VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

FACULTY OF ENVIRONMENTAL ENGINEERING

DEPERTMENT OF ENVIRONMENTAL PROTECTION AND WATER ENGINEERING

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RESEARCH OF DIGESTION OF COW MANURE AND CHICKEN DUNG MIXTURE WITH DIFFERENT ADDITIVES

REPORT

Vilnius, 2025

CONTENT

1. Methodology of the Test

Two reactors of 16 l effective volume each will be used for continuous flow test.

Substrate is a mixture of cow manure and chicken dung without bedding (egg laying).

The proportion of cow manure to chicken dung should be in the range of 70% / 30% by DS.

It is recommended to use digested sludge from WWTP as inoculum to start the anaerobic process immediately. The mixture will be mixed with the inoculum in a ratio of 5:1 based on VSs. From the experience, it was decided that such an amount of inoculum is enough to start the digestion process immediately.

Selected dilution to make the mixture of 7–10 % of DS.

The test is divided into three stages:

1. In the stage I, the first reactor contains raw materials without additives, and the second reactor contain raw materials with BC.Atox Scon 261467 (FeOOH).
2. In the stage II, the first reactor contains raw materials with SBGx Plus, and the second reactor contain raw materials with SBGx.
3. In the stage II, the first reactor contains raw materials with BC.Atox Scon 261467 (FeOOH), and the second reactor contain raw materials with SBGx Plus.

Selected a single dose of additives: 0,2 kg/kg of DS.
Duration of one stage is at least 34 days.
The duration of the test is at least 2 x 34 = 68 days.
Other conditions:

1. Retention time is 30 d.
2. Mesophilic mode: 37–38 °C.
3. pH = 7,0–7,6.
4. Simulation of the CSTR digester where mixing/settlement: 15 minutes / 45 minutes.

Two reactors will be loaded with the mixture of cow manure, chicken dung and digested sludge from Vilnius WWTP as inoculum. Data for loading of reactors is presented in the Table 1.1.

Table 1.1. Data for loading of reactors

	Mass, kg	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	4,040	18,4	87,8	0,743	55,2%	0,652	67,7%
Chicken dung	0,625	50,9	47,5	0,318	23,6%	0,151	15,7%
Digested sludge	6,500	4,4	56,1	0,286	21,2%	0,160	16,6%
Additive	0,269						
Water	5,50						
	16,93	**8,0**	**71,5**	**1,347**	**100,0%**	**0,963**	**100,0%**

After the loading of reactors, the new substrate will be started to supply to the reactors after 4 days. The substrate will be prepared for 10–11 days loading, 6 times/test. Data for 10 days loading of substrate is presented in the Table 1.2.

Table 1.2. Data for 10 days loading of mixture

	Mass, kg	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	1,738	18,4	87,8	0,320	70,0%	0,281	81,2%
Chicken dung	0,269	50,9	47,5	0,137	30,0%	0,065	18,8%
Additive	0,091						
Water	3,600						
	5,70	**8,0**	**75,7**	**0,457**	**100,0%**	**0,346**	**100,0%**

Daily mixture loading: 15,5 l/ 30 d= 0,52 l/d to each reactor. Prepared substrate is stored in refrigerator at 4 °C temperature. Before daily loading a portion of the substrate is heated to 20–25 °C.

Demand of raw materials for preparation of substrate is presented in the Table 1.3.

Table 1.3. Demand of raw materials for preparation of substrate

Parameter	Units	For start up	For 60 days	**Total**
Cow manure	kg	8,08	20,9	29,0
Chicken dung	kg	1,3	3,228	4,5
Digested sludge	kg	13,0	0	13
Additive	kg	0,27	0,546	0,8
Water	kg	11,0	43,2	54,2

Measured parameters

- DS concentration in the substrate and the digested substrates is determined according to EN 15934:2012 (every second day of the test).
- VS concentration in the substrate and the digested substrates is determined according to EN 12880:2002 (every second day of the test).
- pH in the substrate and the digested substrates is measured with pH-meter WTW inolab series 720 (according to possibilities every day of the test).
- Conductivity in the substrate and the digested substrates is measured with device WTW Cond 315i (according to possibilities every day of the test).
- Ammonium nitrogen in the substrate and the digested substrates is determined according to ISO/TS 14256-1:2003 (9 times/test).
- Biogas production rate is measured according to produced volume of biogas (according to possibilities 2 times/day).
- Biogas composition (CH_4, %, H_2S, ppm) is measured with the gas composition analyser GasData series GFM 406 (according to possibilities 1 time/day).

