Journal of Food and Dairy Sciences

Journal homepage & Available online at: www.jfds.journals.ekb.eg

Impact of Using Ultrasound on Chemical Properties and Bioactive Compounds of Olive Oil Extracted from Olive Paste

Asma G. Mhmod[1*]; A. A. M. Zetoun[1]; G. M. Hamad[2]; M. E. Elsorady[3] and M. A. M. Zeitoun[1]

[1] Food Science Department, Faculty of Agriculture Saba Basha, Alexandria University, Alexandria, Egypt.
[2] Department of Food Technology, Arid Lands Cultivation Research Institute, City of Scientific Research and Technological Applications, New Borg El-Arab, Alexandria, Egypt.
[3] Oils and Fats Research Department, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Cross Mark

ABSTRACT

Impact of using ultrasound technology on quality and extraction yield of Coratina and koroneiki olive oil was studied. The application of ultrasound treatment was done to olive paste for 0, 2, 4, 6, 8 and 10 minutes. Oil yield significantly increased 16.65, 18.33% for Coratina and Koroneiki, respectively. Olive paste temperature was increased from 22ºC (after crushing) to about 23, 25, 26.5, 28 and 30 ºC after 2, 4, 6, 8 and 10 minutes of ultrasound, respectively. All examined samples had low contents of FFA, PV, K_{232} and K_{270} and there are no differences in FFA, K_{232}, K_{270} and lipid profile between untreated sample and treated sample with ultrasound for both cultivars. Furthermore, obtained olive oil by ultrasound showed total tocopherols, chlorophyll and carotenes significantly higher than untreated one. Total tocopherols were significantly increased from 5.81 and 4.62% after 10 minutes of sonication for Coratina and Koroneiki, respectively. Chlorophylls were increased after sonication. Carotenes were increased 20.13 and 39.68% after 10 minutes of sonication for Coratina and Koroneiki, respectively. Also, sonicated samples showed decrease in total phenols. It significantly decreased total phenols by 14.53 and 14.24% after 10 min for Coratina and Koroneiki, respectively. Results indicated that the increment time of ultrasound had an increase in fruity attribute and had a decrease in bitterness and pungency intensities. The use of ultrasound had not altered olive oil quality, as extra virgin olive oil in accordance with International Olive Council. So, ultrasound could be a suitable technology for improving olive oil yield.

Keywords: Ultrasound; virgin olive oil; coratina; koroneiki; quality; olive paste

INTRODUCTION

The best appreciation of virgin olive oil was related to its organoleptic properties, chemical composition and bioactive components (e.g. phenols, tocopherols, sterols…etc) (Visioli and Galli 1998). It is extracted by physical or mechanical method from olive fruit (*Olea europaea L.*) (IOC, 2022). The continuous method for olive oil extraction involves steps: (1) milling fruits for cells smash and oil droplets release, (2) olive paste malaxation to prompt merging of oil droplets, (3) decanting and centrifugation processes. The malaxation process increases the yield about 5% more than others have not this process. It is high amount in olive oil processing (Puértolas and Martinez de Maranon, 2015; Andreou *et al.*, 2017).

Continuous method had low efficiency where it extracted about 80% of oil content in olive fruit. The oil remain is still intracellular or emulsion with water. This is related to olive cultivars and extraction circumstances (Aguilera *et al.*, 2010; Clodoveo and Hbaieb, 2013). Increments of malaxation period and/or temperature are used to improve extraction. However, these actions are limited for the negative impact on sensory attributes (Anegrosa *et al.*, 2001).

The malaxation process is carried out in a stainless steel chamber equipped with blades. Olive paste is warmed at 27–29°C for up to 30-45min or may reach up to 90 min then transferred to the decanter. During the process, cell walls of olive break by natural enzymes, release oil, and enhance merging of oil droplets and encourage oil separation in the next process (Leone *et al.*, 2017). Critical process parameters like more time or/and temperature during malaxation have a defect on the extracted oil. For that reason, we should find an innovative technology to achieve equilibrium between quantity and quality.

Emerging technology like ultrasound that alters the cell permeability, promotes the extraction of olive oil process during malaxation, as the consequence for higher oil quantity. Ultrasound technology can decrease the preheating time where sound waves propagate through plant tissues. Part of waves is taken in and transformed into heat. Also, it has mechanistic action and has the ability to damage olive cells, therefore releasing bioactive components like polyphenols, V.E, chlorophyll plus carotenoids (Clodoveo *et al.*, 2013a). The extraction conditions have a significant effect on olive oil quality. The objective of this research was to evaluate of applying novel technology such as ultrasound treatment on olive oil yield and quality.

MATERIAL AND METHODS

Materials:

Coratina and Koroneiki cv. olive fruits were collected during season 2021-2022 from Giza, Egypt, and were transported immediately to lab. The fruits had the same index of maturity (3.0).

All chemicals and reagents used (analytical and HPLC grades) were bought from El-Nasr pharmaceutical

*** Corresponding author.**
E-mail address: faragakrm@gmail.com
DOI: 10.21608/jfds.2023.202208.1105

Chemical Company, Alexandria, Egypt, and from E. Merck (Darmstadt, Germany).

Methods:

Extraction of olive oil:

Coratina and Koroneiki cvs were grinded by a laboratory crusher thereafter malaxation step for olive paste by a laboratory blender for 30 minute at 25°C. Malaxed paste was put in cloth thereafter was compressed by Carver hydraulic press. Obtained juice was centrifuged and superior liquid (oil) was gathered, dried and filtered by anhydrous Na_2SO_4 and filter paper. Oil was kept in dark bottles at -5°C (Elsorady, 2020).

