CO-FERMENTATION EXPERIMENTS WITH AGRICULTURAL MAIN PRODUCTS AND LIQUID PIG MANURE

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ABSTRACT

My research work proposes the study of the impact of the biogas production by the co-fermentation of agricultural products. The basic substance is the dangerous liquid pig manure of the concentrated stock of big pig farms. The energetic utilization of these materials means bigger income for the agricultural enterprises, savings in the replacement of the plant nutrition with the utilization of the bio-manure, increase in the performance of the plant production, making the dung harmless which means a big environmental load. Because of the profitability of bioenergy utilization depends on the local conditions, it is necessary to do experiments to try the available composition of organic wastes in the ratio of the production in advance. I measured the quantity of the methane and CO_2 content of the biogas released from the substrate. The experiment simulated real biogas plant conditions, in mesophilic temperature, continuous biodegradation process. It can be considered, as a semi-industrial size.

Keywords: sustainable agriculture, environmental protection, increasing the profitability of the agricultural production

INTRODUCTION

Based on our research and literature references, it can be proven that the qualitative and the quantitative properties of the biogas released in the biogas plants largely depends on the portioned liquid dung, the additives and the features of the applied technology. Our experiments justified the yield improving effect of the agricultural main and by-products as well as wastes because of the low organic matter content of the liquid pig manure. It may be hypothesized, that these additives and the technological parameters of the biogas production influence the features of the fermented manure and through this the opportunities of the recirculation in a favorable direction.

Our experiments aimed the increasing of the proportion of the renewable energy sources of application, to increase the methane quantity originating from the various organic matters, to increase the intensity of the formation, to produce stabile gas content. Making the organic matters polluting the environment harmless is the indirect result of the application of the technology (GOTTSCHALK, 1979). The biogas increasing the greenhouse effect with big methane content means concentrated environmental load and source of danger, and on the other hand, an unutilized energy source on a farm where the use of the exterior power sources is considerable anyway. While the economic size is its principle from below, the relatively little energy content of the biomass in the view of the transportation expense from above limits the firm concentration (GERARDI, 2003). Because of this, it is expedient to examine the energetic utilization of all possible organic waste at least with laboratory or half firm methods.

MATERIAL AND METHOD

At the Engineering and Agricultural Faculty of the Szolnok College, there is an appropriate, available, semi-automatic experimental system, representing the operating circumstances, providing similar conditions suitable for the formation process of the biogas, regulating the change of influencing factors and all the necessary measurements of typical data. The liquid pig manure was used during our biogas production experiments as basic substance. The application of an appropriate bacterium strain may decrease the time of fermentation and the measure of the demolition may improve and the methane content of the forming biogas may be growing.

The supreme features of the industrial by-products and wastes suitable for biogas production are

- the dry matter-,
- organic matter,
- nitrogen content,
- C:N proportion,
- specific gas yield.

The technology of fermentation experiments, the process of the experiment series:

a) Loading of laboratory digesters, setting of the treatment combinations
b) Sampling.
c) Measurements, examined parameters

The technology of fermentation experiments

We divided the process of the fermentation into sections according to the *Table 1.*

Table 1. The technology of the co-fermentation experiments

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Process period</th><th rowspan="2">Duration</th><th colspan="4">Treatments, fermenters</th><th rowspan="2">Comment</th></tr>
<tr><th>1.</th><th>2.</th><th>3.</th><th>4.</th></tr>
<tr><td>1.</td><td>stabilization</td><td>7 days</td><td colspan="4">Composition:
50% fresh liquid manure; 25% manure from the store; 25% sludge from the store</td><td rowspan="2">same circumstances</td></tr>
<tr><td>2.</td><td>refilling period with fresh substance</td><td>14 days</td><td colspan="4">7 v/v% refilling with fresh substance daily</td></tr>
<tr><td rowspan="2">3.</td><td rowspan="2">refilling with fresh substance daily (running up period)</td><td rowspan="2">15 days</td><td colspan="4">4.4 v/v% refilling with fresh substance daily</td><td rowspan="4">32 – 37 °C different processes</td></tr>
<tr><td>control</td><td>C35
30 g d.m./day</td><td>C36
30 g d.m./day</td><td>Hemp
30 g d.m./day</td></tr>
<tr><td rowspan="2">4.</td><td rowspan="2">refilling with fresh substance daily (comparative experiments)</td><td rowspan="2">15 days</td><td colspan="4">4.4 v/v% refilling with fresh substance daily</td></tr>
<tr><td>control</td><td>C35
30 g d.m./day</td><td>C36
30g d.m./day</td><td>Hemp
30g d.m./day</td></tr>
</table>

We can dose ~50 dm^3 of liquid dung mixture pro treatment to take the factors in connection with the capacity of the fermenters into account. It is possible to examine simultaneously the effect of 9 treatment combinations with hermetically closed fermenters mobile by manual power placed in a heatable room. We applied the continuous (filling up) system, which is most widespread in the practice. The process sections, as the launching, load change, receipt change can be reproduced according to certain experts' opinions, and each single daily measurement combinations for a separate experiment can be qualified (KALMÁR ET AL., 2003).

