



## ORIGINAL ARTICLE

## Monitoring of Edible Oils Quality in Restaurants and Fast Food Centers Using Peroxide and Acid Values

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### KEYWORDS

Determination;  
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**ABSTRACT:** Continuous surveillance and monitoring of used materials in food processing is a tool for achieving to food safety assurance. Peroxide and Acid values are common indicators to detect fat oxidation, frequent and longtime heating and usage of edible oils in cooking or frying of food. This study aimed to quality assessment of used edible oils in restaurants and fast food centers (Sandwich centers) of Zanjan, Iran by determination peroxide value (PV) and acid value (AV). A total 60 oil samples were collected randomly from restaurants (27 samples) and fast food centers (33 samples) based on cluster sampling plan of the Zanjan city. Titration methods were used to determine Peroxide and Acid values according to Iran national standards protocols No. 4179 and 4178. Peroxide value in 22 (81.48%) and 24 (80%) of oil samples and Acid value in 22 (81.48%) and 30 (90.9%) of samples taken from restaurants and fast food centers were higher than standard limit, respectively. Present investigation has shown that High PV and AV in used edible oils of many restaurants and fast food centers in Zanjan, Iran. High range of Peroxide and Acid values indicate an improper use of oils in food preparing centers and presence toxic compounds in used oils and foodstuffs which threaten food consumers' health. Therefore, continuous surveillance and monitoring of restaurants and food preparing centers and training of chefs, food operators in order to apply proper methods of cooking and frying food is very important and necessary.

### INTRODUCTION

Continuous surveillance and monitoring of used materials in food processing is a tool for achieving to food safety assurance [1]. Fats and edible oils are one of the most important ingredients used in food processing, which play an important role in flavoring, taste, consistency and nutritional quality of foods. Frying is one of the oldest and most popular methods for cooking and preparing foods

using edible oils in different sources including vegetables, animals and fishes which are economically important for global trade. [2, 3]. Heating and frying in the food processing lead to changes in the chemical structure of constituents or used ingredients such as proteins, carbohydrates and lipids. Hydrolysis, polymerization and thermo-oxidation of lipids, denaturation of proteins and

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Maillard reaction between proteins and carbohydrates occur in heated foods [4, 5]. Each of these changes in vital molecules especially lipids causes changes in odor, taste, color, texture, formation of toxic compounds, and losing their nutritional quality [6, 7]. Lipid Hydrolysis results in release of long and short chain free fatty acids and acidification of the oil structure. Increasing of free fatty acids (FFAs) facilitates oxidative reactions in the presence of oxidants such as oxygen, heat and light. Development of oxidation causes unpleasant changes such as loss of flavor, nutritional value and color and leading to rancidity of the oil [7, 8].

Lipid thermoxidation causes to accumulate many volatile and non-volatile compounds in oils or food including peroxides, hydroxyls, carboxylic acids, aldehydes, ketones and etc. Peroxides are unstable compounds and quickly converted to secondary metabolites and can create free radicals that not only cause food spoilage but also can damage body tissues of the consumers [7, 9]. Tissue damage caused by free radicals and their effects on human health are commonly seen as chronic signs. There are many reports of mutagenicity, cytotoxicity, carcinogenicity, teratogenicity, inflammatory diseases, cardiovascular disease, liver disease, aging and diarrhea, abdominal pain, nausea and vomiting, weakness and lethargy, headache and etc. following the frequent use of rancid oils [8-12].

The deterioration degree of the oils and fats used in cooking can be determined by measuring various parameters such as Acid Value (AV), peroxide value (PV), saponification value (SV), iodine value (IV), p-Anisidine and TOTOX values, smoke point, viscosity, moisture content and color [8,11]. AV and PV are common parameters to determine the quality of oils or fats. Free fatty acids (FFAs) content determines the acidity and the degree of hydrolysis in the edible oil. In other words they show duration of exposure of the oil or fat to hydrolyzing agent such as heat or light [1]. Acid value (AV) level shows FFAs content which is determined based on the titration and chemical reaction of free fatty acids with potassium hydroxide [13]. Peroxide value shows the amount of peroxides and hydroperoxides formed in the initial stages of lipid oxidation which is determined by iodometric titration [14]. Albeit, newer,

faster and more precise titration methods based apparatus analyzing are invented and used to determine the AV and PV of edible oils or fats [1, 15]. Allowed limits of AV and PV in Iranian national standard are  $\leq 1$  mgKOH /gr and 2-5 mEq/Kg of oil or fat, respectively [13, 14].

