# Screening of Antimicrobial Activity and Cytotoxic Effects of Two *Cladonia* Species

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The present study explores the antimicrobial activity and cytotoxic effects in culture assays of two fruticose soil lichens, *Cladonia rangiformis* Hoffm. and *Cladonia convoluta* (Lamkey) Cout., to contribute to possible pharmacological uses of lichens. *In vitro* antimicrobial activities of methanol and chloroform extracts against two Gram-negative bacteria (*Pseudomonas aeruginosa* and *Escherichia coli*), two Gram-positive bacteria (*Enterococcus faecalis* and *Staphylococcus aureus)*, and the yeast *Candida albicans* were examined using the paper disc method and through determination of minimal inhibitory concentrations (MICs). The data showed the presence of antibiotic substances in the chloroform and the methanol extracts of the lichen species. The chloroform extracts exhibited more significant antimicrobial activity than the methanol extracts. However, a higher antifungal activity was noted in the methanol extract of *C. rangiformis*. The maximum antimicrobial activity was recorded for the chloroform extract of *C. convoluta* against *E. coli.* The cytotoxic effects of the lichen extracts on human breast cancer MCF-7 cells were evaluated by the trypan blue assay yielding $IC_{50}$ values of ca. 173 and 167 $\mu$g/ml for the extracts from *C. rangiformis* and *C. convoluta*, respectively.

*Key words:* Lichen, Antimicrobial Activity, MCF-7, *Cladonia*

## Introduction

Lichens are well-known symbiotic associations between fungi and algae, usually an ascomycete as mycobiont partner and a green alga or a cyanobacterium as photosynthetic partner, so called "lichenized fungi", including over 20,000 species all over the world. They usually grow on rocks and soil as well as epiphytes on trees and leaves.

The use of lichens as herbal medicine is a traditional way to cure ailments; they have been applied for more than five millennia in several civilizations. Even today, in many developing countries plant materials continue to play a major role in primary health care as therapeutic agents. Most of the preliminary information on biological activity and potential use of lichen metabolites is derived from their ethno-botanical lore (Ingolfsdottir, 2002; Romagni and Dayan, 2002). These unique organisms are able to produce lichen-specific secondary compounds, which have been used in medicine, food, cosmetics, dye, and for other ethno-botanical purposes from ancient to recent times (Llano, 1950; Romagni and Dayan, 2002; Çobanoğlu and Yavuz, 2003; Yavuz and Çobanoğlu, 2010).

Lichen compounds have been shown to have a range of activities, depending on the species of lichen, concentration of the extract, type of the solvent, and the tested organisms. Many lichen species have antimicrobial (Esimone and Adikwu, 1999; Yılmaz *et al.*, 2004; Ranković *et al.*, 2009; Çobanoğlu *et al.*, 2010), antifungal (Proksa *et al.*, 1996; Halama and Van Haluwyn, 2004; Schmeda-Hirschmann *et al.*, 2008; Zibbu and Batra, 2010), antioxidant (Aslan *et al.*, 2006; Odabasoglu *et al.*, 2006; Luo *et al.*, 2009; Ranković *et al.*, 2010), antiviral and cytotoxic (Karagöz and Aslan, 2005), as well as anticancer and anti-inflammatory (Shukla *et al.*, 2010; Suleyman *et al.*, 2002) effects, respectively. Many herbal medicines and compounds isolated from natural products have potential

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