



Studies in Natural Products Chemistry: Chapter 10. Accumulation of Potential Pharmaceutically Relevant Lichen Metabolites in Lichens and Cultured Lichen Symbionts

Elfie Stocker-Wörgötter, Lucimara Mach Cortes Cordeiro, Marcello Iacomini

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Lichens are fascinating symbiotic organisms, biosynthesizing a broad spectrum of interesting secondary metabolites and polysaccharides. A considerable number of them have been found to exert biological activities, such as antibiotic, antimycobacterial, antiviral, anti-inflammatory, analgesic, antipyretic, antiproliferative, and cytotoxic effects. Only a very low percentage of “lichen substances” have been actually screened for their biological activities and their potential therapeutic applications in medicine. This is due to difficulties to obtain large quantities of lichens from nature, isolated lichen fungi and algae from cultures for extractions. Ten years ago, we have started to bypass these problems by introducing first traditional and then by exploring novel microbiological techniques and advanced molecular tools for our culture experiments. “Case studies” with selected cultured mycobionts and photobionts, accumulating considerable quantities of a focused compound, have been performed as tests for large-scale culturing, to be able to utilize facilities like phytotrons and bioreactors (small-scale bioreactors) for future approaches. Further studies have focused on the chemical identification of the metabolites from cultures and the genetic characterization of lichen PKS genes (Polyketide synthase genes). Another interesting group of lichen metabolites is cell wall polysaccharides. All lichen species investigated so far produce these polymers in considerable amounts and many of them have been shown to exhibit antitumor, immunostimulating, antiviral as well as other types of biological activity. Lichen polysaccharides are mainly of the following structural types: α -glucans (isolichenan, nigeran, pseudonigeran, and pullulan), β -glucans (lichenan, pustulan, laminaran, and lentinan-type glucan), galactomannans, and complex heteroglycans (galactoglucomannan, galactomannoglucan, rhamnopyranosylgalactofuranan, and glucomannan). Investigations on lichen polysaccharides were carried out using material extracted from the entire thallus with no mention of the origin of component polymers (fungal partner or photobiont). In order to understand the contribution of the symbiotic partners to the polysaccharide present in the lichen thallus, the carbohydrates produced by some aposymbiotically cultured mycobionts and photobionts (*Trebouxia*, *Asterochloris*, and *Coccomyxa*) were analyzed. The studies demonstrated that most of the polysaccharides previously found in the symbiotic thalli were also produced by the aposymbiotically cultivated fungal partner, while there were no similarities between the polysaccharides extracted from the photobiont with those from the respective lichen. Surprisingly, the photobionts synthesized very interesting polysaccharides, such as β -galactofuranan, mannogalactofuranan, rhamnopyranosylgalactofuranan, and an O-methylated mannogalactan. One of them was biologically active, having in vitro activity on murine peritoneal macrophages.

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