

Lichens and therapeutic applications

Lichens have been used as medicines since ancient times. It should be recalled that from the 16th century, man has sought in possible remedies a certain identity with a diseased organ or symptoms of disease (the so-called signature theory, [1]). In the case of lichens, it was thought that *Usnea* could grow hair and cure neurological diseases, that *Xanthoria parietina*, with her yellow colour, cured yellows. *Peltigera canina* was recommended to cure rabies, a disease transmitted by the bites of rabid dogs.



Figure 1. *Cetraria islandica* (left; photo source © C. Remy) is used for the production of cough drops [Source: © J. Asta]. Right: Fertile *Lobaria pulmonaria* [Source: © J. Asta]

The most commonly used lichen in the pharmacopoeia is *Cetraria islandica* [2], common in the mountains in the subalpine and alpine stages, whose calming properties are applied to the manufacture of candy to relieve sore throats and sold commercially under the misnomer "Icelandic Moss" (Figure 1). This species has been the subject of much research for its antitumor, immunomodulatory and anti-inflammatory activities. It has been shown that this lichen has gastroprotective properties and is active against *Helicobacter pilori*, a bacterium implicated in gastric ulcers. Similarly, *Lobaria pulmonaria* is used to form syrups to fight cough.



Figure 2. Top, left : *Usnea* on trunk [Source: © J. Asta]; Top, right *Stereocaulon evolutum*: on the right [Source: Drawing by J. Asta]; Abbreviations: ap: apothecia. S: squamula (or phyllocladium); P: pseudopodetium); below [Source Photo © J.P. Gavériaux].

The first explorers of America were intrigued by the fact that Indians treated wounds by applying *Usnea*. In the 1940s, the antimicrobial properties of these lichens were discovered. The evidence was found by observing the destructive effects of lichen. But here too, this process has been replaced by the use of fungi, which grow much faster, and then by the artificial synthesis of molecules. However, usnic acid, a major metabolite of *Usnea*, has properties (antimicrobial, anti-inflammatory, antiparasitic, antiviral, antitumor, etc.) that have been used for various cosmetic and therapeutic purposes. [3]

At present, the various properties of lichen metabolites and their applications are the subject of much work worldwide. Researchers specializing in pharmacognosy have demonstrated the photoprotective properties of lichens through the presence of mycosporins for anti-cancer purposes to fight melanomas. [4] Five new compounds extracted from lichen *Parmotrema tsavoense* have shown cytotoxic activities on cell lines of hepatocellular liver carcinoma, lung cancer and breast cancer. [5] These scientists also showed that atranorin, an important metabolite of *Stereocaulon evolutum*, and some analogues, interfere with both the entry of hepatitis C virus into human cells and the replication of the virus [6]. Even if the mechanisms of action of these antiviral substances have yet to be elucidated, this opens the way to the discovery of new treatments from a cheap natural resource [7] (Figure 2).

Notes and references

[1] Signature theory is a way of understanding the world in which the appearance of creatures, mainly plants, is supposed to reveal their use and function. It applies mainly to medicinal plants, by virtue of their therapeutic powers (Paracelsus formulates the principle *similia similibus curantur* "let like cured by the like"). Developed in the medieval West and during the Renaissance, this theory disappeared from the learned world in the 18th century.

[2] *Cetraria islandica* is on the official list of medicinal plants listed in the pharmacopoeia and authorised for sale by pharmacists (Decree of August 22, 2008, France).

[3] Cocchiello, M., Skert, N. & Nimis, P.L. 2002- A review on usnic acid, an interesting natural compound. *Die Naturwissenschaften*, 89, 137-146.

[4] Roullier, C., Chollet-Krugler, M., Pferschy-Wenzig, E.M., Maillard, A., Rechberger, G.N., Legouin-Gargadenec, B., Bauer,

R. & Boustie, J. 2011 - Characterization and identification of mycosporins-like compounds in cyanolichens. Isolation of mycosporin hydroxyglutamicol from *Nephroma laevigatum* Ach. *Phytochemistry*, 72, 1348-1357.

[5] Duong, T.H., Chavasiri, W., Boustié, J. & Nguyen, N. 2015 - New meta-depsidones and diphenyl ethers from the lichen *Parmotrema tsavoense* (Krog & Swinscow), Parmeliaceae. *Tetrahedron*, 71, 52, 9684-9691.

[6] Vu, T.H., Le Lamer, A-C. Lalli, C. Boustie, J., Samson, M., Lohézic-Le Dévéhat, F. & Le Seyec, J. 2015 - Depsides, lichen metabolites active against Hepatitis C virus, *PLoS One*, 10(3), 1-14.

[7] Several species of lichens (various *Parmelia*, *Evernia prunastri*) can cause contact allergies with hand eczema formation due to the erannic acids, fumarprotocetraric acids etc. they contain. Others, such as *Letharia vulpina*, a species very rich in soralia, can cause sneezing and sometimes even nosebleeds.

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