

Evaluation of Methane Fermentation Process in Carbon Cycling System Using Seaweed

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According to the IPCC Sixth Assessment Report AR6, "it is unequivocal that human influence has warmed the atmosphere, ocean, and land." The report indicates that climate change, including global warming caused by human activity, is one of the most serious problems facing the earth. As members of the international community, while thinking about what we can do to contribute to the solution of global warming, we came across the concept of carbon neutrality. Carbon neutral means achieving a balance between CO₂ emissions and absorption. By substantially reducing CO₂ emissions, the progression of global warming can be suppressed. Many companies worldwide are striving to achieve carbon neutrality. This action is not only necessary to prevent further global warming and preserve the environment for future generations, but also to create a society in which people can live comfortably today. In order to achieve such a society, it is essential to meet basic needs such as the supply of electricity while also taking measures against global warming, such as achieving carbon neutrality. To link our research with the above perspective, we decided to conduct a study focusing on the blue carbon system of carbon sequestration and storage in seaweed, as well as the methane fermentation of organic matter by microorganisms. The ultimate goal of this research is to establish a cycle in which seaweed absorbs carbon dioxide through photosynthesis, generates methane through fermentation using seaweed as a substrate, and then absorbs the resulting carbon dioxide from energy conversion of methane. Such a cycle can contribute to achieving carbon neutrality while meeting the basic need of electricity supply for the current generation by generating power using methane. We set such a final goal and conducted experiments. In previous experiments, we cultured mud collected from tidal flats for several days and injected glucose, which is a decomposition product of seaweed cellulose and a substrate for fermentation. We then investigated the relationship between the time after glucose injection and the amount of carbon dioxide generated, and calculated the amount of methane generated based on the chemical reaction formula for methane fermentation from the amount of carbon dioxide generated. This experiment allowed us to roughly understand the relationship between the time after glucose injection and the amount of methane generated. When we used the experimental results to calculate, we found that the amount of carbon dioxide absorbed by seaweed exceeded the total amount of carbon dioxide generated during seaweed fermentation and during the conversion of methane into energy, which allowed us to achieve carbon neutrality. On the other hand, two major reflection points were identified in our recent experiments. Firstly, our recent experiments ignored how much microbes associated with methane fermentation would increase. Secondly, we converted carbon dioxide emissions into methane emissions, using the chemical equation of methane fermentation. The equation is so simplified that it is unclear whether it can indicate all processes of complicated methane fermentation accurately, so there was a problem in the accuracy of figures we calculated with the equation. Therefore, we decided to do new research on methane fermentation from more points of view, considering culture time of the microbes and glucose concentration in order to improve the reflection points that had been mentioned.

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