Universidade Vigo

CHEMICAL AND NUTRITIONAL CHARACTERIZATION OF VARIOUS BY-PRODUCTS OF THE INDUSTRY OLEA EUROPEA L. SOURCE OF HEALTHY INGREDIENTS

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INTRODUCTION

Nowadays food industry is searching for ingredients from different natural sources with bioactive properties that may increase the health benefits of food products [1]. In this work, we evaluate the content in phenolic compounds (PC), fatty acids (FA) and minerals of several by-products from the *Olea europaea* L. processed industry, including olive cake, olive water, olive fiber and olive leaves, to enable the development of healthier and more sustainable foods, supplements under a circular economy concept to meet market demand, while giving added value to underexploited food waste [2]. Currently, there are several food supplement products derived from *Olea europaea* L. available on the market, such concentrates of hydroxytyrosol (HT) and some products derived from olive leaf extracts due to their oleuropein (OLE) content. Figure 1 represents the scheme of the antioxidant, anti-inflamatory and antitumor mechanism of HT and OLE [3]. Both compounds inhibit the oxidation of blood cholesterol, reducing the LDL cholesterol levels in the blood and protects against mitochondrial dysfunction in models of early Alzheimer's disease and brain aging.

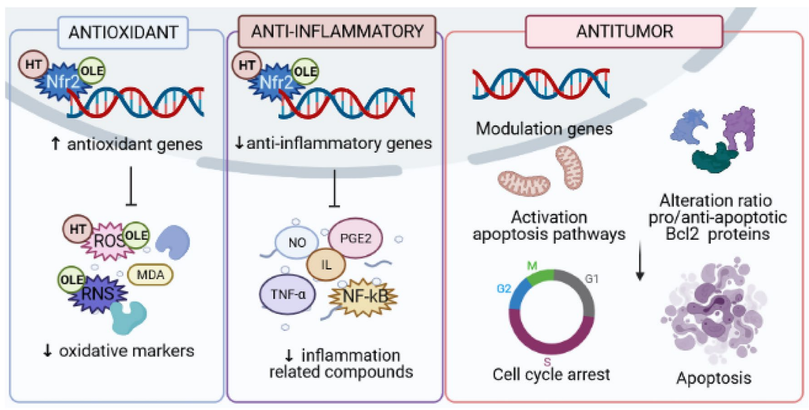

Fig. 1. Antioxidant, anti-inflammatory and antitumor mechanisms of HT and OLE [3].

METHODOLOGY

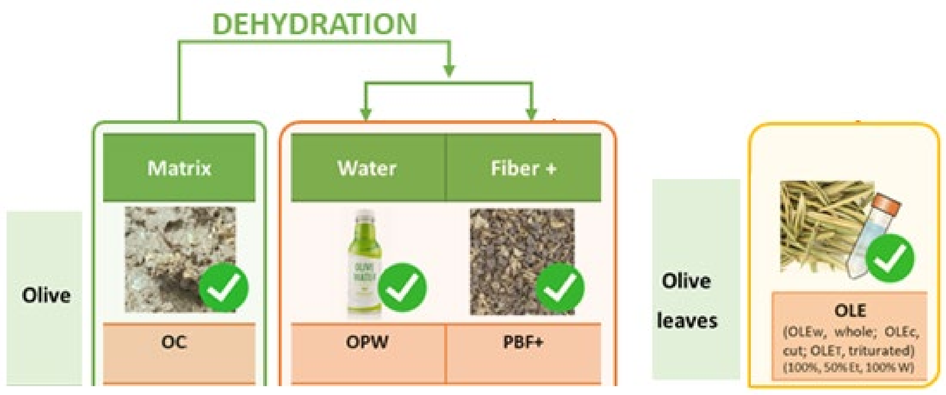

Fig. 2. Schematic representation of olive by-products analysed: Olive cake (OC), Olive water (OPW), Olive fiber (PBF+) and Olive leaves (OLE)

1. Analysis of phenolic content (PC) were performed by liquid chromatography–mass spectrometry (LC–MS).

High Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS, 1260 Series, Agilent) coupled to a compact Mass Detector equipment (TRIPLE QUAD 3500; AB SCIEX INSTRUMENTS) was used. PC were separated using a C18 column (PHENOMENEX LUNA, 150 mm × 2 mm and 3 µm). The phenolic acids analysed were: 4-chlorobenzoic acid (4-CBA), vanillic acid (VA), cinnamic acid (CA), dihydroxibenzoic acid (DA), *p*-coumaric acid (p-CA), phthalic acid (PA), *m*-toulic acid (M-TA), luteolin (LU), protocatechuic acid (PTA), quercetin (QE), vanillin (VN), salycilic acid (SAA), catechin (CAT), epycatechin (ECAT), tyrosol (TYR), hydroxytyrosol (HTYR), ligstroside (LIG), Oleacin (OLE), oleuroside (OLS), oleuropein (OLP).

