Nat. Volatiles & Essent. Oils, 2022; 9(2): 160-166

NVEO
Natural Volatiles &
Essential Oils

Effect Of Microwave Oven Exposure On Olive Oil Stability Against Oxidation

Saif Nabeel Qasim and Shaymaa Riyadh Abdulsalam

Department of Food Science, College of Agriculture and Forestry, University of Mosul, Nineveh, Iraq.

Abstract

The study aimed to investigate the effect of microwave radiation at different exposure periods (0, 2, 4, 6, 8, or 10 min) on the chemical composition and physical and chemical properties of olive oil. The effect of microwave radiation on olive oil was also tested after adding some antioxidants including vitamin E, BHT and BHA at concentrations of 300, 400, 500) ppm, respectively. The measurements included calculating the pH, peroxide, viscosity, density, refractive index and absorbance (UV at wavelengths of 232 and 270 nm). The results showed that exposing olive oil to microwave rays increased, although not significant, in acidity number, refractive index and density. On the other hand, the values varied between significant and insignificant with respect to smoking point and viscosity until the end of the exposure period, while the absorbance increased at wavelength 232 and 271 nm with increasing exposure period.

Keywords: olive oil, pH, refractive index, UV absorbance, BHA

INTRODUCTION

Microwave cooking is one of the newest cooking methods compared to traditional methods such as roasting, grilling and roasting, and the best quick methods for heating food. The use of these ovens has contributed to an increase in their use all over the world (Fadl, 2007). Olive oil has been known for a long time and has proven a great superiority over the rest of vegetable oils, not only in terms of nutritional value, but also for other reasons, by virtue of its natural production and manufacture, far from chemical and thermal conditions. Olive oil is a natural fatty food, and olive oil has nutritional and biological properties that are unmatched among other oils. It contains unsaturated fatty acids, including the essential fatty acid linoleic, and vitamins, including vitamin E or tocopherols, which are the most important compounds that resist oxidation and help preserve oil for a long time (Tombesi, 1994 and Khalif, 2000).

Antioxidants are useful compounds that are available in natural forms in the form of phenolic compounds in colorful fruits and fresh vegetables. These compounds are distinguished by their superior ability to protect the cells of the body from damage, as antioxidants contribute to preventing free radicals from attacking and destroying the cells of the body (Ojo and Ladeji, 2005). There are also industrial antioxidants in the form of phenolic compounds such as BHT (Butylated Hydroxy Toluene), BHA (Butylated

Hydroxyanisole), P.G (Propyle galate) and others. In general, these compounds are added to oils in particular, in certain concentrations, as compounds that help to hinder the oxidative rancidity of the oil and prolong the shelf life (Rodrigo (2009).

Amira (2014) noted that the pH value remained constant and almost unchanged when olive oil was exposed for 15 minutes to microwave radiation. Whereas, Ricardo et al. (2009) reported that the density value increased in olive oil samples exposed to microwave radiation for 16 min. They also noticed that the amount of increase in oil density depends on the amount of polymers formed, the type of fatty acids, and the location of the double bond. Therefore, this study aimed to aimed to evaluate the effect of microwave radiation at different exposure periods on the chemical composition and physical and chemical properties of olive oil treated or fortified with some phenol antioxidants.

MATERIALS AND METHODS

Virgin olive oil, cold extracted from fresh local fruits, was used for the 2018 season. The samples were kept in dark bottles, tightly closed under refrigeration until use in the experiments under study. In case of microwave oven treatments, the oil was treated with microwave using MW type Nikai NMO-502N Japan, at a frequency of 2450 MHz for the periods of time 2, 4, 6, 8 and 10 minutes and the voltage difference was 220 volts, and the changes in the different characteristics were observed. The temperature of the oil immediately after each treatment.

Added antioxidants

Three types of antioxidants, namely Butyl Hydroxy Anisole (BHA), Butyl Hydroxy Toluene (BHT) and Vitamin E, were added in the quantities of 300, 400, and 500 ppm, respectively. The effect of the added antioxidants on the different properties of the microwaved oil under study was observed.

Measurements

As for the acidity value of the oil, it was estimated using potassium hydroxide (A.O.A.C., 2004) method. Peroxide value was also estimated using potassium iodide (Pearson (1973). The experiment also included determination of the refractive index and dissolved solids of samples using the Abbe Refractometer at laboratory temperature (AOAC, 2000), the determination of the density of the oil using a special density Pycnometer vial of 25 ml (Pearson, 1973).

On the other hand, the absorbance of the oil was tested in the ultraviolet spectrum using a dual-beam spectrophotometer, UV 1800 from Shimadzu company, according to the method recommended by IUPAC, 1987), where the absorbance was measured for all samples and in the presence of the comparison sample. (cyclohexane) at wavelengths of 232n.m and 270 nm.

