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ANTIOXIDANT ACTIVITY OF OLIVE LEAF, POMACE AND VIRGIN OIL EXTRACTS FROM PICUAL CULTIVAR AND THEIR HEAT AND pH STABILITY

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ABSTRACT: ***Antioxidant activity of olive leaf, olive pomace and olive virgin oil as affected by ethanol, ethyl acetate and chloroform solvents were evaluated. Ethanol extracts of olive leaf and olive pomace as well as chloroform extract of olive virgin oil had higher antioxidant activity than those from other solvents. Leaf ethanol extract and α-tocopherol had the similar antioxidant activity. Pomace ethanol extract had a higher ($p \leq 0.05$) antioxidant activity than that of α-tocopherol however; virgin oil chloroform extract had a lower ($p \leq 0.05$) antioxidant activity than that of α-tocopherol. Antioxidants of leaf ethanol extracts were heat-stable with retaining 67.04, 74.15, and 75.60% of its activity after dry heating at 100°C for 30 min, boiling at 100°C for 35 min and autoclaving at 121°C for 30 min, respectively. Antioxidants of pomace ethanol extracts were fairly heat-stable with 57.71, 63.75, 51.73% activity after dry heating at 100°C for 30 min, boiling at 100°C for 35 min and autoclaving at 121°C for 30 min, respectively. Antioxidant activities of leaf ethanol extract, pomace ethanol extract and virgin oil chloroform extract extracts were the maximum at pH 5.5. The induction periods of sunflower oil with 1% pomace ethanol extract, leaf ethanol extract and virgin oil chloroform extract were increased by 42.22, 35.56 and 16%, respectively as compared with the control sunflower oil. Pomace ethanol extract and leaf ethanol extract might be promising sources of natural antioxidant to be used in food products.***

Key words: ***Antioxidant activity, Olive fraction extracts, Heat stability, pH stability and Induction period***

INTRODUCTION

The high levels of free radicals in living systems can oxidize biomolecules, leading to tissue damage, cell death, or various diseases such as skin irritations, degenerative processes associated with ageing, cardiovascular diseases, arteriosclerosis, diabetes, neural disorders, and cancer (Hadjaz *et al*., 2011; Jung *et al*., 2005; Trush *et al*., 1994). The antioxidant compound can deactivate and scavenge free radical by donating hydrogen atom or chelating metal. Therefore, commercial antioxidants are in high demand, and most of them are synthesized, including butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and propyl gallate (PG). However, these synthetic antioxidants are reported to be toxic and carcinogenic in animal models (El- Bedawey *et al*., 2010; Bouaziz *et al*., 2008; Mansour and Khalil, 2000). Thus, there is a growing request and interest on natural and safer antioxidants found in various kinds of land plants, such as

cereals, vegetables, fruits and herbs; in which tocopherol, vitamin C, carotenoid, and polyphenols are good sources of antioxidant (El-Bedawey *et al*., 2010; Hussen *et al*., 2009; Gardner *et al*., 2000; Mansour and Khalil, 2000).

Virgin olive oil is obtained using mechanical pressing without any treatment other than washing, decanting, centrifugation, and filtering (International Olive Oil Council, 2003). It is rich in phytochemicals such as phenolic compounds. (Sicari, 2017; Franco *et al*., 2014; Bendini *et al*., 2007). The production of olive oil is associated with the generation of large amounts of olive pomace. Olive pomace is a complex lignocellulosic material consisting mainly of olive stones, pulp residues and fruit skins (Nunes *et al*., 2016). Olive pomaces considered a rich source of phenolic compounds with a wide array of biological activities (Morsi *et al*., 2016). Olive leaves are a waste of the olive oil processing industry and represent a good source of phenolic compounds (Difonzo *et al*., 2018, 2017; Zeitoun *et al*., 2017).

On the other hand, olive virgin oil, olive pomace and olive leaves can be used to prepare phenolic-rich extracts, suitable for food use. The use of olive fraction extracts allows improving the shelf-life of foods. Moudache *et al*., (2017) and Hayes *et al*., (2011) reported that olive leave extract improves lipid stability in meat products. Jiménez *et al*., (2017) and Zribi *et al*. (2013) showed an antioxidant effect of olive leave extract in frying oil. In addition, different authors showed that olive leave extract exhibits significant antioxidant activity, which could enhance the oxidative stability of vegetable oils (Rahmanian *et al*., 2015; Kiritsakis *et al*., 2010; Bouaziz *et al*., 2008).

