Chemical Studies on Olive Pomace and Seeds as A By-Product from Olive Oil Extraction

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ABSTRACT

The extraction of olive oil is an industry with economic and social significance for Mediterranean nations. The extraction process has a large environmental impact due to the production of highly polluted wastewater and/or solid residue; thus, the present studies aim to make a chemical analysis of these by-products (olive pomace and olive seeds) to determine their nutritional properties. Proximate composition, mineral, phenolic and flavonoid content and antioxidant activity were determined. Additionally, dietary fiber, fatty acid composition, phenolic and flavonoid compounds were also carried out. Results showed that both olive pomace and olive seeds are rich sources of ditery fiber and minerals. About 12 phenolic and flavonoid compounds for olive pomace extract were detected, the highest values for phenolic compounds were gallic acid (15.73 µ/g) followed by cinnamic (10.33 µ/g). For flavonoid compounds lutoelin (7.38 µ/g) had the highest value followed by apegenin (5.17 µ/g). 12 phenolic and flavonoid compounds for olive seed extract were detected; the highest values for phenolic compounds were ferulic (15.63 µ/g) followed by syringic (9.10 µ/g). For flavonoid compounds, catechin (14.36 µ/g) had the highest value followed by kaempferol (8.10 µ/g). The total saturated fatty acids of olive pomace were 21.02%; palmitic acid had the highest value followed by stearic and caprylic which had the lowest value. The total saturated fatty acids of olive seeds were 16.5 %; palmitic had the highest value and lauric acid (C:12:0) had the lowest value. This study showed that olive by-products have high nutritional value and can be applied as a good source of functional components in many types of foodstuff.

Keywords: olive by-products, proximate composition, mineral content, dietary fiber, phenolic profile, fatty acid profile.

INTRODUCTION

The food industry generates a lot of waste and by-products, which is a major issue from an economic and environmental perspective. Because waste and by-products represent a source of bioactive chemicals as well as a possible source of energy, researchers are becoming more interested in them. The latter can be utilized as food additives or employed as markers to ensure food authenticity (Difonzo *et al*., 2021).

Around the world, 45% of fruits and vegetables are wasted; it has one of the greatest rates of waste among the categories. The continents of Europe, Latin America, North America, and Oceania have the greatest rates of agricultural waste, which is around 10% more than that of industrialized Asia. Furthermore, the largest production waste, (about 20%), is located in Sub-Saharan Africa (FAO, 2015).

An industry with economic and social significance for Mediterranean nations is the extraction of olive oil. Depending on whether the olive oil extraction (destoning process in particular) or table olive procedure is used, the extraction process produces highly contaminated wastewater and/or solid residue, which has a significant negative impact on the environment (Spizzirri *et al*., 2011).

Olive pomace, a waste product of the olive oil industry that harms the environment, has a lot of bioactive chemicals that can be used in many ways (Rahmani *et al.,* 2024).

Phenolic compounds are abundant in olive fruits, but almost 99 percent of them are lost in olive waste (Cecchi *et al*., 2019).

The chemical, organoleptic, and nutritional qualities of virgin olive oil and table olives are greatly influenced by the bioactive substances found in the olive stone, especially phenolic compounds, which are strong antioxidants. When plants are attacked by pathogens or insects, they develop secondary metabolites called phenolic compounds, which act as defenses against negative elements. Phenolic components found in olive products have been shown in numerous studies to possess a variety of pharmacological characteristics, such as anti-inflammatory, anti-allergic, anti-fungal, antibacterial, antiviral, anticancer, and anti-atherogenic actions (Mumcu and Deliboran, 2025).

Recently, attention has focused on olive pomace, the leftover material after oil is extracted as a valuable source of phenolic chemicals, specifically hydroxy

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tyrosol and tyrosol. After any remaining oil has been removed, the process of conventional solvent extraction (CE) is typically used to extract phenolic components from olive pomace (Jurmanović *et al*., 2019).

Mousavi *et al*. (2022) reported that, tyrosol is effective over the long term at preventing the overproduction of reactive oxygen species (ROS). Hydroxytyrosol, on the other hand, has demonstrated more radical-scavenging activity.

