i	0.2800±0.02j 1.3700±0.02a	29.0±1.0i 41.0±1.0 g	34 60
2	Control Used	0.31±0.030l 2.5±0.150I	127.0±3.0de 118.0±1.0 g	0.33±0.20hi 0.31±0.02ij g	13.0±0.5m 23.0±0.5 k	13.6 28
3	Control Used	0.31±0.030 l 8.1±0.20c	127.0±3.0 de 121.0±1.0 fg	0.33±0.20 hi 0.53±0.02d fg	13.0±0.5 m 36.0±1.0 h	13.6 52.2
4	Control Used	0.31±0.030 l 2.75±0.25	127.0±3.0 de 123.0±2.0 ef	0.33±0.20 hi 0.53±0.01d	13.0±0.5 m 18.0±0.1l	13.6 23.5
5	Control Used	0.31±0.030 l 7.5±0.350d	127.0±3.0 de 122.0±2.0fg	0.33±0.20 hi 0.87±0.03 bc	13.0±0.5 m 29.0±.5 i	13.6 44
6	Control Used	0.0±0.0l L 0.3±0.03K	67.0±2.0k 50.0±1.0 m	0.39±0.01gh 0.83±0.02 c	9.0±0.5 n 58.0±2.5 c	58.6
7	Control Used	0.0±0.0l L 1.1±0.10K	67.0±2.0 k 63.0±1.0 k	0.39±0.01 gh 0.43±0.010 fg	9.0±0.5 n 65.0±1.0 a	9 67.2
8	Control Used	0.0±0.0l L 1.2±0.05cd	67.0±2.0 k 58.0±1.0 l	0.39±0.01 gh 0.53±0.03 d	9.0±0.5 n 54.0±1.5 d	9 56.4
9	Control Used	0.0±0.0l L 5.6`±0.34f	67.0±2.0 k 49.0±1.0 m	0.39±0.01 gh 1.37±0.05 a	9.0±0.5n 62.0±1.0 b	9 73.2 n.r
10	Control Used	0.4±0.05L 8.1±0.05c	139.0±1.0b 134.0±2.0c	0.39±0.01gh 0.53±0.01 d	21.0±0.6k 44.0±1.5 f	21.8 60.2
Sig		.000	.000	.000	.000	

*Different alphabetic letters indicate statistically significant difference at p<0.05., **Totox, total= the total oxidation

AV is produced from the hydrolysis of hydroperoxides as a result of the existence air and water and during frying process high temperature [20]. With the exception of sample 9, the high AV 0.28 to 1.37 was seen. The reason in addition to other factors may be due to the use aluminum fryers. However, in samples 6 and 7, despite the use of aluminum frying pans, but they have a low acidity 0.39 to 0.83 and 0.39 to 0.43 respectively, as a result of the use of fat instead of oil for these two samples, the fryer types noticeably influence the progression of deterioration of oil and without add oil to replenishment. Furthermore, A large volume to surface ratio of fryer for minimum chances for contacts of oil with air is suggested for deeper frying process [21].

According to the standard Codex Alimentarius, the standard limit of AV for refined oils is between 0.6 and, for cold extraction oils is 4 mg KOH/g oil. A small increase of the values may be associated with hydrolytic process. The data showed that The FFA percentage is increasing parallel with the increasing frying time. It is proposed that the frying oil triacylglycerol may be subjected to hydrolysis. This results has been confirmed by the previous study who stated that AV and FFA value increase with increasing time and frying[22].

Determination p - AV empowers us to a clearly insight into the amount of compounds that are carboxylic non - volatile material expressing secondary oxidation products. The most common materials are aldehydes. p-AV assesses the amount of aldehyde in oil, especially 2,4-dienals and 2-alkenals. These productants are generated as the lipids secondary oxidation [23].

The oil' refractive index and peroxide value were measured to determine its state of degradation. The refractive index of oil is affected by the heating process. In general, there is an increase in the RI with an increase in oxidation or PV. For example, in the first sample, RI and PV were higher for the fresh 1.4707 and 2.53 mEq/kg, but from used 1.730 and 9.8 mEq/kg. The refractive index of oil is linearly affected by the peroxide values, as shown by correlation and regression [24]. 49.25 Plamitate, 3.85 Stearate, 46.44 oliec and 61.41.

