

ANAEROBIC TREATMENT OF MANURE AND CO-FERMENTATION SUBSTRATE – STRATEGIES OF EPIDEMIC AND PHYTOHYGIENIC MONITORING

Werner Philipp, Katja Ade, Milan Drca, Helge Lorenz¹, and Reinhard Böhm

University of Hohenheim, Institute for Environmental- and Animal Hygiene

¹⁾ *University of Hohenheim, Institute of Phytomedicine*

philipp@uni-hohenheim.de

Abstract

The use of biological waste products in anaerobic treatment plants designed for processing manure must assure elimination of epidemiologically relevant and phytopathogenic microorganisms. If duration times in the fermenter are long enough and the temperatures reached high enough, these pathogens can be eliminated. However, the tobacco mosaic virus (TMV) is known to require very high temperatures and exposure times to be inactivated (i.e. 1 hr at 90 °C). If the future German law for biological waste treatment does not alleviate sanitation requirements for agriculturally used co-fermentation plants, all the plants currently in use have to be technically upgraded by installing a preheating (pasteurizing) step for biological wastes. German Federal and State legislation are in the process of developing guidelines for realistic adaptation of the BioAbfV (Regulation for biological waste treatment), by allowing reasonable relaxations of hygiene requirements. There is still a debate to what extent these considerations will be reflected in European Union Legislation.

INTRODUCTION

Especially for treatment of biological wastes in fermentation plants designed for processing manure, there are still many uncertainties to what extent sufficient sterilization of the end products (fermentation products) is achieved. Through the design of the processes (reactor temperature 55°C/ 24 h) or preheating of the substrates (70°C/ 1h) all relevant pathogens are known to be killed. However, in laboratory fermenters as well as in full scale biogas plants, it is extremely problematic to eliminate the plant pathogen tobacco mosaic virus (TMV). Additionally, recent discussions in the European Union have led to a list of 'new' microbial parameters, which have to be validated in comparative studies with regard to adaptation of national laws. The aim of ongoing studies is, therefore, to decide whether continuous monitoring of fermentation processes, especially in small agriculturally used biogas plants with low technical standard, is necessary. A reasonable alternative would be description and definition of the microbiological quality of the fermentation, as well as the definition of the expected level of sterilization in anaerobic fermenters via microbiological controls of the substrate before and after anaerobic treatment, in combination with indirect process monitoring (i.e. measurements of temperature) (1).

MATERIALS AND METHODS

We employed well established and commonly used methods for bacteriological diagnostics and for detection of phytopathogens, to examine lab-scale and full scale (agriculturally

used biogas plants) anaerobic fermentation processes. Presented here are some of the data collected.

RESULTS

Substrate analysis in agriculturally used anaerobic fermenters - Hygienic aspects

Figure 1 shows representative results of microbiological studies in an anaerobic biogas plant. No Salmonella were detected in any of the samples. The numbers of total coliforms (GCF), fecal coliforms (FCF), as well as enterococci (EC) showed big variations. It is noteworthy, that the latest data collected so far show an increase in numbers of enterococci, whereas numbers of 'fecal germs' were all around $< 5 \times 10^3$ cfu/g (see table 1).