Applications of olive pomace or olive pomace bioactives in the creation of functional foods have been the subject of numerous studies. Since the antioxidant and anti-inflammatory qualities of these bioactive compounds constitute important agents against multiple chronic conditions, including type II diabetes, cancer, and cardiovascular diseases, there is a movement to supplement various food matrices with olive pomace or olive pomace bioactives (Tsoupras *et al*., 2024).

Compared to the olive fruit itself, olive seeds have a significant amount of oil (22–27% of their weight) that is higher in total polyunsaturated fatty acids (PUFA) and individual sterols. Furthermore, studies have demonstrated the abundance of phenolic chemicals found in olive stones, primarily flavones, as well as glycoside molecules such as salidroside, glucose nuzhenide, and nuzhenide-oleoside. One of the main phenolic compounds in the fruit flesh is verbascoside (Jahanbakhshi and Ansari, 2020).

Therefore, the present studies aim to make a chemical analysis of these by-products (olive pomace and olive seeds) to determine their nutritional properties.

MATERIAL AND METHODS

Olive oil by-products produced from olive oil industry were obtained in 2021. The samples; first phase extraction (traditional method); were obtained from olive extraction factory in Siwa City –Matrouh Egypt. The samples were transported in an insulated ice box under cooling conditions into the laboratory in the Faculty of Agriculture, Alexandria, Egypt.

The chemicals used in the present study were of analytical grade and were purchased from El-Gomhouria company for chemical and medical requisites, Alexandria, Egypt.

Preparation of olive by-products:

Olive by-products (olive seeds and olive pomace) were grinded and sieved to pass from 45 mesh screen to be ready to use.

Chemical methods:

Proximate composition:

The proximate composition including, crude protein, total fat, moisture content total ash and fiber was determined according to the methods of A.O.A.C. (2006). The carbohydrate content of the tested sample was determined by difference using the arithmetic difference method according to the A.O.A.C. method (2006) as follows:

% carbohydrate (CHO) =100- (% fat +% ash +% protein).

Mineral content:

Minerals were determined according to the method of A.O.A.C. (2006), Mn, Fe, and Cu were determined by Atomic Absorption Spectrophotometric (Shimadzu model (AA-6650) while K and Na were determined by Flame photometer.

Dietary fiber:

Neutral detergent fiber (NDF) and acid detergent fiber (ADF), were determined using an ANKOM 220 fiber analysis unit (ANKOM technology corporation, NY, USA) according to the A.O.A.C. (2006).

Total flavonoid content:

The extract was prepared by mixing 1 g of olive pomace or seeds powder with 50 ml of methanol then filtration. The total flavonoid content of olive pomace and seeds extracts was determined by the method of Qing *et al.* (2020) as follows: a 10 ml volumetric flask was first precisely filled with 2 ml of the sample solution. Then, 0.6 ml of 5% sodium nitrite ($NaNO_2$) was added, shaken, and allowed to sit for 6 minutes. Second, the volumetric flask was filled with 0.5 ml of a 10% aluminium nitrate ($Al(NO_3)_3$) solution, shaken, and allowed to stand for 6 minutes. Prior to determination, 3.0 ml of a 4.3% sodium hydroxide (NaOH) solution was added to the volumetric flask. Water was then poured up to the scale, agitated, and allowed to stand for 15 minutes. A spectrophotometer was then used to measure absorbance at 500 nm. Total flavonoid content was calculated as mg rutin equivalent/g.

Total phenolic content:

The total phenolic content of olive pomace and seeds extact was determined according to the methods of Ainsworth and Gillespie (2007) using the Folin-Ciocalteu reagent. The extract was mixed with 5 ml of Folin-Ciocalteu reagent, and 4 ml of sodium carbonate (75 g/l) was added. The mixture was vortexed for 15 s and allowed to stand for 30 min at 40°C for colour development. Absorbance was measured at 765 nm using a spectrometer. Total phenolic content was expressed as mg gallic acid equivalent/g.

