Effects of glycine on oligomerization of methionine under high temperature and high pressure

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Abiotic polymerization of amino acids seems to be an important process for the formation of the first life. Previous studies have implied the importance of pressurized conditions for the production of longer peptides, simulating the conditions of marine sediments [1, 2, 3]. These previous studies also suggest the skepticism about the formation of peptides composed of plural amino acids, showing a variety in reactivity of amino acids. In this study, we investigated the oligomerization of methionine and glycine under the conditions of high temperature and high pressure (at 175°C, 150 MPa, and 0-96 hours).

Methionine and glycine were used for representatives of each low and high reactive amino acid, respectively. Starting materials were solid methionine or solid methionine mixed with solid glycine, water, aqueous ammonia, or ammonium hydrogen carbonate. The additives other than glycine (water, aqueous ammonia, and ammonium hydrogen carbonate) are simulated decomposition products of glycine. Each starting material was sealed into a gold capsule. Then, high temperature and pressure conditions were applied using a test-tube-type autoclave system. After these experiments, experimental products were analyzed with a high performance liquid chromatograph connected to a mass spectrometer.

The rates of methionine decomposition and methionine-peptide formation were increased with additives. These rates were especially increased in samples containing aqueous ammonia and ammonium hydrogen carbonate, suggesting that ammonia promote both the production rates of peptides and the decomposition reactions of methionine. The difference in reaction rates might have been caused by the difference in pH as suggested in a previous study [4]. Our results suggest that amino acids of lower reactivity may have been activated by amino acids of higher reactivity, and then promoting peptide formation composed of plural amino acids. Such new finding may have happened commonly in prebiotic environments.

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A newly identified microorganism affecting the N cycle: Ammonium oxidation in iron reducing soils

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A novel anaerobic ammonium (NH_4^+) oxidation process coupled with iron reduction was first noted in a forested riparian wetland in New Jersey (1, 2). In this reaction, NH_4^+ is oxidized using ferric iron as the electron acceptor. Either this same pathway, or a very similar one, was also reported in a biological reactor (3), and a tropical rainforest soil (4) and coined Feammox (3).

Here we focus on characterizing the microbiology responsible of the Feammox process described for our previous study site (1,2), through an anaerobic incubation experiment and using 16S rDNA PCR-DGGE and qPCR analysis. Production of both nitrite (NO_2^-) and ferrous iron were measured repeatedly during incubations when soil slurries were supplied with iron oxide (ferrihydrite or goethite) and ammonium chloride. Significant changes in the microbial community were observed during the incubation, and one of the dominant microbial species (an uncultured *Acidimicrobiaceae* bacterium A6), belonging to the *Acidimicrobiaceae* family, similar to *Ferrimicrobium acidiphilum* (with 92% identity), is believed to be responsible for this Feammox pathway. This novel bacterium is considered to be autotrophic since its activity increased substantially when inorganic carbon was supplied. Through qPCR analysis using specific designed primers, *Acidimicrobiaceae* bacterium A6 was also found at a storm-water detention pond, which has similar high NH_4^+ and iron oxide content, indicated that the Feammox pathway might be widespread in soil environments.

The Feammox process provided denitrifiers and anammox bacteria with the necessary NO_2^- under this anaerobic incubation, and achieved total nitrogen loss via denitrification and anammox pathways. Therefore, Feammox may be an important process in the nitrogen cycle in soil environments under oxygen limited conditions, and reveals a new linkage between these two significant biogeochemical cycles (iron and nitrogen cycle).

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