Universität Rostock Traditio et Innovatio

Development of a test procedure for realistic assessment of the biology of fermentation of NaWaRo-biogas plants

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3. Biogas-Innovationskongress Osnabrück 2010

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Introduction

- **Motive and purpose**

Growing number of biogas plants : medium to long term is to be expected of a shortage or price increase of available substrates.

Objectives: optimum utilization of available substrates, Development of new, in Anaerobic fermentation unutilized biomass.

For both tasks process aids are already available on the market. Effectiveness is difficult to assess in practice facilities

Molecular biological methods : time-consuming, expensive, no direct conclusions about the actual degradation rate in the fermenter.

The activity is a manageable test procedures are developed,, which allows a comparative quantification of the degradation rate of the fermenter biology.

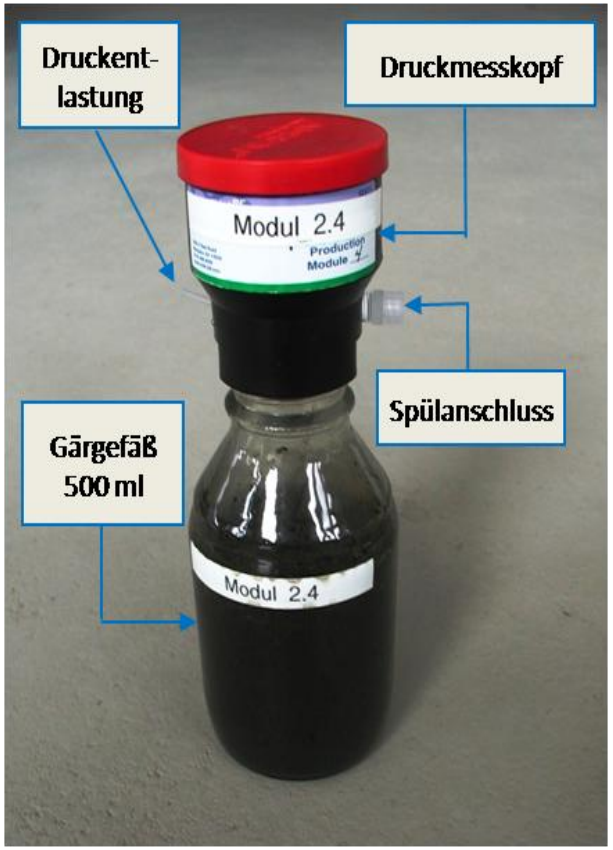
Development of the test procedure

- **Equipment and methods**

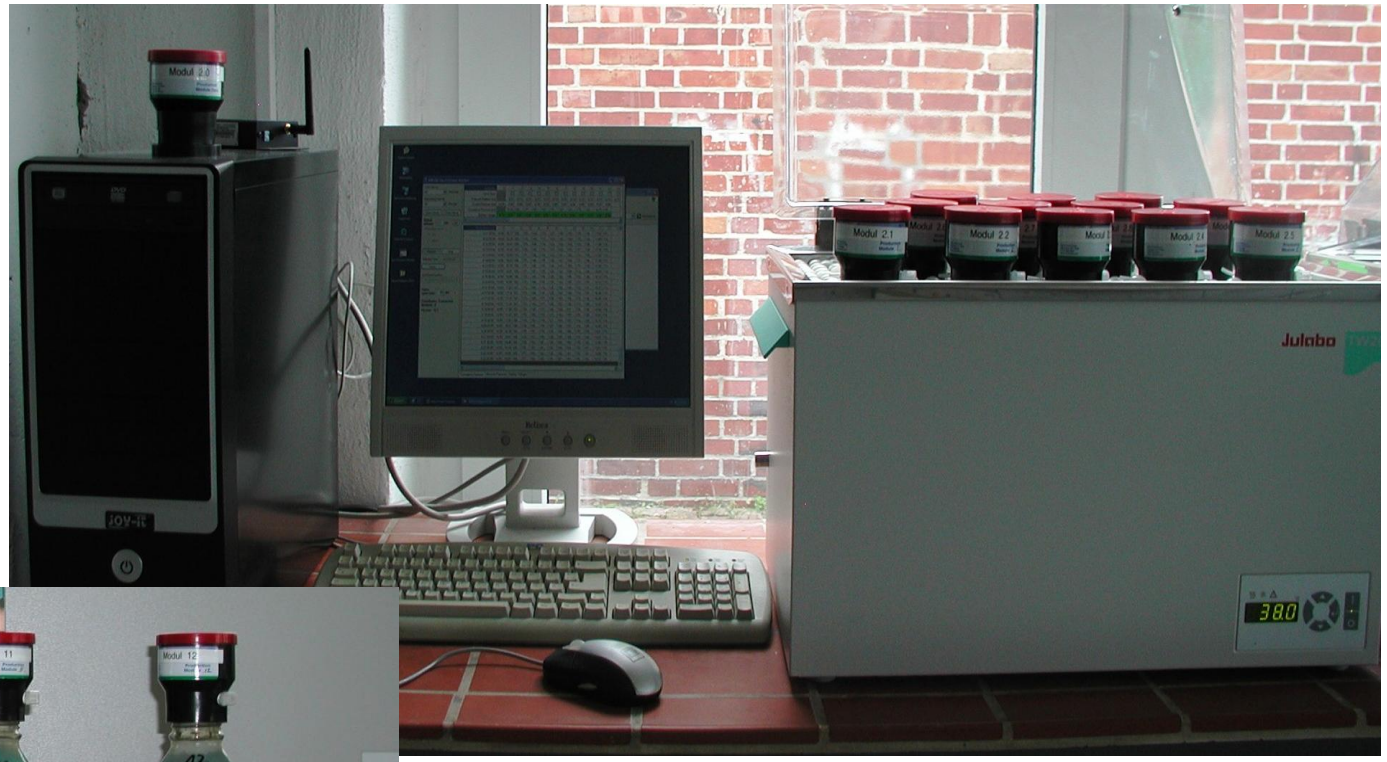
Test procedure: The biogas production of a standard substrate is measured under standardized conditions with high temporal resolution.