2. Actual Loading of Reactors

2.1 Loading of the Reactors on 2024-10-30 (Stage I)

Loading of reactor No. 1 based on calculated data is presented in the Table 2.1 and loading of reactor No. 2 based on calculated data is presented in the Table 2.2.

Table 2.1. Loading of reactor No. 1 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	3,98	3,16	18,4	87,8	0,732	55%	0,643	67,7%
Chicken dung	0,62	0,53	50,9	47,5	0,314	24%	0,149	15,7%
Digested sludge	6,40	6,40	4,4	56,1	0,282	21%	0,158	16,6%
Water	5,40	5,40						
	16,4	**15,5**	**8,6**	**71,5**	**1,328**	**100,0%**	**0,95**	**100,0%**

Measured DS without additive is 8,2 % or 82 g DS/l, measured VS without additive is 72,9 %, and 59,9 g VS/l.

Table 2.2. Loading of reactor No. 2 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	3,98	3,16	18,4	87,8	0,732	45,9%	0,643	67,7%
Chicken dung	0,62	0,53	50,9	47,5	0,314	19,7%	0,149	15,7%
Digested sludge	6,40	6,40	4,4	56,1	0,282	17,7%	0,158	16,6%
FeOOH	0,266	0,40			0,266	16,7%		
Water	5,40	5,40						
	16,7	**15,9**	**10,0**	**59,6**	**1,594**	**100,0%**	**0,95**	**100,0%**

Measured DS with additive is 9,7 % or 97 g DS/l, measured VS with additive is 64,0 %, and 62 g VS/l.

2.2 Daily Loading of Reactors from 2024-11-04 to 2024-12-04 (Stage I)

The proportion of cow manure to chicken dung is in the range of 70% / 30% by DS. Prepared mixture based on calculated data is presented in the Table 2.3.

Table 2.3. Prepared mixture based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	1,901	1,51	18,4	87,8	0,35	70,0%	0,307	81,2%
Chicken dung	0,294	0,25	50,9	47,5	0,15	30,0%	0,071	18,8%
Water	3,95	3,95						
	6,25	**5,71**	**8,8**	**71,5**	**0,50**	**100,0%**	**0,378**	**100,0%**

Daily loading of substrate is 15,5 l/ 30 d= 0,52 l/d to each reactor. Prepared amount of substrate for 5,71 l/ 0,52l/d = 11 d. Dose of additive is 0,2 kg/kg of DS. So, 0,50 kg DS / 11 d x 0,2 kg/kg DS x 1000 = 9,1 g of FeOOH/d is added into the daily portion of substrate to be loaded to reactor No. 2.

Prepared substrate is stored in the refrigerator at 4 °C temperature. Before daily loading, a portion of the substrate is heated up to 25–30 °C.

2.3 Loading of the Reactors on 2024-12-04 (Stage II)

Loading of reactor No. 1 based on calculated data is presented in the Table 2.4 and loading of reactor No. 2 based on calculated data is presented in the Table 2.5.

Table 2.4. Loading of reactor No. 1 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	4,23	3,35	17,3	88,7	0,731	45,8%	0,648	67,7%
Chicken dung	0,61	0,53	50,9	47,5	0,313	19,6%	0,149	15,6%
Digested sludge	6,48	6,48	4,4	56,1	0,285	17,9%	0,160	16,7%
SBGx Plus	0,27	0,20			0,266	16,7%		
Water	5,20	5,20						
	16,8	**15,8**	**10,1**	**60,0**	**1,595**	**100,0%**	**0,957**	**100,0%**

Measured DS with SBGx Plus additive is 9,9 % or 99 g DS/l, measured VS with SBGx Plus additive is 62,4 %, and 62 g VS/l.

Table 2.5. Loading of reactor No. 2 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	4,23	3,35	17,3	88,7	0,731	45,8%	0,648	67,7%
Chicken dung	0,61	0,53	50,9	47,5	0,313	19,6%	0,149	15,6%
Digested sludge	6,48	6,48	4,4	56,1	0,285	17,9%	0,160	16,7%
SBGx	0,27	0,20			0,266	16,7%		
Water	5,20	5,20						
	16,8	**15,8**	**10,1**	**60,0**	**1,595**	**100,0%**	**0,957**	**100,0%**

Measured DS with SBGx additive is 9,9 % or 99 g DS/l, measured VS with SBGx additive is 61,8 %, and 61 g VS/l.

