RESEARCH ARTICLE

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Evaluation of Peroxide Value and Acid Number of Edible Oils Consumed in the Sandwich and Fast Food Shops of Qom, Iran in 2016

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Background & Aims of the Study: The quality of the edible oils is made with chemical compositions and percentage of the degree of unsaturation fatty acids. The peroxide value (PV) always measures the extent of primary oxidation (rancidification) of oils. Oils Rancidity can produce potentially toxic compounds associated with health effects such as heart and neurological disorders. In order to investigate initial oxidative rancidity of the oils, PV will be measured. The aim of this paper is determination of PV and the acid number taking place in oils during frying process and its relationship with demographic characteristics and environmental conditions.

Materials &Methods: In this study, the statistical populations are sandwich and fast food shops of Qom city, Iran. Samples were conducted, using cluster sampling. For data collection, a questionnaire and chemical tests were used. Samples were transferred in the laboratory under cool conditions for PV and acid number (AN) examination. A hundred fifty different sample of oil were collected. Statistical analysis was performed by SPSS. The ANOVA, T-test and Pearson coefficient were used for data analysis.

Results: From the points of view of PV, 80% of oils were consumable and 20% were not. The lowest and the highest number of PV were 0.6 to 16.5, respectively. The minimum and the maximum number of AN were 0.028 to 0.2, respectively. With the assumption of equal variances ($p>0.05$), a significant relationship between the increase after the age of the chefs and the lack of obtaining a health card was shown. The small correlation between the temperature of the oils and PV, $r(150)=-0.21$, $p=0.009$ is shown. There wasn't seen any relation between the type of oils with PV and AN.

Discussion: Antioxidants, oil saturation and the reduction of temperature can reduce the production of peroxide; thus, PV was reduced. Due to the results, temperature increasing lead to increases the peroxide content. In this case, 3.3% of the edible oil samples were in rancidity conditions.

Conclusion: This study has indicated that PV in almost sample was lower than the standard amount. However, removing the oil absorbed into the food leads to reducing the peroxide content and other hazardous compounds by fast-food consumers. This survey indicated that some cookers are not completely aware of government regulation and control procedures for PV and AN of frying oils.

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Background

One of the major concerns in the food industry is fat oxidation, due to the loss of production quality (1). Nowadays, edible oils are widely

used in the food products and food industry, but may that easily oxidized during the food preparation and storage. Oxidation of oils in food can be producing food poisoning in consumers (2-4). Some of the frying oils have high resistance oxidation, stability at high-temperature use, odor and flavor blends and free fatty acids below 1%. The chemical reactions speed, during food frying, depends on some factors such as frying properties, heating conditions, the actual unsaturated fatty acid concentration, the oxygen concentration of oils surface and inside the oil, the temperature and the presence of some metals as a catalyst (5). The frying oil is continuously heated to high temperatures in the presence of oxygen and water, which can react to thermal oxidation, polymerization and hydrolysis (6).

The fat oxidation is an important phenomenon that has significant results in terms of the quality and value of all types of fats and oils. In the first stage of oxidation of the oil, hydroxides produce an initial oxidation product. It can break down to low molecular weight compounds such as ketones, fatty acids, aldehydes, and alcohols. During the first process, rancidity of oils is happened (7). In the oxidation of fat's food deficiencies, changes in taste, smell and color are happened; also, increased toxic metabolites and reduced food quality (8). In the lipid oxidation process, fatty acyl hydroperoxide is made because unsaturated fatty acids react with molecular oxygen (9).

Peroxide Value (PV) is one of the most common determinants of edible oil quality in the production, storage and recovery processes which indicates the amount of oxidation in the foodstuff (10). In the aspect of food quality, PV determination is one of the most basic methods for determination of the quality control of deep frying oils. PV is considering as an indicator during initial oil oxidation (11). The PV indicator shows the amount of peroxide in milligrams of active oxygen per 1000 g of an oil sample (12). In fresh oils, the amount of PV is less than one meq/kg and the values of PV is higher than 10 meq/kg which indicates the spoilage of the oil (13).

