CO-OPERATION FOR FOOD: LONG STORY OF METHANOGENIC ARCHEA AND ANAEROBIC FUNGI

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Degradation of lignocellulose-rich material into biogas is an attractive strategy to face growing energy demands and moderate greenhouse gas emissions from the exploitation of fossil energy resources. Lignocellulosic residues (e.g. crop residues, green waste, mill waste) are highly frequent (1), they are easily accessible, cheap and do not require additional land to grow on in this way do not trigger “food or fuel” conflicts. This biomass is composed of interwoven cellulose and hemicellulose, coated by anaerobically almost undegradable lignin (2). This is the explanation why bacteria and archaea in the biogas reactor are not efficient in disintegration of the lignin, leaving a considerable portion of the more easily convertible sugars untouched. Microbial pre-treatment utilizing the fibre degrading potentials of aerobic fungi may be a much cheaper alternative but there are some drawbacks e.g. loss of carbohydrates by respiration and biomass build-up and the requirement of long pretreatment periods (3). Anaerobic fungi (AF) from the phylum Neocallimastigomycota living in the rumen are of particular importance in the nutrition of herbivorous animals (4), as they are able to break down lignocellulose with high efficiency. The AF attach to the plant material and crack the fibres mechanically by growth and expansion of their rhizoids or bulbous holdfasts (5). To exploit this feature, we need to understand what the ideal conditions are for them and which microbes are their "favorite" partners. During our study, we isolated anaerobic fungi and their methanogenic partners from anoa, elephant and mouflon. In our experiments, we monitored the degradation efficiency using pure anaerobic fungal culture and anaerobic fungal - methanogenic co-cultures.
In this study, treatment with anaerobic fungi cultures (14-day) increased the total biomethane yield during the experimental period of 20 days. Pretreatment with anaerobic fungi significantly improved the degradability of substrates. The results for AF biomethane yields correlated well with the organic acid concentrations measured by HPLC and with the enzyme activities. From these it can be concluded that the anaerobic fungi degraded the substrate efficiently during the 14-day long treatment.
Based on these results AF isolates were effective in enhancing cellulose degradation and successfully increased biogas production.

References

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