



# *Cistus ladanifer* as a source of chemicals: structural and chemical characterization

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## Abstract

Different biomass fractions of *Cistus ladanifer* and solid residues from essential oil distilleries were structurally and chemically evaluated. The *C. ladanifer* biomass fractions showed chemical differences mainly related to extractives (e.g., 10.8% and 53.7% in stems and leaves) and lignin (e.g., 21.2% and 15.4% in stems and leaves). The distillery residues were characterized by 41.5% extractives and 19.3% lignin, and polysaccharide glucose 51.7% and xylose 24.9% of total monosaccharides. The polar extracts had a high content of phenolics and revealed high antioxidant activity (IC<sub>50</sub> 3.2 µg/mL and 4.7 µg/mL in stems and cysts extracts).

The lignin structure showed a predominance of S units in the stem (H:G:S of 1:25:50) and a balanced proportion of H, G, and S units in leaves (H:G:S of 1:1.4:1).

The characteristics of *C. ladanifer* biomass allow several routes of valorization. The high extractive contents point out to the potential use as a source of phytochemicals by applying extraction procedures, while the remaining lignocellulosic material after extraction may be directed towards lignin and carbohydrates applications. The use of *C. ladanifer* biomass for an extractives-lignocellulosic-based biorefinery therefore represents a potential valorization that may contribute to additional revenue for the present essential oil distilleries.

**Keywords** Extractives · Antioxidant activity · Polysaccharides · Lignin · Biorefinery

## Abbreviations

CL *Cistus ladanifer*

CLR Steam distillation residues

DPPH 1,1-Diphenyl-2-picrylhydrazyl

FRAP Ferric reducing antioxidant power

TEAC Trolox equivalent antioxidant capacity

GAE Gallic acid equivalent

QE Quercetin equivalent

CE Catechin equivalent

H *p*-Hydroxyphenyl lignin monomeric unit

G Guaiacyl lignin monomeric unit

S Syringyl lignin monomeric unit

CZE Capillary Zone Electrophoresis

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## 1 Introduction

Most genera of the Cistaceae family, including shrubs, semi-shrubs, and herbs, are distributed in the Mediterranean region where they occur especially in open areas and poor soils [1]. In particular, the genus *Cistus* of dicotyledonous perennial herbaceous plants is widespread and includes some species whose extracts have been used in folk medicine and as fragrances [2]. *Cistus ladanifer* (CL) is one of the main species producing labdane, a resin employed as a natural fixative and as a fragrance for composing amber and leathery notes, and also used as an incense [2, 3]. Other odoriferous materials may also be obtained from fresh leaves and branches: essential oil