Some studies about PV in frying oil show that 58% of heated oils in restaurants and 97% of the sandwich oils had higher peroxide concentration than standards (14). In many studies, the effects of communication of environmental condition's maintenance have been studied about the amount of PV and AN of frying oil (15-26). In other studies, the relationship between PV and AN has been studied. Furthermore, the amount of peroxide content has been measured in some fast foods and sandwich (16,23,27-29). Several literature studies have indicated a close relationship between PV and increasing of heat in oil frying. These studies show that by increasing the cooking temperature time and increasing the storage lifetime of oil, the PV increases. In fact, with increasing the temperature of deep oil frying the number of PV will be increased.

The acid number (AN) is interpreted as the amount of potassium hydroxides needs to neutralize the free fatty acids. It measures the rancidity of free fatty acids and normally formed during reactions of oil glycerides (30). The AN is expressed as percent of free fatty acids calculated as oleic acid. The AN is determined by directly titration the oil or fat in an alcoholic medium against standard potassium/sodium hydroxide solution (31).

Studies have shown that with increasing the heat time, AN of the oil will be increased. The amount of AN in deep oil frying depends on some parameters such as the types of oil, heating time, heating temperature, moisture and food content. Contrary in AN, increasing the temperature or heating time does not always lead to increasing the PV. However, the process of heating the frying oil usually increases the PV (32). For fresh oil sample, the average initial (fresh) acid value was 0.1 mg KOH/g fat. Also, based on Iranian national standards organization studies, the average AN in

rapeseed oil, raw sunflower oil and olive oil are 0.08, 1.39 and 5.5 mg/g, respectively (33).

Qom is one of the Shiite holy places that people travel to this city from different parts of the world in different days of the year, especially on Fridays and Tuesdays every week for the pilgrimage to holy places. The countless people who travel to Qom these days will usually be in Qom to eat lunch or dinner. One of the most important catering centers for the pilgrims are fast food and sandwich shops in Qom. So far, similar studies have not been done to measure PV and AN in Qom yet.

Aims of this study:

Considering the importance of peroxide and acid index in some food and increasing the tendency of citizens to ready meals, this study was conducted to determine the peroxide value and acid number in edible oils used in fast food, sandwiches and restaurants of Qom city in 2016.

Materials & Methods

Methods

A cross-sectional study based on descriptive-analytic conducted peroxide value and Acid Number of frying oil which is used in the sandwich and fast foods in Qom, 2016. From 790 of restaurants and fast foods in the city of Qom, 150 units were selected as samples. The following equation was used for the sample size determination:

$$n = \frac{(Z_{1-\alpha/2})p(1-p)}{d^2} \Rightarrow \frac{(1.96)0.75(1-0.75)}{0.05^2} \Rightarrow 147 \approx 150$$

Where p is the Estimates of a ratio and determined from same studies=75%, d is accuracy=0.05 and Z is confidence level and assumed 95% (95%–Z score=1.96) respectively. Regarding the dispersion of the statistical population, 150 samples were considered, based on the health center cover. The distribution of samples based on the sample size is shown in Table 1.

Table 1) List of existing and selected guilds units of restaurants and fast foods

Health Center Name	Guilds number		Health Center Name	Guilds number	
	available	selected		available	selected
Zaree	27	6	Abdolahhi	80	16
Shohada	62	13	Panbechi	44	8
Masjed-jamee	22	4	Imam Hassan	52	10
Khorakian	30	6	Chamran	88	17
Baghiatallah	32	6	Imam Reza	32	6
Salamat	44	9	Al-zahra	29	5
Imam Khomeini	77	16	Imam sadegh	45	9
Jandaghian	24	5	Forghani	41	8
Jamkaran	5	1	Rural center	25	5

Sampling and analytical procedures

Before sampling, the temperature of the heated oil was determined with an infrared thermometer by the questionnaire. Furthermore, demographic data, education level, nationality, raw material storage conditions, frying oil type, number of cooks, health card etc. were recorded by the questionnaire.