Oil yield (%) and Oil extractability were calculated by the following equations (Carrapiso *et al.*, 2013).

$$\text{Oil yield (\%)} = \frac{\text{Oil volume (cm3)} \times 0.915}{\text{Weight of paste (g)}} \times 100$$

$$\text{Oil extractability} = \frac{\text{Oil yield}}{\text{Oil content}} \times 100$$

Ultrasound treatment:

Olive paste was sonicated by ultrasonic waves, a SELECTA ultrasonic bath with the following specifications: 300×140×150 mm tank dimensions, 6L tank capacity, 150 w power generator and 40 KHz frequency. Olive paste was bottled and put into bath was filled with distilled water. Olive paste was treated with ultrasound waves for various times (0, 2, 4, 6, 8 and 10 minutes) and temperature were monitored. After ultrasound treatment, olive paste was directly processed by malaxation (Gila *et al.,* 2021).

Analytical parameters of virgin olive oil quality

Free fatty acids % (FFAs), peroxide values (PV) and ultraviolet (UV absorption (K_{232}, K_{270} and Δk) were identified in accordance with the described methods by IOC (2022).

Bioactive compounds:

Total phenols:

The determination total phenols were done in accordance with Gamez-Meza et al. (1999) method using Folin-Ciocalteu reagent.

Total tocopherols:

The determination total tocopherols were done in accordance with Wong et al. (1988) method. The expressed tocopherol content was as mg/kg α-tocopherol.

Chlorophyll and Carotenoids content:

Chlorophyll and carotenoids were determined according to Minguez-Mosquera et al. (1991) method. The expressed values were as mg/kg.

Oxidative stability:

The determination of oil stability was done using Rancimat apparatus at 100ºC according to Gutierrez (1989) method.

Fatty acid composition:

Methylesters of fatty acids were esterified by methanolic solution with KOH. Methylesters of fatty acids were separated and quantitatively determined using Gas-Liquid Chromatography (Agilent 6890 series GC) according to described method by IOC (2017).

Sensory evaluation:

Organoleptic assessment of olive oils was evaluated in accordance with the described assessment by IOC (2018).

Statistical analysis:

Statistical analysis was done by SPSS program version 16^{th}.

RESULTS AND DISCUSSIONS:

Impact of ultrasound on olive paste temperature:

Energy of ultrasound wave is converted into heat through plant cells (Clodoveo *et al.,* 2013a). Figure (1) showed sonication time effect on temperature of olive paste. A positive relation between sonication time (2, 4, 6, 8 and 10 min) and temperature of olive paste is observed. Olive paste temperature was increased as sonication time was extended. Results revealed that olive paste temperature after crushing was 22ºC. It was increased about 2 ºC from room temperature (20ºC) because of mechanical energy of crushers is converted to heat energy (Clodoveo *et al.,* 2013a). Olive paste temperature was increased from 22 ºC (after crushing) to about 23, 25, 26.5, 28 and 30 ºC after 2, 4, 6, 8 and 10 minutes of ultrasound, respectively. The obtained results agreed with Jiménez *et al.* (2007), Clodoveo and Hbaieb, (2013), Clodoveo *et al.* (2013a) and Gila *et al.,* (2021). Wave kinetic energy is converted into thermal energy in the matter (Legay *et al.,* 2012).

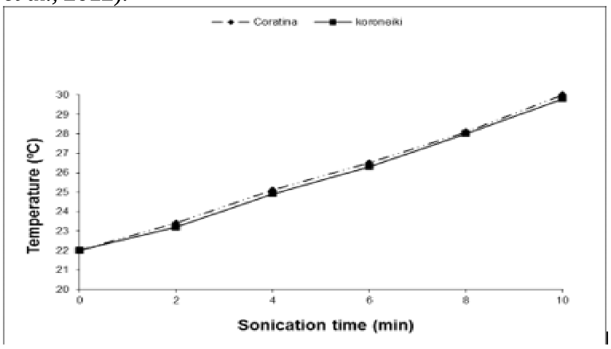

Fig. 1. Impact of sonication time on temperature of olive paste.

Impact of ultrasound treatment on yield and extractability of oil:

The impact of ultrasound treatments on oil yield and extractability are indicated in Fig. (2). and Table (1). Data indicated that olive paste treated with ultrasound waves can improve oil yield and extractability. It is agreed with Jiménez *et al.* (2007); Clodoveo *et al.* (2013a). Results revealed that there is significantly increment in yield and extractability until 10 minutes of ultrasound treatments for studied varieties. After 10 min of ultrasound treatment, yield was significantly increased 16.65% from 10.69 to 12.47 % for Coratina and 18.33% from 10.20 to 12.07% for Koroneiki. Oil extractability was significantly increased 19.33% from 57.85 to 69.03% for Coratina and 21.52% from 56.97 to 69.23% for Koroneiki.

Table 1. Ultrasound impact of coratina and koroneiki olive paste on oil yield and extractability.