ANKOM ®Gas Production System:

- Compression-proof fermentation vessel.
- Module with pressure sensor , purge valve and vent valve.
- Pressure sensor detects the actual pressure in the head space and transmitted wirelessly to the PC
- Evaluation software (calculated by considering the current air pressure) the cumulative increase in pressure in the headspace of each fermentation vessel.



Development of the test procedure



Module in a water bath (top)

Daily homogenization using a magnetic stirrer (left)

Development of the test procedure

- **Equipment and methods**

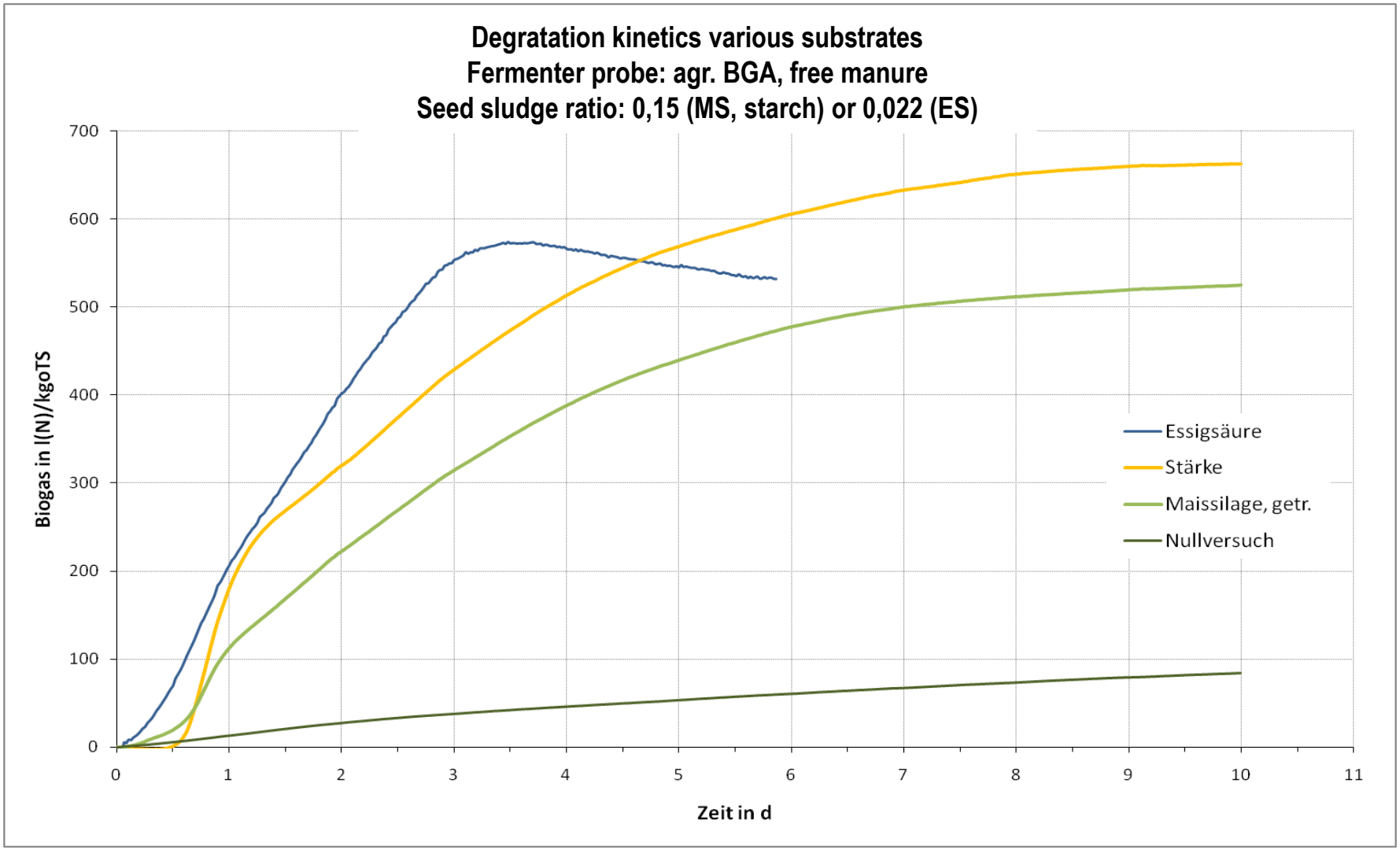
Requirement of the standard substrate:

- Reproducibility: Known and representable composition
- Quantification of the results: known gas yield
- Degradability: The composition of the major nutrients should be about the substrate of biogas plants
- No influence on the study objective : itself free of promoters / inhibitors