Sampling was performed according to National Standard No. 493 of the Institute of standards and industrial research of Iran (isiri) (30). Sampling was carried out in clean and dust-free glass containers. Around 300 ml of oil samples were taken directly from the frying in-use oil into a test tube capped glass and labeled. After sampling, they were kept at 5 to 15 °C. Sampling was done at peak time and was carried out at about 11 to 14 and 7 to 11 pm in January to May, 2016.

Acid number and peroxide value were determined according to the methods 977.17, 969.17 and 965.33 of the Association Official of Analytical Chemists (34).

For determination of PV, measuring the amount of iodine, which is formed by the reaction of peroxides with iodide ion is needed. In this procedure, 5 g of oil sampled is placed in the conical flask. 30ml of the mixture of two volumes of chloroform and three volume of glacial acetic acid was added. Then, the mixture was shacked to dissolve the oil and added 0.5 ml of saturated potassium iodide solution. One minimum shake then added 30 ml of water. Then, titrate with 0.01-mole sodium thiosulphate with vigorous shaking until fading of the yellowish iodine color occurs. Then, peroxide was the value calculated with the related formula. To analyze the data, descriptive statistics and t-student, ANOVA and Pearson's tests were used.

Results

Some results such as mean, median, standard deviation values and ranges of the measured parameters are shown in Table 2.

Table 2) frequencies variables of quantity parameter of study

	mean	median	Std. Deviation	maximum	minimum
Cooks age	32.8	31	9	55	18
Frying oil temperature	134.2	144	40.9	288	26
Peroxide value	4	3.6	2.1	16.6	0.6
Acid number	0.069	0.064	0.03	0.2	0.028

The most restaurants (83%) were used sunflower oil and some others used corn for their frying. Cookers mostly perform oil frying for all days and replace it if decreases the oil amount. At the end of the day, cookers usually dispose the remaining oil and refill in the next day. 75.2% of cookers said they are changing oil every day.

A one-sample t-test was performed to determine if the mean number of PV was significantly different from the standard value (5 meq/kg). The independent variables are PV and AN in the Qom city. The dependent variable is standard PV concentration. In the null hypothesis assumed that there is no significantly difference between the mean number of PV and standard number. The alternative hypothesis states that there is a significant difference between the mean number of PV and the standard amount. From 150 oil samples, PV concentration was about 80% of consumable oils and 20% non-consumable. The lowest and the highest number of PV were 0.6 to 16.5, respectively. Table 3 is shown PV in oils with minimum and maximum amounts. Descriptive statistical analysis of oil and staff parameter is shown in table 4.

Table 3) PV concentration in all types of oils as meq/kg

Oil type	N	Mean	Std. Deviation	Minimum	Maximum
Liquid oil	23	3.56	1.63	1.80	9.00
Frying oil	126	4.07	2.24	.60	16.60
Solid oil	1	3.60	.	3.60	3.60

An independent sample t-test was conducted to compare the cooker's age and having health card. Age was another dependent variable that was measured, using an interval scale where each number represented cookers' age. The null hypothesis for this analysis states that there is no significant difference in education level between having the health card and cooker's age.

The alternative hypothesis states that there is a significant difference in chef's age and having health card. Alternatively, pot material used for frying oil, scum and odor of heated oil studied with peroxide value and acid number.

Table 4) descriptive statistical analysis of oil and staff parameter

parameter	subcategory	Percent (%)
Shop ownership	Owner	14.5
	Tenant	85.5
Having Health Card	To have	80
	Not having	20
Foaming formation	Yes	20
	No	80
Odor formation	Yes	10
	No	90
Raw oil storage conditions	Desirable	78
	undesirable	22
cooks nationality	Iranian	97
	Foreign	3
Oil types	Frying	83
	Liquid	17

With the assumption of equal variances ($p>0.05$), a significant relationship between the increasing the age of the cookers and the lack of obtaining a health card was shown. Furthermore, no significant relationship between having a health card and PV, AN and oil temperature were seen ($p>0.05$). Also, due to non-assumed equal variances ($p> 0.05$); there was a significant relationship between the oil odor and oil temperature. Also, there was no significant relationship between oil odor and peroxide number, acid number and cooker's age. Regarding the non-assumed equal variance ($p> 0.05$), a significant relationship was found between the oil and oil temperature. But, no significant relationship was found between oil and peroxide number, acid number and age.