Table 2. The parameters measured during the experiment series

Serial No.	Measured parameter	Device	Method	Comment
1.	fermenter temperature (°C)	digital thermometer		
2.	gas yield (dm^3)	gas meter		once a day, at the same time
3.	gas content (%)	GA45 gas analyser		
4.	conductivity (mS/cm)			
5.	soluted oxygen (mg/l)			
6.	pH	Hydrolab	electrometric	once a day, at the same time
7.	salination (PSS)			
8.	redoxpotential (mV)			
9.	BOD5 (mg/l)	Oxi Top 110	pressure dropping	from samples selected based on professional viewpoints
10.	COD (mg/l)	NANOCOLOR	photometry	
11.	dry matter content	drying cupboard		once a day, at the same time

We measured the most important parameters to follow the degradation process (*Table 2*). *Table 1.* contains the different treatments in the different process periods.

The statistical methods used for the evaluation of co-fermentation experiments

We used Excel spreadsheet and SPSS for Windows 18.0 for the statistical analysis. The data were analyzed by variance with independent two-T sample. We examined the homogeneity with Levene test. For the group pair comparison Tamhane test was used in the case of heterogeneity, and LSD test in the case of homogeneity. The relationship between variables was determined with correlation analysis tests (Pearson's correlation coefficient) and linear regression analysis.

RESULTS

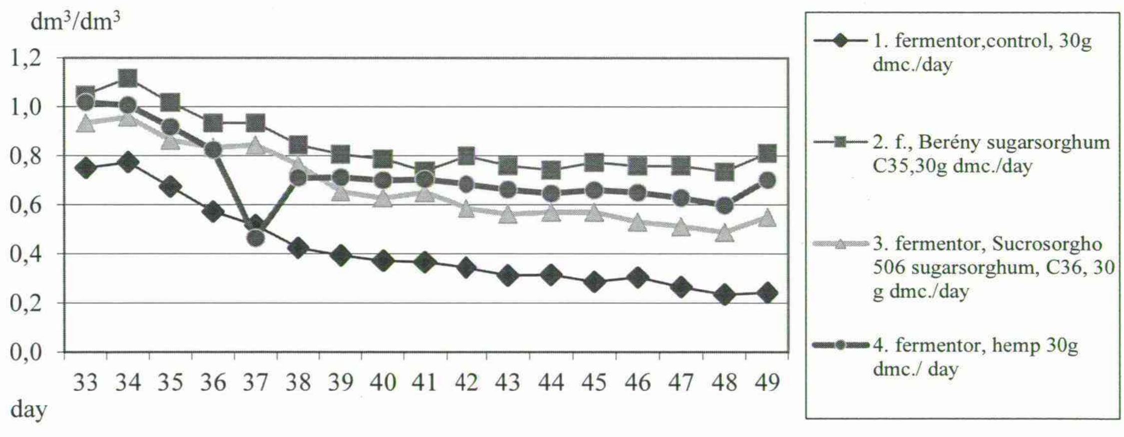
The average biogas yield of the control fermenter was 21 Nm^3/day, the methane production at 55-57% methane content was 12.7 Ndm^3/day. The specific methane production related to 1 kg dry matter was 78 Ndm^3 (*Table 3*). The C35 sugar sorghum doped (fermenter No. 2) produced 42.2 Ndm^3 biogas per day, the average biogas yield of the fermenter No.3 was 33 Ndm^3/day. The reason of the difference is the maturation status of the different species and the different sugar content.

