

EXPERIMENTS DEALING WITH ENERGETICAL UTILIZATION OF AGRICULTURAL MAIN AND BY-PRODUCTS

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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 the performance of the plant production, making harmless the dung 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 and the methane and CO₂ content of the biogas released from the substrate. The experiment simulated real biogas plant conditions, in mesophil temperature, continuous biodegradation process. It can be considered, as a semi industrial size.

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

INTRODUCTION

It can be provable based on my research and literature references, that the qualitative and the quantitative properties of the biogas releasing 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 and 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 on a favorable direction the features of the fermented manure and through this the opportunities of the recirculation.

The target of my experiments aimed the increasing of the proportion of the renewable energy sources of application is to increase the methane quantity originating from the various organic matters, to increase of 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 [3]. The biogas increasing the greenhouse effect with big methane content means concentrated environmental load and source of danger and on the other hand unutilized energy source in on a farming area where the use of the exterior power sources is considerable anyway. While the economy size is his principle from below, the relatively little energy content of the biomass in the view of the transportation expense from above limits the firm concentration [2]. Because of this it is expedient to examine the energetic utilization of all possible organic waste at least with laboratory or half firm methods.

MATERIALS AND METHODS

Activity sampling. At the Engineering and Agricultural Faculty of Szolnok College there is an appropriate, available, semi-automatic experimental system, representing the operating circumstances, providing similar conditions suitable the formation process of the biogas, regulating change of influencing factors and all of necessary measurements of typical data. The liquid pig manure was used during my biogas production experiments as basic substance. The application of appropriate 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 industrial by-products and wastes suitable for biogas production: 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.

Technology of co-fermentation experiments.

No.	Process period	Dura-tion time	Treatments, fermenters				Comment
			1.	2.	3.	4.	
1.	Stabilization	7 days	Composition: 50% fresh liquid manure; 25% manure from the store; 25% sludge from the store				Same circumstances
2.	refilling period with fresh substance	14 days	7 vol.% refilling with fresh substance daily				
3.	refilling with fresh substance daily (running up period)	15 days	4,4 vol% refilling with fresh substance daily				32 – 37 °C different process
			control	C ₃₅ 30g dm./day	C ₃₆ 30g dm./day	Hemp 30g dm./day	
4.	refilling with fresh substance daily (comparative experiments)	15 days	4,4 vol% refilling with fresh substance daily				
			control	C ₃₅ 30g dm./day	C ₃₆ 30g dm./day	Hemp 30g dm./day	

We can dose ~50 dm³ of liquid dung mixture pro treatment to take the factors in connection with the capacity of the fermenters into account. It is possible the simultaneous examination the effect of 9 treatment combinations with in a heat able room placed, mobile by manual power, hermetically closed fermenters. We applied the continuous (filling up) system, which is most widespread in the practice, it can be reproduced the process sections, as the launching, load change, receipt change, according to certain expert opinions each single daily measurement combination for a separate experiment can be qualified [4].

Table 2

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

serial number	measured parameter	device	method	comment
1.	Fermenter temperature (°C)	digital thermometer		once a day, at the same time
2.	gas yield (dm ³)	gas meter		
3.	gas content %	GA45 gas analyser		
4.	conductivity (mS/cm)	Hydrolab	electrometric	once a day, at the same time
5.	soluted oxygen (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 viewpoints
10.	COD (mg/l)	NANOCOLOR	photometry	
11.	dry matter content	drying cupboard		once a day, at the same time

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

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

I used for the statistical analysis Excel spreadsheet and SPSS for Windows 18.0. The data were analyzed by variance with independent two-T sample. I examined the homogeneity with Levene test. By the group pair comparison I used Tamhane test 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.

RESEARCH RESULTS

The average biogas yield of the control fermentor 21Nm³/day, the methane production besides 55-57% methane content is 12,7 Ndm³/day. The specific methane production related for 1kg dry matter is 78 Ndm³ (Table 3.). The C₃₅ sugar sorghum doped (2. fermenter) produced 42,2 Ndm³ biogas /day, the average biogas yield of the No.3 fermenter is 33 Ndm³/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(C₃₅,C₃₆), and hemp whole plant additives

Fermenters, treatment	Average production			Specific gas production			
	biogas	methane		biogas	methane	biogas	methane
	Ndm ³ /day	%		Ndm ³ /kg DM	dm ³ /dm ³ fermenter-volume/day		
1. fermenter (control)	21,0	12,7	60,5	129,6	78,4	0,42	0,25
2. fermenter: Berény sugar sorghum, C ₃₅ , 30g dm./ day	42,2	22,6	53,6	22,7	118,6	0,84	0,45
3. fermenter: Sucrosorgho 506 sugar sorghum C ₃₆ , 30g DM./ day	33,8	20,0	59,2	162,4	96,1	0,68	0,4
4. fermenter: hemp, 30g dm./ day	36,1	19,8	54,8	183,9	100,9	0,72	0,40

The C₃₅ sugar sorghum with higher sugar content produced more biogas at the time of the experiments, but the methane content of this lower, and that why the yield is only 2,6 dm³/day more, than the methane production of the other fermenter with lower sugar content.

