THE PRECIPITATION OF BIVALENT TOXIC METALS VIA THE DISSIMILATORY SULFATE REDUCTION

Bida I., Havryliuk O., Hovorukha V., Tashyrev O.
D.K. Zabolotny Institute of Microbiology and Virology of the NAS of Ukraine,
e-mail: iryna.bida@imv.org.ua

Metal mining is the base for the economic development of any country, but it is hazardous for ecosystems. Heavy metals are released into the environment as a result of metal ore mining. It has caused significant environmental damage to soil and water resources. We offer a biological method based on dissimilatory sulfate reduction to solve the problem of metals precipitation. Such metabolic pathway as the dissimilatory sulfate reduction is promising to solve the problem of treatment of metal-contaminated ecosystems. In the process of sulfate reduction, microorganisms use sulfates as terminal electron acceptors. In this way, sulfates are reduced to sulfides, which precipitate a wide range of bivalent cations (Co^{2+}, Ni^{2+}, Zn^{2+}, Hg^{2+}, Fe^{2+}) in the form of insoluble metal sulfides ($CoS\downarrow$, $NiS\downarrow$, $ZnS\downarrow$, $HgS\downarrow$, etc.).

The aim of the work was to investigate the patterns of Co^{2+} and Ni^{2+} precipitation by sulfate-reducing microorganisms during anaerobic fermentation of model protein waste. For this purpose, slightly soluble gypsum $CaSO_4$ (Klebrig, Czech Republic) was studied as an electron acceptor. Protein polymers (meat) and alanine (amino acid) served as electron donors. The meat was pre-cleaned and cut into 5 mm cubes. The methane tank sludge was sampled at the Bortnychi aeration station of Kyiv and used as a source of sulfate-reducing microorganisms (inoculum). The study of the bivalent cations precipitation via sulfate reduction was tested by the insertion of Co^{2+} and Ni^{2+} solutions into the culture medium to a final concentration of 100 mg/L. Cultivation was carried out in hermetic flasks (250 mL) at 32 ^{o}C. The metals concentration was determined by the colorimetric method with 4-(2-pyridylazo)resorcinol (PAR) (0,1%).

As a result of the study, the process of precipitation of bivalent metal cations by sulfate-reducing microorganisms was highly effective. The duration of complete Ni^{2+} precipitation in the medium with both alanine and meat was 25 days. The duration of Co^{2+} precipitation in the medium with alanine and meat was 23 and 20 days, respectively. Hydrogen was synthesized during the fermentation of model protein waste. The high concentration of H_2 in the gas phase (20-30%) indicates the possibility of using sulfate-reducing microorganisms for both the precipitation of toxic metals and for producing a high-energy carrier.

Thus, the high effectiveness of bivalent metals precipitation via dissimilatory sulfate reduction was experimentally confirmed. This approach can be used as a basis for the development of new biotechnologies for the treatment of soils and water reservoirs polluted by heavy metals with the simultaneous utilization of protein waste and biogas production.