Realization by:

- Acetate(acetic acid directly for the methane-producing microorganisms available
- Corn starch: Substrate for hydrolyzing and acid-forming microorganisms
- Corn silage: practical substrate complex
- Synthetic substrate complex: Mixture of cellulose, starch, glucose, urea and phosphate buffer in a fixed composition

First results and perspective



Development of the test procedure

- **Realisation and prozess**

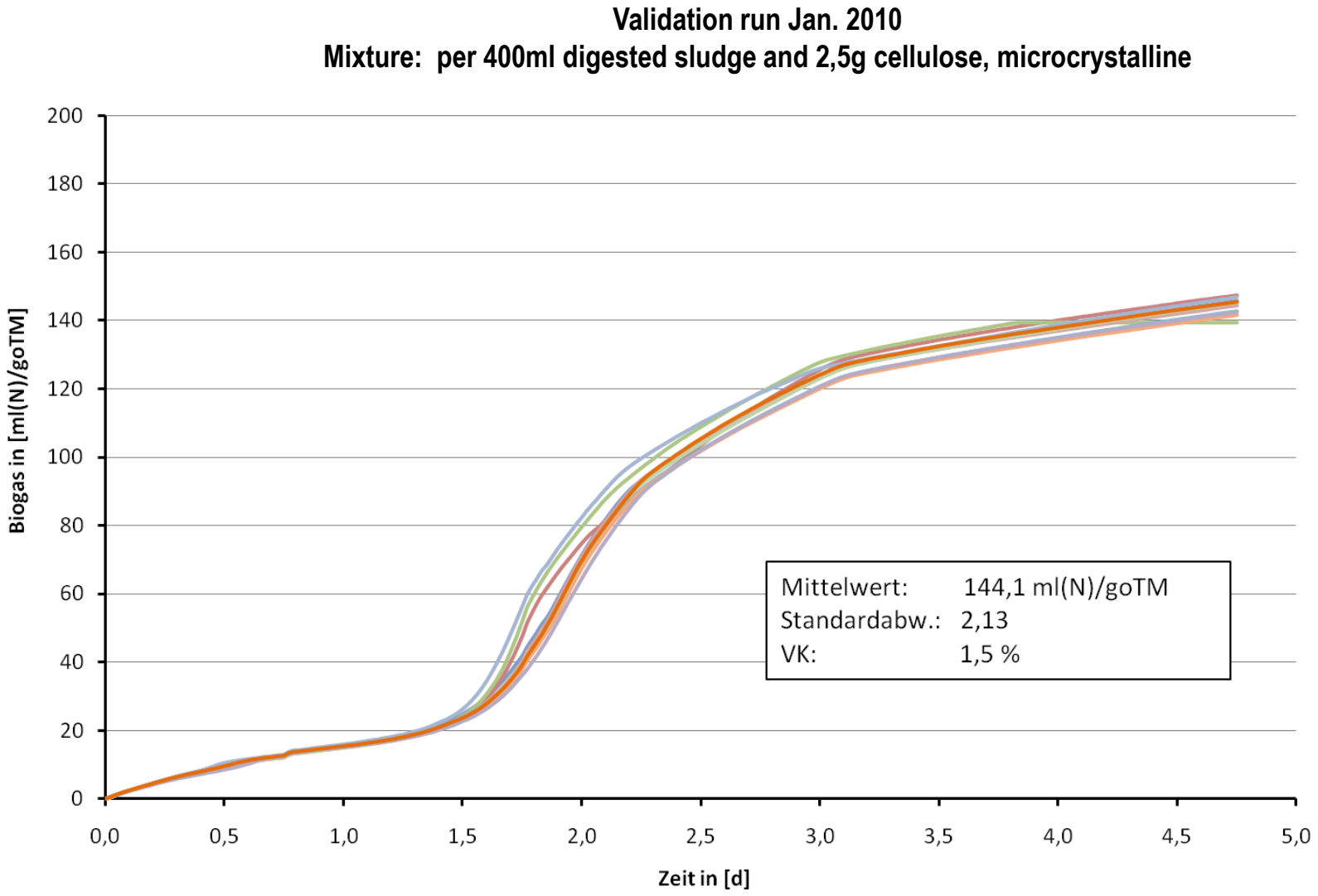
For the experimental procedure the fermentor to be is researching taken from a sample of a possible active area (sampling adapter, if any, circulatingg, ggf. overflow to digestate storage…)

Initial weight per fermentation vessel (500 ml volumen) : 200 … 400 g fermenter probe bzw. 15 g oDM, ggf. dilution (with VE-water)

In addition to BLANK (only Fermenter content) a control experiment (with standard substrate) and any attempts at treatment applied.(n=3)

Recording intervall 30 min. ; once a day homogenization of contents of the fermentation vessel using magnetic stirrer.