To the best of our knowledge there are no reports concerning the effect of different heat treatments and pH values on the antioxidant activity of olive leaves, pomace and virgin oil extracts. Therefore, this study was carried out to evaluate the effect of different solvent extractions on the antioxidant activity of olive leaves, pomace and virgin oil. The best solvent extracts of olive fractions which showed the highest antioxidant activities were selected for studying the heat and pH stabilities of their antioxidant. Sunflower oil oxidative stability by adding olive fraction extracts was also evaluated.

MATERIALS AND METHODS

Materials

Olive leaf, pomace and virgin oil

The ripe olive (*Olea europaea* L.) fruits and leaves of picual cultivar were obtained in season of 2014/2015 from Matrouh Farms, Marsa Matrouh, Egypt. The pomace and virgin oil were prepared in Matrouh factory and transported in ice boxes to the laboratory.

Preparation of olive leaves and pomaces:

Olive leaves and pomace were dried in an electric air draught oven (Nüve San. Malz, Model FN 500, Akyuri, Ankara, Turkey) at 40 ºC for 12 h. The dried samples were ground using a laboratory electric mill (Braun, Model 2001DL, Germany) to pass through a 60 mesh sieve and stored in screw cap plastic containers at 4°C.

Preparation of olive leaf, pomace and virgin oil extracts

Fifty grams of olive leaf, pomace and virgin oil were extracted three times with 500 ml of each solvent (ethanol 97%, ethyl acetate 97%, and chloroform 97%) using a Teflon- coated magnetic stir bar and stir plate (Framo-Geratetechnik, Germany) for 6 h at room temperature. Extracts were filtrated through Whatman No. 1. The combined filtrates from each material were concentrated in a rotary

evaporator (Laboratory 4000; Heidolph Instruments GmbH & Co. KG, Germany) at 40°C to a final volume of 100 ml of crude extracts and stored at -20°C until used.

Analytical methods

Determination of antioxidant activity

Antioxidant activity was determined using the 2,2-dipheny-l-1picrylhydrazyl (DPPH) radical scavenging method according to the procedure described by Brand-Williams *et al*. (1995). Fifty µl from each extract (stock solution was 20.0 g/liter) was placed in a cuvette, and 2 ml of 6×10^{-5} M methanol solution of DPPH was added. Absorbance was measured immediately at 517 nm (UNICO 2802 C/PCS Series Spectrophotometer, USA). The decrease in absorbance was measured every 5 min for 1 h. Alpha-tocopherol was used for comparative purposes. The absorbance of the DPPH radical without antioxidant (control) was measured daily. Special care was taken to minimize the loss of free radical activity of the DPPH radical stock solution (Blois, 1958). The percentage of inhibition of the DPPH radical by the extracts (antioxidant activity) was calculated according to the equation of Yen and Duh (1994):

$$\% \text{ inhibition} = [(AC(o)_{517} - AA(t)_{517}) \div AC(o)_{517}] \times 100$$

Where: $AC(0)_{517}$ is the absorbance of the control at t = 0 min.

$AA(t)_{517}$ is the absorbance of the antioxidant at t = 1 h

Factors affecting the antioxidant activities stability of olive fraction extracts

The antioxidant activities stability of olive fraction extracts were determined as described by Mansour and Khalil (2000) as follows:

Dry heat stability of olive fraction extracts

Olive fraction extracts were pre-incubated in dry heating at different temperatures (40, 60, 80, 100) °C for 30 min. The residual antioxidant activity was determined as previously mentioned.

Boiling stability of olive fraction extracts

Olive fraction extracts were boiled in water bath for 0, 15, 25, 35, 45 and 60 min. The residual antioxidant activity was determined as previously mentioned.

Autoclaving stability of olive fraction extracts

Olive fraction extracts were autoclaved at 121°C and Pressure 1.5 Bar for 0, 15, 20, 25, 30, 35 and 40 min. The residual antioxidant activity was determined as previously mentioned.

pH stability of olive fraction extracts

Olive fraction extracts were pre-incubated at pH values in the range of 4.0 – 8.0 for 30 min. The residual antioxidant activity was determined as previously mentioned.

