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BIOGAS EXPERIMENTS WITH PIG SLURRY AND MUSHROOM COMPOST WITH CORN SILAGE

LASZLO SALLAI

University of Szeged Faculty of Agriculture
Institute of Plant Sciences and Environmental Protection
Andrássy út 15., 6800 Hódmezővásárhely, Hungary
sallai@mgk.u-szeged.hu

ABSTRACT

Mushroom growing is a sector of the national horticulture and the compost production is an essential part of the technology. The mushroom compost production is an environmental activity, because there is an opportunity in economical processing of big quantity of agricultural by-products. The mushroom compost contains chicken manure, straw, peat, yielded mushroom residue (residual stump, mycelium, mushroom) and sometimes horse manure. During the technology the quantity of ammonia emitted by the firms and the odour emission and the stench contamination is a serious problem. The large-scale manure production modelling of biogas experiments used liquid pig slurry as raw material. The additives were bran, mushroom compost and maize silage. The industrial by-products and wastes suitable for biogas production are defined by the dry matter, organic matter, nitrogen content, C:N ratio, specific gas yield. The intensity of the methane production is the direct measure of the activity of the methanogenic bacteria, and the most sensitive, typical indicator of the digester's yield. The combination and the yield of the produced gas features may be useful to estimate the stability of the anaerobic system. Consequently, the results of the examinations bring practical profit on the sizing, investment and firm operational area indispensable.

Keywords: organic matter decomposition, gas yield, methane content

INTRODUCTION

An energetic aim of the utilisation of the manure meaning serious environmental load with other wastes and by-products of a certain micro-region may increase the profit-making ability of agricultural investments. The economical operation of the pork breeding claims the increase of the firm size especially, which may entail the considerable growing of the environment-damaging effects (GOTTSCHALK, 1979). The multiple beneficial effects of the biogas production (energy production + environmental protection investment + biomanure production + the treatment of hazardous waste and its utilisation) are expounded if the possible power generating ability of the co-ferment is modelled similar to operating circumstances on an experimental way beforehand (GERARDI, 2003). The research of appropriate technology may decrease the time of fermentation, the measure of the demolition may improve and the methane content of the forming biogas may grow.

MATERIAL AND METHOD

The large-scale manure production modeling of biogas experiments used the liquid pig slurry as raw material. The additives were mushroom compost and maize silage, the recipe of the co-ferments and the dry matter content of the substrate is in *Table 3.* The industrial by-products and wastes suitable for biogas production were defined by the dry matter, organic matter, nitrogen content, C:N ratio and specific gas yield.

The technology of the fermentation experiments

At the Engineering and Agricultural Faculty of the College of Szolnok there is an appropriate, 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 provide the opportunity of all the necessary measurements of typical data. The liquid pig manure was used during our biogas production experiments as basic substance. The research of appropriate technology may decrease the time of fermentation and the rate of the decomposition may improve and the methane content of the forming biogas may grow.

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

- 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

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

Table 1. The parameters measured during the experiment series, measuring devices, methods, frequency

Serial number	Measured parameter	Device	Method	Comment
1.	fermentor temperature (°C)	digital thermometer		once a day, at the same time
2.	gas yield (dm^3)	gas meter		
3.	gas content (%)	GA45 gas analyser	electrometry	once a day, at the same time
4.	conductivity (mS/cm)	Hydrolab		
5.	soluted oxigen (mg/l)			
6.	pH			
7.	salination (PSS)			
8.	redoxpotential (mV)			
9.	BOD5 (mg/l)	Oxi Top 110	pressure dropping	from samples selected based on professional view points
10.	COD (mg/l)	NANOCOLOR	photometry	
11.	dry matter content (%)	drying cupboard		once a day, at the same time

We can dose ~50 dm^3 of liquid dung mixture pro treatment to take the factors in connection with the capacity of the fermentors into account. It is possible the simultaneous examination the effect of 9 treatment combinations with in a heat able room placed, periodically mixed, hermetically closed fermentors. We applied the continuous (filling up), mezophilic system, which is most widespread in the practice. The process sections, such as the launching, load change, receipt change can be reproduced, according to certain expert's opinions each single daily measurement combination for a separate experiment can be qualified (KALMÁR ET AL., 2003).

We divided the process of the fermentation into sections according to *Table 2*.

Table 2. Technology of the co-fermentation experiments

Serial number	Period of the process	Treatment	Duration time
1.	stabilization		7 days
2.	refilling period with fresh substance	running-up period with fresh substance	14 days
3.	running-up period		21 days
4.	comparative experiments		21 days

The biogas production depends on changing the quality of the liquid pig slurry basis during the fermentation process, that's why it is necessary to use control experiments with pure pig slurry with different dry matter content (ARTHURSON, 2009)*(Table 3)*.