Development of the test procedure



Development of the test procedure

Analysis and interpretation of data

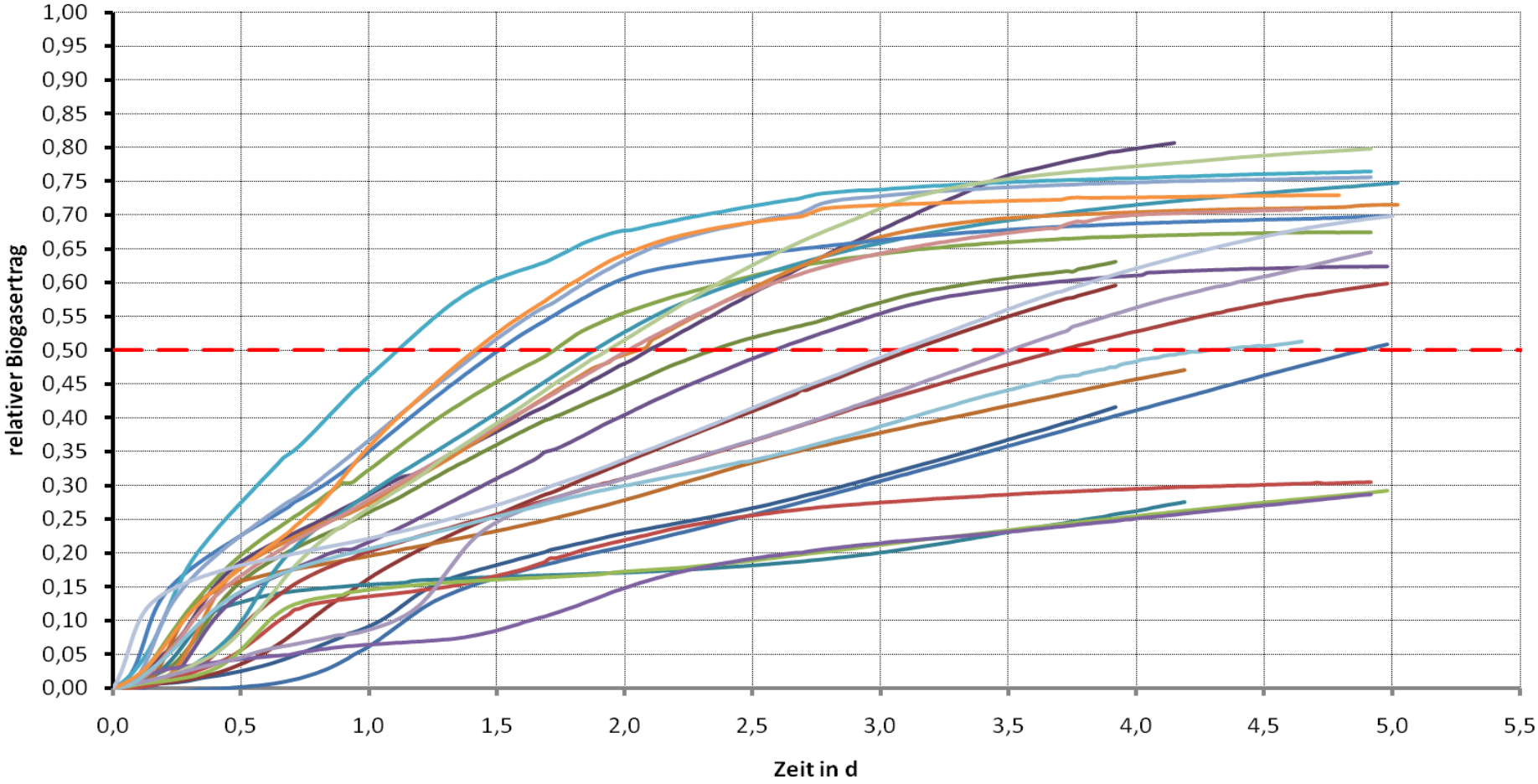
Test period : 5 bis 10 d

Presentation of results: Gas volume s (in l(N)/kg_{oDM}) to the theoretical maximum Gas production potential of the standard substrate (calculated by BUSWELL)