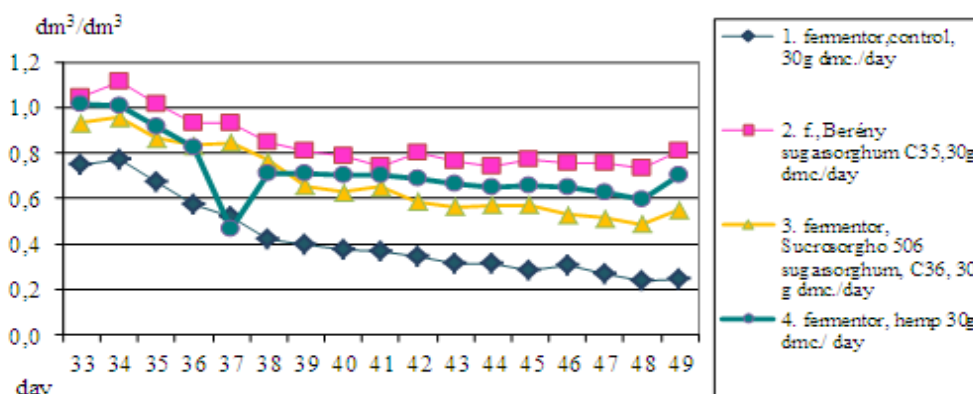


Figure 1 Specific biogas yield of the fermenters during the comparative period of the experiment compared to the fermenter volume

The stability of the biogas production is the property of the deconstruction of the organic matter, the quality of the technology, the amount of organic matter overloaded (Figure 1.). The most stable yield intensity experience able in the case of 2. fermenter. In the case of other fermenters the production decreasing only in a few way(Figure 1). The

decreasing production sometimes belonging to a little increasing dry matter content(*Figure 3*).The figures of the biogas production and the methane content if the released biogas proved the relation between the biogas production intensity and in connection with the methane content about my experience. The level of the correlation is the next aim of my resource work.

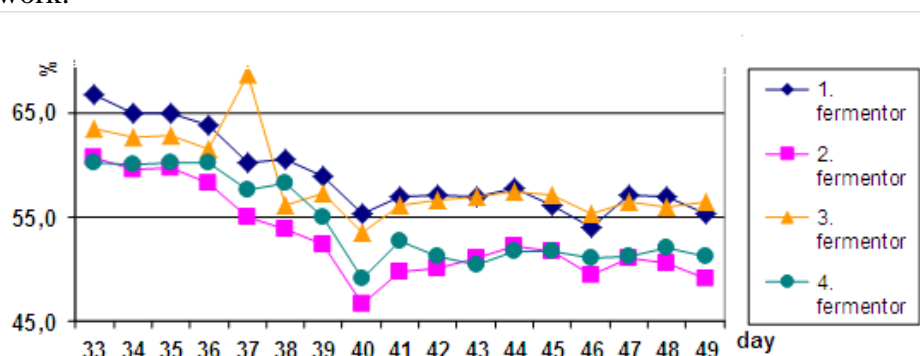


Figure 2. Methane content of the biogas during the comparative experiments

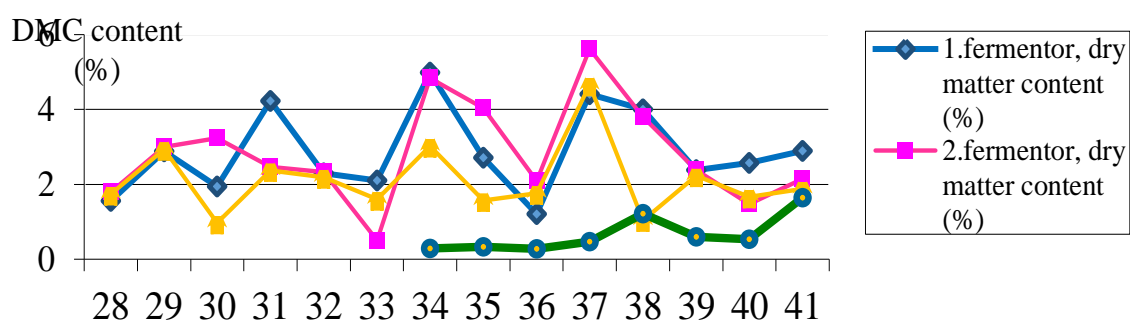


Figure 3. Dry matter content during the examination period

CONCLUSIONS

The biogas production based on the pork liquid dung, and the other wastes of agricultural main product of processing known, and accepted technological procedure in the EU's member states, as the result of this biogas and fermented manure is produced. The quantity and the quality of the raw materials and additives, the parameters of the applied technology and the biogas forming are strongly depending.

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

REFERENCES

1. **ARTHURSON, V.**, 2009, Closing the Global Energy and Nutrient Cycles through Application of Biogas Residue to Agricultural Land – Potential Benefits and Drawbacks. *Energies* 2, 226-242.;
2. **GERARDI, 2003, MH.** The Microbiology of Anaerobic Digesters. USA: Wiley-Interscience,
3. **GOTTSCHALK, G.**, 1979, Bacterial Metabolism. New York: Springer-Verlag,
4. **KALMÁR, I, KL KOVÁCS, és BAGI, Z.**, 2003, Sertés hígtrágyára alapozott biogáz referencia üzem. MTA AMB Kutatási és Fejlesztési Tanácskozása. Gödöllő, 2:82-86