Industrial Crops and Products 70 (2015) 116–124

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

# Olive by-products: Challenge application in cosmetic industry

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ARTICLE INFO

*Article history:*
Received 3 December 2014
Received in revised form 18 February 2015
Accepted 11 March 2015
Available online 20 March 2015

*Keywords:*
Olive by-products
Olive stone
Olive leaves
Cosmetics
Skin

ABSTRACT

Olive tree is a traditional plant which fruits (*Olea europaea* L.) are used for olive oil production, especially in Mediterranean countries. Olive oil extraction produces by-products, which can become a major environmental issue. Recently, some studies have been carried out on these residues regarding phytochemical identification and biological and toxicological evaluation. The bioactive compounds contained by these by-products have a high antioxidant activity (especially oleuropein), a characteristic fatty acids profile and an interesting mineral composition. Indeed, taking into account its composition and sustainability issues, the reuse of these disposal residues is advisable. These agro-industrial by-products have the potential to be used with different purposes, providing economical advantage. In particular, the field of skin care products and cosmetics may benefit from these remaining materials, as those bioactive compounds can fulfill a real cosmetic function and activity. This review presents the composition of the different olive by-products and their bioactive compounds. The possible application of these wastes as cosmetic ingredients was critically reviewed.



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## 1. Introduction

Olive trees are usually native to the Mediterranean countries, but their growth has spread globally during the past two decades due to health benefits attributed to olive oil consumption. The health promoting properties are associated with the presence of monounsaturated fatty acids (MUFA), and functional bioactive compounds like tocopherols, carotenoids, phospholipids and phenolics (Benavente-García et al., 2000; Ghanbari et al., 2012).

*Abbreviations:* DNA, deoxyribonucleic acid; EU, European Union; FA, fatty acids; HT, hydroxytyrosol; K, potassium; MMP, matrix metalloproteinase; Mg, magnesium; MUFA, monounsaturated fatty acids; N, nitrogen; NMF, natural moisturizing factor; OMP, olive mill pomace; OMWW, olive-mill wastewater; P, phosphorus; ROS, reactive oxygen species; SWOT, strengths-weakness-opportunities-threats; UV, ultraviolet; 3,4 DHFEA-EDA, 3,4-DHPEA-elenolic acid di-aldehyde.

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http://dx.doi.org/10.1016/j.indcrop.2015.03.027
0926-6690/

In 2013, production of olive oil accounted for 2.67 million tons with human consumption being its main purpose (Romero-García et al., 2014). The estimated production for 2014 is 3.01 million tons (International Olive Council, 2014). Olive oil extraction and olive table represent an economic and social activity highly relevant in the Mediterranean countries (Rodríguez et al., 2008), generating about 98% of the world production (Vergara-Barberan et al., 2014). Actually, European Union's (EU) olive sector has about 2.5 million producers, which make up roughly one-third of all EU farmers (Niaounakis and Halvadakis, 2006).

The olive fruit can structurally be separated into the following three parts: (1) the skin, called epicarp (1.0–3.0% of the drupe weight), which contains chlorophylls, carotenoids and anthocyanins that account for the color; (2) the pulp or flesh, called mesocarp (70–80% of the whole fruit), is the major part of the olive and is the reserve supply of all the constituents; (3) the stone, called the woody endocarp (18–22% of the olive weight), which contains the seed (Bianchi, 2003).

Untreated olive by-products discharged into the environment are a major ecological issue for olive oil-producing countries due to their highly toxic organic loads and low pH (Dermeche et al., 2013). At the moment there is no European legislation regulating olive mill discharges, being this issue a task of each country. The practices currently applied include land disposal, discharge into nearby rivers, lakes or seas and storage/evaporation in lagoons (Paraskeva and Diamadopoulos, 2006). Thus, recent research studies highlight on the treatment approaches and valorization options for dealing with olive by-products, predominantly those allowing a sustainable recovery of valuable natural components (Dermeche et al., 2013).

Cosmetic application could be a new way to reuse these by-products. As it is well known, human skin is a complex organ that regulates body heat and water loss, whilst preventing the entry of toxic substances and microorganisms. Natural ingredients, phytonutrients, microbial metabolites, dairy derived actives, minerals and animal protein components have long been believed to benefit healthy skin aging (Prakash and Majeed, 2009). Olive oil has been used on the skin for thousands of years but most of the mechanisms underlying these beneficial effects remain unclear (Badiu et al., 2010). According to Badiu et al. (2010) olive oil has antioxidant properties and contains several essential fatty acids required for the production of phospholipids, being the case of alpha-linolenic acid and gamma-linolenic acid. For olive by-products, different studies have been carried out regarding their composition, but any review evaluated their possible application as active ingredients in the cosmetic field. In this review, the challenge applications of olive by-products as active ingredients for skin care products were discussed, analyzing the main compounds responsible for their activity and highlighting their effects on skin.