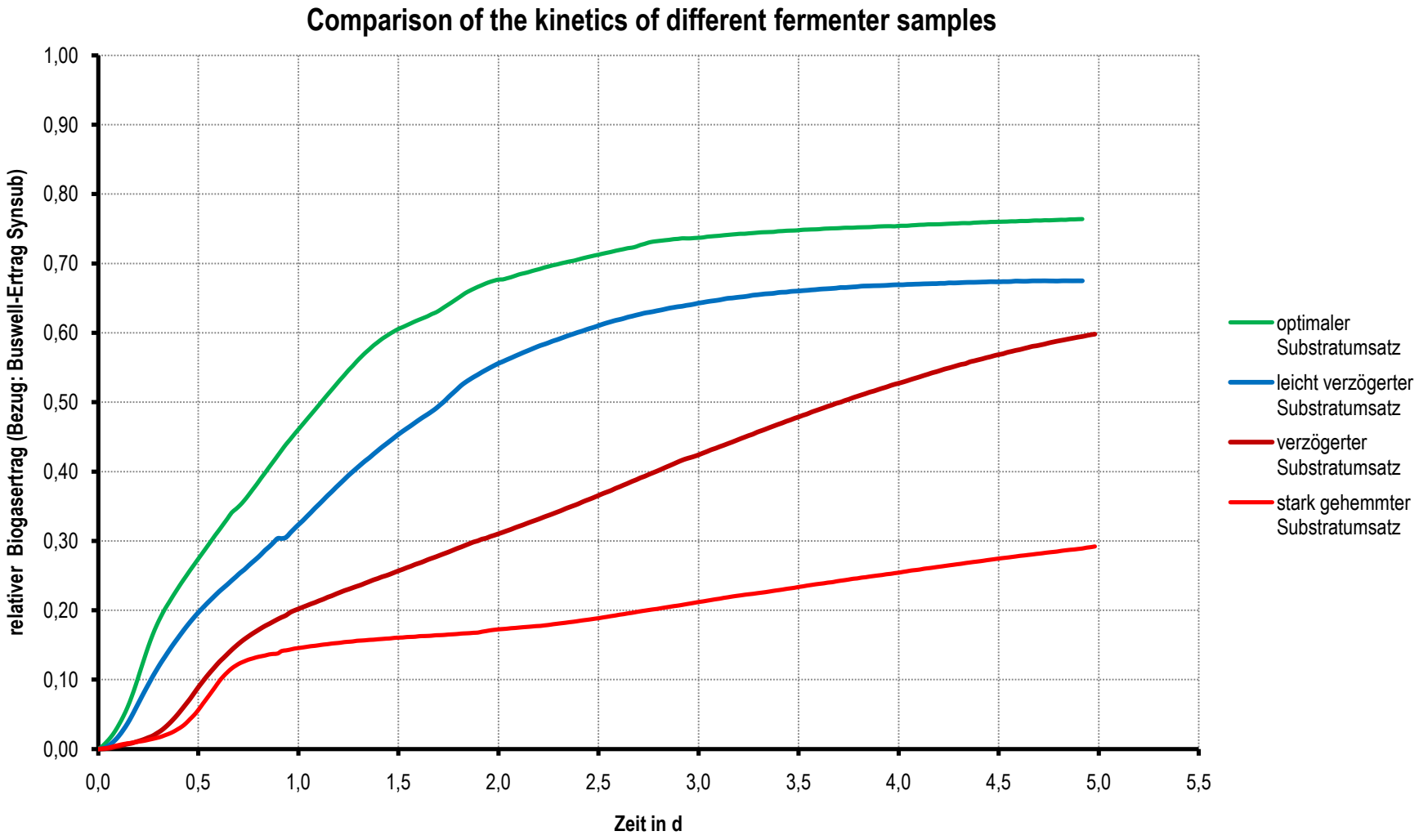
Representation is a time-curve.

For comparison of different fermentation samples, the first criterion to be used as a time t_{50}, which is required to achieve 50% of the theoretical biogas yield. Quantify the performance degradation using mathematical models is provided as the project continues.

Development of the test procedure

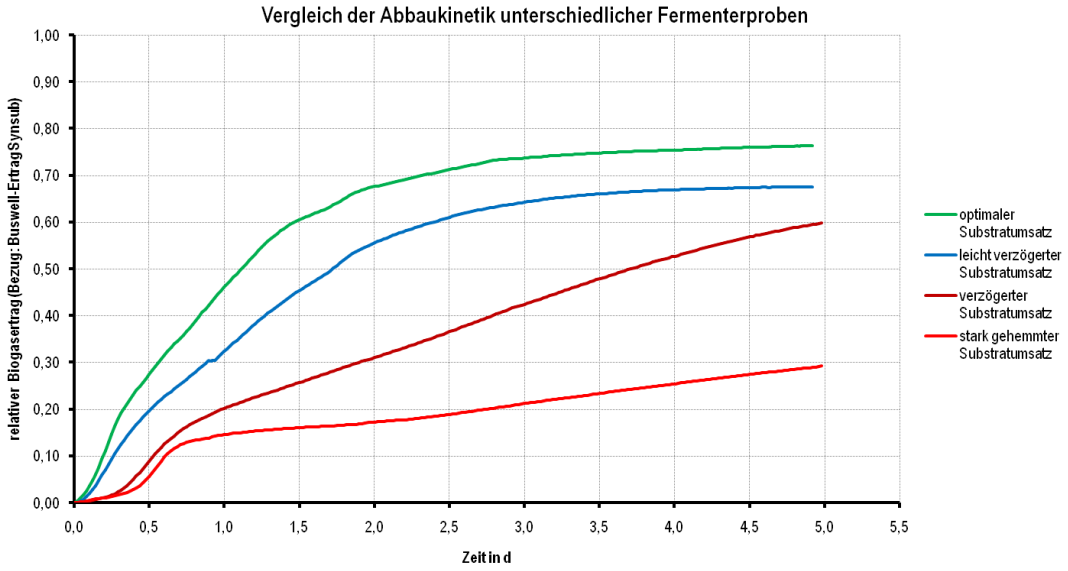


First results and perspective



First results and perspective

Example: Substrate conversion and trace elements supply



The fermenter sample Nr. 4 (strongly inhibited substrate degradation) shows in almost all trace elements examined, the lowest concentrations.