Variables	Ultrasound time (minute)					
	0	2	4	6	8	10
			Coratina			
Oil yield(%)	10.69±0.19 ^{a}	11.18±0.19 ^{b}	11.63±0.09 ^{c}	11.93±0.06^{d}	12.13±0.06 ^{d}	12.47±0.15 ^{e}
Extractability (%)	57.85±1.18 ^{a}	60.92±1.18 ^{b}	63.79±0.52 ^{c}	65.72±0.36 ^{d}	66.98±0.37 ^{d}	69.03±0.97 ^{e}
			Koroneiki			
Oil yield (%)	10.20±0.10 ^{a}	10.67±0.06 ^{b}	11.10±0.10 ^{c}	11.63±0.06 ^{d}	11.97±0.06 ^{e}	12.07±0.15 ^{e}
Extractability (%)	56.97±0.66 ^{a}	60.04±0.38 ^{b}	62.88±0.66 ^{c}	66.39±0.38 ^{d}	68.57±0.38 ^{e}	69.23±1.00 ^{e}

***a-e letters indicate significant difference ($p < 0.05$).**

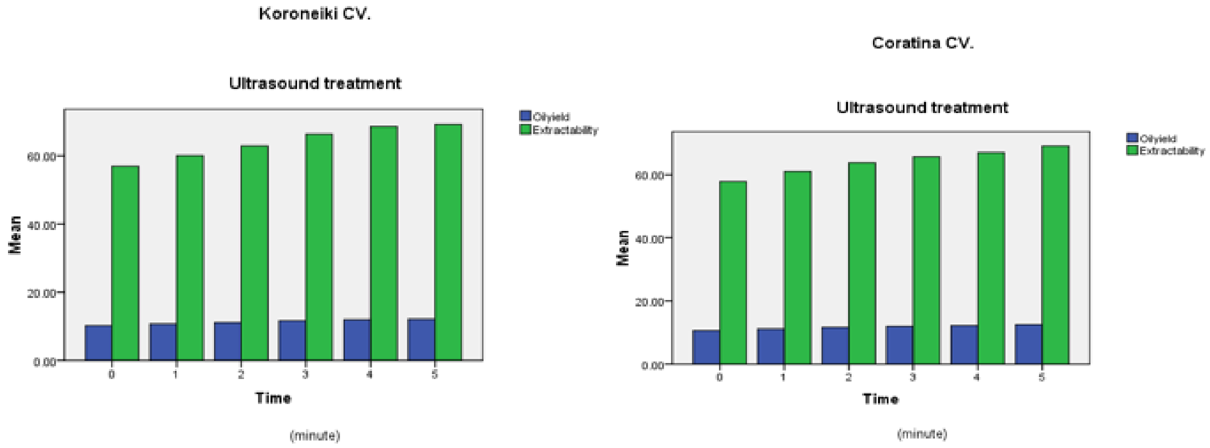

Fig. 2. Ultrasound impact of coratina and koroneiki olive paste on oil yield and extractability

Impact of ultrasound treatments on oil quality:

Data indicated ultrasound impact on quality of olive oil (Table 2). In general, all samples had low contents of FFA, PV, K_{232} and K_{270} and there are no differences in FFA, K_{232} and K_{270} between untreated sample and treated sample with ultrasound for both cultivars. There were slight differences in PV (index of primary oxidation) and Δk. FFA is the resultant from hydrolysis reaction of TAGs (Di Giovacchino, 2013). K_{232} is index of primary product of oxidation such as hydroperoxides, conjugated dienes and trienes and carboxylic compounds, while K_{270} is index of secondary products of oxidation formed from hydroperoxides degradation (Gila *et al.*, 2021). FFA, PV, K_{232}, K_{270} values did not degrade the oils after ultrasound treatment. Classification of oils were extra virgin in accordance with trade standards (FFA≤ 0.8% as oleic acid, PV≤20 meqO_2/kg oil, K_{232}≤ 2.50, K_{270}≤ 0.22), which established by IOC (2022). Comparable results were reported by Jimenez *et al.* (2007), Clodoveo and Hbaieb, (2013), Clodoveo *et al.* (2013a, 2013b), Iqdiam *et al.* (2018), and Tamborrino *et al.* (2021).

Table 2. Impact of Sonication treatment on Coratina and Koroneiki olive oil quality.

Variables	Ultrasound time (minute)					
	0	2	4	6	8	10
			Coratina			
FFA	0.43±0.03^{a}	0.43±0.01^{a}	0.44±0.02^{a}	0.44±0.01^{a}	0.44±0.01^{a}	0.45±0.01^{a}
PV	6.35±0.05^{a}	6.40±0.05^{ab}	6.48±0.03^{c}	6.47±0.03^{bc}	6.48±0.03^{c}	6.47±0.03^{bc}
K_{232}	1.42±0.02^{a}	1.42±0.01^{a}	1.43±0.01^{a}	1.43±0.01^{a}	1.42±0.01^{a}	1.42±0.01^{a}
K_{270}	0.13±0.01^{a}	0.14±0.01^{a}	0.14±0.01^{a}	0.14±0.00^{a}	0.14±0.00^{a}	0.14±0.00^{a}
Δk	0.000±0.000^{a}	0.001±0.001^{ab}	0.001±0.001^{ab}	0.001±0.001^{b}	0.001±0.001^{b}	0.001±0.001^{b}
			Koroneiki			
FFA	0.51±0.02^{a}	0.52±0.01^{a}	0.52±0.01^{a}	0.53±0.01^{a}	0.53±0.01^{a}	0.53±0.02^{a}
PV	7.03±0.15^{a}	7.17±0.06^{ab}	7.22±0.08^{b}	7.23±0.03^{b}	7.22±0.06^{b}	7.22±0.03^{b}
K_{232}	1.75±0.01^{a}	1.74±0.01^{a}	1.75±0.02^{a}	1.76±0.01^{a}	1.76±0.01^{a}	1.75±0.01^{a}
K_{270}	0.18±0.01^{a}	0.18±0.01^{a}	0.18±0.01^{a}	0.18±0.01^{a}	0.19±0.01^{a}	0.19±0.01^{a}
Δk	0.000±0.000^{a}	0.001±0.001^{ab}	0.001±0.001^{ab}	0.001±0.001^{b}	0.001±0.001^{b}	0.001±0.001^{b}