The aim of one-way ANOVA test was the comparison of the education level, work experience and the storage conditions of frying oil, with the peroxide value and acid number. A one-way ANOVA was conducted to assess if there were differences in the storage conditions of frying oils, level of education and work experience of chefs. In this study, PV and AN are independent variables. The independent categorical variable was level of education and the five categories were illiterate, elementary education, intermediate education, high school education and academic. Another independent categorical variable was work experience and four categories were less than 1, 1to 5, 5 to 15 and more than 15 years. Another independent categorical variable was frying oil storage conditions and four categories were against sunlight, moist condition, very warm condition and other condition. The dependent continuous variable was PV where scores ranged from 0.6 to 16.60. Another dependent continuous variable was AN where scores ranged from 0.028 to 0.2.

The null hypothesis states that there are no significant differences in independent and dependent variables. The alternative hypothesis states that there are significant differences between independent and dependent variables. For homogeneity of variance Levine's test is used, that shows homogeneity of variance in order to evaluate the assumption of quality of variances. The results of Levine's test were not significant and the one-way analysis of variance was statistically significant.

The higher value for PV corresponded to higher-level temperature. No linear relationship between any of variables was as the null hypothesis states. So, a linear relationship between the variables was as hypothesis states. Based on the conventional of size effect for correlation (ignoring the sign), where 0.10-0.29 are small (week correlation), 0.3-0.49 are medium (moderate correlation) and 0.5 to 1.0 is large (strong correlation), there was a small correlation between all variables. The results showed there is a small correlation between the temperature of the oils and peroxide value, $r(150)=-0.21$, $p=0.009$. There wasn't any relation among other variables. The result of the bivariate Pearson correlations is in table 5.

Table 5) Pearson correlations in temperature of oils, peroxide value and acid number

parameter	1	2	3	4
Oils temperature	-			
Peroxide value	-0.202	-		
Acid number	0.247	0.09	-	
Work experience	-0.08	-0.03	-0.19	-

Discussion

Considering the high levels of PV in this study and its harmful effects on community health; also, some diseases which are associated with atherosclerosis and coronary artery disease, more concern should be considered in fast-food permanent customers (35). Other studies that were carried out in Kashan, Ilam, Shahrekord and Yazd showed a number of samples had higher levels of peroxide value than standard (14,36,37). Factors such as temperature, the amount of unsaturation, light radiations, oil pollution with rancidity of fatty matter, the presence of air and metals can accelerate the rancidity of oils. Antioxidants, oil saturation and the reduction of temperature can reduce the production of peroxide; also, reduction of PV (37). In a study, the PV higher than 10 is a sign of oil rinsing (5). In this case, 3.3% of the samples were in rancidity conditions. Considering the oil uses conditions, it seems that the basic factor in the generation of peroxide composition is the long-term use of oils. Using some antioxidants, lick as vitamin E, would be reducing peroxide levels during deep frying of oils. The absorption of oil with higher peroxide levels in food can lead to health problems (13). Therefore, removing the absorbed oil in the food can reduce the amount of peroxide and other hazardous compounds by fast-food consumers.

Conclusion

In this study, deep frying oils analyzed may not pose the significant health hazard and were found a low in terms of quality. This is very important for both pilgrims and public health. The survey has indicated, PV is almost lower of the standard amount. Educating the restaurant owners and cookers for maintaining frying oil in suitable condition and renew heated oil are needed in this area. This survey indicated that some cookers are not aware of the control procedures and government regulation for frying oils.

Footnotes

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Conflict of Interest:
The Authors have no conflict of interest.

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