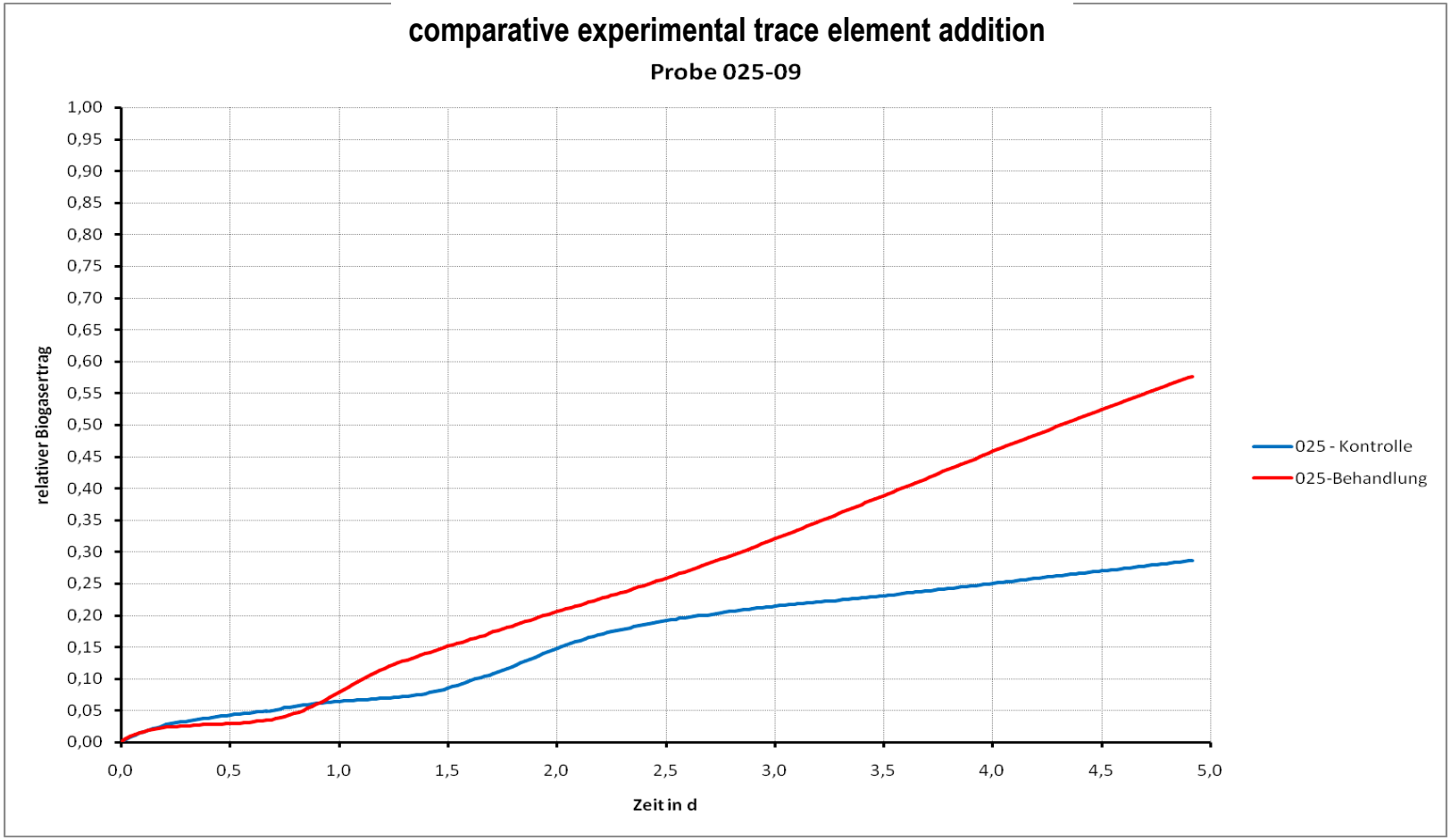
Trace element deficiency?

(Color table: Comparison of the four shown in the diagram fermenter samples.)

	mg/kgTM									
Probe	**Cu**	**Ni**	**Zn**	**Fe**	**Bor**	**Co**	**Mn**	**Mo**	**Se**	**W**
1	129,13	9,99	342,68	5688,0	21,51	1,95	733,83	3,65	0,46	2,24
2	213,43	7,80	166,97	2371,0	28,42	1,63	248,23	4,33	0,55	0,91
3	184,55	6,01	686,83	1006,0	41,91	2,03	327,30	4,38	1,12	3,87
4	18,00	3,70	127,30	1504,5	13,30	0,40	285,90	2,10	0,58	0,70