***a-c letters indicate significant differences ($p < 0.05$).**

Impact of ultrasound on bioactive components of olive oil:

Bioactive components such as (phenols, tocopherols, chlorophyll and carotenes) of virgin olive oils are unique and important natural antioxidants (Clodoveo et al., 2013a). Table 3 shows ultrasound impact on bioactive components of Coratina and Koroneiki virgin olive oils.

Table 3. Impact of sonication treatment on bioactive components and stability of Coratina and Koroneiki virgin olive oils.

Variables	Ultrasound time (minute)					
	0	2	4	6	8	10
			Coratina			
Total phenols (mg/kg)	222.68±2.61^{f}	216.26±0.97^{e}	210.75±1.72^{d}	205.55±1.32^{c}	200.31±0.92^{b}	190.32±1.98^{a}
Total tocopherols(mg/kg)	151.54±1.52^{a}	154.27±0.69^{b}	155.24±0.97^{bc}	156.48±0.78^{c}	159.30±0.82^{d}	160.34±0.85^{d}
Chlorophyll (mg/kg)	8.15±0.05^{a}	8.54±0.05^{b}	8.89±0.02^{c}	9.23±0.06^{d}	9.55±0.08^{e}	9.69±0.04^{f}
Carotenes (mg/kg)	4.52±0.02^{a}	4.76±0.06^{b}	5.00±0.09^{c}	5.33±0.06^{d}	5.36±0.04^{d}	5.43±0.06^{d}
Oxidative stability (h)	36.4±0.20^{f}	34.50±0.61^{e}	32.53±0.51^{d}	30.70±0.56^{c}	29.77±0.31^{b}	28.27±0.21^{a}
			Koroneiki			
Total phenols (mg/kg)	211.57±3.54^{e}	208.77±1.54^{e}	201.35±0.63^{d}	195.06±0.61^{c}	190.85±0.61^{b}	181.44±1.20^{a}
Total tocopherols (mg/kg)	139.62±0.53^{a}	139.64±0.55^{a}	141.21±1.00^{b}	142.48±0.18^{c}	144.68±0.40^{d}	146.07±0.15^{e}
Chlorophyll (mg/kg)	7.10±0.20^{a}	7.30±0.10^{ab}	7.57±0.06^{bc}	7.60±0.44^{bc}	7.90±0.10^{cd}	8.27±0.06^{d}
Carotenes (mg/kg)	3.10±0.10^{a}	3.37±0.06^{b}	3.60±0.10^{c}	3.80±0.10^{c}	4.03±0.15^{d}	4.33±0.21^{e}
Oxidative stability (h)	33.60±0.36^{f}	30.83±0.35^{e}	29.67±0.51^{d}	26.50±0.30^{c}	25.70±0.20^{b}	23.37±0.45^{a}

***a-e letters indicate significant difference ($p < 0.05$).**

Olive oil stability, bitterness and pungency were related to polyphenols (Angerosa *et al*. 2001). Table (3) indicated that ultrasound treatments were occurred a significant decrement in phenols content for 10 min for both cultivars. It significantly decreased total phenols by 14.53 and 14.24% after 10 min for Coratina and Koroneiki, respectively. This decrease may be related to the forces generated by ultrasound like rapid heating and mechanical shear, which may alter function and structure of phenols (Clodoveo et al. 2013b, Jiménez et al. 2007). In addition, that decrease could be related to oxygen presence in headspace of malaxator. This oxygen can activate polyphenol oxidase and peroxidase which oxidize phenols components (Yoruk and Marshall 2003, Clodoveo et al. 2013a). Therefore, it should to reduce oxygen headspace during malaxation (Gomez-Rico et al., 2009, Selvaggini et al., 2014).

Olive oil tocopherols are considered natural antioxidants (Blekas et al., 1995). Data in Table (3) indicated that there was significant increment in total tocopherol with increment of ultrasound duration time for both oils. Total tocopherols were significantly increased 5.81 and 4.62% after 10 minutes of sonication for Coratina and Koroneiki, respectively.

Also, Table (3) showed that ultrasound treatment significantly increased chlorophylls for both oils with increasing duration of ultrasound. Chlorophylls were increased about 18.90 and 16.48% after 10 min of sonication for Coratina and Koroeniki, respectively.

However, results revealed that increasing time duration of ultrasound treatment had a significant increase in carotenes content for both oils. Carotenes were increased 20.13 and 39.68% after 10 minutes of sonication for Coratina and Koroneiki, respectively. Clodoveo et al. (2013b) cited that ultrasound waves had a sonic cavitation and mechanical effect on ruptured cells improving mass transfer of tocopherol, chlorophyll, and carotenoids from these cells. Data agreed with Jiménez et al. (2007). Olive oils should store in dark bottles because of presence of chlorophyll which act as pro-oxidants in the light (Malheiro et al., 2013).

