Microbial precipitation of Cr(VI) during methane fermentation of the ecologically hazardous plant *Ambrosia artemisiifolia*

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Plants of the *Ambrosia* genus are invasive and cause many ecological problems, including the suppression of the growth of crops, and the production of strong allergens [1]. Thus, the problem of hazardous weeds spreading entails serious economic and social consequences. Another ecological problem is the pollution of the environment by toxic metals, particularly soluble Cr(VI) compounds [2]. Plant *A. artemisiifolia* can be used as a high-energy substrate for biomethane production and chromate detoxification simultaneously during its anaerobic degradation due to the reduction soluble CrO_4^{2-} to insoluble $Cr(OH)_3{\cdot}nH_2O\downarrow$.

Herein, the work aimed to confirm experimentally the possibility of methanogenic degradation of *A. artemisiifolia* biomass and effective detoxification of toxic chromate.

The thermodynamic prediction was used to justify the optimal pathways of the detoxification of Cr(VI) by the methanogenic microbiome. Plant biomass of *A. artemisiifolia* was used as a substrate for the anaerobic degradation and as the electron donor for the microbial chromate reduction. The sludge of methane tanks (Bortnytsia aeration station in Kyiv, Ukraine) was used as the source of the microorganisms. The solution of K_2CrO_4 was added to the jars to the final concentrations of 100, 200, 500 and 1000 mg/L of Cr(VI). The concentration of Cr(VI) was determined spectrophotometrically via the reaction with 1,5-diphenylcarbazide (0.5 % solution).

The high efficiency of chromium reduction and precipitation occurred only at the 100 and 200 mg/L Cr(VI) concentrations. The effectiveness of precipitation was 100 %. The duration of complete precipitation was only 8 h for 100 mg/L Cr(VI) and 34 h for 200 mg/L. In variants with 500 mg/L of Cr(VI), only partial precipitation of chromium occurred with the efficiency of 19.0 %. Thus, the concentration of Cr(VI) decreased from 509 to 412.5 mg/L during the 26 h of growth of the methanogenic microbiome and remained stable thereafter. At Cr(VI) concentration of 1000 mg/l, complete inhibition of microbiome growth was observed. Despite the presence of toxic chromium, methane was synthesized during cultivation, and the content of CH_4 was 30–70 % in the gas phase.

It shows the possibility to obtain energy carrier methane in the combined process of the degradation of hazardous to health A. artemiifolia with simultaneous detoxification (precipitation) of chromate. The obtained results are promising for the development of environmental and energy biotechnologies.

References

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