Table 3. fatty acid composition of oils and fats samples

Sample no	Plamitate		Stearate		Oliec		Linoliec	
	Control	Used	Control	Used	Control	Used	Control	Used
1	5.79*	14.08	3.14	3.85	27.22	37.84	62.49	35.31
2	4.95	5.45	2.55	1.68	40.63	30.55	50.81	61.41
3	4.95	5.36	2.55	1.53	40.63	32.55	50.81	59.43
4	5.70	10.65	2.86	1.62	32.13	40.18	57.86	47.2
5	5.70	11.67	2.86	1.95	32.13	36.02	57.86	49.44
6	49.25	63.80	3.98	1.73	37.35	31.16	6.97	3.32
7	49.25	45.21	3.98	1.68	37.35	46.44	6.97	5.66
8	49.25	50.78	3.98	2.09	37.35	40.82	6.97	5.48
9	49.25	51.41	3.98	3.30	37.35	37.39	6.97	6.32
10	5.79	5.54	3.14	2.70	27.22	29.74	62.49	60.96

*The numbers are in %

The p-AV of the fresh oils was ranged from 9 to 29. (Table 3). According to our results, p-AV of the oil samples one is 65 that can be an indication oxidation at high level. Gupta (2005) suggests that the p-AV of higher quality oil should be below 4 with the maximum level of 6 if exceed this limit it could be deemed as highly oxidized [25]. But, Ali et al. (2014) proposed that the p-AV should not exceed 10 for high oil quality [26]. It is highly crucial to keep good oil quality management restaurants by having a replenishment schedule and volume of replenishment. Mahboubifar et al. (2016) has reported that the p-AV of oils is increased gradually over 24 hr of frying palm oil. It was also stated that the most tolerable to thermo-oxidation during deep frying was olein [27]. However, nutritionally it is deemed to be the least healthy. These heat-resistance properties might be attributed to the high content saturated fatty acids compared to other oil types.

The results of IV for fresh and fried oils are within the standardized value. The change in IV of oils used can be an indication of extent of deterioration and the IV decreases, because in all the frying systems, there were ran of reducing in the amount of unsaturated fatty acids. The data showed that decreases in IV of the studies samples 139 mg I2/100 g in sample 10 and the lowest was49 mg I2/100 g in sample 9. These are mostly composed of unsaturated fatty acids and they melt and leach out into the medium during the heating process, where they are steeply undergoing oxidation and turn mostly saturated. The saturation level increases at a quicker value oils, causing steeper reduce in IV [28]. The results of IV are in accordance with the fatty acid composition fresh oils, because the fatty acid composition is dominated by linolenic acid (C18:2) %, while the composition of is dominated by oleic (C: 18:1) % and palmitic fatty acid (C16: 0) % (Table 3).

The analysis of fatty acid content data showed that the some of the samples the saturated fatty acids were increasing while unsaturated fatty acids were decreasing post of frying process. It was found that the oleic (C18:1) fatty acid ranges between 1.01 – 15.19% and increase palmitic fatty acid (C16:0) fatty acid to 0.46- 14.55 used in the research, as for the rest of the fatty acids, there is a difference in the percentage of their increase or decrease according to the frying process (Table 1). Although fried oils are complex of triacylglycerol’s mixtures, that are a various degraded materials initially from fatty acids [29].

In the current study, the viscosity values fried oil was increased (Table 4). That can be undesirable properties. Increasing the viscosity is an indicator of the increasing polymerization level [13] quality
The results found that the control samples were around 54±2 and the highest viscosity of heated sample was one by 161 K Pa·s.
The viscosity of the oil increases with the increase in the frying period compared to fresh oil, and when oil is replenishments during the process, the viscosity decreases for a while and then increases [10]. This results were confirmed by previous studies who stated that viscosity is of edible oil increased with heating using conventional and modern deteriorating, and results in accelerated of polymerized and oxidized species formation, and in turn, leads to non and volatile compounds formation [30].

methods[31]. This can be due to the polymerization of the unsaturated fatty acid with presence of air and moisture (from the product) [32] and the saturating of the constituents [33]. Viscosity is one of these physical properties that are identified by its use and explained for its use in preparing it and its suitability for use in manufacturing processes and the accompanying precise details and storage conditions under which the oil will be stored [34].