Antioxidant activity by DPPH radical scavenging assay:

The techniques outlined by Moyo *et al.* (2012) were used to determine the impact of pomace and seed extracts on DPPH radicals. One millilitre of the extract was combined with one millilitre of a DPPH (0.135 mM) solution. 50 ml of methanol and 1 g of powdered olive pomace or seeds were combined to create the extract, which was then filtered. After giving the reaction mixture a thorough vortex, it was allowed to sit

at room temperature for half an hour in the dark. Using BHA as a reference, the mixture's absorbance was measured at 517 nm. The radical scavenging activity was calculated by the following equation:
DPPH radical scavenging activity (%)=

$$\frac{(Abs_{control} - Abs_{sample})}{Abs_{control}} * 100$$

Where, $Abs_{control}$ is the absorbance of DPPH radical, Abs_{sample} is the absorbance of DPPH radical solution mixed with sample extract /standard.

Fatty acid composition:

The methyl ester of fatty acids was made using Radwan's (1978) method. Two drops of the leftover oil were dissolved in five millilitres of GC-grade benzene, and seven millilitres of GC solvent (1% H_2SO_4 in methanol) were added. The mixture was then heated in oven for 90 minutes at 90ºC. The liquid was shaken vigorously after adding two millilitres of distilled water until it divided into two layers. Sodium sulfate was applied to the top layer in order to remove any surplus moisture. A 0.22µl micro filter was used to prepare the filtrate for injection into the GC column. A split injector and FID detector were included in the ACME model 6100 GC (Young LIN Instrument Co., Korea) used for the gas chromatographic analysis. The carrier gas, nitrogen, had a flow rate of 0.5 milliliters per minute. The detector temperature was set at 260ºC, and the components were separated on a 30m SP-2380 fused-silica capillary column with 0.25 mm i.d. and 0.2 µm film thickness (Supelco, Bellefonte, PA). In split mode, with a split ratio of 1:80, the injector temperature was set at 220ºC. After being kept at 140ºC for five minutes, the temperature was raised to 240ºC at a rate of 4ºC per minute.

High performance liquid chromatography (HPLC) analysis of phenolic and flavonoid compounds:

Phenolic and flavonoid compounds were analyzed using Agilent Series 1100 high performance liquid chromatography (HPLC) equipment (Agilent, USA). An auto-sampling injector, two LC- pumps (series 1100), a solvent degasser, a UV/Vis detector (tuned at 360 nm for flavonoids and 250 nm for phenolic acids), and ChemStation software were all included. The analysis was conducted using a C18 column (125 mm × 4.60 mm, 5 µm particle size). Phenolic acids were separated using a gradient mobile phase made up of two solvents: A (methanol) and B (acetic acid in water (1:25)). For the first three minutes of the gradient procedure, the concentration was maintained at 100% B. Following this, 50% eluent A was used for the next five minutes. Then, for the next two minutes, the concentration of A was raised to 80%, and for the next five minutes, it was lowered to 50% once more at a detection wavelength of 250 nm.

Two solvents: A (acetonitrile) and B (0.2% (v/v) aqueous formic acid) were used in the mobile phase of an isocratic elution (70:30) process to separate flavonoids. With a solvent flow rate of 1 ml/min, the separation was performed at 25°C. The injection volume was 25 µL (Lin *et al.*, 1996 and Kuntić *et al.*, 2007).

Statistical analysis:

Data were statistically analyzed as randomized complete block design (R.C.B.D) according to Gomez and Gomez (1984). Least significant difference values (L.S.D) at 0.05 level of probability were used to compare the differences between treatment means.

RESULTS AND DISCUSSION

Proximate composition of olive pomace and olive seeds:

The percentage of moisture content, protein, total ash, total fat, crude fiber and carbohydrates for olive pomace are shown in Table (1); which were 33.78, 9. 43, 3.16, 9.5, 31.49 and 77.91%; respectively. Lin *et al.* (2017) reported that percentage of ash and protein content of olive pomace was 3.14 % and 2.76 %; respectively. Sleim *et al.* (2020) reported that protein content, ash, fiber contents and total lipids were 7%, 3.75% and 57.5% and 6.57 % on dry weight basis (DW); respectively. While, Quero *et al.* (2022) mentioned that olive pomace protein, fat, ash was 5.66%, 12.06%, 4.55%; respectively.