Table 3. The gas production of the fermenters during the comparative experiments with sugar sorghum (C_{35},C_{36}) and hemp whole plant additives

Fermenters, treatment	Average production			Specific gas production			
	biogas	methane		biogas	methane	biogas	methane
	Ndm³/day		%	Ndm³/kg d.m.		dm³/dm³ fermenter-volume/day	
Fermenter No. 1 (control)	21.0	12.7	60.5	129.6	78.4	0.42	0.25
Fermenter No. 2: Berény sugar sorghum, C_{35}, 30 g d.m./day	42.2	22.6	53.6	22.7	118.6	0.84	0.45
Fermenter No. 3: Sucrosorgho 506 sugar sorghum, C_{36}, 30 g d.m./ day	33.8	20.0	59.2	162.4	96.1	0.68	0.40
Fermenter No. 4: hemp, 30 g d.m./ day	36.1	19.8	54.8	183.9	100.9	0.72	0.40

The C_{35} sugar sorghum with higher sugar content produced more biogas at the time of the experiments. However, the methane content of this was lower thus the yield is only 2.6 dm³/day more than the methane production of the other fermenter with lower sugar content.

Figure 1. Specific biogas yield of the fermenters during the comparative period of the experiment compared to the fermenter volume



The stability of the biogas production is depending on the decomposition of the organic matter, on the quality of the technology and on the amount of organic matter overloaded (*Figure 1*). Experiments of the most stable yield intensity could be performed with the fermenter No. 2. In the case of other fermenters, the production decreased in a few ways only (*Figure 2*). The decreasing production was sometimes in connection with a little increasing dry matter content (*Figure 3*).

In our experiments, the figures of the biogas production and the methane content of the released biogas proved the relation between the biogas production intensity and the methane content. To determine the level of the correlation is the next aim of our research.

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Figure 2. Methane content of the biogas during the comparative experiments

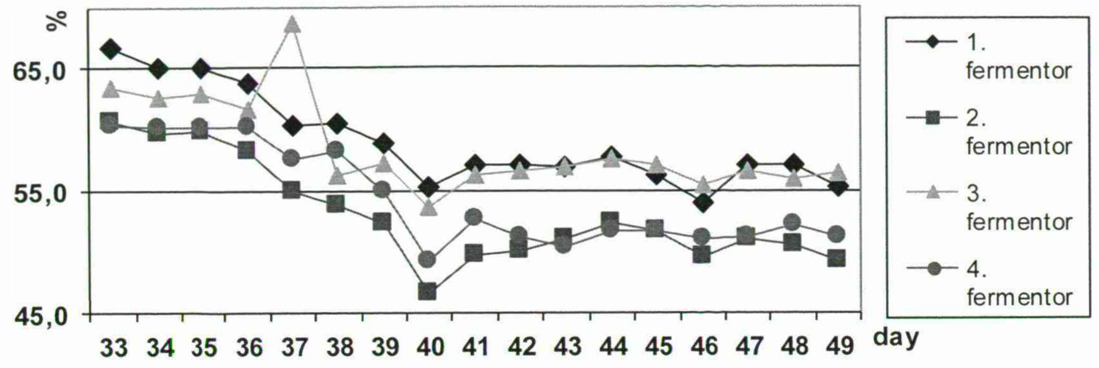
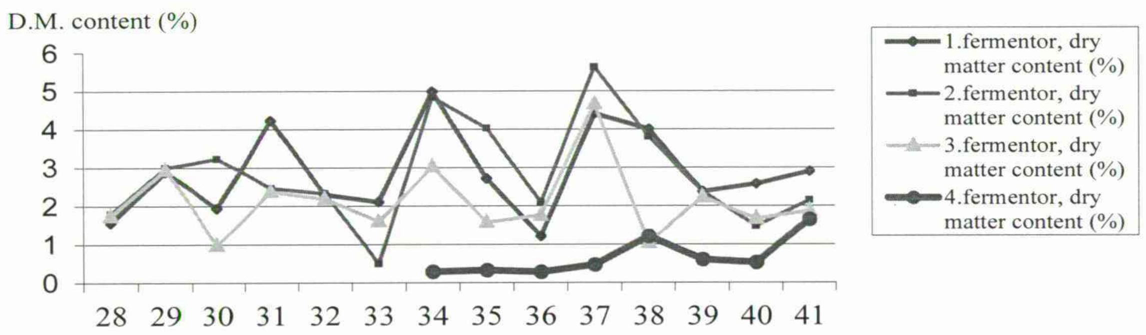


Figure 3. Dry matter content during the examination period



CONCLUSIONS

The biogas production technology based on the pork liquid dung and on the other wastes of the processing of agricultural main products known, and the accepted technological procedures in the EU's member states, results in the production biogas and fermented manure. The quantity and the quality of the raw materials and additives, the parameters of the applied technology as well as the biogas production are strongly depending from each other.

At the end of the comparative experiments, we can determine, that the utilization of the whole plant additives increases the biogas production of the liquid pig slurry, and this increase is significantly bigger than the decrease of the methane content. The justification of the relation between the maturation degree and the value of the sugar content of the different species needs further investigations.

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