Table 3. The dry matter content and composition of the daily treatment of fermentor

	Control I. (liquid pig slurry)	Control II. (liquid pig slurry)	100 g/(MC:CS=75:25)	100 g/(MC:CS=50:50)
Average dry matter content (%)	3.40	4.59	3.99	3.96

MC: yielded mushroom compost; CS: corn silage

The statistical methods used

For the statistical analysis Excel spreadsheet and SPSS for Windows 18.0 were used. The data were analysed by variance with independent two-T sample. The homogeneity was examined with Levene test. By 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 performed with correlation analysis tests (Pearson's correlation coefficient) and linear regression analysis.

RESULTS

The results of the experiments of mushroom compost and corn silage additives with liquid pig slurry co-fermentation are displayed in *Table 4*. The other gases (hydrogen sulfide, ammonia, etc) reduce large-scale application conditions.

Table 4. Average gas yield of liquid pig slurry basis, mushroom compost (MC) and corn silage (CS) added

Load of fermentor	Dry matter content (%)	Gas releasing (Ndm^3/day)	Methane content (%)	CO_2 content (%)	Average methane releasing (Ndm^3/day)	Gas releasing, referred to fermentor volume unit (Ndm^3/dm^3/day)	
						biogas	methane
Control I.	3.40	16.98	58.92	26.5	14.5	0.30	0.20
Control II.	4.59	23.04	59.07	30.6	10.3	0.41	0.26
100 g/(MC:CS=75:25)	3.99	74.47	48.86	37.4	13.7	1.49	0.73
100 g/(MC:CS=50:50)	3.96	58.16	40.42	30.9	28.7	1.16	0.47

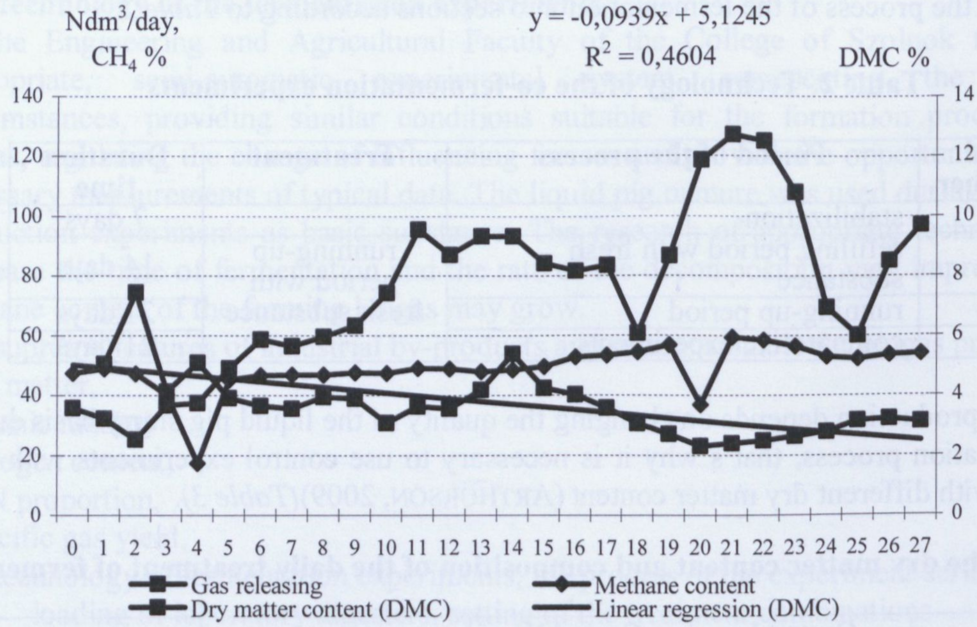

Figure 1. Evolution of parameters in the mushroom compost - corn silage (MC/CS=75:25) experiment (100 g dry matter/day)

The changing trend of dry matter content can be described by the y = -0.0939 + 5.1245 x function in the case of the daily 100 g dry matter, MC:CS ratio = 75:25 yielded mushroom compost – corn silage addition ($R^2 = 0.4604$). The co-fermentation can work with 74.47 Ndm^3/day average biogas production in a sustainable way *(Figure 1)*.

