BIOLOGICAL PRE-TREATMENT OF LIGNOCELLULOSIC WASTES TO IMPROVE BIOGAS PRODUCTION

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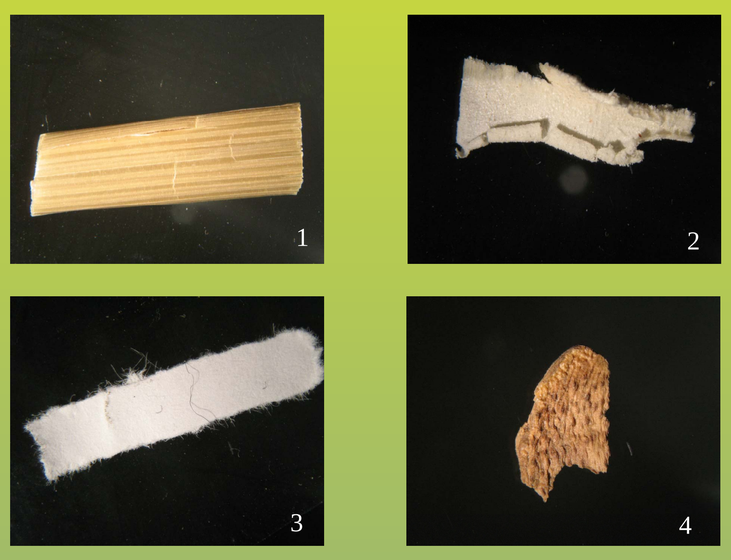
SUMMARY

The extension of the raw material basis for biogas station was the main object of this research. The biological pre-treatment of lignocellulosic wastes (straw, waste paper, sawdust, and poppy-heads residues) improvement in biogas production was investigated.

In the first stage, the lignocelluloses were hydrolyzed aerobically for 2-12 weeks, using three cellulolytic microorganisms: *Trichoderma reesei*, *Trichosporon cutaneum* and strain with operational name - Tur3. This stage was followed by anaerobic digestion at 55 °C for 40 days. The biogas volume and concentration of released methane were determined during the process.

The biological pre-treatment of poppy-heads residues with *Trichoderma reesei* increased the production of methane by 6.5 % after four weeks; pre-treatment of straw by 26.4 % after 12 week, pre-treatment of paper by 9.7 % after 12 weeks and sawdust by 14.7-40.8 % after 2-4 weeks. Four week pre-treatment of poppy-heads residues with *Trichosporon cutaneum* improved methane production by 25.0 %, pre-treatment of straw by 10.4-28.9 % after 2-4 weeks, pre-treatment of paper by 3.3-16.5 % after 8-12 weeks, pre-treatment of sawdust by 21.0 % after 12 weeks. Strain Tur3 did not prove significant increase in methane production (straw 2.5 % 12 weeks and sawdust 9.3 % 2 weeks). In other cases, the biological pre-treatment had negative influence on methane production.

Tested substrates:

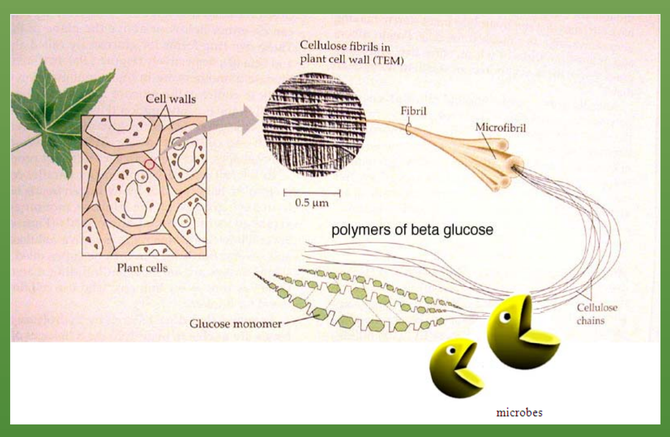


1 - straw (10-30 mm), 2 - sawdust 3 - shredded office paper, 4 - poppy-heads residues (stereomicroscopic images, magnified 7.5x)

Course of experiments:

substrate preparation (cut wheat straw)

aerobic phase: 30 °C, 90 RPM



aerobic phase: aerobic biodegradation, 2-12 weeks

After the aerobic phase was finished, the content of flasks was analyzed (organic dry matter, dry matter, COD_{Cr}). The content and digestate were transferred into flasks with blue caps. Then the anaerobic phase followed.

anaerobic phase: 40 days, 55 °C, initial inoculum load 0,3 g/g

Monitoring of aerobic stage:

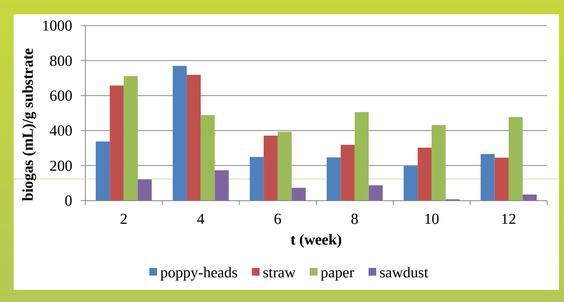
- cellulolytic activity
- cellulolytic microbes counts

Monitoring of anaerobic stage:

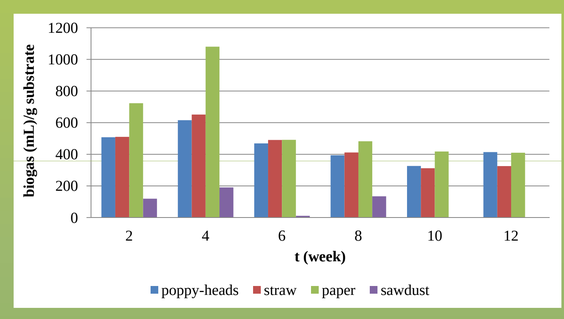
- volume of released biogas, biogas composition (GC/TCD)
- output analysis: dry matter, organic dry matter, COD_{Cr}, pH and low fatty acids (GC/FID)

Results:

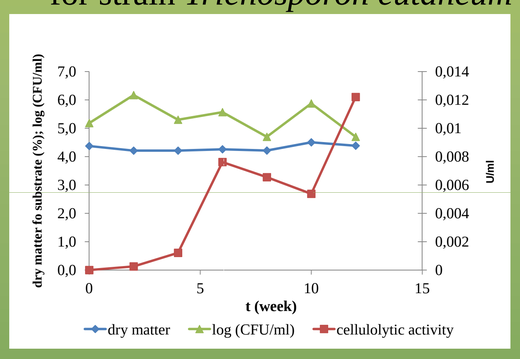
- for strain *Trichosporon cutaneum*



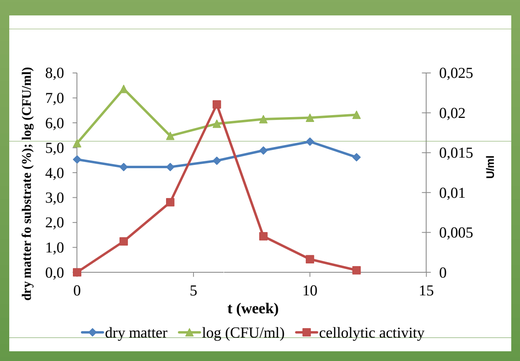
Maximum substrate production of biogas after 2-12 weeks of biological pre-treatment using T. cutaneum.



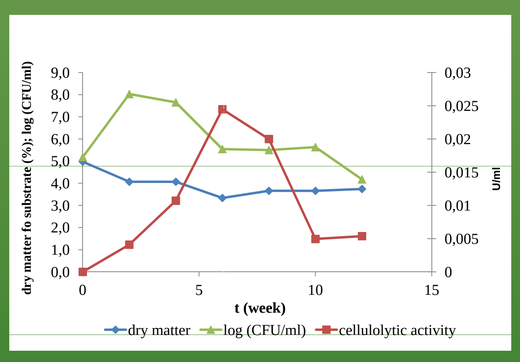
Maximum substrate production of biogas – blanks (without pre-treatment).



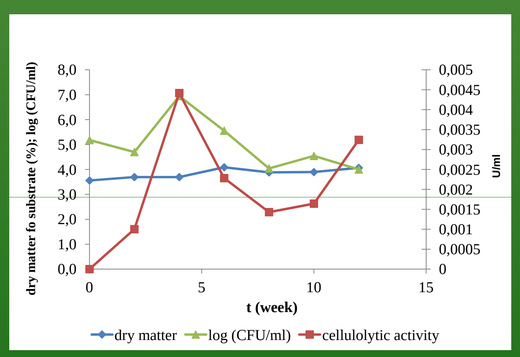
wheat straw



shredded office paper



poppy-heads residues



sawdust

	pre-treatment time (week)	2	4	6	8	10	12
Tur3	poppy-heads residues	-22,9	-42,9	-50,4	-17,5	-32,7	-46,3
	wheat straw	-21,6	-30,2	-16,4	-25,3	-14,7	2,5
	paper	-13,9	-19,9	-9,0	-6,3	-17,2	-3,0
	sawdust	9,3	-10,0	-75,7	-1,0	0,0	-7,8
TR	poppy-heads residues	-16,8	6,5	-18,5	-31,5	-29,8	-7,9
	wheat straw	3,3	-15,7	-33,4	-16,5	-32,1	26,4
	paper	9,0	2,3	1,0	8,2	2,0	9,1
	sawdust	40,8	14,7	-65,6	-47,3	-27,2	-35,4
TC	poppy-heads residues	-33,5	25,0	-46,9	-37,5	-39,5	-35,8
	wheat straw	28,9	10,4	-24,4	-22,6	-3,1	-24,7
	paper	-1,6	-37,5	-20,0	4,8	3,3	16,5
	sawdust	1,3	-9,4	-34,7	-35,2	-3,1	21,0

Summary of results: the efficiency of substrate pre-treatment.
TR – *Trichoderma reesei*, TC – *Trichosporon cutaneum.*

Conclusion:

- the lowest biogas (methane) production was determined after sawdust pre-treatment (probably due to the high content of lignin)
- biological pre-treatment of sawdust using *T. reesei* increased the biogas (methane) production by 40.8 %
- the highest substrate production was observed after paper pre-treatment
- pre-treatment of substrates using strain *T. cutaneum* increased methane production by 3.3-28,9 % and *T. reesei* by 6.5-40.8 %
- the strain Tur3 is not suitable for substrate pre-treatment

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