2. Analysis of fatty acid (FA) was obtained by gas chromatography coupled to flame ionization detector (GC-FID).

Samples and standards were submitted to the same trans-esterification step [10] and then, fatty acid methyl esters (FAMEs)were analyzed by a GC–MS-FID using 7890 A System (AgilentTechnologies, (Loveland, CO 80537, USA). The system comprises asplit/splitless injector, electronic pressure control G4513 A autoin-jector, a 5975C triple-axis mass spectrometer detector and GC–MSSolution software. The column used was an Agilent HP-5MS UI cap-illary column (30 m × 0.250 mm × 0.25 m).

3. Analysis of the minerals was performed by inductively coupled plasma optical emission spectrometry (ICP-OES).

The concentration of microelements [iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn)] and macroelements [calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P), sodium (Na), sulfur (S), silicon (Si)] were simultaneously analyzed by inductively coupled plasma optical emission spectrometry (ICP-OES) using a Perkin–Elmer Optima 4300 DV spectrometer (Shelton, CT, USA), equipped with an AS-90 autosampler, axial system, a high dynamic range detector and a cross-flow type nebulizer for pneumatic nebulization.

CONCLUSIONS

The by-products derived from the olive processing industry are secondary but valuable products, from which different bioactive molecules can be recovered and reused, for various purposes following circular economy policies.

RESULTS

1. IDENTIFICATION AND QUANTIFICATION OF PC

Olive fiber (PBF+):
- **Hydroxytyrosol** (HTRY, 171.2 mg/kg)
- **Oleacin** (OLE, 150 mg/kg)

Table 1. Quantification of phenolic compounds in olive by-products

PRODUCT	PHENOLIC COMPOUNDS (mg/kg)																					
	4-CBA	VA	CA	DA	FA	P-CA	PA	SA	M-TA	LU	SY	PTA	QE	VN	SAA	RU	TYR	HTYR	LIG	OLE	OLS	OLP
OC	-	7.38	0.30	30.78	1.62	8.98	0.42	0.06	0.03	12.23	4.75	0.25	2.15	0.41	-	0.659	8.62	7.03	0.0187	4.00	0.058	0.087
OPW	-			0.048	0.006	0.229	-	-	-	0.014	-	-	1.042	-	-	0.228	8.10	3.747		0.488	87.275	0.112
PBF+	-	1.53	0.29	68.74	0.36	2.76	0.28	0.01	0.12	4.43	2.19		0.96	0.54	0.01	1.303	11.35	171.23	0.062	149.67	3.17	4.750
OLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.971	0.143	0.141	1.311	1.726

2. IDENTIFICATION AND QUANTIFICATION OF FA

Table 2. Short chain fatty acids in olive samples.

PRODUCT	SHORT CHAIN FATTY ACID (mg/kg)														
	C4:0	C6:0	C8:0	C10:0	C11:0	C12:0	C13:0	C14:0	C14:1	C15:0	C15:1	C16:0	C16:1	C17:0	C17:1
OC2	-	-	239	-	-	-	-	28	-	-	29	12376	765	89	84
PBF+	-	-	129	-	-	-	-	59	-	-	-	13628	666	434	-
OPW	-	-	-	-	-	-	-	7	-	-	-	424	17	-	-
OLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Olive fiber (PBF+):
- PUFA (11%)
- MUFA (71%)
- SFA (18%)

→ Linoleic acid, Oleic acid, α-linolenic acid

Table 3. Quantification of long chain fatty acid in olive by-products

PRODUCT	LONG CHAIN FATTY ACID (mg/kg)																						
	C18:0	C18:1 trans	C18:1 cis	C18:2 trans	C18:2 cis	C18:3 n6	C20:0	C18:3 n3	C20:1	C21:0	C20:2	C20:3 n6	C22:0	C20: n3 + C22:1	C20:4	C23:0	C22:2	C20:5	C24:0	C24:1	C22:6
OC2	3732	-	77801	-	4221	-	569	754	213	-	-	-	246	-	23	-	-	-	202	-	-
PBF+	4615	-	78777	-	10734	-	531	1612	267	-	-	-	276	-	93	-	-	-	439	-	-
OPW	51	-	192	-	164,1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OLE	-	-	29	-	4.5	-	-	6.5	-	-	-	-	-	-	-	-	-	-	5	-	-

3. IDENTIFICATION AND QUANTIFICATION OF MINERALS

Table 2. Quantification of minerals in olive by-products

PRODUCT	MINERALS (mg/kg)												
	Ca	Cu	Fe	K	Mg	Mn	Na	P	Zn	Al	B	Cr	Ni
OC	6326	17	615	4882	466	16	1063	851,7	2,7	-	-	-	-
OPW	-	-	-	-	-	-	-	-					
PBF+	3327	25	5,3	6621	458	11	1004	54,3	3,7	-	-	-	-
OLE	4,93	0	-	39,3	6,2	0	2,3	2,89	-	-	-	-	-

Relevant values of K and Mg in olive cake and fibers (~ 5 g/kg K and ~ 0.5 g/kg Mg).

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