In oil samples, the dynamic viscosity was estimated using the Brookfield device according to the method described by Rasul (2010)

Statistical Analysis

The treatments in the experiment were distributed according to the factorial experiment using a complete randomized design (Factorial Experiment Conducted in C.R.D.) (Al-Rawi and Khalaf Allah (2000). The SAS (2001) program was used for data analysis, and the averages were tested by Duncan's Multiple Range Test (P≤0.05).

RESULTS AND DISCUSSION

The results showed an increase in the pH values of olive oil samples exposed to microwave oven and treated with antioxidants (Table 1). In general, the increase in pH values was accompanied by an increase in the exposure time, and the highest values were after exposure for 8 minutes. The increase in the pH value of the treated oil samples may be due to the decomposition of fatty acids, especially the unsaturated ones. This is due to some active factors such as light, oxygen and others (Khalif and

Table 1. Effect of exposing period to microwave on pH values of olive oil fortified with different antioxidants

Antioxidants (treatments)	Exposure time to microwave radiation (min)					
	0	2	4	6	8	10
Blank	0.220 a	0.230 a	0.230 a	0.250 a	0.260 a	0.260 a
BHA	0.220 a	0.220 a	0.220 a	0.230 a	0.230 a	0.230 a
Vt. E	0.220 a	0.210 a	0.210 a	0.220 a	0.240 a	0.230 a
BHT	0.220 a	0.220 a	0.230 a	0.230 a	0.240 a	0.240 a

*Values are means of three replications, and the antioxidant treatments are: Blank (B), Butyl Hydroxy Anisole (BHA), Vitamin E (Vt. E), and Butyl Hydroxy Toluene (BHT).

Al-Esh, 1998), and the high acidity is evidence of the hydrolysis and isolation of free fatty acids (AOCS, 2009).

The results of Table (2) indicate that the values of the peroxide number for olive oil samples increased with the increase in the microwave exposure period until the fourth minute, then the peroxide values decreased with the increase in the microwave exposure period until the end of the period. The high values of hydroperoxides may be due to the interaction of oxygen with unsaturated fatty acids, which are primary products of this reaction. Then these values begin to decrease at a temperature of 180C° and above due to the demolition of peroxide compounds and their transformation into intermediate compounds (Obrine , 2009; Rasul, 2010), and this is similar to the results obtained by Abaas et al. (2016).

As for the density, Table 3) shows the increase in the density values for olive oil samples fortified with different antioxidants and treated in a microwave oven, and this increase continued until the end of the exposure period (10 minutes). The highest value of the oil density was in the comparison treatment at 10 minutes of exposure, and it was 0.930 g/cm3, and the lowest for oil samples before the exposure was 0.910 g/cm^3.

Table 2. Effect of exposing period to microwave on peroxide values of olive oil fortified with different antioxidants

Antioxidants (treatments)	Exposure time to microwave radiation (min)					
	0	2	4	6	8	10
Blank	20.000a	20.700a	21.800a	21.700a	21.400a	21.000a
BHA	20.000a	20.930a	21.370a	21.300a	21.250a	21.100a
Vt. E	20.000a	20.900a	21.500a	21.8420a	21.380a	21.200a
BHT	20.000a	20.950a	21.420a	21.300a	21.300a	21.150a

*Values are means of three replications, and the antioxidant treatments are: Blank (B), Butyl Hydroxy Anisole (BHA), Vitamin E (Vt. E), and Butyl Hydroxy Toluene (BHT).

Table 3. Effect of exposing period to microwave on density values of olive oil fortified with different antioxidants

Antioxidants (treatments)	Exposure time to microwave radiation (min)					
	0	2	4	6	8	10
Blank	0.910 a	0.910 a	0.910 a	0.920 a	0.920 a	0.930 a
BHA	0.910 a	0.910 a	0.920 a	0.910 a	0.920 a	0.920 a
Vt. E	0.910 a	0.910 a	0.920 a	0.920 a	0.920 a	0.920 a
BHT	0.910 a	0.910 a	0.920 a	0.920 a	0.920 a	0.920 a

*Values are means of three replications, and the antioxidant treatments are: Blank (B), Butyl Hydroxy Anisole (BHA), Vitamin E (Vt. E), and Butyl Hydroxy Toluene (BHT).

Similarly, the viscosity value of olive oil samples enriched with antioxidants increased with increasing exposure time to microwaves (Table 4). The highest value of the viscosity of olive oil was recorded for the control treatment which was 54.300 c.p in a period of 10 minutes of exposure, while the lowest value 48.00 c.p. of the oil viscosity was recorded before the exposure to the microwave.