Table (4) The physical testes of fried oil samples

Sample No.	Type Sample	Refractive index 25 oC Mean DS	Viscosity 25 oC [K Pa·s]
1	Control	1.4707±0.001 f	53.5
	Used	1.4730±0.0004	161
2	Control	1.4696±0.0005bcd	56.7
	Used	1.4698±0.0003 abcd	59.3
3	Control	1.4696±0.0005 bcd	56.7
	Used	1.4694±0.0004 bcd	97.4
4	Control	1.4696±0.0005 bcd	55.3
	Used	1.4693±0.0003 cd	98.1
5	Control	1.4696±0.0005 bcd	56.7
	Used	1.4698±0.0007 abcd	78.9
6	Control	1.4691±0.0004d	*
	Used	1.4703±0.0003 abcd	
7	Control	1.4696±0.0005 d	*
	Used	1.4626±0.0003 e	
8	Control	1.4691±0.0005 d	*
	Used	1.4693±0.0005 cd	
9	Control	1.4691±0.0005 d	55.3
	Used	1.4707±0.0006 ab	99.7
10	Control	1.4701±0.0005 abcd	53.5
	Used	1.4705±0.0004 abcd	55.4

* Fats; solid at room temperature
[mPa·s]; millipascal-second, [Pa·s]; pascal-second

The main limitation of this study includes the difficulties of collaboration with restaurants owners and not easily willing to take samples by our research team. This might lead to limit researchers' ability to freely choose some restaurants and take samples accordingly.

Conclusion

The current study indicated the majority of the restaurants in Erbil city use oil for a long period of time without changing, instead of that they are replenished. The type of food, type of the oil, utensils and frying time greatly influences the fat or oil frying life. Longer frying period can lead to oil oxidization of secondary oxidized materials. Over consumption of highly degraded oil could lead to health risks. It is suggested that local authorities exert their effort to impose health guidelines on restaurants to used standard oil quality. This is due to the fact some of the restaurants do not use standardized oil due to low price, easy access and luck of proper check by local authorities. Therefore, it was found that the oil used in the assessed restaurants deteriorated after using and the quality was reduced. It also important to structure an educational program by policy maker in order to train the owners and workers about proper oil quality monitoring strategy (i.e. assess physical and sensorial quality of fresh and fried oil including viscosity, hour use and smoking assessment). It is also important to reduce the consumption of deep fried oil and potentially reduce the formation of carcinogenic material during frying such acrolyn and acrylamide particularly where starches are fried.

Conflict of interest: None

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مجلة جامعة كركوك للعلوم الزراعية

دراسة جودة زيت الطعام في مطاعم الوجبات السريعة في مدينة أربيل

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الملخص

هدفت هذه الدراسة إلى تقييم جودة الزيت المقلي في مدينة أربيل. لذلك، تم جمع عينات الزيوت والدهون المقلية من 10 مطاعم للوجبات السريعة بشكل عشوائي. تم إخضاع ظروف عملية القلي وكذلك الزيوت المقلية للتقييم بتقدير بعَ الخواص الفيزوكيميائية كقيمة بارا-انيسيدين، قيمة اليود، قيمة البيروكسيد، قيمة الحموضة و محتوى الاحماض الدهنية باستخدام GC-MS بالاضافة الى معامل الانكسار واللزوجة . النتيجة كانت الاستخدام الشائع لغالبية المطاعم التي تمت مشاهدتها زيت عباد الشمس كوسط للقلي، البطاطس (البطاطس المقلية) بين الأطعمة المقلية، الأواني الفولاذية والغاز كمصدر للتدفئة. بالإضافة إلى ذلك، تراوحت درجات حرارة القلي بين 150 إلى 217 درجة مئوية، مع اضافة الزيت للتجديد بدلاً من تغييره في نهاية نوبة العمل أو اليوم. أشارت النتائج إلى أن أعلى قيمة للحموضة كانت في العينة الأولى 1.3(ملغم KOH /غم) واناه قيمة في العينة الخامسة 0.3(ملغم KOH /غم) . كما أن أعلى قيمة للبيروكسيد وقيمة اليود وقيمة الأنيسيدين كانت 9.5 (ملي مكافئ/كغم زيت) و144 (غم/100 غم زيت) و65 وأقلها 0.3 (ملي مكافئ/كغم زيت) و51 (غم/100 جغ زيت) و9 على التوالي. . وفيما يتعلق بمعامل الانكسار فقد تراوح بين 1.46 إلى 1.47. كما أظهرت البيانات أن الدهون والزيوت الطازجة (الضوابط) تبدو ضمن المواصفات القياسية العراقية. أما بالنسبة لقيمة الحموضة العالية فقد دلت على أن الزيت المقلي قد تجاوزت المواصفة القياسية. كما تشهد اللزوجة (cP) للزيت المقلي، زيادة ملحوظة مع زيادة زمن القلي . أظهرت نتائج GC-MS أن أعلى نسبة للحوامض الدهنية من البالميتك والستياريك والأوليك واللينوليك كانت 51.41، 3.85، 46.4، و62.49% في العينات 15، 1، 13، و1 على التوالي.

الكلمات المفتاحية: الخواص الفيزيائية والكيميائية لجودة الزيت، المخاطر الصحية لمطاعم الوجبات السريعة.