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The biological activities of natural lignans from olives and virgin olive oils: A review

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ABSTRACT

Dietary guidelines recommend diets rich in plant foods, because they are associated with a lower incidence of chronic diseases, such as cardiovascular disease and certain cancers. The compounds that exhibit these health benefits are a matter of debate; however, scientific evidence assigns an important role to the action of so-called minor compounds. Lignans are polyphenols found in plants, and they are part of the phytoestrogen family, which is known for its health properties. The natural lignans (+)-pinoresinol and 1-acetoxypinoresinol are typically found in olives and, consequently, virgin olive oils (VOOs), which are genuine fruit juices. Although (+)-pinoresinol has been identified in other plants, 1-acetoxypinoresinol is specifically observed in olives. In this review, we collected information regarding these two main lignans found in VOOs, because a number of researchers believe that they may play a prominent role in the health effects attributed to virgin olive oils.

Contents

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1. Introduction

The incidence rates of certain chronic diseases, such as certain cancers and cardiovascular disease, are higher in Western countries, where people consume a diet rich in fat and animal protein, compared to countries that follow a Mediterranean diet rich in plant foods that contain phytoestrogens. Therefore, it has been postulated that phytoestrogens may be involved in conveying the beneficial effects attributed to the Mediterranean diet. In fact, phytoestrogens are abundant in the plasma and urine of subjects living in areas with a low cancer incidence rate (Adlercreutz, 2007).

The two main groups of phytoestrogens are isoflavonoids and lignans. It is widely assumed that the intake of lignan-rich foods is part of a healthy diet, and several reviews have conveyed information about lignans derived from different sources in the plant kingdom, as flaxseeds and sesame (Dar & Arumugam, 2013; Kajla, Sharma, & Sood, 2015; Pan et al., 2009; Saleem, Kim, Ali, & Lee, 2005; Umezawa, 2003). However, this is the first review that describes, specifically, the lignans typically found in olives and virgin olive oils (VOOs) and their implications on health and several diseases. These natural lignans found in olives and VOOs, which is the main source of fat in the Mediterranean diet, are (+)-pinoresinol and 1-acetoxypinoresinol. In fact, although (+)-pinoresinol has been identified in other plants, 1-acetoxypinoresinol is specifically found in olives. It is widely accepted that the consumption of lignans (Adlercreutz, 2007; Lin, Yngve, Lagergren, & Lu, 2012; Peterson et al., 2010) and VOOs (Toledo et al., 2015), provide health benefits, and several studies have highlighted beneficial effects of (+)-pinoresinol and 1-acetoxypinoresinol characteristics of VOOs (Menendez et al., 2008a; Owen et al., 2000a). Consequently, both (+)-pinoresinol and 1-acetoxypinoresinol represent a high interest based on their biological and pharmacological properties. Unfortunately, the information known about these compounds is largely ambiguous and diverse, making more work for researchers who want to study and gather information on these compounds. Thus, this review summarizes the current published information related to the bioactivity and potential health benefits associated with (+)-pinoresinol and 1-acetoxypinoresinol, as well as their chemical characteristics, distribution and metabolism in humans. In addition, this study highlights the importance of further studying these compounds, due to their pharmacological potential.

2. Classification, chemical structure and metabolic pathway

Polyphenols are secondary metabolites in plants that are involved in the defence against ultraviolet radiation and aggressive pathogens (Manach, Scalbert, Morand, Remesy, & Jimenez, 2004). This group includes the lignans pinoresinol and 1-acetoxypinoresinol, the subjects of this review.

Specifically, pinoresinol ($C_{20}H_{22}O_6$) and 1-acetoxypinoresinol ($C_{22}H_{24}O_8$) are phenolic compounds that form a dimer, which means they possess two phenol groups in their chemical structure (Fig. 1). Each phenol group consists of an aromatic ring (phenyl or benzene group) bound to a hydroxyl group (OH). Both, the phenol group and the benzene ring are associated with several health benefits in humans including antioxidant and/or anti-inflammatory effects (During, Debouche, Raas, & Larondelle, 2012; Sok, Cui, & Kim, 2009; Yang et al., 2013).

The molecular weights of pinoresinol and 1-acetoxypinoresinol are 358.38 and 416.42 g/mol, respectively. Their structures are very similar, except for the appearance of a -$COOCH_3$ group in 1-acetoxypinoresinol that is not present in pinoresinol.

The biosynthesis of pinoresinol has been investigated in *Forsythia* spp (Kim et al., 2009; Umezawa, 2003). This compound is synthesized by the stereospecific coupling of two units of

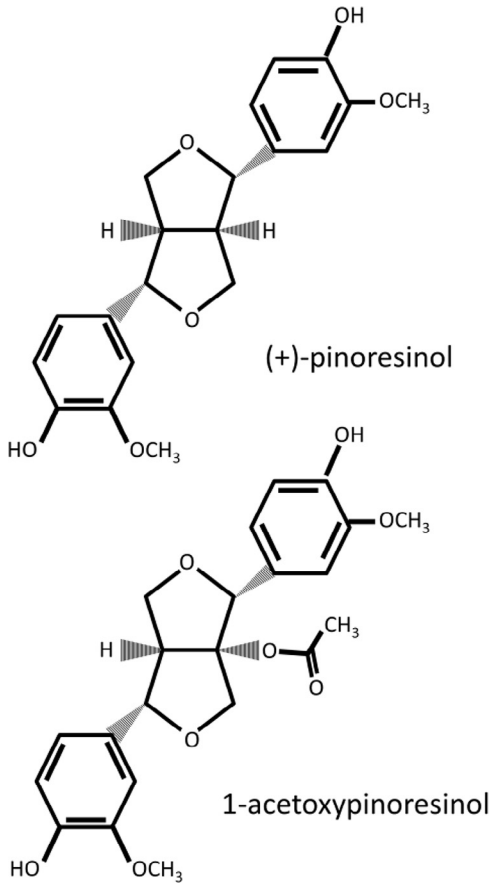

Fig. 1 – Chemical structures of (+)-pinoresinol and 1-acetoxypinoresinol.