2.4 Daily Loading of Reactors from 2024-12-09 to 2025-01-08 (Stage II)

The proportion of cow manure to chicken dung is in the range of 70% / 30% by DS. Prepared mixture based on calculated data is presented in the Table 2.6.

Table 2.6. Prepared mixture based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	1,970	1,713	17,3	88,7	0,34	70,0%	0,302	81,4%
Chicken dung	0,287	0,271	50,9	47,5	0,15	30,0%	0,069	18,6%
Water	3,85	3,85						
	6,20	**5,83**	**8,4**	**76,2**	**0,49**	**100,0%**	**0,371**	**100,0%**

Daily loading of substrate is 15,8 l/ 30 d= 0,53 l/d to each reactor. Prepared amount of substrate for 5,83 l/ 0,53l/d = 11 d. Dose of additive is 0,2 kg/kg of DS. So, 0,49 kg DS / 11 d x 0,2 kg/kg DS x 1000 = 8,9 g of SBGx Plus/d is added into the daily portion of substrate to be loaded to reactor No. 1, and 8,9 g of SBGx/d is added into the daily portion of substrate to be loaded to reactor No. 2.

Preparation of substrate for daily loading is presented in Figure 2.1.

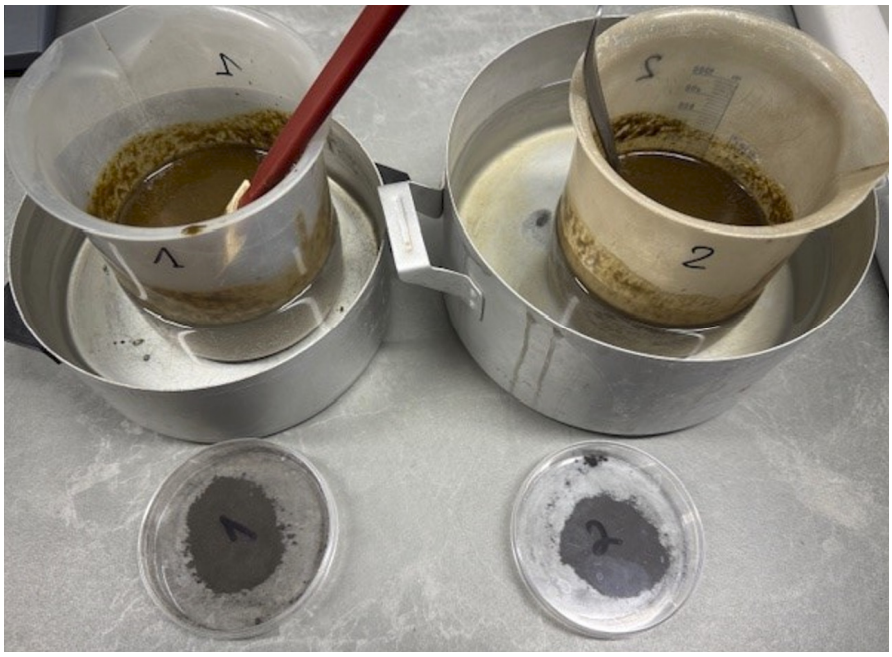

Figure 2.1. Preparation of substrate for daily loading

Prepared substrate is stored in the refrigerator at 4 °C temperature. Before daily loading, a portion of the substrate is heated up to 25–30 °C.

2.5 Loading of the Reactors on 2025-01-08 (Stage III)

Loading of reactor No. 1 based on calculated data is presented in the Table 2.7 and loading of reactor No. 2 based on calculated data is presented in the Table 2.8.

Table 2.7. Loading of reactor No. 1 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	4,23	3,92	17,3	88,7	0,732	44,7%	0,649	67,9%
Chicken dung	0,61	0,61	50,9	47,5	0,310	18,9%	0,147	15,4%
Digested substrate	4,18	4,18	7,8	49,0	0,326	19,9%	0,160	16,7%
FeOOH	0,27	0,34			0,270	16,5%		
Water	6,90	6,90						
	16,2	**15,95**	**10,3**	**58,4**	**1,638**	**100,0%**	**0,956**	**100,0%**

Measured DS with FeOOH additive is 9,8 % or 98 g DS/l, measured VS with FeOOH additive is 63,2 %, and 62 g VS/l.