Oxidative stability is an important parameter to evaluate oil stability (Aparicio et al., 1999). Olive oil stability is related to $C_{18:1}$ and phenols content (Rotondi et al., 2004, Salvador et al., 2003). Table (3) indicates significantly decrement in oxidative stability with ultrasound treatment in both varieties. It decreased the induction time about 2.34, 30.45% after 10 minutes of sonication for Coratina and Koroneiki, respectively. Ultrasound causes heating that reducing the content of phenols which considered the main components of oxidative stability (Boskou 1999). There is positive relation between phenols of olive oil and stability (Baldioli et al., 1996).

These results agreed with Jimenez et al. (2007), Clodoveo and Hbaieb, (2013), Clodoveo et al. (2013a, 2013b), Iqdiam et al. (2018). The decrement polyphenols and the increment antioxidants such as tocopherols may be interpreted by polyphenols (hydrophilic) in bulk system which aligned with interface of air–oil and was more antioxidant than tocopherols (lipophilic), that keep in oil (Frankel, 1996).

Impact of ultrasound treatments on fatty acids composition:

Sonication impact on fatty acids profile of Coratina and Koroneiki oils are shown in Table (4). Tsimidou and Karakostas, (1993) and Uceda et al. (2008) indicated that cultivars can differentiate fatty acids. Also, weather, soil, ripening, agriculture, and oil extraction can alter sensory and chemical properties of oil (Elsorady et al., 2014, 2015). There is no difference in fatty acid composition after 10 min of ultrasound treatment. Results revealed that no alter on fatty acid profile, like breakdown of fatty acid carbon chains (Fedeli, 1988) and fatty acid composition is agreed with IOC standards (IOC, 2022). Gila et al. (2021) indicated that ultrasound treatment did not change lipid profile.

Table 4. Impact of sonication treatment on fatty acid profile of Coratina and Koroneiki olive oils.

Variables	Ultrasound time (minute)					
	0	2	4	6	8	10
			Coratina			
C16:0	14.10	14.08	14.06	14.09	14.08	14.07
C16:1	0.85	0.84	0.86	0.84	0.83	0.89
C18:0	3.10	3.14	3.12	3.09	3.15	3.10
C18:1	68.10	68.05	68.10	68.15	68.12	68.03
C18:2	12.14	12.14	12.11	12.13	12.12	12.15
C18:3	0.65	0.68	0.67	0.64	0.64	0.69
C20:0	0.44	0.47	0.46	0.44	0.46	0.46
C20:1	0.45	0.43	0.46	0.45	0.44	0.45
C22:0	0.17	0.17	0.16	0.17	0.16	0.16
Σ SFA*	17.81	17.86	17.80	17.79	17.85	17.79
Σ USFA**	82.19	82.14	82.20	82.21	82.15	82.21
MUSFA***	69.40	69.32	69.42	69.44	69.39	69.37
PUSFA****	12.79	12.82	12.78	12.77	12.76	12.84
			Koroneiki			
C16:0	15.40	15.42	15.44	15.40	15.45	15.43
C16:1	1.12	1.14	1.08	1.12	1.11	1.13
C18:0	3.50	3.47	3.49	3.51	3.54	3.52
C18:1	66.89	66.91	66.86	66.90	66.84	66.87
C18:2	11.57	11.50	11.58	11.59	11.52	11.55
C18:3	0.70	0.68	0.69	0.70	0.73	0.70
C20:0	0.42	0.44	0.45	0.42	0.43	0.42
C20:1	0.25	0.26	0.25	0.23	0.25	0.24
C22:0	0.15	0.18	0.16	0.13	0.13	0.14
Σ SFA*	19.47	19.51	19.54	19.46	19.55	19.51
Σ USFA**	80.53	80.49	80.46	80.54	80.45	80.49
MUSFA***	68.26	68.31	68.19	68.25	68.20	68.24
PUSFA****	12.27	12.18	12.27	12.29	12.25	12.25

Saturated fatty acids= SFA;**Unsaturated fatty acids=USFA;Monounsaturated fatty acids=MUSFA;****Polyunsaturated fatty acids=PUSFA.**

Ultrasound impact on sensory evaluation of olive oil:

Sensorial assessment is a decisive procedure to identify olive oil differences. Results revealed that olive oils were free of defects (Table 5) and consequently categorized as extra virgin olive oil. It agreed with IOC standards (IOC, 2022). Moreover, ultrasound as fast heating technique not induce "burnt" defect in oil.

Table 5. Impact of Sonication treatment on sensory attributes of Coratina and Koroneiki extra virgin olive oils.

Variables	Ultrasound time (minute)					
	0	2	4	6	8	10
			Coratina			
Fruity	5.27±0.25 [a]	5.53±0.06 [a bc]	5.77±0.06 [c]	5.67±0.21 [bc]	5.67±0.15 [bc]	5.40±0.10[ab]
Bitter	2.53±0.06 [d]	2.36±0.06 [c]	2.27±0.06 [c]	2.07±0.11 [b]	1.98±0.03 [ab]	1.93±0.06[a]
Pungent	2.07±0.12 [e]	1.87±0.06 [d]	1.87±0.03 [d]	1.63±0.06 [c]	1.43±0.06 [b]	1.27±0.12[a]
Defects	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
			Koroneiki			
Fruity	5.00±0.50 [a]	5.10±0.10 [a]	5.23±0.25 [a]	5.43±0.15 [a]	5.40±0.20 [a]	5.43±0.51[a]
Bitter	2.03±0.06 [d]	1.90±0.10 [d]	1.70±0.10 [c]	1.53±0.06 [b]	1.40±0.10 [b]	1.10±0.10[a]
Pungent	1.93±0.06 [e]	1.84±0.01 [d]	1.80±0.02 [d]	1.72±0.03 [c]	1.65±0.05 [b]	1.53±0.02[a]
Defects	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