## 2. Olive by-products

Olive oil extraction involves different processes such as olive washing, grinding, beating and the extraction itself, that constitutes the basic stage of the whole process. A number of different by-products are originated during olive oil production, such as pomace residues with olive stones, wastewater and leaves, and the uses of which can be the focus of a sustainable valorization in innovative products (Romero-García et al., 2014).

The extraction of olive oil can be achieved through a discontinuous process (also known as traditional pressing), used for many centuries with minor modifications, and a continuous process (also called centrifugation) (Dermeche et al., 2013; Roig et al., 2006). Both systems generate residues with different characteristics. Fig. 1 summarizes the processes used for olive oil extraction.

The extraction process has quite a large environmental impact due to the production of highly polluted wastewaters and/or solid residues, depending on the olive oil extraction or table olive process (Rodríguez et al., 2008). Installations that recover olive oil *via* the "three-phase system" produce three main residues: a solid cake (also known as olive pomace), and large amounts of two liquid phases (olive oil and an aqueous liquid known as olive-mill wastewater (OMWW). In the "two-phase" system the volume of OMWW produced is reduced because less water is used and some water and toxic substances are held within the solid olive cake, thus producing a semisolid residue (Linares et al., 2003). The toxicity of these wastewaters is reduced when comparing with the wastewater toxicity in three phase system (Justino et al., 2012). However, both by-products could be harmful to the environment and their negative effects on soil microbial populations have been demonstrated (Rana et al., 2003).

According to different authors, one hectare of olive tree originates about 2500 kg of olives, being estimated that for 100 kg of treated olives, 35 kg of solid waste (olive cake) and 55–200 L of liquid waste are produced, according to the extraction process (FAOSTAT, 2014). Leaves represent about 5% of the weight of olives (Niaounakis and Halvadakis, 2006; Romero-García et al., 2014).

It is clear that this agro-industrial activity generates significant amounts of by-products. In most cases, they are undervalued, even though these could be converted into a high value added source of natural compounds. Thus, it is urgent to find new ways for treating olive oil industry by-products. The use of environmentally friendly extraction techniques may represent innovative opportunities to sustainably face such challenge. Besides, this can also answer to the consumers' demands, once natural additives are clearly preferred over their synthetic counterparts (Herrero et al., 2011).

## 3. Olive by-products composition

### 3.1. Leaves

Leaves are considered by-products of olive farming, representing a significant material arriving to the olive mill (Xynos et al., 2012).

For many centuries olive leaf or their extracts have been associated with health and preservation. In folk medicine these have been used to treat diabetes, hypertension or even hypercholesterolemia (de Bock et al., 2013; Sato et al., 2007).

Olive leaves also gather the interest of the scientific community and the industries worldwide, as their health promoting benefits are constantly being shown by an ever-increasing number of scientific data (Erbay and Icier, 2010). According to Luque de Castro and Japón-Luján (2006) leaves have the most potent radical scavenging power of the different parts of olive trees. Several studies showed the great diversity of olive phenols including flavones (luteolin-7-glucoside, apigenin-7-glucoside, diosmetin-7-glucoside, luteolin, and diosmetin), flavonols (rutin), flavan-3-ols (catechin), substituted phenols (tyrosol, hydroxytyrosol, vanillin, vanillic acid, and caffeic acid) and secoiridoids (oleuropein) in olive leaves. The most

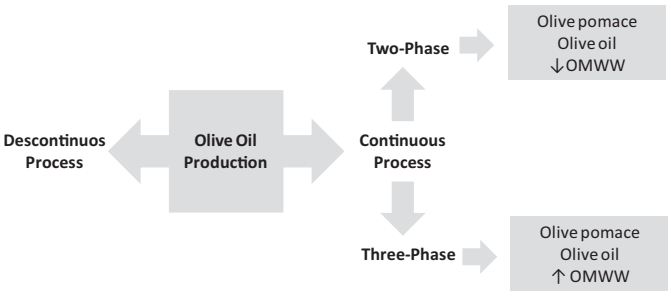


**Fig. 1.** Different methods for olive oil production. OMWW – Olive mill wastewater.