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ABILITY OF ALKALOPHILIC CYANOBACTERIAL STRAINS TO DEGRADE PHOSPHONATE XENOBIOTICS

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Abstract

Organophosphonates, compounds characterized by the presence of a direct, carbon to phosphorus (C-P) bond, are endowed with a striking stability even at extreme pH values and in a broad range of temperatures. Nowadays, synthetic phosphonates are widely used in various fields of human activity as pesticides, antibiotics, polymer additives, flame extinguishers and corrosion inhibitors. As a consequence of an increasing range of applications, thousand tons of phosphonate xenobiotics are released annually into the environment. The lack of information on their environmental fate, linked to analytical problems that hamper the determination of trace concentrations of these substances, led to an indiscriminate and to date unregulated use in most EU countries. This could exert undesirable environmental effects, particularly in aquatic ecosystems. Moreover, the biodegradation of organophosphonates has been thoroughly studied only in the case of a few substances, and it was generally investigated with soilborne microorganisms.

If the effect of these compounds on terrestrial ecosystems seems limited by the ability of soil bacteria to cleave the C-P bond, mainly under conditions of phosphorus starvation, an increasing amount of data suggests that the release of phosphonate xenobiotics may induce adverse effects on water ecosystems. Besides a consequent enrichment of nutrients, especially phosphorus and nitrogen, possibly leading to water eutrophication, because of their inherent ability to chelate divalent cations phosphonates were reported to interfere with mineral nutrition and inhibit algal growth.

Results of our studies indicated that some cyanobacterial strains, when grown in media containing phosphonates, possess a remarkable ability to degrade the C-P bond. As a consequence, pollution by organophosphonate could represent the basis for cyanobacterial blooming that often occurs in lakes and ponds, with severe adverse consequences on water quality. Additionally, we confirmed a relatively low toxicity of some compounds used on industrial scale, mainly polyphosphonates, towards various species of cyanobacteria.

Metabolization of some aminophosphonates by *Spirulina platensis* and *Arthrospira fusiformis* was followed by non destructive ^{31}P NMR analysis, showing the ability to completely degrade millimolar levels of these compounds. This unusual capability was confirmed in a lab-scale pilot plant for bioremediation of polyphosphonates from polluted waters.