Induction periods of sunflower oil containing different levels of olive fraction extracts

The olive fraction extracts (leaf ethanol extract, pomace ethanol extract and virgin oil chloroform extract) and α-tocopherol was added to sunflower oil at the concentrations of 0, 0.5, 1, 2 and 3%. The mixture was kept at 40ºC for 30 min and then in vacuum rotary evaporator (Buchi 011, Buchi, Switzerland) below 40ºC for 1 h to complete removal of the solvent. A 679 Rancimat (Metrohm, Herisan, Switzerland) was used. Five grams from each test sample were loaded into the reaction vessel cylinder. Six different samples were conducted in one batch. The air supply was maintained at 20 ml/min and the heating temperature kept at 100ºC throughout the experiment

as described by Antolovich *et al.* (2002). The induction period (h) was recorded automatically.

Statistical analysis:

Data are presented as mean ± SD (standard deviations). The comparison between antioxidant activity of the best solvent of olive fraction extracts and α-tocopherol was analyzed using one-way analysis of variance. Two-way randomized blocks design was used for the other data. An analysis of variance was conducted using Costat version 6.311 (Copyright 1998-2005, CoHort software). When a significant main effect was detected, the means were separated with the Student Newman Keuls test. The predetermined acceptable level of probability was 5% (P≤0.05) for all comparisons.

RESULTS AND DISCUSSION

Antioxidant activities of olive fraction extracts

Antioxidant activities of olive as affected by olive fractions and solvent type were presented in Table (1). Picual olive leaf extracts had higher ($p \leq 0.05$) mean antioxidant activity (70.29%) than Picual olive pomace extracts (44.16%) and Picual virgin oil extracts (41.82%). Ethanol extract had higher ($p \leq 0.05$) mean antioxidant activity (66.06%) than chloroform extract (49.75%) and ethyl acetate extract (40.47%). This effect might be attributed to the solvent polarity index. Ethanol was the best solvent to extract responsible compounds for the antioxidant effect from olive leaf (79.35%) and olive pomace (93.45%), however chloroform was the best solvent for olive virgin oil (78.37%). Antioxidant activity value of olive leaf ethanol extracts was 79.35% lower than the values (82.1 and 87.9%) reported by Zeitoun *et al.* (2017) and Sheikh and Gabr (2016), respectively for olive leaf ethanol extract. Antioxidant activity of pomace ethanol extract (93.45%) was comparable with the value (95.83%) reported by Mohamed (2009) for olive pomace ethyl acetate extract. However, much lower values (14.06-57.50%) were reported by EL-Shemy (2014) for olive pomace ethanol extract. Antioxidant activity of virgin oil chloroform extracts (78.37%) was lower than the value (97.86%) reported by Mohamed (2009) for virgin oil ethyl acetate extract, but, much higher than the values (14.8-26.6%) reported by Franco *et al.* (2014) for virgin oil methanol extract. This difference might be due to the interspecies variation, solvent type and or the methods of antioxidant activity determination.

Table (1): Antioxidant activity of picual olive as affected by olive fraction and solvent types

Solvent types	Olive fractions			Means[1]
	Leaf	Pomace	Virgin oil	
Ethanol	79.35±0.51	93.45±0.76	25.37±0.24	66.06[a]
Ethyl acetate	75.02±0.72	24.66±1.18	21.74±0.19	40.47[c]
Chloroform	56.50±0.52	14.37±1.57	78.37±1.23	49.75[b]
Means[2]	70.29[a]	44.16[b]	41.82[c]	

(1) Means in the same column with different letters are significantly different (P≤0.05), LSD = 0.81
(2) Means in the same row with different letters are significantly different (P≤0.05), LSD = 0.68

Antioxidant activities of the best solvent extracts of olive fractions compared to α-tocopherol were presented in Table (2). Pomace ethanol extract (93.45%) had higher ($p \leq 0.05$) antioxidant activity than α-tocopherol (80.40%) and other olive fraction extracts. Alpha-tocopherol had higher ($p \leq 0.05$) antioxidant activity than virgin oil chloroform extract. Non-significant ($p > 0.05$) difference in antioxidant activity was observed between leaf ethanol extract (79.35%) and α-tocopherol (80.40%) and between leaf ethanol extract (79.35%) and virgin oil chloroform extract (78.37%). El-Bedawey *et al.,* (2010) reported that ginger roots petroleum ether extract, orange peel, and guava leaf ethanol extracts exhibited higher antioxidant activities than that of α-tocopherol while, guava seeds, sesame coat ethanol extracts had lower antioxidant activity compared to α-tocopherol.

