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Evaluating the effective factors for producing peroxide in the oil consumed in Iran

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ABSTRACT

Peroxide is the immediate product of fatty materials oxidation. In general, the higher degree of unsaturated fat leads to greater amounts of fat or fatty materials for oxidation. Although the produced peroxide does not directly cause unpleasant taste and smell, it expedites the fat oxidation as a catalyst. Thus, the present research aimed to determine the effective factors for producing peroxide in fats.

This study was a case-experimental research. About 16 samples of consumed fat and 23 samples of unconsumed fat were sampled during three phases at different intervals at the end of the work, based on the National Standards and Industrial Research of Iran, No 493). The effects of parameters such as fat temperature, heating time, type of fat consumption, and the type of cooking utensil, were determined. The obtained samples were transferred to the Babol of food stuffs laboratory and the peroxide number of the fats was evaluated on the basis of National Standards and Industrial Research of Iran, No. 4179. The data were analyzed using SPSS software. The valuation of the peroxide index in the research revealed that a relationship exists between the amount of peroxide and temperature. This indicates that the amount of peroxide increased by increasing the temperature; however, no significant relationship was observed between them ($p = 0.069$). Moreover, a relationship was observed between the type of consumed oil and peroxide value; however, this relationship was not significant ($p = 0.74$). A significant relationship was found between the time of frying and the peroxide value ($p = 0.001$) and also between the peroxide value and the type of cooking utensil ($p = 0.047$). The results indicated that several factors such as temperature, time of frying, type of consumed oil, and type of utensil used, were effective in increasing the amount of the peroxide value.

Introduction

At present, food and nutrition form a major issue worldwide. The increasing population and producing food for the next generation has led to several researches in various fields such as agriculture, husbandry, technology, and dependent sciences. Therefore, it is essential to produce healthy food in terms of nutrition and hygiene [1]. Frying the food in oil gives it a pleasant taste; therefore, several people prefer fried food. High heating at the presence of air changes the oxidative in unsaturated Acyl group in glyceride and other unsaturated components in oils and fats. Peroxide is the first component of fat and oil oxidation [2,3]; therefore, it decreases the nutritional value of fat. Moreover, heating the oil for a longer duration leads to increase in the oxidation of fats and produces hydro-peroxides and volatile compounds such as aldehydes, ketones, carboxyl acids, and other unpleasant chemicals [4]. Oil oxidation is initiated by the separation of one hydrogen atom, which releases from the dual bond of carbon in the fatty acid and expedites the oxidation. Furthermore, the produced alkyl compounds react with oxygen and produce peroxide radical, which in turn attacks intact fatty acid and produces new radicals and hydroperoxide by their separation. Therefore, continuation of this chain-reaction may lead to more oxidation and destruction of fatty acids. Notably, the produced peroxide lacks taste and has an unpleasant smell. Finally, because of oxidation, the produced peroxide converts to aldehyde and ketone [5]. The free radicals resulting from this chain-peroxidation may affect the live cells and cause disorders such as cell necrosis in the immune system, digestion Epithelial, leucopenia, hair fall, lack of appetite, and cancerous tumors [6]. Many studies have supported the hypothesis that lipid peroxidation and impaired antioxidant status are implicated in the initiation of atherosclerosis [7]. This disorder results from the genetic and environmental factors and their mutual effects, which leads to lipid and lipoprotein changes in the serum and finally causes atherosclerosis [8]. Several methods may be used to evaluate the oxidation in oils; however, the peroxide value estimation is majorly preferred. Peroxide value measures the produced peroxide and hydroperoxide concentration at the beginning of the oxidation and its standard value is 5 meq/Kg [9].

Method

This was a case-experimental study. About 16 samples of consumed fat and 23 samples of unconsumed fat during the three steps at different intervals at the end of work were sampled based on National Standards and Industrial Research of Iran, No 493. Fat temperature, heating duration, type of fat consumption, and the type of cooking utensil were assessed and the samples were transferred to the food stuffs laboratory to evaluate the peroxide number of fat on the basis of National Standards and Industrial Research of Iran, No 4179 [9]. The method was as follows: the peroxide molecules in oil release the iodine from saturated iodide potassium. Thereafter; the released iodine was titrated with sodium thiosulfate in the presence of an indicator such as starch paste; and eventually, the number of peroxide mili equivalent of oil was determined for 1000 g sample by considering the weight of sample and the volume and normality of sodium thiosulfate. The data were analyzed using SPSS software, Pearson's correlation test, chi-square test, and Mann–Whitney U test.