The percentage of moisture content, protein, total ash, total fat, crude fiber and carbohydrates for olive seeds was 22.54, 6.40, 5.12, 6.9, 39.53 and 81.58%; respectively Table (1). Analysis of variance indicated that there were highly significant differences between olive pomace and seeds for all chemical components. Means of the studied chemical traits showed that olive pomace had higher moisture, protein, fat, than seeds on the contrast, olive seeds had higher values of ash, fiber. It was in the same range which reported by Zidan and Samea (2019) the olive seeds recorded the value of moisture, protein, ash and fibers (9.97,12.47, 4.16, 21.32 g/100 g); respectively, Eid *et al.* (2021) results revealed that moisture; fat, crude fiber and ash of roasted olive stones powder were decreased from 10.56, 7.36, 16.66, 0.85% to 2.04, 5.98, 13.64, and 0.82%; respectively with increasing roasting time from 25 min to 50 min at 200ºC. While, Awaad *et al.* (2024) reported that fiber ash, fat, protein, moisture, and carbohydrate contents of olive seeds powder were (50.30, 1.24, 7.20, 5.30, 6.12, and 80.14 g/100g), respectively.

Table 1. Chemical composition of olive pomace and olive seeds

Source	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	**Carbohydrate (%)
Pomace	33.78[a] ±0.19	9.43[a] ±0.08	3.16[b] ±0.12	9.53[a] ±1.15	31.49[b] ±0.9	77.91[b] ±1.06
Seed's	22.54[b] ±0.09	6.40[b] ±0.19	5.12[a] ±0.09	6.90[b] ±0.18	39.53[a] ±0.13	81.58[a] ±1.45

*On a dry weight basis. **Carbohydrate by difference.
The results presented are the means ±SD of three replications.
Means in the same column followed by the same letter are not significantly different according to L.S.D$_{0.05}$ values.

Table 2. Mineral content for olive seed and pomace

Mineral (mg /100 g)	Olive pomace	Olive seed
Copper (Cu)	0.91147±0.009	0.72833±0.003
Manganese (Mn)	0.6030±0.006	0.34215±0.005
Iron (Fe)	22.6676±1.212	11.1093±1.004
Sodium (Na)	9.9518±1.002	127.1916±2.126
Potassium (K)	61.0401±1.206	19.6479±1.106

*on a dry weight basis. The results presented are the mean ± SD of three replications.

Mumcu and Deliboran (2025) reported that olive stone chemical composition was 3.20, 5, 53, 9.79% (w/w) for protein, fat and moisture; respectively. Dermeche *et al.* (2013) reported that chemical composition of olive pomace also varies according to olive species, origin of the olives, and extraction process and also Portarena *et al.* (2017) reported that the proximate composition of olive pomace is influenced by many factors including ripening stage and agriculture practices.

Mineral content:

The mineral content of olive pomace and olive seeds are shown in Table (2). The mineral content of olive pomace was 0.91147, 0.6030, 22.6676, 9.9518 and 61.0401 for copper, manganese, iron, sodium and potassium; respectively. It was in the same range reported by Lin *et al.* (2017). They reported that the values of iron, copper, sodium, and manganese were 2.342, 0.425, 2.791, and 1.253 mg/100g; respectively. It is a good source of potassium and iron. Locallo *et al.* (2019) mentioned that wet olive pomace have zinc 1.9 mg/100g, managanese 1.1 mg /100g and copper 1.6 mg/100g. Difonzo *et al.* (2021) reported that olive pomace is a rich source of minerals.

The mineral content of olive seeds (mg/100g) was 0.72833, 0.34215, 11.1093, 127.1916 and 19.6479 for copper, manganese iron, sodium and potassium; respectively. It was less than the results reported by Masteri *et al.* (2019) they reported that the values of potassium, sodium were 557.9, 275.8 mg/100g; respectively. It is a good source of potassium and iron. Zidan and Samea (2019) results showed that olive seeds contained higher amounts of Na, K, Fe, Mn and Cu (9277.750, 325.210, 9.407, 0.829 and 0.435 mg/100g), respectively.