***The best extracts which selected bassed on its antioxidant property.**

Factors affecting the antioxidant activities stability of olive fraction extracts

Dry heat stability of olive fraction extracts

Antioxidant activities of olive fractions as affected by dry heating at 40-100°C for 30 min were presented in Table (3). The mean antioxidant activities of pomace ethanol extracts (67.05%) followed by leaf ethanol extracts (61.36%) were more ($p \leq 0.05$) stable than virgin oil chloroform extracts (43.20%) when heated at 40-100°C for 30 min. There was significant ($p \leq 0.05$) difference in antioxidant activities among dry heated olive fraction extracts. Increasing the dry heating from 40°C to 100°C resulted in a significant ($p \leq 0.05$) decrease in the antioxidant activities of olive fraction extracts. The mean antioxidant activities of olive fraction extracts were reduced by 26.62, 34.83, 44.86 and 52.72% when dry heated at 40, 60, 80 and 100°C, respectively as compared with unheated olive fraction extracts. Saleh (2017) found that antioxidant activity of chamomile water extract was reduced by 37.90% when dry heated at 80°C for 30 min. El-Bedawey *et al.* (2010) found that heating ginger roots extract at 100°C for 30 min reduced the antioxidant activity by 18.1%. However, Mansour and Khalil (2000) reported a higher reduction value (25%) for ginger roots.

Table (2): Antioxidant activity of the best solvent extracts of picual olive fractions compared to α-tocopherol

Olive fraction extracts	Antioxidant activity (%)
Leaf ethanol extract	$79.35^{bc} \pm 0.51$
Pomace ethanol extract	$93.45^{a} \pm 0.76$
Virgin oil chloroform extract	$78.37^{c} \pm 1.23$
Alpha-tocopherol (0.02g /10 ml methanol 97%)	$80.40^{b} \pm 0.65$
LSD	1.23

Means in the same column with different letters are significantly different ($p \leq 0.05$)

Table (3): Effect of dry heating at 40-100°C for 30 min on antioxidant activities (%) of picual olive fraction extracts

(°C)	Ethanol extract		Chloroform extract	Means[1]
	leaf	pomace	virgin oil	
unheated	79.35±0.52	93.95±0.76	78.37±1.23	83.89[a]
40	60.58±1.19	67.74±1.13	56.35±0.95	61.56[b]
60	58.19±0.32	60.19±0.82	45.62±0.77	54.67[c]
80	55.50±0.71	59.17±1.26	24.12±1.25	46.26[d]
100	53.20±0.31	54.22±0.29	11.56±0.73	39.66[e]
Means[2]	61.36[b]	67.05[a]	43.20[c]	

(1) Means in the same column with different letters are significantly different (p≤0.05), LSD = 0.85
(2) Means in the same row with different letters are significantly different (p≤0.05), LSD = 0.66

Boiling stability of olive fraction extracts

Antioxidant activities of olive fractions as affected by boiling at 100°C for different times were presented in Table (4). The mean antioxidant activities of pomace ethanol extracts (65.34%) followed by leaf ethanol extracts (61.83%) were more ($p \leq 0.05$) stable than virgin oil chloroform extracts (58.01%) when boiled at 100°C for 15-60 min. There was significant ($p \leq 0.05$) difference in antioxidant activities among boiled olive fraction extracts for different times. Increasing the boiling time from 15 to 60 min resulted in a significant ($p \leq 0.05$) decrease in the antioxidant activities of olive fraction extracts. The mean antioxidant activities of olive fraction extracts were reduced by 23.11, 28.38, 30.78, 33.87 and 42.38% when boiled for 15, 25, 35, 45 and 60 min, respectively as compared with unboiled olive fraction extracts. The similar reduction in antioxidant activity by boiling treatment was reported by Reddy *et al.* (2014b) who found that the radical scavenging activity of *Canthium parviflorum* leaf extract was reduced from by 41.18% when boiled at 100°C for 30 min. El-Bedawey *et al.* (2010) reported that boiling ginger root, guava leaf, guava seed, orange peel, sesame coat, rice bran and wheat germ extracts at 100°C for 60 min reduced the antioxidant activities by 22.97, 20, 66.78, 41.47, 20.51, 39.21 and 57.26%, respectively. Hussein *et al.* (2009) reported that boiling ginger root, canola seed, soybean, and fenugreek seed extracts at 100°C for 60 min reduced the antioxidant activities by 37.41, 48.09, 35.68 and 41.46%, respectively. Mansour and Khalil (2000) found that boiling ginger root, fenugreek seed, and potato peel extracts at 100°C for 120 min reduced the antioxidant activity by 72, 42 and 36.8%, respectively. The opposite results were reported by Reddy *et al.* (2014a) who found that boiling of *Abrus precatorius* leaf extract at 100°C for 30 min resulted in an increase of radical scavenging activity by 53.57%.

