THE RESISTANCE OF ECUADOR SOIL MICROBIOME TO TOXIC COPPER (II) COMPOUNDS

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The thermodynamic prognosis of microbial interaction with metals is an effective method for development of novel environmental biotechnologies. Copper is one of the most toxic and environmentally dangerous metals. The cation of Cu^{2+} is a metal of combined action. The mechanism of its toxic effect is the oxidation of living cell components and the replacement of Mg^{2+}, Ca^{2+}, etc. cations in the active centers of enzymes. Microbial growth in the presence of the oxidized forms of toxic metals at super high concentrations is theoretically permissible if the redox potential of the system formed by the metal and its reduced form, in its high concentration, is inside the zone of thermodynamic stability of water (in the range of standard redox potentials (E'_o) from –414 to +814 mV).

According to the prognosis, microorganisms resistant to toxic copper (II) compounds at high concentrations are premised to exist in any natural ecosystem. Natural soils are the source of diversified microbial communities as well as industrially promising copper-resistant strains for application in environmental biotechnologies. By that means, the aim of our work was to determine the quantitative regularities of resistance of Ecuador soil microbiome to toxic copper(II).

Soil samples were collected nearby Papallacta city in Ecuador. The resistance of microbiome was determined by the thermodynamic prognosis of microbial interaction with metals. Content of copper-resistant microorganisms in soil was determined by the colony forming units (CFU) on the agar nutrient medium (NA) with concentration gradient of Cu (II) from 100 ppm to 1000 ppm with 50 ppm increase. Accumulation of Cu (II) in CFU was detected by H_2S test. According to the prognosis microorganisms resistant to toxic copper (II) in high concentrations were confirmed to be present in Ecuador soil. They grew in the medium containing Cu (II) at concentrations up to 500 ppm ($CuSO_4$ solution) and up to 800 ppm (in citrate complex). Chelation of copper (II) with citrate led to 38 % increase of microbial resistance. Thus, high microbial resistance to toxic copper was experimentally shown. The increase of copper concentration led to drastic 3 orders decrease of the number alive cells. But the number of alive cells was $5.0 \cdot 10^2$ CFU/g even at 800 ppm of Cu^{2+}. The dependence of the number of alive microorganisms from the concentration of Cu (II) is described by a hyperbolic curve. The «right shoulder» of the hyperbolic curve shows the amount of high resistant to Cu (II) microorganisms.

As a result, we obtained experimental confirmation of our theoretical suggestion that natural ecosystems contain microorganisms that are super resistant to toxic metals particularly to copper. The suggested approach is suitable for isolation of copper-resistant microorganisms promising for further industrial implementation for environmental biotechnologies.