Table 2.8. Loading of reactor No. 2 based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	4,23	3,92	17,3	88,7	0,732	44,7%	0,649	67,9%
Chicken dung	0,61	0,61	50,9	47,5	0,310	18,9%	0,147	15,4%
Digested substrate	4,18	4,18	7,8	49,0	0,326	19,9%	0,160	16,7%
SBGx Plus	0,27	0,19			0,270	16,5%		
Water	6,90	6,90						
	16,2	**15,8**	**10,4**	**58,4**	**1,638**	**100,0%**	**0,956**	**100,0%**

Measured DS with SBGx Plus additive is 9,9 % or 99 g DS/l, measured VS with SBGx Plus additive is 62,3 %, and 62 g VS/l.

The substrate for loading the reactors was prepared in one volume (Figure 2.2). The substrate was loaded into both reactors, then the additive was dosed: into reactor No. 1 – BC.Atox Scon 261467 (FeOOH), into reactor No. 2 – SBGx Plus. The amount of additive added is indicated in Tables 2.7 and 2.8, and the weighing procedure of additives is presented in Figure 2.3.

Figure 2.2. Prepared substrate for loading of the reactors

Figure 2.3. Weighing procedure of additives

2.6 Daily Loading of Reactors from 2025-01-09 to 2025-02-12 (Stage III)

The proportion of cow manure to chicken dung is in the range of 70% / 30% by DS. Prepared mixture based on calculated data is presented in the Table 2.9.

Table 2.9. Prepared mixture based on calculated data

	Mass, kg	**Volume, l**	**DS, %**	**VS, %**	**DS, kg**	**Part of DS, %**	**VS, kg**	**Part of VS, %**
Cow manure	1,970	1,826	17,3	88,7	0,34	70,0%	0,302	81,4%
Chicken dung	0,287	0,287	50,9	47,5	0,15	30,0%	0,069	18,6%
Water	3,74	3,74						
	6,10	**5,85**	**8,4**	**76,2**	**0,49**	**100,0%**	**0,371**	**100,0%**

Daily loading of substrate to reactor No. 1 is 16,0 l/ 30 d= 0,53 l/d and to reactor No. 2 is 15,8 l/ 30 d= 0,53 l/d. Prepared amount of substrate for 5,85 l/ 0,53l/d = 11 d. Dose of additive is 0,2 kg/kg of DS. So, 0,49 kg DS / 11 d x 0,2 kg/kg DS x 1000 = 8,9 g of FeOOH/d is added into the daily portion of substrate to be loaded to reactor No. 1, and 8,9 g of SBGx Plus/d is added into the daily portion of substrate to be loaded to reactor No. 2.
Preparation of substrate for daily loading is presented in Figure 2.4.

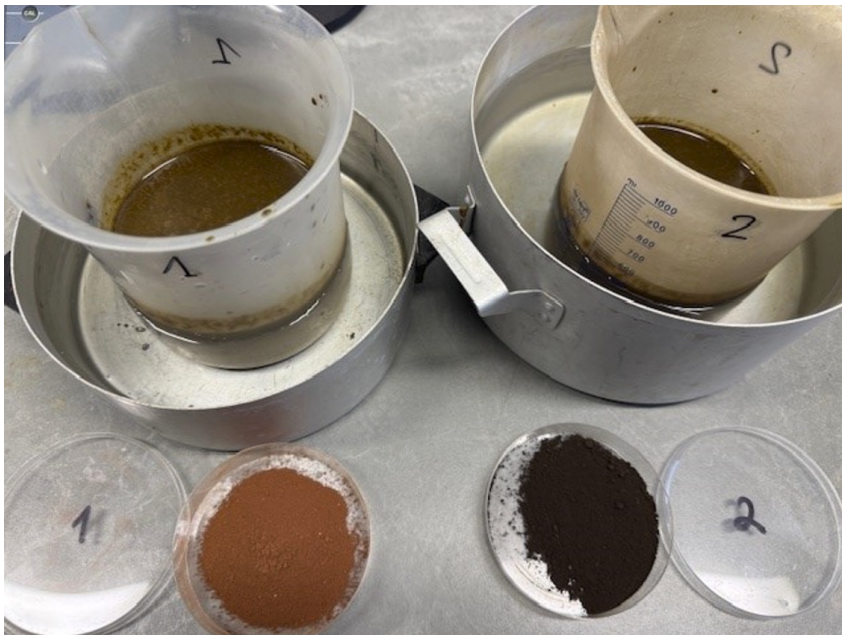

Figure 2.4. Preparation of substrate for daily loading

Prepared substrate is stored in the refrigerator at 4 °C temperature. Before daily loading, a portion of the substrate is heated up to 25–30 °C.