Refractive index: The results (Table 5) showed that the values of the refractive index of olive oil samples enriched with different antioxidants and treated with microwave oven, witnessed a slight increase in all treatments until the end of the exposure period. The highest value recorded for the refractive index was 41.480 in the control treatment at the end of the exposure period 10 minutes compared to the lowest value that was recorded in the treatments before exposure in a period of 2 minutes and it was 1.4765.

Table 4. Effect of exposing period to microwave on viscosity value of olive oil fortified with different antioxidants

Antioxidants (treatments)	Exposure time to microwave radiation (min)					
	0	2	4	6	8	10
Blank	41.000 a	41.800 a	41.700 a	41.700 a	43.000 a	43.500 a
BHA	41.000 a	41.350 a	41.730 a	41.800 a	42.684 a	43.250 a
Vt. E	41.000 a	41.430 a	41.200 a	41.450 a	42.850 a	43.010 a
BHT	41.000 a	41.220 a	41.600 a	41.800 a	42.300 a	43.200 a

*Values are means of three replications, and the antioxidant treatments are: Blank (B), Butyl Hydroxy Anisole (BHA), Vitamin E (Vt. E), and Butyl Hydroxy Toluene (BHT).

Table 5. Effect of exposing period to microwave on refractive index of olive oil fortified with different antioxidants

Antioxidants (treatments)	Exposure time to microwave radiation (min)					
	0	2	4	6	8	10
Blank	1.4654a	1.4654a	1.4676a	1.4687a	1.4687a	1.4698a
BHA	1.4655a	1.4664a	1.4677a	1.4688a	1.4688a	1.4699a
Vit E	1.4654a	1.4664a	1.4677a	1.4698a	1.4708a	1.4708a
BHT	1.4654a	1.4654a	1.4675a	1.4695a	1.4707a	1.4709a

As for the effect of different treatments on the absorbance of ultraviolet rays in the treated oil, the results showed an increase in the absorption curve of ultraviolet rays at the wavelength of 232 nm for olive oil samples treated with microwave oven and antioxidants. The rise began at the sixth minute of exposure and continued until the end of the period, and that the control treatment recorded the highest values, followed by the sample supplemented with BHT, then supplemented with BHA, and finally fortified with vitamin E.

The UV absorbance at 270 nm wavelength was also tested for olive oil samples treated with microwave oven and anti-oxidants. The results (Fig. 2) showed that the absorbance values began to rise after the fourth minute of exposure until the end of the period, and the highest values were recorded in the comparison treatment, followed by the sample fortified with vitamin E, then the sample treated with BHT, and finally the sample to which the antioxidant BHA was added.

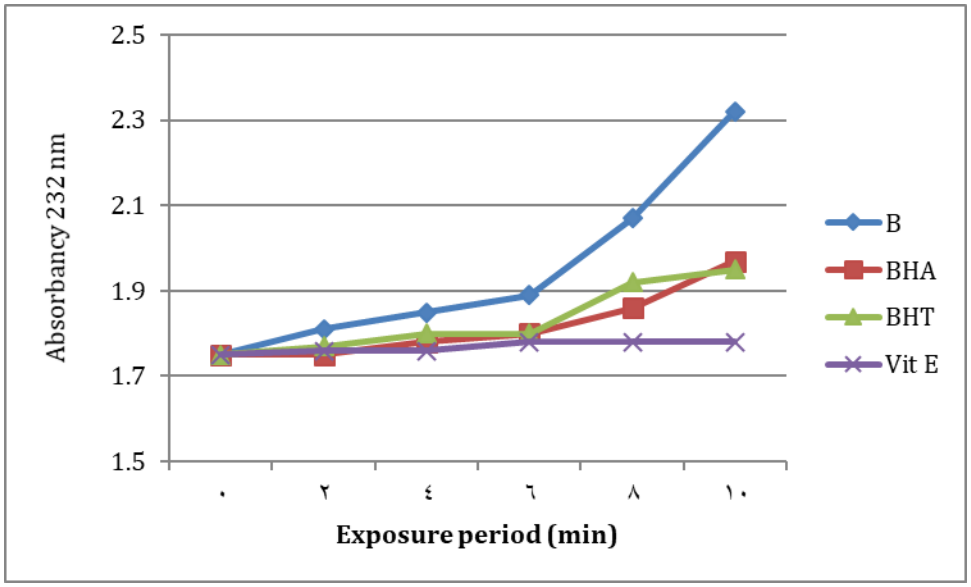

Figure 1. UV absorbance (at 232 nm wavelength) of olive oil treated with antioxidants (Blank (B), Butyl Hydroxy Anisole (BHA), Butyl Hydroxy Toluene (BHT) and Vitamin E) and exposed to microwave radiation

