Application of Mössbauer and FTIR Spectroscopic Techniques in Structural Research Related to Microbial Signalling and Cellular Responses to Environmental Factors

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Processes of microbial intercellular communication, exchange of molecular signals between microbial cells and their host macroorganisms, involving specific low-MW diffusible substances (used as a 'chemical language'), and cellular responses are at the peak of current research in biosciences [1, 2]. This fundamental interest is due to the unique possibility of controlling the microbial behaviour and metabolism by influencing their signalling pathways. On the other hand, abiotic impact of the environment (medium) on extracellular molecular signals is also of great importance, as any of their chemical interactions (e.g., complexation or oxidation) represent direct interferences in the process of 'signal delivery' [3].

In this work, chemical interaction of microbial extracellular molecular signals (indolic derivatives – auxin phytohormones [1, 4]; alkylresorcinols – chemical analogues of microbial autoregulators [3]) with iron(III) was monitored using ^{57}Fe Mössbauer spectroscopy in rapidly frozen aqueous solutions and in dry solids. The conditions applied were designed to simulate possible processes occurring in soils, where ferric iron is commonly ubiquitous. In moderately acidic media, gradual reduction of iron(III) was observed coupled to oxidative degradation of the organics. Some alkylresorcinols were found to be significantly more rapidly oxidised by iron(III) than indole-3-acetic acid, exhibiting a notable oxidation rate already within a few minutes; their reducing power was found to be much higher for derivatives with a longer alkyl chain. This finding is yet more interesting, since the non-alkylated analogue (resorcinol) was earlier reported to show no iron(III) reduction (see [3] and references reported therein).

Bacterial cellular responses to host plant-root signal represented by plant lectin [5] were for the first time shown to be nondestructively detectable in whole bacterial cells using FTIR spectroscopy in the diffuse reflectance mode (DRIFT). Some alterations in secondary structure components of cellular proteins were observed as a response both to the host-plant signal and to a nutritional stress (nitrogen deficiency), also with accumulation of intracellular polyester storage compounds in the latter case [5]. In addition, FTIR spectroscopy allowed different responses of endophytic and epiphytic strains of the same bacterial species to heavy-metal stress to be observed [6], with emission ^{57}Co Mössbauer spectroscopy used to monitor metabolic transformations of $^{57}Co^{II}$ traces in live cells, as compared with dead biomass.

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