3. Results

3.1 Results of the Stage I (2024-11-04–2024-12-04)

The first reactor (No. 1) contained substrate without additives, and the second reactor (No. 2) contained substrate with BC.Atox Scon 261467 (FeOOH).

3.1.1 Biogas production

As the gasholders rises (Figure 3.1), the pressure changes. Thus, when measuring the volume of biogas, the influence of pressure was evaluated according to the relationship presented in Figure 3.2.

Figure 3.1. The stand with two reactors and two gasholders: 1 – reactor No. 1; 2 – reactor No. 2; 3- gasholder of reactor No. 1; 4 - gasholder of reactor No. 2

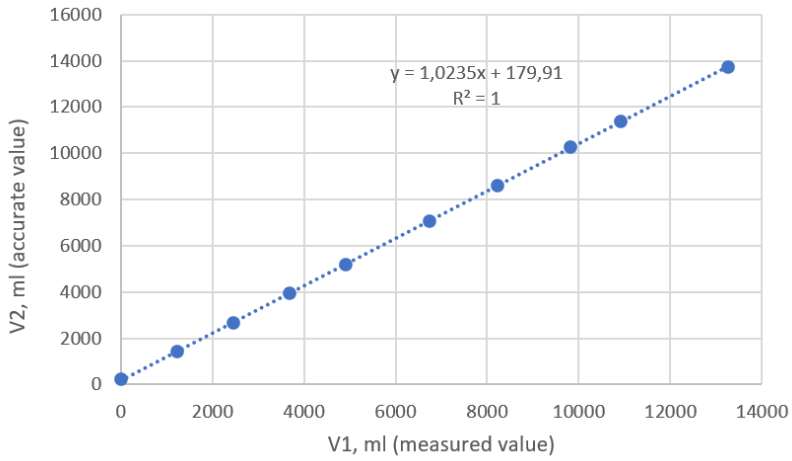

Figure 3.2. Relationship between measured volume and accurate volume

Biogas production and biogas quality are presented in Figures 3.3–3.6, and data on hourly biogas production are provided in Annex 1, clause 1.