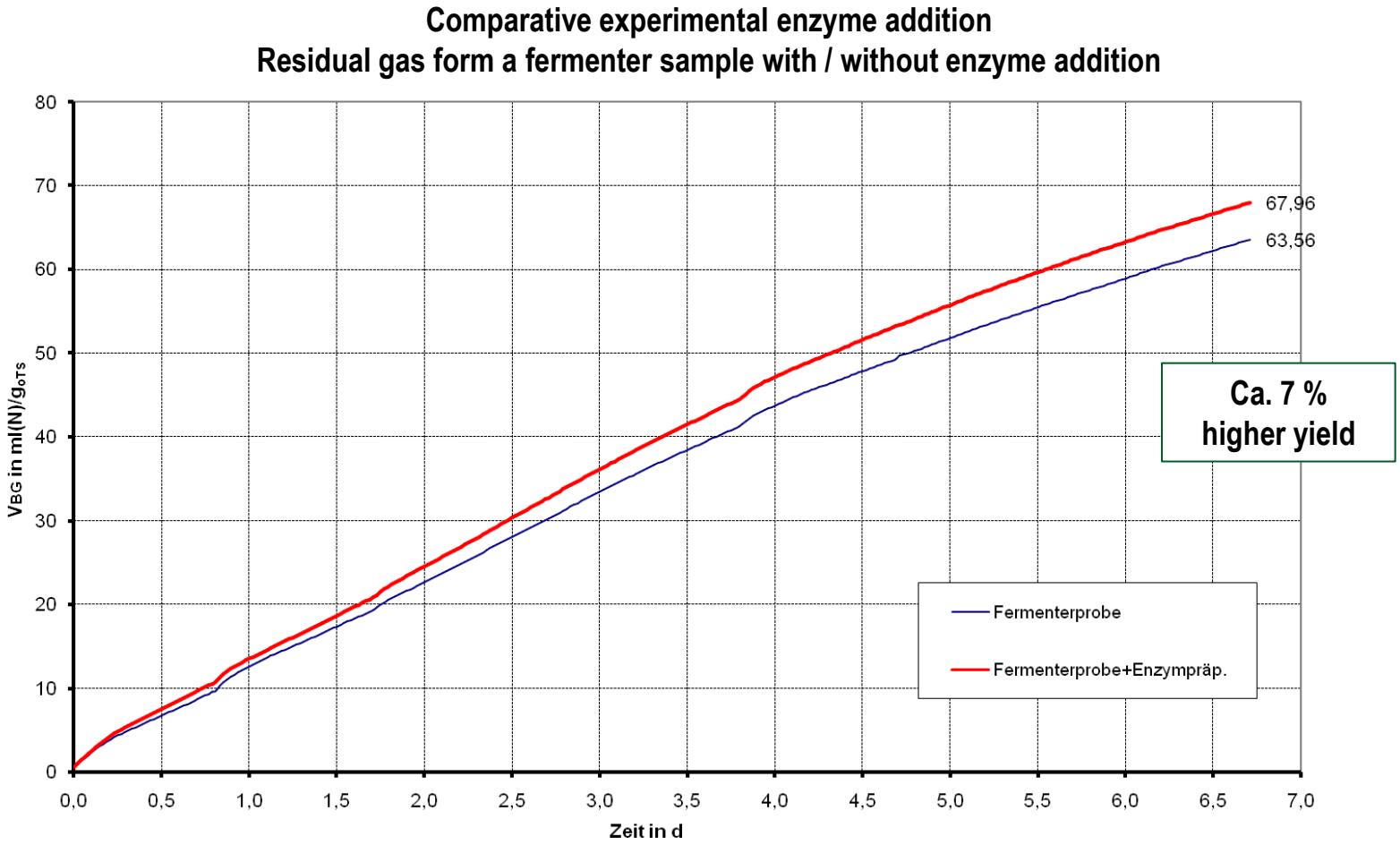
First results and perspective

Evaluation of effects of fermentation aids



First results and perspective

Evaluation of effects of fermentation aids



First results and perspective

Assessing the effect of inhibitors

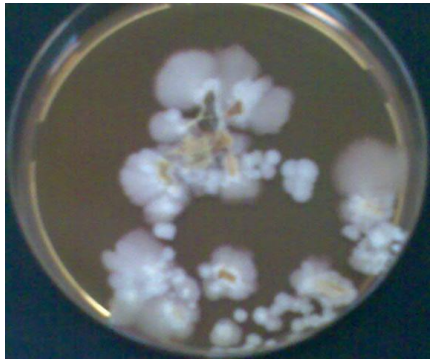
Objective of the experiment:

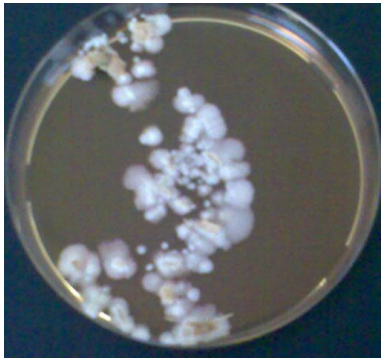
- Evaluate the impact of massive fungal infection on the kinetics of fermentation of corn silage

Preparation:

- Corn silage was stored in air influence, to clear fungi can be seen (image)
- In the activity test comparison with the original material without fungi
- Smear on special fungi-agar, morphological investigation is still pending