Dietary fiber:

According to the obtained results presented in Table (3) the Acid detergent fiber (ADF) and neutral detergent fiber (NDF) for olive pomace were 54.98% and 51.68%; respectively. Anaylsis of variance indicated that there were significant differences between olive pomace and seeds for NDF percent. Means of the studied chemical traits showed that olive seeds had higher NDF percent than pomace on the other hand there is no significant differences between olive pomace and olive seeds for ADF percent. Lin *et al.* (2017) reported the total dietary fibre (TDF) that accounted for around 80 % of the olive pomace composition with insoluble dietary fibre (IDF) representing the greatest part (72.75% of TDF).

Dietary fiber content of olive seeds was 51.42 % acid detergent fibers and 60.71% neutral detergent fiber. It was in the same range reported by Mumcu and Deliboran (2025) the acid detergent fiber and neutral detergent fiber for olive seeds were 58.2 and 80.1%. Consequently, both olive seeds and olive pomace are good source of dietary fiber.

Table 3. Deitary fiber content of olive pomace and olive seeds

Source	ADF (%)	NDF (%)
Pomace	54.98[a] ±4.0	51.68[b] ±1.0
Seed's	51.42[a] ±0.42	60.71[a] ±0.29

* On a dry weight basis.
The results presented are the means ±SD of three replications.
Means in the same column followed by the same letter are not significantly different according to L.S. D$_{0.05}$ values.

The proper amount of dietary fiber can reduce the risk of cardiovascular illnesses, obesity, cancer, diabetes, and gallstones. This is because consumers are becoming more and more interested in eating nutritious foods that are low in calories and fat (Jahanbakhshi and Ansari, 2020).

Total phenolic, total flavonoid content and antioxidant activity:

The total phenolic content of olive pomace presented in Table (4) was 186.06 mg GAE/100g. Sliem *et al.* (2020) results showed that the polyphenols content varied from 829 to 3624 mg/100g (DW). Methanolic extract recorded the highest total polyphenolic content higher than the other solvents while acetone extract presented the less polyphenolic contents.

The total phenolic content of olive seeds was 495.08 mg GAE /100g; it is higher than the results reported by Elbir *et al.* (2015).

The total flavonoid of the olive seeds and olive pomace were 52.40 and 75.62 mg rutin equivalent /100g. The percentage of inhibition of DPPH radical by the extract was 63.01 and 97.25% for olive pomace and olive seeds; respectively. Anaylsis of variance indicated that there were highly significant differences between olive pomace and seeds for all chemical components. Means of the studied chemical traits showed that olive seeds had higher total phenolic, flavonoids, DPPH scavenging % than pomace, while olive pomace had IC 50 value higher than seeds. Awaad *et al.* (2024) results showed that the Olive Seeds Powder is considered as having much greater levels of total phenolic (mg GAE/100 g), and antioxidant activity (AO) % than DSP and WF, i.e., 850.50 mg/100 g, and 80.60% (Hassan *et al*., 2022) reported that olive pomace produced from press process extraction methods contains high natural anti-oxidants than three phase extraction method.

Many diseases, including atherosclerosis, various cancers, inflammatory illnesses, and Parkinson's disease, are known to be brought on by the oxidative stress that free radicals create. The antioxidant effect of these compounds is supported by the strong association seen between the total phenol content (as assessed colorimetrically) and the free radical scavenging activity (Parveen *et al*., 2015).

High concentrations of phenolic chemicals, including hydroxytyrosol and oleuropein, which are not converted to olive oil, were found in the by-products obtained during the manufacturing of olive oil. These chemicals can be regarded as high-value products due to their wide range of biological activity, and methods for their effective recovery should be further researched and developed (Araújo *et al*., 2015).

HPLC analysis of phenolic and flavonoids compounds:

There are 12 phenolic and flavonoid compounds were identified from olive pomace extract by HPLC analysis as shown in Table (5). The detected phenolic compounds were chlorogenic, syringic, p-coumaric, cinnamic, caffeic, pyrogallol and gallic acid. Gallic acid had the highest value followed by cinnamic. Tyrosyl had the highest value followed by oleuropein glycoside as reported by Sleim *et al.* (2020). Chanioti *et al.* (2021) mentioned the main phenolic compounds of olive pomace which is Hydroxy tyrosol, oleourpein, vanillin, apigenin, rutin and lutulin The detected flavonoid compounds were naringin, quercetin, kamperol, luteolin and apegenin. Lutoelin had the highest value followed by apigenin.