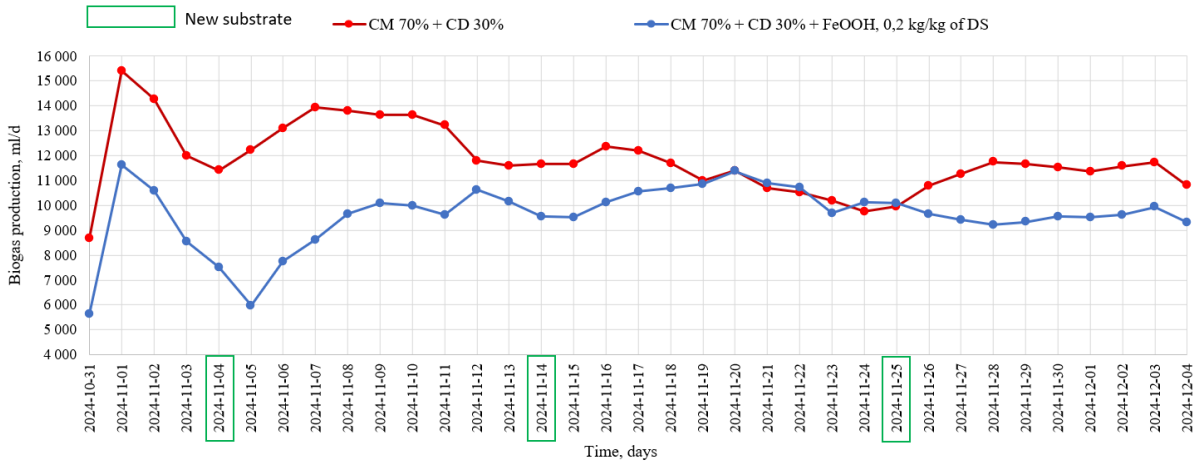

Figure 3.3. Biogas production: CM – cow manure, CD – chicken dung

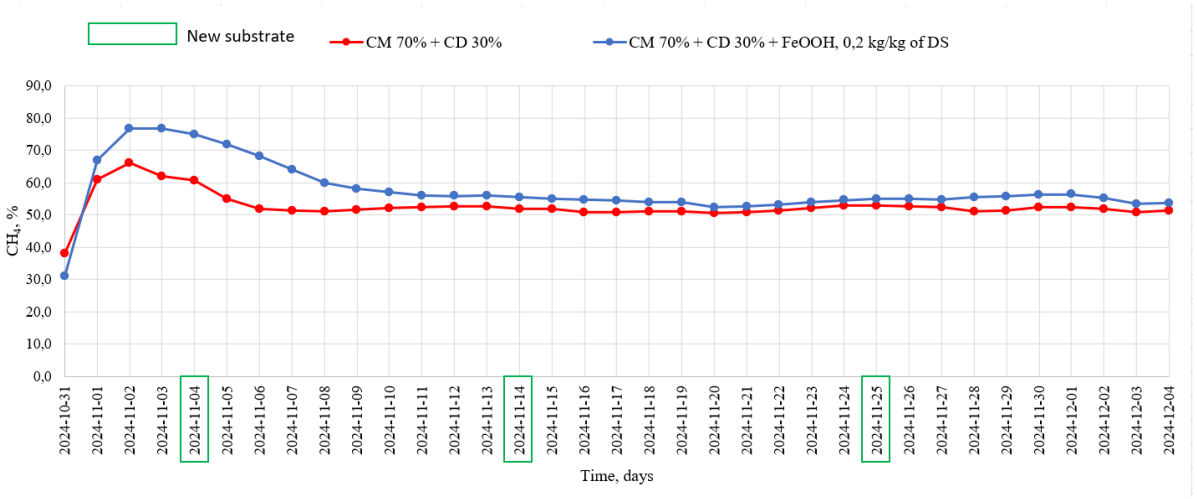

Figure 3.4. Methane content in biogas, Stage I: CM – cow manure, CD – chicken dung