***a-d letters indicate significant difference ($p < 0.05$).**

Olive oil extracted from ultrasound paste has less bitterness and pungency median score than olive pastes not treated with ultrasound (Table 5). The median of bitterness and pungency were decreased as sonication time increased. This is related to total phenols content. Phenols components are accountable for stability, bitter and pungent tastes (Caldovo *et al.,* 2013b). These results agreed with Jimenez *at al.* (2007), Clodoveo and Hbaieb, (2013), Clodoveo *et al.* (2013a, 2013b).

CONCLUSION

Ultrasound technology is a clean technology which has no effects olive oil quality. During sonication, it observed a slight increment in temperature of olive paste. Also, ultrasound treatment had no effects on olive oil quality characteristics and lipid profile, whereas, tocopherols, chlorophylls and carotenes contents were increased. On the other hand, phenols content was decreased. With regard to organoleptic assessment, increment time of ultrasound had an increase in fruity attribute and had a decrease in bitterness and pungency intensities as a result of decrement of phenols content.

Therefore, according to the obtained results in this study, ultrasound is a suitable emerging technique that improves oil yield. The applying ultrasound effects on olive paste are only thermomechanical effects (facilitate oil separation from plant tissues) and they do not change virgin olive oil quality.

Acknowledgements: Authors thank collages at Faculty of Agriculture Saba-Basha and Food Technology Research Institute for assessing sensory analysis of olive oil samples.

Conflicts of interest: The authors declare no conflicts of interest.

REFERENCES

Aguilera, M. P., Beltrán, G., Sánchez-Villasclaras, S., Uceda, M., and Jiménez, A. (2010). Kneading olive paste from unripe Picual fruits: I. Effect on oil process yield. Journal of Food Engineering, 97, 533–538.

Andreou, V., Dimopoulos, G., Alexandrakis, Z., Katsaros, G., Oikonomou, D., Toepfl,S., Heinz, V. and Taoukis, P. (2017). Shelf-life evaluation of virgin olive oil extracted from olives subjected to non-thermal pretreatments for yield increase, Innovative Food Science and Emerging Technologies, 40, 52-57, https://doi.org/10.1016/ j.ifset.2016.09.009.

Angerosa, F., Mostallino, R., Basti, C., and Vito, R. (2001). Influence of malaxation temperature and time on the quality of virgin olive oils. Food Chemistry, 72(1), 19–28. https://doi.org/10.1016/S0308-8146(00)00194-1.

Aparicio, R., Roda, L., Albi, M. A., and Gutiérrez, F. (1999). Effect of various compounds on virgin olive oil stability measured by Rancimat. Journal of Agricultural and Food Chemistry, 47(10), 4150–4155. https://doi.org/ 10.1021/jf9812230.

Baldioli, M., Servili, M., Perretti, G., and Montedoro, G. F. (1996). Antioxidant activity of tocopherols and phenolic compounds of virgin olive oil. Journal of the American Oil Chemists' Society, 73(11), 1589–1593. https://doi.org/ 10.1007/BF02523530.

Blekas, G., Tsimidou, M., and Boskou, D. (1995). Contribution of tocopherol to olive oil stability. Food Chemistry, 52(3), 289–294. https://doi.org/10.1016/0308-8146(95)92826-6.

Boskou, D. (1999). Non-nutrient antioxidants and stability of frying oils (pp. 183–204). Technomic Publishing CO., INC. Lancaster, Pennsylvania.

Carrapiso, A.I., Garcia, A., Petron, M.J. and Martin, L. (2013).Effect of talc and water addition on olive oil quality and antioxidants. Eur. J. Lipid Sci. Technol. 115: 583–588.

Clodoveo, M. L., and Hbaieb, R. H. (2013). Beyond the traditional virgin olive oil extraction systems: Searching innovative and sustainable plant engineering solutions. Food Research International, 54, 1926–1933.

Clodoveo, M.L. Durante, V., La Notte, D., Punzi, R. and Gambacorta, G. (2013b). Ultrasound-assisted extraction of virgin olive oil to improve the process efficiency. Eur. J. Lipid Sci. Technol. 2013b, 115, 1062–1069

Clodoveo, M.L., Durante, V. and Notte, D. (2013a). Working towards the development of innovative ultrasound equipment for the extraction of virgin olive oil. Ultrasonics Sonochemistry 20, 1261–1270.

Di Giovacchino, L. (2013). Technological Aspects, in: R. Aparicio, J. Harwood (Eds.), Handbook of Olive Oil, Springer, Nueva York, 2013, pp. 57–96.

Elsorady, M. E. (2020). Effect of using some extraction coadjuvants on extraction yield and quality of olive oil extracted from some Egyptian olive cultivar. Annals. Food Science and Technology, 21(1):64-71.

Elsorady, M. E. I., Girgis, A. Y. and Mostfa, D.M.M. (2015). Influence of some cultivation regions in Egypt on characteristics and quality of koroneiki C.V olive oil. Egypt. J. Agric. Res., 93, 4 (C), 939-959.