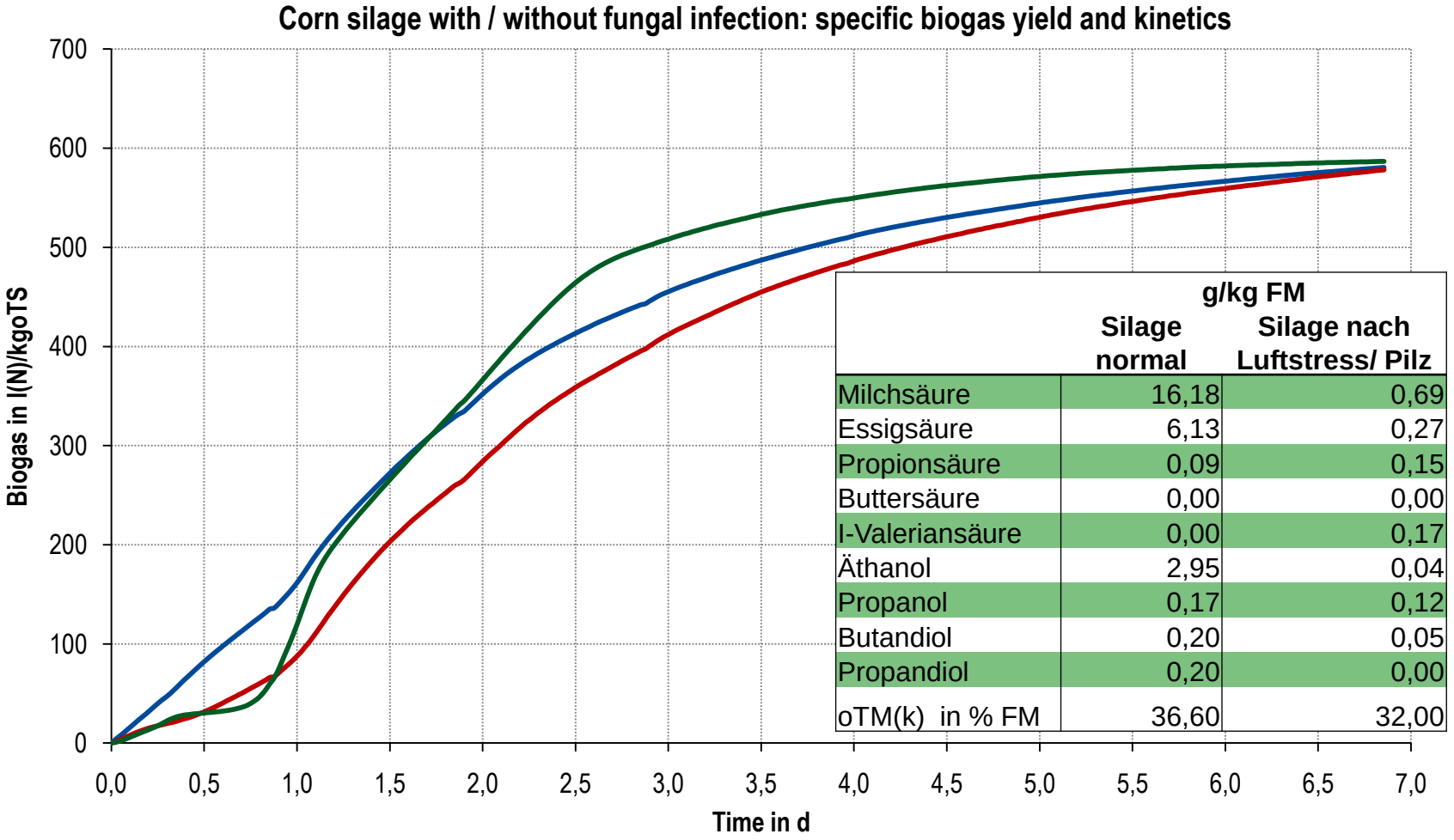
Silage with fungal infection after air stress (top)





Smear on fungi-agar (left)

First results and perspective



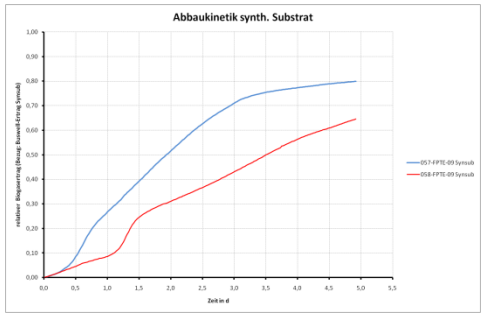
	g/kg FM	
	Silage normal	Silage nach Luftstress/ Pilz
Milchsäure	16,18	0,69
Essigsäure	6,13	0,27
Propionsäure	0,09	0,15
Buttersäure	0,00	0,00
I-Valeriansäure	0,00	0,17
Äthanol	2,95	0,04
Propanol	0,17	0,12
Butandiol	0,20	0,05
Propandiol	0,20	0,00
oTM(k) in % FM	36,60	32,00

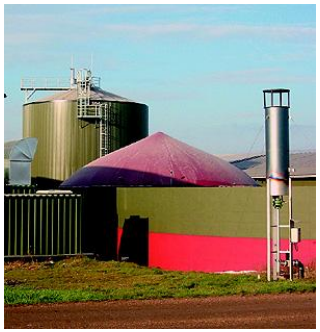
First results and perspective

Current research projects

In the current research project is to test the activity developed and used for detailed investigations of the supply of NaWaRo-biogas digesters with trace elements.

As part of the project, a screening system based on the activity tests carried out and completed with studies on the supply of the fermenter biology with essential trace elements.





Project partners and promotion

Fraunhofer Institut für Umwelt- Sicherheits- und Energietechnik UMSICHT, Oberhausen

Fraunhofer UMSICHT

HAWK HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFT UND KUNST
University of Applied Sciences and Arts

HAWK Fachhochschule Göttingen
Fakultät Ressourcenmanagement,
Fachgebiet NEUTec

Universität Rostock
Agrar- und Umweltwissenschaftliche Fakultät
Institut für Umweltingenieurwesen
Lehrstuhl Abfall- und Stoffstromwirtschaft

Universität Rostock

The IGF-project 16 103 BG Research Association Association for the Promotion of Energy and Environmental Technology-TEU, Bliersheimer Straße 60, 47229 Duisburg was the AIF under the program to promote industrial research and development (IGF) of the Federal Ministry of Economics and Technology based on a decision of the German Bundestag encouraged.

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Vielen Dank für Ihre Aufmerksamkeit !

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