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Effect of using High Temperature on Nutritional Chemical Properties of Oils

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Abstract: Frying process causes changes in physical, chemical, nutritional and sensory properties of oils. Some products that produced during this process have been implicated in producing adverse health effects as they destroy vitamins, inhibit enzymes and could cause highly oxidized oils may also produce polyaromatic hydrocarbons which have carcinogenic effects. The aim of this research is to determine the effect of deep frying using high temperature (200°C) on nutritional chemical characteristics of commercial oils that include iodine number, peroxide value, acid value and saponification number. Chemical analyses of potato were (80.61%) for moisture (0.22%) for fat (1.54%) for protein (98%) for ash and (46%) for fiber. Iodin number was decreased depend of increased of number of potato frying times. Significant differences (p• 0.05) were observed for iodine number between types of oils as well as among number of frying times. Peroxide value, acid value and saponification number were increased depend on increased of number of potato frying times. Significant differences (p• 0.05) for these values between types of oils as well as among number of frying times. However, no significant differences were observed for saponification number between types of oils. Results from this research indicate that deep frying using high temperature (200°C) significantly affects the nutritional chemical characteristics of oils.

Key words: Oils, temperature, nutritional, chemical properties, acid value, saponification

INTRODUCTION

Fried foods have desirable flavor, color and crispy texture which make deep-fat fried foods very popular to consumers (Boskou *et al*., 2006). Frying is a process of immersing food in hot oil with a contact among oil, air and food at a high temperature of 150-190°C (Yamsaengsung and Moreira, 2002). It is primarily a dehydration process which means that water and water-soluble substances are extracted from the product being deep fried and transferred to the cooking fat (Choe and Min, 2007). Oils play a dual role in the preparation of fried foods because they serve as a heat transfer medium between the food and the fryer and they also contribute to the food's texture and flavor characteristics (Tseng *et al*., 1996). During the frying process, oil undergoes changes in physical, chemical, nutritional and sensory properties which affects its frying performance (Ramadan *et al*., 2006). The repeated use of oil could affect the shelf life and nutritional quality as bioactive compounds of fried foods due to the development of rancidity in the frying oil taken up by the products (Man and Jaswir, 2000; Santos *et al*., 2018).

High frying temperature, associated with the presence of air and moisture, lead to production of breakdown products that include volatile and non-volatile compounds. These products result from oxidation of unsaturated fatty acids, lipid hydrolysis and transformation of linear fatty acids in cyclical compounds and fatty acid or lipid polymerization. The volatile products such as aldehydes are lost during the frying process, the non volatile fraction remains in the frying medium and is absorbed by the fried food. Some of these remaining products have been implicated in producing adverse health effects as they destroy vitamins, inhibit enzymes and could cause mutations or gastrointestinal irritations (Clark and Serbia, 1991).

MATERIALS AND METHODS

Analysis of potato

Moisture determination: Moisture for potato was determined according to, AOAC. (1970).

Fat determination: Fat for potato was determined according to, AOAC. (1989).

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Protein determination: Protein for potato was determined, according to (Kjeldahl method) that was reported by AOAC. (1980).

Ash determination: Ash for potato was determined according to, AACC. (1976).

Fiber determination: Fiber for potato was determined according to, AACC. (1976).

Chemical analyses for oils:
Iodin number determination: Iodin number was determined according to, Hanes method that was reported by AOAC. (1970).

Peroxid value, acid value and saponification number determination: Peroxid value, acid value and saponification number were determined according to, Pearson and Henry (1976).

Statistical analysis: Completely Random Dand Least Significant Design (LSD) were used for statistical analysis.

RESULTS AND DISCUSSION

Analysis of potato: Content of potato that grown in Iraq at fall was shown in Table 1. High percent of moisture (80.61%) while protein percent was (1.54%). Low percent of fat was found in potato (0.22%). Ash and fiber percent were (0.98%) and (0.46%), respectively.