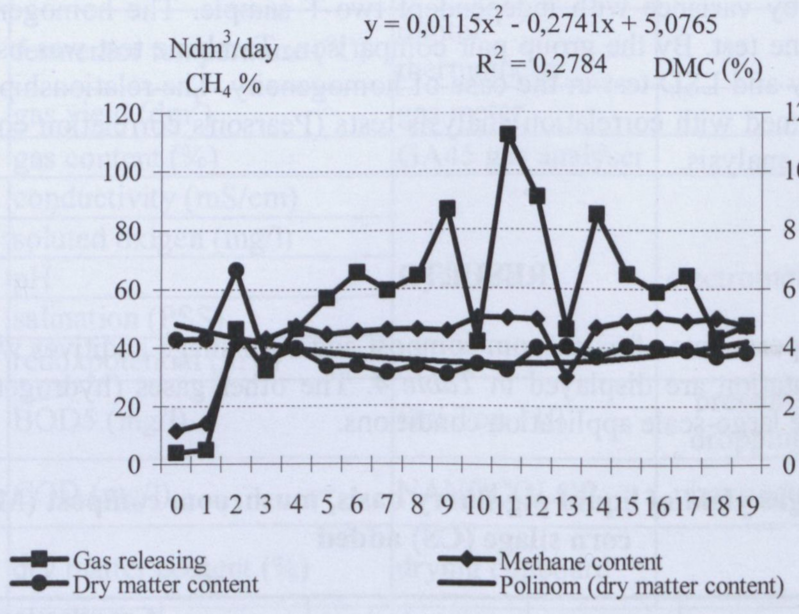

Figure 2. Evolution of the parameters in the mushroom compost - corn silage (MC/CS=50:50) experiment (100 g dry matter/day)

The changing trend of dry matter content can be described by the y = 0.0115 x^2, - 0.2741x + 5.0765 x function in the case of the daily 100 g dry matter, MC:CS = 50:50 yielded mushroom compost - corn silage co-ferment addition ($R^2 = 0.2784$). The co-fermentation works *(Figure 2)* with 58.16 Ndm^3/day average biogas production and only an average of 40.42% methane content.

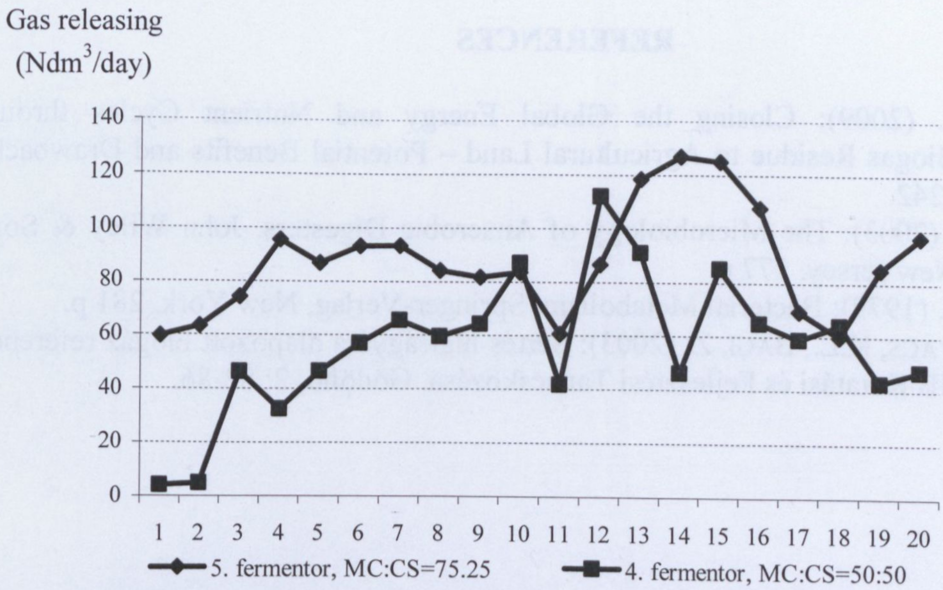

Figure 3. Gas formation trends in the 4th fermentor (MC:CS = 50:50) and in the 5th fermentor (MC:CS = 75:25)

Dry matter content (DMC): 0.20-0.22% dose/day, 4% DMC containing of liquid pig slurry basis

The experiments show that the by-products used as additives significantly increased the low dry matter content of organic material of liquid pig slurry, but with the exception of the 50-50% recipe, did not reduce the methane content of biogas *(Figure 3)*. The different yield increasing impact of the different additives may be caused by the different C/N ratio of them. The parallel fluctuations in the methane have various technological reasons.

CONCLUSIONS

The impact of the additive composition on the average daily gas production differs significantly. The reason could be the different C/N ratio of the different additives and the degradability of the different components. The production of 100 g of dry matter quantity, in a 75% mushroom compost and 25% corn silage containing biogas system in relation to five times the biogas, methane production in relation to 3.6-fold in the same dry matter content compared to controls. 100g dry matter quantity, 50% mushroom compost and biogas system containing 50% corn silage in biogas production in relation to 3.7-fold, 2.7-fold relative to methane production in the same dry matter content compared to controls. The gas production and methane content of the biogas yielded by the 50% maize silage and 50% mushroom compost differed significantly. The cause could be the inappropriate homogeneity of the silage. The system failed to reach an average methane content of 50% and greatly increased the amount of other gases. In addition to corn silage, chop conditions can also affect starch fermentation. The mushroom compost environment, the bigger, less deconstructable silage corn chaff size of bigger proportion produced biogas with lower methane content. This can be utilized with properly converted burners for direct heat production or for example in micro-turbine electric power generation, too.

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