Elsorady, M. E. I., Mohamed, A. S. and Mohamed, E. SH.A. (2014). Influence of organic fertilization and irrigation on quality of maraqi cultivar virgin olive oil. Egypt. J. Agric. Res., 92 (2):709-728.

Fedeli, E. (1988). The behavior of olive oil during cooking and frying, in: G. Varela, A.E. Bender, I.D. Morton (Eds.), Frying of foods, Ellis Harwood Ltd, Chichester,1988, pp. 52–81.

Frankel, E. N. (1996). Antioxidants in lipid foods and their impact on food quality. Food Chem. 1996, 57, 51–55.

Gamez-Meza, N., Nriega-Rodiguez, T.A., Medira-Jularz, L.A., Ortega-Gracia, J., Cazarazez-Casanova, R. and Angulo-Guerrero, O. (1999). Antioxidant activity in soybean oil of extracts from Thompson grape bagasse. JAOCS. 76: 1445-1447.

Gila A, Sánchez-Ortiz A, Jiménez A, Beltrán G. (2021). The ultrasound application does not affect to the thermal properties and chemical composition of virgin olive oils. Ultrason Sonochem., 70:105320. https://doi: 10.1016/j.ultsonch.2020.105320

Gomez-Rico, A., Inarejos-García, A. M., Salvador, M. D., and Fregapane, G. (2009). Effect of malaxation conditions on phenol and volatile profiles in olive paste and the corresponding virgin olive oils (Olea europaea L. Cv. Cornicabra). Journal of Agricultural and Food Chemistry, 57(9), 3587–3595. https://doi.org/10.1021/jf803505w.

Gutierrez, R.F. (1989). Determinacion de la estabilidad oxidativa de a- ceites de oliva virgenes : Comparacidn entre el mètodo del oxigen. active (AOM) y el mètodo Rancimate. Grasas y Aceites. 40:1-5.

IOC (2017). Determination of fatty acid methyl esters by gas-chromatography, COI/T.20/Doc. No 33/Rev.1

IOC (2018). Sensory analysis of olive oil method for the organoleptic assessment of virgin olive oil in COI/T.20/Doc. No 15/Rev. 10

IOC (2022). Trade standard applying to olive oils and olive pomace oils in COI/T.15/NC No 3/Rev. 19

Iqdiam, B.M., Mostafa, H., Goodrich-Schneider, R., George L. Baker, G.L., Welt, B. and Marshall, M.R. (2018). High Power Ultrasound: Impact on Olive Paste Temperature, Malaxation Time, Extraction Efficiency, and Characteristics of Extra Virgin Olive Oil. Food and Bioprocess Technology, 11:634–644 https://doi.org/ 10.1007/ s11947-017-2035-8

Jiménez, A., Beltrán, G. and Uceda, M. (2007). High power ultrasound in olive paste pretreatment. Effect on process yield and virgin olive oil characteristics, Ultrasonics Sonochemistry, 14 (6): 725-731, https://doi.org/10.1016/ j.ultsonch.2006.12.006.

Legay, M., Simony, B., Boldo, P., Gondrexon, N., Le Person, S. and Bontemps, A. (2012). Improvement of heat transfer by means of ultrasound: Application to a double-tube heat exchanger, Ultrason. Sonochem., 19, 1194–1200.

Leone, A., Romaniello, R., Tamborrino, A., Xu, X. and Juliano, P. (2017). Microwave and megasonics combined technology for a continuous olive oil process with enhanced extractability. Innovative Food Science and Emerging Technologies, 42, 56-63, https://doi.org/ 10.1016/ j.ifset.2017.06.001.

Malheiro, R., Casal, S., Teixeira, H., Bento, A., and Pereira, J. A. (2013). Effect of olive leaves addition during the extraction process of over mature fruits on olive oil quality. Food and Bioprocess Technology, 6, 509–521.

Minguez-Mosquera, M.I., Rejano, L., Gandul, B., Sanchez, A.H. and Garrido, J. (1991). Color-pigment correlation in virgin olive oil. J Am Oil Chem Soc. 68:332–336.

Puértolas. E, and Martinez de Maranon, I. (2015). Olive oil pilot-production assisted by pulsed electric field: Impact on extraction yield, chemical parameters and sensory properties. Food Chemistry, 167, 497-502, https://doi.org/10.1016/j.foodchem.2014.07.029.

Rotondi, A., Bendini, A., Cerretani, L., Mari, M., Lercker, G., and Toschi, T. G. (2004). Effect of olive ripening degree on the oxidative stability and organoleptic properties of cv. Nostrana di Brisighella extra virgin olive oil. Journal of Agricultural and Food Chemistry,52(11), 3649–3654. https://doi.org/10.1021/jf049845a.

Salvador, M. D., Aranda, F., Gómez-Alonso, S., and Fregapane, G. (2003). Influence of extraction system, production year and area on Cornicabra virgin olive oil: a study of five crop seasons. Food Chemistry, 80(3), 359–366. https://doi.org/10.1016/S0308-8146(02)00273-X.

Selvaggini, R., Esposto, S., Taticchi, A., Urbani, S., Veneziani, G., Di Maio, I., Sordini, B., and Servili, M. (2014). Optimization of the temperature and oxygen concentration conditions in the malaxation during the oil mechanical extraction process of four Italian olive cultivars. Journal of Agricultural and Food Chemistry, 62(17), 3813–3822. https://doi.org/10.1021/jf405753c.

