Analytical Identification of Microorganisms

DOI: 10.1134/S106193481203015X

Classical microbiological methods for detection and identification of microorganisms usually require several days. Procedures based on the recognition of antibodies or DNA detection after “multiplication” by the polymerase chain reaction are also not very rapid and require several hours. Methods that are based on the determination of the elemental composition of microorganisms [1] or, in the up-to-date version, on the detection and determination of organic marker biomolecules, are much more rapid and quite reliable.

Such analyses are performed using different analytical methods: capillary electrophoresis with detection by laser-excited fluorescence (e.g., [2]), electrochemical methods (e.g., [3]), and others. However, recently the greatest attention has probably been given to mass spectrometry, particularly in the chromatography–mass spectrometry version. The use of this method was considered in monographs [4, 5], a dissertation [6], a review [7], and a huge number of original papers.

The application of mass spectrometry is aimed at the detection of biomolecules that are specific to a certain species of microorganism. Biomarkers are most often proteins or their proteolytic peptides, which are obtained, for example, after the acid hydrolysis of protein using microwave irradiation. Tandem mass spectra allow the characterization of microorganisms in their mixtures. Mass spectrometry methods are very sensitive: 10000 bacteria can be sufficient for the reliable detection and identification of microorganisms. Analysts can easily adapt previously developed procedures that have already been created for the needs of proteomics and are based on tandem mass spectrometry, chromatography, and bioinformation science (databases) for the identification of bacteria as well. Sample preparation in this case is reduced to a minimum and preliminary fractionation is usually not required.

The development of this methodology has been stimulated by military and antiterrorist services: the threat of the application of biological weapons always exists. For these services, the rapidity of the detection and identification of microorganisms is of crucial importance. The questions of whether it is necessary to protect living beings from biological weapons and how to protect them should be answered in minutes. The question how to treat victims must be elucidated within no more than several hours.

The rapid identification of microorganisms is certainly also necessary in medical diagnostics. Mass spectrometric identification of microbes and bacteria also appears to be rather useful for agriculture, environmental control, or the control of foodstuffs.

In addition to proteins and peptides, in some cases low-molecular weight compounds can be biomarkers, for example, heme in the case of malaria. Phospholipids or fatty acid methyl esters can also be used as markers.

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