Autoclaving stability of olive fraction extracts

Antioxidant activities of olive fractions as affected by autoclaving at 121°C for different times were presented in Table (5). The mean antioxidant activities of pomace ethanol extracts (63.51%) followed by leaf ethanol extracts (62.02%) were more ($p \leq 0.05$) stable than virgin oil

chloroform extracts (54.37%) when autoclaved at 121°C for different times. There was significant (p ≤ 0.05) difference in antioxidant activities among autoclaved olive fraction extracts. Antioxidant activities of olive fraction extracts were significant (p ≤ 0.05) decreased by increasing the autoclaving times from 15 to 40 min. The mean antioxidant activities of olive fraction extracts were reduced by 15.19, 23.52, 32.93, 38.56, 43.01 and 46.35% when autoclaved at 121°C for 15, 20, 25, 30, 35 and 40 min, respectively as compared with unautoclaved olive fraction extracts. The comparable reduction in antioxidant activities was mentioned above for boiled olive fraction extracts (Table 4) and Reddy *et al.* (2014b) for boiled *Canthium parviflorum* leaf extract for 30 min.

Table (4): Effect of boiling for different times on antioxidant activities (%) of picual olive fraction extracts

Time (min)	Ethanol extract		Chloroform extract	Means[1]
	leaf	pomace	virgin oil	
unboiled	79.35±0.52	93.95±0.77	78.37±1.23	83.89[a]
15	62.80±0.46	70.53±0.08	60.16±0.06	64.50[b]
25	59.14±0.02	61.66±0.15	59.45±0.09	60.08[c]
35	58.84±0.06	5٩.89±0.02	55.48±0.02	58.07[d]
45	58.10±0.26	54.48±1.52	53.86±0.02	55.48[e]
60	52.74±0.05	٥1.52 ±0.05	40.75±0.07	48.34[f]
Means[2]	61.83[b]	65.34[a]	58.01[c]	

(1) Means in the same column with different letters are significantly different (p≤0.05), LSD = 0.51
(2) Means in the same row with different letters are significantly different (p≤0.05), LSD = 0.36

Table (5): Effect of autoclaving at 121°C for different times on antioxidant activities (%) of picual olive fraction extracts

Time (min)	Ethanol extract		Chloroform extract	Means[1]
	leaf	pomace	virgin oil	
unautoclaved	79.35±0.52	93.95±0.77	78.37±1.23	83.89[a]
15	65.40±0.90	84.16±0.74	63.84±0.90	71.13[b]
20	64.30±0.45	67.02±0.66	61.10±0.87	64.14[c]
25	59.30±1.08	58.05±0.91	51.40±0.90	56.25[d]
30	59.20±0.33	48.60±0.94	46.80±1.18	51.53[e]
35	53.80±0.80	47.00±0.54	42.60±0.58	47.80[f]
40	52.80±0.17	45.70±0.17	36.50±0.50	45.00[g]
Means[2]	62.02[b]	63.51[a]	54.37[c]	