Tamborrino, A., Taticchi, A., Romaniello, R., Perone, C., Esposto, S., Leone, A. and Servili, M. (2021). Assessment of the olive oil extraction plant layout implementing a high-power ultrasound machine. Ultrasonics Sonochemistry 73, 105505

Tsimidou, M. and Karakostas, K.X. (1993). Geographical Classification of Greek virgin olive oil by nonparametric multivariate evaluation of fatty acid composition, J. Sci. Food Agric. 62, 253–257.

Uceda, M., Aguilera, M.P. and Hermoso, M. (2008). La calidad del aceite de oliva, in: D. Barranco, R. Fernandez-Escobar, L. Rallo (Eds.), El cultivo del olivo, Mundi-Prensa, Madrid, 2008, pp. 699–727.

Visioli, F., Bellomo, G., and Galli, C. (1998). Free radical-scavenging properties of olive oil polyphenols. Biochemical and Biophysical Research Communications, 247(1), 60–64.

Wong, M.L.; R.E. Timms; and E.M. Cioh. (1988). Colorimetric determination of total tocopherols in palm oil, olein and stearin. JAOCS. 65(2): 258-261.

Yoruk, R. and Marshall, M.M. R. (2003). Physicochemical properties and function of plant polyphenol oxidase: a review. Journal of Food Biochemistry, 27(352), 361–422. https://doi.org/10.1111/j.1745-4514.2003.tb00289.x.

تأثير استخدام الموجات فوق الصوتية على الصفات الكيميائية والمركبات الفعالة حيويا لزيت الزيتون المستخلص من عجينة الزيتون

أسماء جمعة محمود[1]، أشرف عبد المنعم زيتون[1]، جمال محمد حمد[2]، محمد السيد الصردى[3]، محمد عبد الحميد محمد زيتون[1]

[1] قسم علوم الاغذية - كلية الزراعة (سابا باشا) جامعة الاسكندرية- الاسكندرية

[2] قسم تكنولوجيا الاغذية- معهد بحوث زراعة الاراضي القاحلة- مدينة الابحاث العلمية والتطبيقات التكنولوجية- برج العرب الجديدة- الاسكندرية

[3] قسم بحوث الزيوت والدهون- معهد بحوث تكنولوجيا الاغذية – مركز البحوث الزراعية - الجيزه

الملخص

تمت دراسة تأثير استخدام تقنية الموجات فوق الصوتية على استخلاص زيت الزيتون Coratina و Koroneiki من حيث الجودة و الانتاجية . تم تطبيق معاملة الموجات فوق الصوتية على عجينة الزيتون لفترات زمنية مختلفة (10.8.6.4.2.0 دقائق) حيث زادت كمية الزيت المستخلص بشكل معنوى 16.65% و 18.33% لصنفى الكوراتينا والكروناكى على التوالى. أظهرت النتائج بإرتفاع درجة حرارة عجينة الزيتون من 22 درجة مئوية (بعد الطحن) الى حوالى 23 ، 25 ، 26.5 ، 28 ، 30ºم بعد 2 ، 4، 6 ، 8 ،10 دقائق من المعاملة بالموجات فوق الصوتية ، على الترتيب . أظهرت النتائج التحليل الكيميائي أن جميع العينات أنخفض محتواها من FFA ورقم البيروكسيد و امتصاص الموجات فوق البنفسجية عند طول موجى 232 و 270 ولاتوجد فروق معنوية في قيم K_{270} و K_{232} وFFA والاحماض الدهنية بين العينات غير المستخدم لها الموجات فوق الصوتية والعينات المستخدم لها الموجات فوق الصوتية لكلا الصنفين. وأظهرت نتائج المركبات الفعالة حيويا ان زيت الزيتون المستخرج من عجينة الزيتون المعاملة بالموجات فوق الصوتية تحتوى على التوكوفيرول والكلوروفيل والكاروتينات بمحتوى أعلى معنويا من مثيله غير المعامل. زادات التوكوفيرولات الكلية بنسبة 5.81 و 4.62% بعد 10 دقائق من المعاملة بالموجات فوق الصوتية لصنفى الكوراتينا و الكروناكى على الترتيب و ايضا ز اد محتوى الكلوفيل بنسبة 18.90 و 16.48% و زاد محتوى الكاروتين بنسبة 20.13 و 39.68% لنفس الصنفين على الترتيب. كما أظهرت ايضا العينات المستخدم لها الموجات فوق الصوتية إنخفاضا في محتوى الفينولات حيث انخفضت معنويا بنسبة 14.53 و 14.24% بعد 10 دقائق من المعاملة بالموجات فوق الصوتية لصنفى الكراتينا و الكروناكى على الترتيب. أظهرت النتائج ان مع زيادة وقت تطبيق الموجات فوق الصوتية نجد هناك زيادة فى شدة صفة Fruity و انخفاض فى شدتى صفتى Bitter و Pungent. استخدام الموجات فوق الصوتية لم يكن له أى تأثير على جودة زيت الزيتون ، مع الحفاظ على أعلى مستويات الجودة وفقا لمعايير المجلس الدولى للزيتون (زيت الزيتون البكر الممتاز). لذلك يمكن ان تكون تقنية الموجات فوق الصوتية مناسبة لتحسين صفات زيت الزيتون المستخلص .

الكلمات الدالة: الموجات فوق الصوتية – زيت الزيتون البكر – كوراتينا – كروناكى – الجودة- عجينة الزيتون.