Regulation of methane emission in various biocatalytic systems

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The problem of CH₄ emission into atmosphere is attend increasing ecological attention, since its concentration has raised significantly over the past 40 years and it is a strong greenhouse gas with a heat absorption potential 30 times greater than that of CO₂. The largest anthropogenic sources of CH₄ emissions on the planet are swamps, bottom sediments of water resources, agriculture, animal husbandry and landfills.

The analysis of various biological systems revealed mechanisms that allowing reduction of CH₄ proportion in the resulting biogas produced by methanogenic archaea, due to syntrophic communication with other bacteria, for example, sulfate-reducing and denitrifying, and the use of such alternative electron acceptors (AEA) as humic substances (HS), Fe³⁺, SO₄²⁻, NO₃⁻, NO₂⁻ [1]. The most pronounced anaerobic oxidation of CH₄ (0.80 ng C /g dry soil/h) was noted in rice soils when pig manure and NaNO₃⁻ (22,3 µg/g soil) were used as fertilizers.

In the marine environment the inhibiting effect of SO₄²⁻ on CH₄ emission was noted, as far as SO₄²⁻ the most common AEA due to its high concentration (~3 g/l). Decrease of CH₄ synthesis up to 10% was observed in the anaerobic zone when a mixture of 3.28 mg SO₄²⁻/g soil and 1.84 mg Fe³⁺/g soil was introduced into the soil used for landfills covering [2].

The addition of HC derivatives enriched with quinonones at concentrations above 1 g/l notably reduced the energy status of cells and the efficiency of methanogenesis catalyzed by various anaerobic consortia [3].

The influence of addition of various fatty acids to animal feedings on CH₄ emissions during the functioning of consortia in the rumen was studied. The inhibition of methanogenesis by long-chain fatty acids (30 mg/l) is based on the solubilization of bacteria lipid layer, which leads to cell lysis, inhibition of enzyme activity and destruction of the electron transport chain [4]. Under large-scale conditions, a similar quenching of CH₄ can be achieved by using long-chain surfactants.

Strong inhibition of acetoclastic methanogens has been shown by treatment with NaCl in concentrations over 20 g/l [5].

Thereby, this analysis shows the possibility of directed regulation of methanogenesis by introducing various natural compounds into biocatalytic systems that can reduce the synthesis of CH₄, for example, in landfills.

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