As shown in Table (6) there are 12 phenolic and flavonoid compounds were identified from olive seed extract. The detected phenolic compounds were syringic, cinnami, caffeic, pyrogallol, ferulic and ellagic. Ferulic had the highest value followed by syringic. The detected flavonoid compounds were 7 - OH flavone, naringin, myricetin, kampferol, apegenin and catechin. The catechin had the highest value followed by kampferol. Awaad *et al.* (2024) mentioned that in olive seeds powder ethanolic extracts 9 compounds from polyphenols namely, Apeginin, Gallic acid, Quinic acid, Chlorgenic acid, Vanillic acid, Hisperidin, P-coumaric, Ferulic acid and Quercitin were detected. Eid *et al.* (2021) reported that roasted olive stone powder had the highest value of Oleourpin followed by catechol.

Fatty acid composition:

The fatty acid composition of the oil extracted from olive pomace and olive seeds were shown in Table (7). The Total saturated fatty acids of olive pomace were 21.02%; Palmitic acid had the highest value followed by stearic and caprylic acid which had the lowest value. Total unsaturated fatty acid of olive pomace was 78.99%, oleic acid had the highest value followed by linoleic. The results agree with those reported by Nunes *et al*. (2018) who reported the total mono unsaturated fatty acids 76.25%, total saturated fatty acids was 14.49% and total poly unsaturated fatty acid 9.25%.

Table 4. Total phenolic, total flavonoid content and antioxidant activity of olive pomace and olive seed

Source	Total phenolic (mg/100g)	Total flavonoid (mg/100g)	DPPH Scavenging %	IC 50(mg/ml)
Pomace	186.06 [b] ±9.01	52.40 [b] ±1.63	63.01 [b] ±2.17	7.94 [a] ±0.19
Seed's	495.08 [a] ±10.66	75.62 [a] ±0.81	97.25 [a] ±0.14	5.14 [b] ±0.01

The results presented are the means ±SD of three replications.
Means in the same column followed by the same letter are not significantly different according to $L.S.D_{0.05}$ values.

Table 5. Phenolic and flavonoid compound content of olive pomace by HPLC

Phenolic compounds		Flavonoid compounds	
Compound	**Concentration (µ/g)**	**Compound**	**Concentration (µ/g)**
Chlorogenic	1.55	Naringin	3.88
Syringic	4.26	Querestin	4.13
p-coumaric	2.15	Kampferol	3.55
Cinnamic	10.33	Luteolin	7.38
Caffeic	2	Apegenin	5.17
Phrogallol	0.41		
Gallic	15.73		

Table 6. Phenolic and flavonoid compound content of olive seeds by HPLC

Phenolic compounds		Flavonoid compounds	
Compound	**Concentration (µ/g)**	**Compound**	**Concentration (µ/g)**
Syringic	9.10	7-OH flavone	4.20
Cinnamic	4.26	Naringin	2.15
Caffeic	1.17	Myricetin	2.06
Pyrogallol	2.14	Kampferol	8.10
Ferulic	15.63	Apegenin	0.56
Ellagic	3.06	Catehin	14.36

Table 7. Fatty acid composition of olive pomace and olive seeds

Olive pomace		Olive seeds	
Fatty acid	**%**	**Fatty acid**	**%**
Caprylic $C_{8:0}$	0.22	Caprylic $C_{8:0}$	0.13
Myristic $C_{14:0}$	1.01	Luaric $C_{12:0}$	0.09
Palmitic $C_{16:0}$	10.34	Myristic $C_{14:0}$	0.33
Stearic $C_{18:0}$	9.45	Palmitic $C_{16:0}$	15.95
TSFAS*	21.02	TSFAS*	16.50
Oleic $C_{18:1n9c}$	63.05	Palmitolic $C_{16:1n9c}$	0.69
Linoleic $C_{18:2n6c}$	14.45	Linoleic $C_{18:2n6c}$	73.39
Gendoic $C_{20:1}$	1.49	Gendoic $C_{20:1}$	9.07
TUSFAS**	78.99	Linolenic $C_{18:3n3}$	0.35
USFAS/SFAS	3.757	TUSFAS**	83.50
		USFAS/SFAS	5.06

*Total saturated fatty acids.
**Total unsaturated fatty acids.

