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Biotechnological approaches as alternatives for exploiting the production of important secondary metabolites- *Rubia tinctorum L.* cell, tissue and organ culture: A case study

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Since early times mankind exploited the genetic diversity of the plant kingdom as a major source of an array of secondary products, widely employed as pigments, food additives, pharmaceuticals, cosmetics and agrochemicals of economic importance. Madder (Rubia tinctorum L.) root has been used for dying textiles in many parts of the world and over the centuries was an important export product throughout Europe. The natural dye components are anthraquinones, especially alizarin, present in the madder root mainly as its glycoside–the ruberythric acid. At the end of the 19th century, the use of madder for dyeing declined due to production at large scale of synthetic alizarin. At present, as the production of synthetic alizarin involves increasing costs and gives polluting side effects, the use of natural dyes became more popular and revitalizing of madder as an industrial crop is reconsidered. Besides being the source of the valuable red dye, madder components are reported to exhibit various pharmacological activities, including anticancer, antimalarial, antibacterial, antifungal and antioxidant activities. Biotechnological approaches, specifically plant cell, tissue and organ culture, play a recognized vital role in the search for alternatives to production and accumulation of valuable compounds. Our preliminary studies focused on defining the conditions for obtaining dependable in vitro cell biomass, resulting in the development of rapidly-growing, long-term callus cultures. Though the detection of alizarin and of other anthraquinones in the madder callus cells was not the purpose of this stage of our experiments, some preliminary testing with the coloring capacity of the madder callus cells on wool fibers were performed, proving that madder cells in culture retain complete genetic information, being chemically totipotent like the mother plant in nature.

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