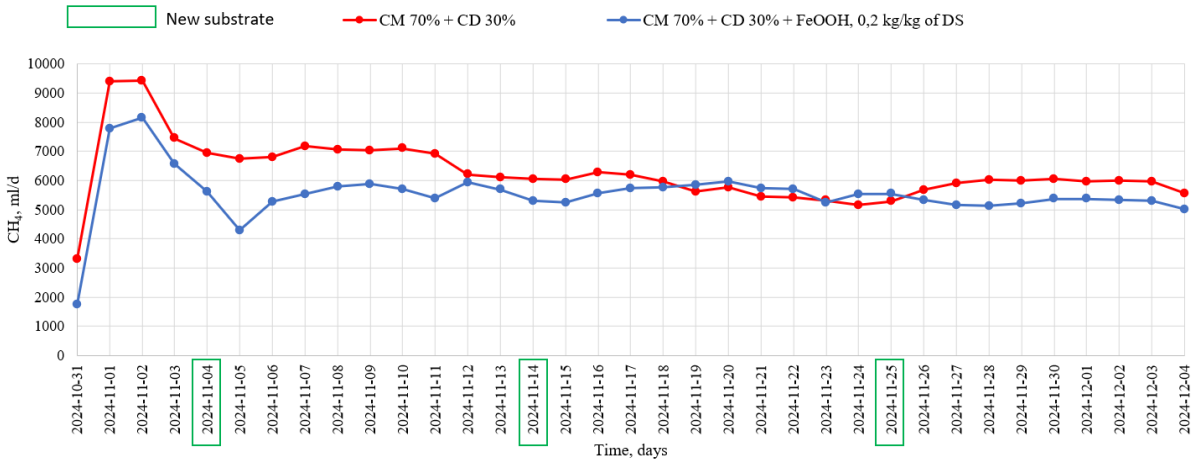

Figure 3.5. Methane production, Stage I: CM – cow manure, CD – chicken dung

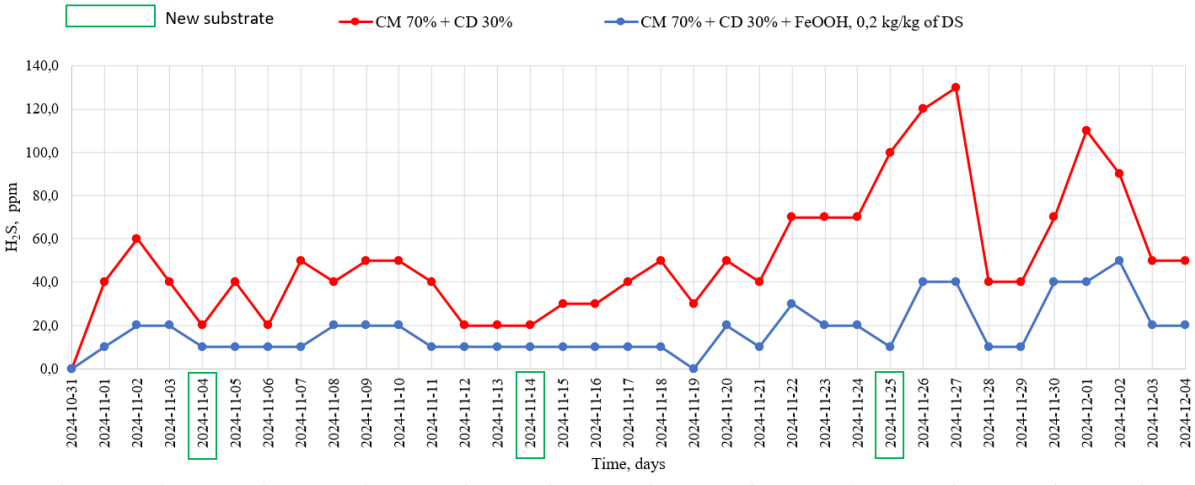

Figure 3.6. Concentration of hydrogen sulphide in biogas, Stage I: CM – cow manure, CD – chicken dung

Biogas production and quality were analysed during the period from 2024-11-04 to 2024-12-04 (31 days), when daily substrate loading into the reactors was performed.

In reactor No. 1, when no additive was used, a total of 364 l of biogas was produced during the analysed period, and in reactor No. 2, when FeOOH additive was used, a total of 300 l of biogas was produced, i.e., 18 % less than in reactor No. 1. The average daily biogas production in reactor No. 1 was 11,8 l/d, and in reactor No. 2 it was 9,7 l/d.

The methane content in biogas from reactor No. 1 was on average 52,1 % (maximum value was 60,8 %), and from reactor No. 2 was on average 56,5% (maximum value was 74,9 %), i.e., 8,4% more than in biogas from reactor No. 1.

The average daily methane production in reactor No. 1 was 6,1 l/d, and in reactor No. 2 it was 5,5 l/d, i.e., 10,7 % less than in reactor No. 1.

The average H_2S concentration in biogas from reactor No. 1 was 52,2 ppm, and in biogas from reactor No. 2 the average H_2S concentration was 18,1 ppm, i.e., 65,3 % less than in biogas from reactor No. 1.

3.1.2 pH Values in the Substrate

Measurement of pH values are presented in Figures 3.7 and 3.8. Values of pH are presented in Figures 3.9 and 3.10, and data on pH values are provided in Annex 1, clause 2.

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Figure 3.7. Measurement of pH value in the digested substrate from reactor No. 1 (2024-11-10)

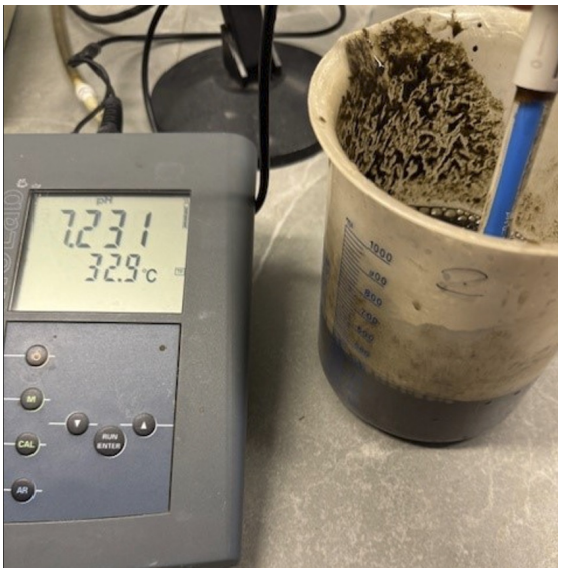

Figure 3.8. Measurement of pH value in the digested substrate from reactor No. 2 (2024-11-10)