The total saturated fatty acids of olive seeds were 16.5 %; Palmitic was the highest value and C:12 had the lowest value. Total unsaturated fatty acids was 83.5%. The results agree with those reported by Maestri *et al.* (2019) who mentioned that total mono unsaturated fatty acids 62.78%, total poly unsaturated fatty acids was 24.63% and total saturated fatty acids was 12.34%. It could be concluded that both olive seeds and olive pomace are a good source of unsaturated fatty acids (Difonzo *et al.,* 2021).

CONCLUSION

It can be concluded that olive oil extraction by products (olive pomace and olive seeds) have high nutritional value, it is a good source of protein, minerals dietary fiber, bioactive compounds, unsaturated fatty acids, it can be considered as a promising functional ingredient that can be incorporated in many functional foods and other food applications.

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الملخص العربي

دراسات كيماوية علي تفل وبذور الزيتون كناتج ثانوى من استخلاص زيت الزيتون

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تعتبر صناعة استخلاص زيت الزيتون ذات أهمية اقتصادية واجتماعية كبيرة بالنسبة لدول البحر المتوسط كما أن مخلفاتها لها تأثير بيئي ضارسواء ما ينتج من سوائل و / أو المخلفات الصلبة، وبالتالي فإن الهدف من هذه الدراسة هو إجراء تحليل كيميائي لهذه المنتجات الثانوية (تفل الزيتون وبذور الزيتون) لمعرفه خصائصها الكيماوية. تم تقدير التركيب الكيماوي التقريبي ومحتوى المعادن والفينولات والفلافونويدات والنشاط المضاد للأكسدة. اضافة إلي تقدير الألياف الغذائية والأحماض الدهنية وأظهرت النتائج أن كل من بقايا الزيتون وبذور الزيتون مصدر غني بالألياف والعديد من المعادن. تم التعرف علي ١٢ مركب فينولي وفلافونويدي لمستخلص تفل الزيتون، وكانت أعلى القيم للمركبات الفينولية هي حمض الجاليك (١٥,٧٣ ميكروجرام / جرام) يليه سيناميك (١٠,٣٣ ميكروجرام / جرام). وبالنسبة للمركبات الفلافونويدية كان اللوتولين (٧,٣٨ ميكروجرام / جرام) أعلى قيمة يليه الأبجينين (٥,١٧ ميكروجرام / جرام). تم التعرف علي ١٢ مركب فينولي وفلافونويدي في مستخلص بذور الزيتون، وكانت أعلى القيم للمركبات الفينولية هي الفيروليك (١٥,٦٣ ميكروجرام / جرام) يليه السيرينجيك (٩,١٠ ميكروجرام / جرام). وبالنسبة للمركبات الفلافونويدية كان الكاتكين (١٤,٣٦ ميكروجرام / جرام) أعلى قيمة يليه كامبفيرول (٨,١٠ ميكروجرام / جرام). بلغ إجمالي الأحماض الدهنية المشبعة في تفل الزيتون ٢١,٠٢ %؛ وقد سجل حمض البالمتيك أعلى قيمة بينما سجل كل من حمض الاستياريك والكابريليك أقل قيمة. وبلغت نسبة الأحماض الدهنية المشبعة الكلية في بذور الزيتون ١٦,٥%، وسجل حمض البالمتيك أعلى قيمة بينما سجل حمض اللوريك أقل قيمة. وقد أظهرت هذه الدراسة أن منتجات الزيتون الثانوية ذات قيمة غذائية عالية ويمكن استخدامها كمصدر للمركبات النشطة في العديد من الأغذية.

الكلمات المفتاحية: منتجات الزيتون الثانوية، التركيب التقريبي، المحتوى المعدني، الألياف الغذائية، المظهر الفينولي، المظهر الدهني.