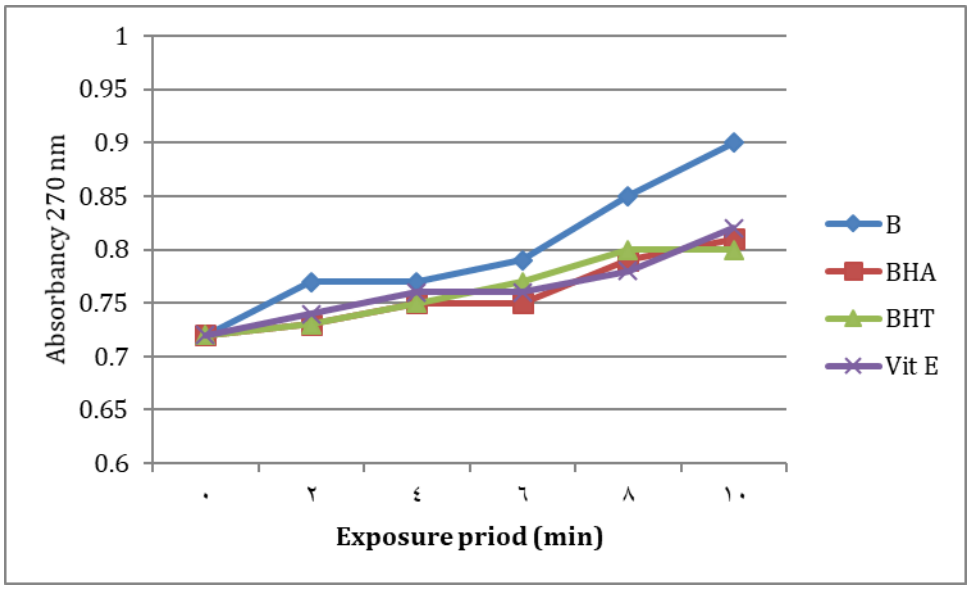

Figure 2. UV absorbance (at 270 nm wavelength) of olive oil treated with antioxidants (Blank (B), Butyl Hydroxy Anisole (BHA), Butyl Hydroxy Toluene (BHT)) and exposed to microwave radiation

CONCLUSION

The findings of this study showed that exposing olive oil to microwave for short periods had no negative effects on the oil quality. Moreover, the microwave treatments increased acidity, refractive index and density of the treated olive oil. On the other hand, some other olive oil traits including smoking point and viscosity were also affected by the exposure periods to microwave oven, the absorbance increased with increasing exposure period.

ACKNOWLEDGMENT

The authors are very grateful to the University of Mosul/College of Agriculture and Forestry for supporting and providing facilities to improve the quality of this work.

REFERENCES

Al-Rawi KM and Khalafallah AA (2000) Design and analysis of agricultural experiments. Directorate of Books House for Printing and Publishing. University of Al Mosul.

Khalif M and El-Esh M (1998) Effect of oil storage time on oil quality.

Khalif M (2000) Olive oil: properties, specifications and means of extraction. Article in the scientific symposium held in Sakiet Al-Daer, Tunisia.

Rasoul NH (2010) Effect of deep frying of some foods in sunflower oil on the physical, chemical and nutritional properties of the oil upon sensory rejection. (PhD thesis) University of Sulaymaniyah.

Fadl, T. I. (2007). Awareness and attitude of Saudi women to the effect of cooking foods in a microwave oven. (Master's Thesis) Saudi Arabia.

Abbas, M., M.Hadi Bin Mesran. R.Abd Latip., N.Hidayu and N.A.Nik (2016). Effect of microwave heating with different exposure times on the degradation of corn oil. International Food Research Journal **23**(2), 842-848.

Amira, Y., R.Ghayth and Ridha Ben Salem(2014). Microwave Heating of Different Commercial Tunisian Oliv Oil: Regarding to Exposure Times on Physical and Chemical Parameters Properties. Biochemistry and Physiology Open Access J **3**(2).

AOAC (2004) Association of official Analytical chemists 12th ed., Washington, D. C.

AOAC (2000) Association of Official Analytical Chemist. Official Methods of Analysis USA .Refractive, 921-58.

AOCS (2009) Official Methods and Recommended Practices of the American Oil Chemists Society. USA.

O'Brien, R. D. (2009). Fats and Oils (Formulating and Processing for Applications). Third edition. CRC Press is an imprint of Taylor & Francis Group, an Informa business. London – New York.

IUPAC (1987) Standard Methods For the Analysis of Oils and Fat and Drivativs.

SAS (2001) SAS Users guide : Statistical system ,Inc. Cary, NC.USA.

Ojo OO and Ladeji O (2005) Hepatoprotective and antioxidant pnperties of Carmellia Sinensis (black tea) in rats. African J. Biotechnology **4**(11), 1432-1438.