Energetic potential of co-fermented substrate of plant and animal biomass

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Introduction Since 1990, the number of livestock has markedly decreased by 65% (-1.023 mil for cattle) and 46% -0.279 mil for sheep). According to data of the Slovak Land Fund, currently the non-productive land covers 300,000 ha of grassland. Energetic use of biomass is a progressive way in which non-utilised agricultural land can be used. The paper shows results from a study comparing co-fermentation of cattle manure with fresh grass biomass or grass silage, using a wet continual fermentation process.

Materials and methods The following substrates were processed in the fermentor: i) cattle slurry (100%); ii) cattle slurry (90%) with fresh herbage (10%); iii) cattle slurry (90%) with grass silage (10%); iv) cattle slurry (80%) with grass silage (20%) v) cattle slurry (80%) with clover silage (20% *Medicago sativa* L.) The parameters measured in the input substrates were as follows: chemical oxygen demand (COD, g l^{-1}), photometrically; SO_4 (sulphates, mg l^{-1}), photometrically; total nitrogen content (N_{tot}, mg l^{-1}), photometrically; dry matter content (DM, %), by weighing scales; organic load rate of fermentor (OLR) kg COD m^3 day^{-1}, calculated. The following parameters were measured in the output substrates: substrate temperature (℃) by a digital thermometer; pH by pH-meter; CH_3COOH (acetic acid, mg l^{-1}), calculated. Biogas composition was analysed (*Schmack SSM 60000*) and these four main compounds were measured: CH_4 (methane, % vol.) by infrared two-ray sensor; CO_2 (carbon dioxide, % vol.) and; O_2 (oxygen, % vol.) and H_2S (hydrogen sulphide, ppm vol.), electrochemically.

Results and discussion Statistically processed experimental data are given in Tables 1 and 2. A comparison of COD the input substrates showed that ii) substrate contained more organic substances. However, the anaerobic decomposition was less efficient than with i) substrate as shown by the decreased biogas production. The mean N_{tot} content was also higher with ii) substrate than with i) substrate. The content of DM in ii) substrate fluctuated markedly in relation to the dry DM content of slurry. Substrate samples were analysed to monitor the anaerobic decomposition. The middle value of pH slightly increased with 10% grass silage addition but was not higher than the optimum pH values of 8-8.5 reported by Braun (2002). Slurry has a high buffering capacity, and high acidity of substrate need not change pH. Consequently, acetic acid content is a better indicator than pH for controlling the process. High content of acetic acid in iii) substrate was inhibiting the production of biogas (Table 2). Methane content in biogas was higher when processing substrates with ensiled grass than when using only slurry. The content of H_2S was also below 1000 ppm and biogas could be directly burned without cleaning (Sargova, 2005). However, the production of biogas was decreasing with rising proportion of preserved grass.

Table 1 *Analyses input and output substrates.*

Substrates	Parameters-Input		Parameters-Output	
i	COD(g l^{-1})	45.5	Temperature	37.5
ii		61.5	(℃)	37.7
iii		38.3		37.9
iv		47.8		37.8
v				37.9
i	N_{tot} (mg l^{-1})	93.0	pH	7.1
ii		105.5		7.4
iii		85.8		7.3
iv		86.5		7.2
v		117.3		7.6
i	DM (%)	4.8		
ii		5.3		
iii		4.3		
iv		4.9		
v		4.8		
i	OLR as kg	3.2		
ii	COD	3.8		
iii	(m3 day^{-1})	2.3		
iv		1.9		
v		3.3		

Table 2 *Biogas analysis*

Parameters	Substrates	
CH_4 (% vol.)	i	55.77
	ii	56.70
	iii	57.09
	iv	54.44
	v	60.70
CO_2 (% vol.)	i	39.07
	ii	43.00
	iii	40.49
	iv	45.55
	v	34.90
H_2S (ppm vol.)	i	158.00
	ii	338.00
	iii	227.50
	iv	81.00
	v	771.0
Biogas production (m^3_N day^{-1})	i	4.80
	ii	3.60
	iii	2.64
	iv	1.27
	v	4.63

Conclusions Research experiments showed that biomass from non-utilised grassland areas could be processed to produce biogas. A mixture of cattle slurry and ensiled grass or *Medicago sativa* L. was the most efficient input substrate. The mixture of cattle slurry and fresh herbage was not very suitable as a substrate for biogas production by anaerobic fermentation.