(1) Means in the same column with different letters are significantly different (p≤0.05), LSD = 0.73
(2) Means in the same row with different letters are significantly different (p≤0.05), LSD = 0.98

pH stability of olive fraction extracts

Antioxidant activities of olive fractions as affected by different pH were presented in Table (6). Antioxidant activities of olive fraction extracts were varied ($p \leq 0.05$) with the pH values. The mean antioxidant activities of pomace ethanol extracts (77.53%) followed by leaf ethanol extracts (70.71%) were more ($p \leq 0.05$) stable than virgin oil chloroform (63.73%) when treated with different pH values. The antioxidant activity of olive fraction extracts gradually increased ($p \leq 0.05$) till pH 5.5 followed by a continuous decrease ($p \leq 0.05$). The mean antioxidant activities of olive fraction extracts were increased by 5.61% at pH 5 and 8.42% at pH 5.5. However, at pH 6, 6.5, 7 and 8, antioxidant activities of olive fraction extracts were reduced by 9.12, 20.16, 27.84 and 37.51%, respectively. The reduction of antioxidant activity at alkaline pH might be attributed to either the loss of antioxidant property of the extracts or the enhancement of lipid oxidation (Mansour and Khalil 2000). Hussein *et al.* (2009) reported that the antioxidant activity of ginger root extracts increased with pH between 5 and 7.

Induction periods of sunflower oil containing different levels of olive fraction extracts and α-tocopherol

Induction periods of sunflower oil containing different levels of olive fraction extracts and α-tocopherol were presented in Table (7). Sunflower oil containing different levels of olive fraction extracts had higher ($p \leq 0.05$) induction period than the control sunflower oil. The highest ($p \leq 0.05$) induction period of sunflower oil was obtained by the addition of 1% followed by 2% olive fraction extracts. The α-tocopherol (8.31 h) had a higher ($p \leq 0.05$) mean induction period than all olive (4.85-5.39 h) fraction extracts. Non-significant ($p > 0.05$) difference was observed in induction period between pomace ethanol extract (5.39 h) and leaf ethanol extract (5.28 h). At 1% level, the antioxidant potential of leaf ethanol extract, pomace ethanol extract and virgin oil chloroform extract were 63.21, 66.32 and 54.09%, respectively compared to α-tocopherol. The induction periods of sunflower oil with 1% leaf ethanol extract, pomace ethanol extract and virgin oil chloroform extract were increased by 35.56, 42.22 and 16%, respectively as compared with the control sunflower oil. Morsi et al. (2016) reported that addition of olive pomace extract at concentration of 150 mg gallic acid/kg oil increased sunflower oil oxidative stability by 36% in comparison with the control sample. Lafka *et al.* (2013) reported that olive leaf ethanol extracts increased the induction time of sunflower oil by 74.09%.

Table (6): Effect of different pH on antioxidant activities (%) of picual olive fraction extracts

pH	Ethanol extract		Chloroform extract	Means[1]
	leaf	pomace	virgin oil	
4	76.10±0.04	90.89±0.04	72.57±0.01	79.85[c]
5	87.47±0.09	92.04±0.01	73.47±0.01	84.33[b]
5.5	88.14±0.01	93.45±0.19	78.13±0.03	86.57[a]
6	79.13±0.03	78.29±0.02	60.28±0.11	72.57[d]
6.5	65.00±0.04	67.74±0.03	58.50±0.09	63.75[e]
7	57.70±0.05	61.29±0.03	53.86±0.01	57.62[f]
8	41.40±0.01	59.03±0.03	49.28±0.01	49.90[g]
Means[2]	70.71[b]	77.53[a]	63.73[c]	

[1]Means in the same column with different letters are significantly different ($p \leq 0.05$), LSD = 0.06
[2]Means in the same row with different letters are significantly different ($p \leq 0.05$), LSD = 0.04

Table (7): Induction period (h) of sunflower oil containing different levels of picual olive fraction extracts and α-tocopherol

Extract types	Olive fraction extracts levels (%)					Means[1]
	0	0.5	1	2	3	
Leaf ethanol extract	4.50 ±0.26	5.33 ±0.13	6.10 ±0.30	5.43 ±0.05	5.02 ±0.12	5.28[b]
Pomace ethanol extract	4.50 ±0.26	5.60 ±0.14	6.40 ±0.09	5.86 ±0.02	4.57 ±0.02	5.39[b]
Virgin oil chloroform extract	4.50 ±0.26	4.99 ±0.08	5.22 ±0.26	5.01 ±0.02	4.55 ±0.05	4.85[c]
Alpha-tocopherol (0.02g /10 ml methanol 97%)	4.50 ±0.26	8.60 ±0.10	9.65 ±0.13	9.68 ±0.03	9.10 ±0.10	8.31[a]
Means[2]	4.50[e]	5.96[c]	6.62[a]	6.34[b]	5.76[d]	