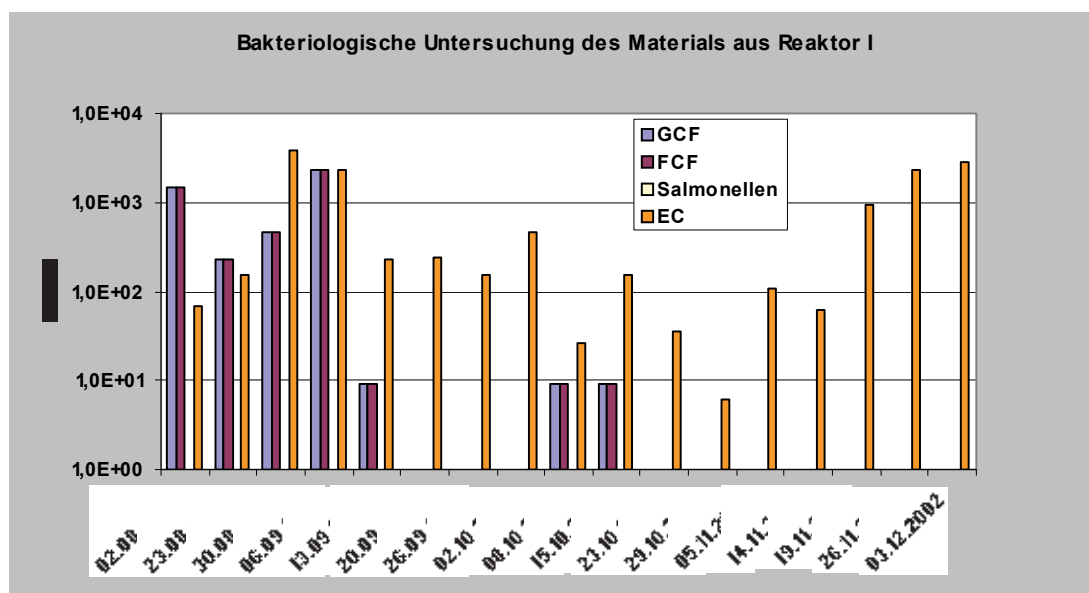


Figure 1. Representative data for microbiological studies of substrate samples from anaerobic treatment plant

DISCUSSION

Examination of a total of 20 agriculturally used biogas plants has shown that out of 11 plants, which employ preheating of co-substrates, in 6 plants the recommended numbers of fecal coliforms and fecal streptococci of $< 5 \times 10^3$ cfu/g fermentation product were too high. Out of 9 examined mesophilic plants, 4 plants could not achieve the recommended sterilization levels. With regard to future monitoring strategies for anaerobic fermentation plants, especially for agricultural co-fermentation plants, these results lead to 2 important questions: First, should samples be collected from the pretreated substrates (pasteurization at $70^\circ\text{C}/1\text{h}$), or from the thermophilic area of the fermenter ($55^\circ\text{C}/24\text{h}$), or from the end product storage containment (Note: up to the storage container, mixing of treated and untreated substrates cannot be

avoided). Secondly, should manure also be preheated, as demanded by a new European Union regulation (see EC no. 1774/2002; (2)). If the limits for bacterial numbers in fermentation end products, recommended by the guidelines (see table 1), have to be followed in all cases, it would mean for the future that also manure, when used in anaerobic treatment plants, has to undergo heat treatment (70°C/ 1 h). An additional requirement is that no Salmonella are detected in 50 g, or rather 25 g (3) of substrate. The parameters for enterobacteriaceae (limits for bacterial counts < 300 cfu/g end substrate), still kept in the EC regulations, are controversial because in our experience with output substrates from anaerobic plants, they can rarely be met.

Table 1. Suggested guidelines for microbial counts in fermentation end products ('output controls')

Type of Plant	Total Bacterial Numbers at 37°C	'E. coli' Fecal Coliform Bacteria	Enterococci
Anaerobic Treatment (Fermentation)	$\leq 5 \times 10^8$ cfu/g	$\leq 5 \times 10^3$ cfu/g	$\leq 5 \times 10^3$ cfu/g

In our experience, to be sure to eliminate TMV, it is necessary to heat the substrate at 90°C for 1 h, before introducing it into the anaerobic fermenter. So far this is not part of the German biowaste regulations. It needs to be seen in how far this problem will be addressed in the European Union biowaste regulations (3).

REFERENCES

- (1) **Bioabfallverordnung (BioAbfV) (1998):** Verordnung über die Verwertung von Bioabfällen auf landwirtschaftlich, forstwirtschaftlich und gärtnerisch genutzten Böden. BGBl part I, no. 65, 2955-2981
- (2) **Verordnung (EG) Nr. 1774/2002** DES EUROPÄISCHEN PARLAMENTS UND DES RATES October 3rd 2002 mit Hygienevorschriften für nicht für den menschlichen Verzehr bestimmte tierische Nebenprodukte. Amtsblatt der Europäischen Gemeinschaften, 10.10.2002, L 273/1-L 273/96
- (3) **W. Philipp, C. Beyer, W. Beyer, H. Buchenauer, A. Knie, H. Lorenz, K.-H. Hellwald und R. Böhm (2002):** Optimierung der Anaerob-Technik zur Behandlung von Bioabfällen aus hygienischer Sicht. In: Bioabfallverwertung-know-how-Transfer aus Forschung und Praxis. Editors: Kleinke/Bidlingmaier, ESV-Verlag-Initiativen zum Umweltschutz, volume 49, pp.108-131, ISBN 3 503 07025 7