Today, consumption of ready-to-eat foods and food consuming in restaurants and fast food centers (Sandwich centers) is becoming accustomed due to lack of time to cooking at home and food diversity. Considering to high usage of oils or fats in restaurants and fast food centers for cooking and frying of different foods, effects of frequent heating on oil's quality and destructive effect of deteriorated oils on the individuals and society health because of high content of toxic compounds, continuous monitoring of used oil's quality is necessary. Many studies have been conducted throughout the world including Iran, on the quality of the used oils for cooking and frying [6, 15-18]. Consumption of ready-to-eat foods in restaurants and fast food (Sandwich) centers is usual in Zanjan province, Iran. Based on our knowledge according to literature review, there are no study on quality of used oils in restaurants and fast food centers in Zanjan province, Iran. Therefore, this study aimed to determine the quality of used oils for frying and cooking in restaurants and fast food centers (Sandwich centers) in Zanjan, Iran.

## MATERIALS AND METHODS

### *Sampling*

In this descriptive cross-sectional study, during the spring of 2017, 60 edible oil samples used for cooking and frying food in 33 fast food centers (Sandwich centers) and 27 restaurants were collected in dark bottles based on the cluster sampling plan of Zanjan, Iran. All samples were transferred as soon as possible to the laboratory and the amount of peroxide and acid values were evaluated in accordance proposed national standard protocol of Iran NO. 4179 and 4178 [13, 14]. Sampling time at restaurants and fast food centers was determined between 12:00 and 14:30. Most activities were being performed to prepare foods at this time in the above mentioned places. All measurements were replicated three times.

### Peroxide value determination

The PV for oil samples were determined by titration method based on national standard protocol of Iran [14]. Briefly, 5.00 g of each sample was weighed into a 250 ml Erlenmeyer flask and 20 mL chloroform with 30 mL acetic acid (2:3) was added to flask. After shaking, 0.5 mL saturated potassium iodide (KI) solution and 100 mL D.W were added and swirled 1 minute. Then solution was slowly titrated with 0.01N sodium thiosulphate with constant shaking. It was continued for color changes to light yellow. In this step 0.5 mL of 1 percent soluble starch as an indicator was added to solution to change light yellow color to blue. The sodium thiosulphate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) was added until disappearance of the blue color. All steps were performed for blank solution. The following formula was used to calculation of PV as meq peroxide/kg of oil:

$$\text{Peroxide Value} = \frac{(V - V_0 \times N \times 1000)}{m}$$

V: Volume of sodium thiosulphate used for sample; V<sub>0</sub>: Volume of sodium thiosulphate used for Blank; N: Normality of sodium thiosulphate; m: Weight of sample

### Acid value determination

The AV for oils samples were determined by titration method based on national standard protocol of Iran [13]. Briefly, based on color and expected AV in samples, adequate amount of oil was weighted and added into a 250

ml Erlenmeyer flask. In another flask, 50 mL ethanol solution containing 0.5 mL Phenolphthalein indicator was heated to the boiling point. After reaching the ethanol temperature to 70°C, it was added to first flask and it was slowly titrated with 0.1N solution of KOH or NaOH and continued until disappearing the color of solution. The following formula was used to calculation of AV as mgKOH/g of oil:

$$\text{Acidity Value} = \frac{56.1 \times NV}{m}$$

N: Normality of KOH solution; V: Volume of KOH used for titration; m: Weight of sample

### Statistical analysis

All tests were conducted in triplicate. The mean±SD, minimum and maximum were obtained using SPSS software (version 16, Chicago, IL, USA).

## RESULTS

Table 1 and 2 show PV and AV content in the oil samples collected from restaurants and fast food centers, respectively. As is shown in table 1, PV was higher than standard limit in 22 (81.48%) and 24 (80%) samples taken from restaurants and fast food centers, respectively. AV was higher than standard limit in 22 (81.48%) and 30 (90.9%) samples taken from mentioned places, respectively (Table 2).

**Table 1.** Peroxide value (PV) range in oil samples taken from restaurants and Fast food (sandwich) centers of Zanjan

Sampling Places PV (mEq/gr)	Restaurants				Fast food (Sandwich) centers			
	NO (%)	MIN.	MAX.	Mean±SD	NO (%)	MIN.	MAX.	Mean±SD
5 (≤standard limit)	5 (18.52)	1.2	4.8	3.53±0.2	9 (27.27)	1.2	3.8	2.11±0.08
5-20	10 (37.04)	5.8	18.2	14.32±0.37	13(39.39)	5.8	16.8	10.75±0.11
21-100	7 (25.92)	52.2	78.2	57.03±0.56	5 (15.15)	29.8	82.2	51.68±1.25
>100	5 (18.52)	118.2	258.2	185.5±0.12	6 (18.19)	138.2	298.2	211.82±1.2
<b>Total</b>								
		27 (100)				33 (100)		