Results and Discussion

The peroxide index in this research revealed that the average values of temperature in the 16 consumable and 23 inconsumable oils were 120 and 125.22 Degrees Celsius, respectively (Table 1). Moreover, the average values of frying times in the consumable and inconsumable oils were 1.5 and 2.61, respectively (Table 2). Essentially, 56.5% of the liquid oils and 17.4% of the solid oils were considered for frying, whereas 26.1% of the solid oils were inconsumable and were not used for frying purpose (Table 3). The results of the oil conditions with the kind of cooking utensil are presented in Table 4. The peroxide index in this research revealed that the average values of temperature in the 16 consumable and 23 inconsumable oils were 120 ± 6.325° and 125.22 ± 8.98°, respectively. These results indicated that a relationship existed between the peroxide value and temperature; however, it was not significant (p = 0.069). The average values of frying times in the consumable and inconsumable oils were 1.5 ± 0.51 and 2.61 ± 1.07, which revealed that a significant relationship was observed between the peroxide value and frying times (p = 0.001). About 56.5% of the liquid oils and 17.4% of the solid oils were applicable for frying and 26.1% of the solid oils were inconsumable and were not used for frying, which indicated a non-significant relationship between the peroxide value and type of oils (p = 0.74). A significant relationship was observed between the type of cooking dishes and the peroxide value. During this research, 16 places used allowable oils; in 13 places (81.3% of total) the cooking dish was made of zinc type material and in 3 places (18.8%), the cooking dish was a Teflon type. Twenty-three places used inconsumable oils, and the cooking dishes were as follows: 43.5% made of zinc, 43.5% Teflon type, and 13% fryer type. Based on our results, a significant relationship was observed between the peroxide value and the type of dishes ($p = 0.047$). Takeoka et al. studied the effect of temperature on fried oil characteristics and reported that heating of oils for a longer duration released several toxic and volatile compounds, which affect the food quality and pose hazard to the consumers' health. They stated that as the duration of heating and the number of repeated use of oil increased, the chemical reaction could enhance, and their results are in consistent with this study [10]. According to another study conducted in Yasuj city, in terms of sanitary at least, 50% and 70% of consuming oils had undesirable conditions in restaurants and sandwiches' respectively. Furthermore, the peroxide values in the consumable oils of restaurants and that used in making sandwiches were 58.3% and 97.3%, respectively, which were higher than the permissible level [11]. In a study conducted by Perez et al. in the Spanish and Mediterranean countries in 2002, it was reported that hamburgers fried in oil with high temperature caused high mutagenic activities in the consumers [12]. Compounds responsible for the mutagenic activities were usually heterocyclic compound and some of them were carcinogenic [13]. Studies on the mice showed that the consumption of oils contains oxidation produced in high temperature, caused teratogen effects and increased fetal abnormalities and anti-oxidation consumption with mentioned oils decreased these effects [14, 15]. Hadizadeh et al. reported that the peroxide values of the oils delivered to the foodstuffs control laboratory were 29.49, 9.57, 11.86, and 29.49% in 2005, 2006, 2007, and 2008, respectively, and these figures did not match the standard values [16]. The findings of the present study indicated that the generated peroxide in solid and nonfrying oils was less than the frying and liquid oils. The study carried out by Asemi et al. in Kashan in 2008 reported that the peroxide produced in the solid oil was less than that in the liquid and frying oil after three times frying [17], which are in good agreement with the results of this research. The results of this study indicated that several factors such as the use of improper and unstable oil directly above fire, nonstandard cooking patterns, untrained cooks and other interventional factors increase the production of peroxide and consequently affect the community health and provoke harmful health effects [18].

Table1. Type of oil and temperature

Type of oil	Samples	Temp. average	SD
Inconsumable oil	23	125.22 °C	8.98
Consumable oil	16	120 °C	6.32

Table 2. State oil and fry count

Type of oil	Fry count		
	Samples	Average	SD
Inconsumable oil	23	2.61	1.07
Consumable oil	16	1.5	0.51

Table 3. Kind and status of oil (p=0.74)

Oil	Status of oil (%)	
	Inconsumable	Consumable
Solid oil for frying	13 (56.5%)	11 (68.8%)
Frying oil	4 (17.4 %)	2 (12.5%)
Non-oil fries	6 (26.1%)	3 (18.8%)

Table 4. Status of oil and type of cooking dish (p=0.047)

Status of oil (%)	Type of cooking dish		
	Zinc	Teflon	Fryer
Consumable oil	13 (81.3)	3 (18.8)	0
Inconsumable oil	10 (43.5)	10 (43.5)	3(13)

Conclusion

The present study investigated the effective factors on the production of peroxide in the oil consumed in Iran. It was found that the type of cooking dishes is crucial in producing peroxide, and the generated peroxide in zinc dishes is less than in comparison with Teflon and frying dishes. Hence, it is necessary to evaluate the peroxide in cast iron in the future research. Collectively, the temperature, the repeated use of oil, the type of oil, and dishes are effective in estimating the peroxide values.

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