Iodin number: Effect of number of frying times for oils under study on iodine number during potato frying at high temperature (200°C) were shown in Table 2. Results indicated that decreased of iodine number for oils depend of increased of number of potato frying times. This may be attributed to break down of unsaturated bonds (Choe and Min, 2007). The iodine number is a measure of the degree of unsaturation that is widely used to characterize fats and oils. The iodine number is expressed in terms of a percentage of the absorbed iodine. A decrease in the iodine number is consistent with the decrease in double bonds as an oil becomes oxidized. As shown in Table 2, iodin number for oils (1-4) before heating treatment were (132.4, 123.6, 136.3, 128.1) while these values were decreased to (122.5, 114.8, 127.8, 118.7), respectively, after six times of frying. The higher significant ($p<0.05$) change in the iodine number was shown by oil (4), thus, indicating that the highest decrease in double bonds occurred in this oil during frying. This observation could be due to the presence of a high amount of PUFAs.

Table 1: Content of potato

Fiber	Ash	Fat	Protein	Moisture	Content
0.46	0.98	0.22	1.54	80.61	%

Table 2: Effect of number of frying times using high temperature (200°C) on iodine number for oils

	Types of oil			
No. of frying	1	2	3	4
Before	132.4	123.6	136.3	128.1
After first	130.7	121.8	135.4	126.3
After second	129.2	120.8	134.1	124.2
After third	128.1	119.3	133.4	123.0
After fourth	126.5	118.6	131.9	121.3
After fifth	124.6	116.7	130.0	120.3
After sixth	122.5	114.8	127.8	118.7

Table 3: Effect of number of frying using high temperature (200°C) on peroxid value (milli equivalents/kg) of oils

	Types of oil			
No. of frying	1	2	3	4
Before	1.10	1.4	2.1	2.4
After first	2.30	4.3	4.2	5.3
After second	2.90	5.6	5.1	6.1
After third	6.10	6.2	5.4	6.5
After fourth	8.20	7.7	5.9	6.9
After fifth	10.6	8.9	6.2	7.4
After sixth	13.7	9.4	7.1	8.5

The greater the unsaturation (or high iodine number), the more rapid the oil tends to be oxidized, particularly during deep-fat frying (Alireza *et al*., 2010). Overall, oil (3) had the highest stability against lipid oxidation; therefore, the formulation of oil (3) is a good choice for deep-fat frying, results of this study showed that there were significant differences ($p• 0.05$) between types of oils as well as between number of frying times. Results of this study were agreement with Al-Zamily (1980) and Irshad *et al.* (1999). Al-Zamily indicated that iodine number for three oils before frying treatment were (136.3, 124.9, 54.3), respectively but these values were decreased after frying treatment for potato slices at 180°C for 90 h to (114.8, 105.9, 40.3), respectively. Rastogi *et al.* (2006) also reported a significant decrease in iodine number of cooking oils after deep-frying.

Peroxide value: Effect of number of frying times for oils on peroxide value during potato frying for oils (1-4) at 200°C were shown in Table 3. Unlike iodine number, peroxide value in this study was increased for all types of oils depend on increased of number of potato frying times because of formation of active free radicals due to available unsaturated bonds and other cofactors like light and heat, thereby these free radical will convert to peroxides in case of available of oxygen. As shown in Table 3, peroxid value for oils (1-4) before heating

treatment were (1.1, 1.4, 2.1, 2.4) while these values were increased to (13.7, 9.4, 7.1, 8.5), respectively, after six times of frying. Results of this study showed that there were significant differences (p• 0.05) between types of oils as well as between number of frying times. Results of this study were consistent with findings from previous studies such as El-Sharkawi *et al.* (1983), Irshad *et al.* (1999) and Drozdowski *et al.* (1999) where they indicated that peroxide value was increased based on increase of frying temperature and number times of frying.