**Table 2.** Acid value (AV) range in oil sample taken from restaurants and Fast food (sandwich) centers of Zanjan

Sampling places AV (mg KOH/gr)	Restaurants				Fast food (Sandwich) centers			
	NO (%)	MIN.	MAX.	Mean±SD	NO (%)	MIN.	MAX.	Mean±SD
≤ 1(standard limit)	5 (18.52)	0.56	0.84	0.73±0.12	3 (9.1)	0.56	0.84	0.75±0.02
1-6	22 (81.48)	1.12	5.35	1.83±0.47	24(72.72)	1.12	5.07	2.15±0.25
>6	0 (0)	0	0		6 (18.18)	6.92	13.81	10.66±0.46
<b>Total</b>		27 (100)				33 (100)		

## DISCUSSION

The results of this study showed that more than 80 % of oil samples in point of view PV and AV had higher range than recommended limits in national standard of Iran for PV and AV in edible oils in restaurants and fast food (sandwich) centers in Zanjan, Iran (Table 1 and 2). Determination of PV is one of the best indicators to detect fat oxidation, frequent heating and usage of oils for cooking or frying [17]. High PV in the oil samples in present study regardless to the oil type indicates the onset of oxidation in oils and progress of oil deterioration and in particular long time and high heating of used oils in restaurants and sandwich centers [5]. There are other reasons to increase the PV in heated and used oils which are not likely to be considered in food centers including regarding to hygiene regulations while working with oil, cleaning surfaces in contact with oil, proper disposing of burnt oil and low heating of used oil for cooking or frying the foods [11, 19].

High PV was reported in many researches conducted on heated edible oils used in restaurants and sandwich centers throughout the world including Iran. Taghipour Fardardekani and Taghipour (2015), Pour Mahmoudi and colleges (2009) and Arbabi and Doris (2011) reported that 98%, 97.3% and 100 % used edible oils in restaurants and sandwich centers of Behbahan, Yasooj and Sharekord cities of Iran had higher PV than standard allowed limit [11,19 and 20]. In another study Rahimzadeh and colleges (2011) reported higher PV value in 58.3% and 100% of used edible oils in restaurants and sandwich centers of Gorgan city from Iran [18]. Results of these studies are consistent with our results. Freire and colleges (2013) from Brazil reported high PV in 1.43 % of oil samples but in yilmaz and

Aydeniz study (2011) from turkey PV of the samples was within the standard range. Results of both studies are lower and not consistent with our results [21, 22]. PV decreases with the continuous heating of the oil [1, 7]. In Park and Kim (2016), Arbabi and Doris (2011), Takeoka and colleges (1997) and Herchi and colleges (2016) studies, it have been shown that produced peroxides due to oil heating are unstable and were converted to other metabolites [17, 19, 23 and 24].

Oil acidity increases due to heat treatment. The main reason for this raising is production of free fatty acids (FFAs) due to the hydrolysis of esteric lipids in the oil (lipolysis) which increases with heating time lapsing and frequent heating cycles in the oil [17]. Increase in FFA content and AV due to lipolysis caused by heating in used oils was reported in several studies [8, 11 and 24]. Free fatty acids, especially short chain FFAs are susceptible to oxidation and cause unpleasant smell of the oils due to hydrolytic rancidity [2]. High levels of peroxide and acid value in used oils in restaurants and sandwich centers can be attributed to the frequent use of oil for cooking or frying [11]. Frequent heating of the oil causes polymerization, oxidation and hydrolysis reactions of the lipids and formation of various unpleasant and toxic compounds such as acrolein, hydroxides, ketones, hydrocarbons, polymers and aldehydes which have harmful effects on the health of the community and consumers of food prepared with these types of oils [8]. Their amount is affected by the frying temperature, frying time, type of used edible oil, presence of antioxidants in the oil, filtering, use time of the cooking oil or fat and frequent use until disposal of oil, heating of the oil and the type of

fryer [4, 25]. The high degree of oxidative degradation in the oils used in food shops and restaurants indicates the lack of awareness or attention to the quality of the oil and non-compliance with health principles when using oil by food operators and low quality of the used oils. Therefore, continuous surveillance and monitoring of restaurants and food shops and training of Chefs, food operators in order to apply proper methods of cooking and frying food is very important and necessary.

### CONCLUSIONS

Present investigation has shown that the PV and AV in used edible oils of many restaurants and fast food centers were higher than Iranian standard allowed limit which indicate an improper use of oils in these food shops and presence toxic compounds in used oils and foodstuffs which can threaten food consumers' health. Therefore, given to increasing amounts and high consumption of ready to eat (RTE) foods particularly fried foods in today's community, it is necessary to train food operators and notifying people to the harmful effects of these foods on their health.

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### Conflicts of interest

The authors declare that there is no conflict of interest.

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