[1]Means in the same column with different letters are significantly different (p≤0.05), LSD = 0.12
[2]Means in the same raw with different letters are significantly different (p≤0.05), LSD = 0.09

CONCLUSION

From the above results, it could be concluded that leaf ethanol extract, pomace ethanol extract and virgin oil chloroform extract are potential source of antioxidants which are responsible for the antioxidant activity. The induction periods of sunflower oil with 1% leaf and pomace ethanol extracts were increased by 35.56 and 42.22%, respectively as compared with the control sunflower oil. The stability to heat and pH of the different olive fraction extracts with strong antioxidant activity indicates their scope for utilization in food and biological systems.

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النشاط المانع للأكسدة لمستخلصات أوراق الزيتون وتفلة الزيتون وزيت الزيتون البكر لصنف البيكوال وثباتها للحرارة والحموضة

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الملخص العربى

تم تقييم النشاط المانع للأكسدة لمستخلصات الإيثانول ومستخلصات أسيتات الإيثيل ومستخلصات الكلوروفورم لكل من أوراق الزيتون وتفله الزيتون (المتبقي بعد عصر الزيتون) وزيت الزيتون البكر لصنف البيكوال. وأوضحت النتائج أن مستخلصات الإيثانول لأوراق الزيتون وتفل الزيتون ومستخلص الكلوروفورم لزيت الزيتون البكر لديها نشاط مانع للأكسدة أعلى من المستخلصات الأخرى. وكان لمستخلص الإيثانول لأوراق الزيتون نفس نسبة النشاط المانع للأكسدة لألفا- توكوفيرول. وكان لمستخلص الإيثانول لتفل الزيتون نسبة نشاط مانع للأكسدة أعلى من ألفا- توكوفيرول، بينما كان لمستخلص الكلوروفورم لزيت الزيتون البكر نسبة نشاط مانع للأكسدة أقل من ألفا- توكوفيرول. وكان مستخلص الإيثانول لورق الزيتون ذو ثبات حرارى عالي فنشاطه المانع للأكسدة يمثل ٦٧,٠٤ ، ٧٤,١٥ ، ٧٥,٦٠٪ بعد التسخين الجاف عند ١٠٠° م لمدة ٣٠ دقيقة، والغليان عند ١٠٠° م لمدة ٣٥ دقيقة والتعقيم عند ١٢١° م لمدة ٣٠ دقيقة، على التوالي. وكان مستخلص الإيثانول لتفل الزيتون ذو ثبات حرارى متوسط فنشاطه المانع للأكسدة يمثل ٥٧,٧١ ، ٦٣,٧٥ ، ٥١,٧٣٪ بعد التسخين الجاف عند ١٠٠° م لمدة ٣٠ دقيقة، والغليان عند ١٠٠° م لمدة ٣٥ دقيقة والتعقيم عند ١٢١° م لمدة ٣٠ دقيقة ، على التوالي. وكان النشاط المانع للأكسدة لمستخلص الإيثانول لأوراق الزيتون ومستخلص الإيثانول لتفل لزيتون ومستخلص الكلوروفورم لزيت الزيتون البكر يبلغ أقصاه عند رقم حموضة ٥,٥. زادت فترة مقاومة الفساد لزيت عباد الشمس بإضافة 1 % من كل من مستخلص الإيثانول لتفل الزيتون ومستخلص الإيثانول لأوراق الزيتون ومستخلص الكلوروفورم لزيت الزيتون البكر بنسبة ٤٢,٢٢، ٣٥,٥٦، ١٦ ٪، على التوالي مقارنة بزيت عباد الشمس الكنترول. مستخلص الإيثانول لأوراق الزيتون وتفل الزيتون قد تكون مصادر واعدة لمانعات الأكسدة الطبيعية لإستخدامها في المنتجات الغذائية.

الكلمات الدالة: النشاط المانع للأكسدة، مستخلصات أجزاء الزيتون المختلفة، الثبات الحراري، الثبات لدرجة الحموضة وفترة مقاومة الفساد

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