Acid value: Acid value is a measure of the free fatty acids in the oil. Normally, fatty acids are found in the triglyceride form, however during processing the fatty acids may get hydrolyzed into free fatty acid. The higher the acid value found, the higher the level of free fatty acid which translates into decreased oil quality. Acceptable levels for all oil samples should be below 0.6 mg KOH/g (measured in potassium hydroxide per gram) (AOCS., 2003). Effect of number of frying times for oils on acid value during potato frying at for oils (1-4) at 200°C were shown in Table 4. Results indicated that increased of acid value for oils depend of increased of number of potato frying times because of increased of free fatty acids due to hydrolysis during frying treatment (Pearson and Henry, 1976). As shown in Table 4, acid value for oils (1-4) before heating treatment were (0.29, 0.24, 0.20, 0.26 mg KOH/g) while these value increased to (0.40, 0.38, 0.36, 0.41), respectively, after six times of frying. Higher increase in acid value after sixth frying was in oil (3) while the lower increase was in oil (1). Results of this study showed that there were significant differences (p• 0.05) in acid value between types of oils as well as between number of frying times.

Results of this study showed that there were significant differences (p• 0.05) between types of oils as well as between number of frying times. Results of this study were agreement with Abdel-Rahman (1984) who is showed that increased of acid value during frying of potato in four types of oils (cotton seed oil, soybean oil, sunflower oil and corn oil) at 180°C -+2. Also, it agreement with Hazuka *et al.* (2000) who is indicated that acid value for liquid and hydrogenated sulfur seed oil was increased from (0.2, 0.5-1.3,1.5 mg KOH/g), respectively. Results in the present study indicated that all oil brands had acceptable acid value after frying as per codex standard (1999) (0.6 mg KOH/g).

Saponification number: Saponification number is an indication of the molecular weights of triglycerides in oil. It is inversely proportional to the average molecular weight or chain length of the fatty acids (Muhammad *et al*., 2011). Effect of number of frying times on saponification number during potato frying for oils (1-4) at 200°C were shown in Table 5. Saponification number in this study was increased for all types of oils depend on increased of number of potato frying times because of increase the low molecular weight fatty acids due to autooxidation and break down for oils. As shown in Table 5, saponification number for oils (1-4) before heating treatment were (182.57, 196.48, 176.98, 198.87) while these values increased to (213.39, 216.25, 214.36, 217.28), respectively, after six times of frying. Results of this study showed that there were significant differences (p• 0.05) in saponification number between number of frying times but no significant differences between types of oils. Results of this study were agreement with Al-Zamily (1980), Irshad *et al.* (1999) and Hani and Samir (2003). Hanna indicated that saponification number for three oils before frying treatment were (193.54, 171.0, 199.15), respectively but these values were increased after frying treatment at 180°C to (208.16, 208.15, 211.76), respectively. Onigbogi and Sowunmi also observed a significant decrease in saponification number of oils after deep-fat frying.

Table 4: Effect of number of frying using high temperature (200°C) on acid value (mg KOH/gm) of oils

	Types of oil			
No. of frying	1	2	3	4
Before	0.29	0.24	0.20	0.26
After first	0.31	0.27	0.23	0.29
After second	0.32	0.30	0.25	0.31
After third	0.34	0.32	0.27	0.33
After fourth	0.35	0.33	0.30	0.35
After fifth	0.37	0.36	0.32	0.38
After sixth	0.40	0.38	0.36	0.41

Table 5: Effect of number of frying using high temperature (200°C) on saponification number of oils

	Types of oil			
No. of frying	1	2	3	4
Before	182.57	196.648	176.98	198.87
After first	198.34	201.680	199.77	203.95
After second	203.39	205.820	202.65	206.79
After third	208.23	209.120	206.91	209.68
After fourth	210.58	212.230	209.88	213.13
After fifth	212.49	214.680	212.48	215.83
After sixth	213.39	216.250	214.35	217.28

CONCLUSION

Highly oxidized oils may also produce polyaromatic hydrocarbons which have carcinogenic

effects where the levels of oxidation products in the oils increased with the frying frequency (Koh and Surh, 2015).

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