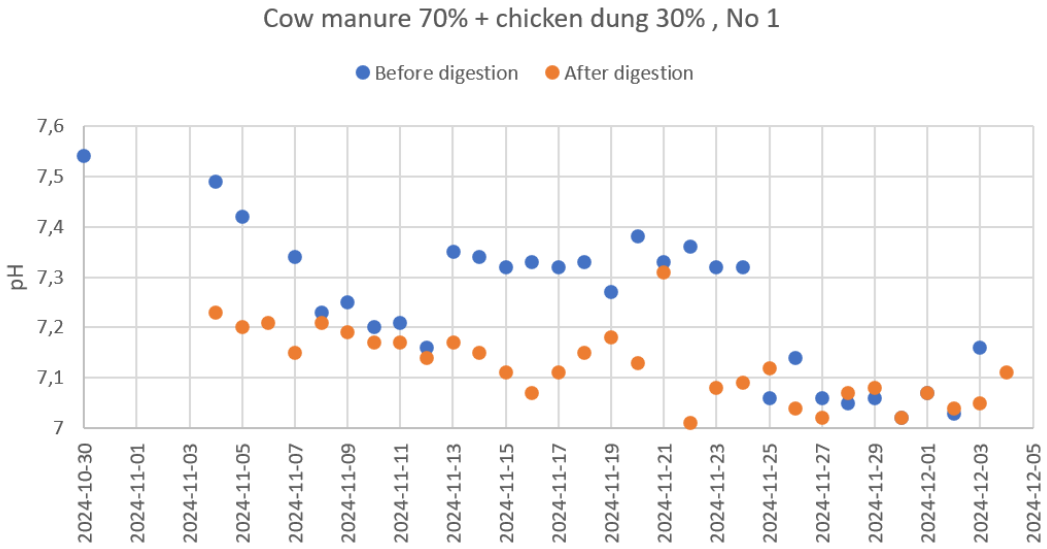

Figure 3.9. pH values of substrate before and after digestion (reactor No. 1, Stage I)

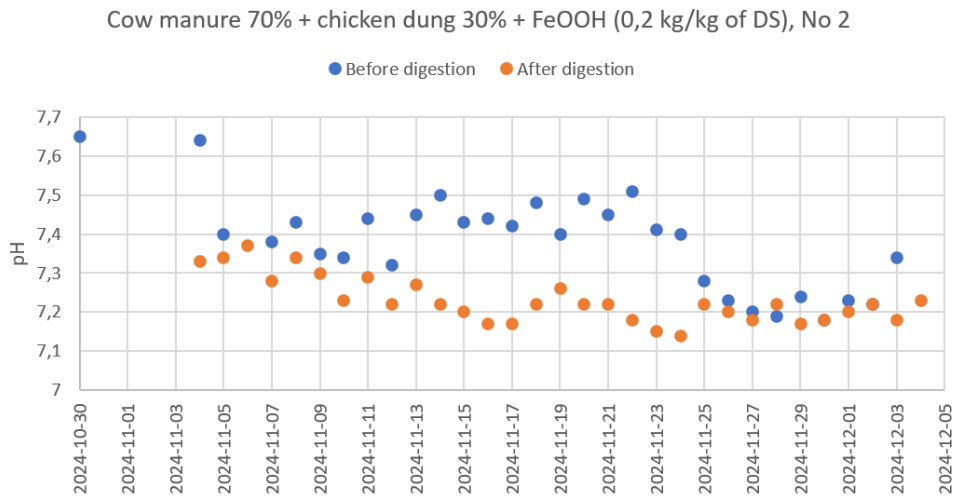

Figure 3.10. pH values of substrate before and after digestion (reactor No. 2, Stage I)

The pH values of the substrate loaded to reactor No. 1 ranged from 7,0 to 7,5, with an average pH value of 7,25. The use of the additive slightly increased the pH values, as the pH values of the substrate loaded to reactor No. 2 ranged from 7,2 to 7,7, with an average pH value of 7,38.

A similar situation was observed after digestion, i.e., the pH values in the digested substrate from reactor No. 2 were slightly higher. The pH values of the substrate unloaded from reactor No. 1 ranged from 7,0 to 7,3, with an average pH value of 7,12. The pH values of the substrate unloaded from reactor No. 2 ranged from 7,1 to 7,4, with an average pH value of 7,23.

The determined pH values show that the substrate digestion environment was suitable in terms of pH for the efficient digestion process.

3.1.3 Conductivity Values in the Substrate

Measurement of conductivity values are presented in Figures 3.11 and 3.12. Values of conductivity are presented in Figures 3.13 and 3.14, and data on conductivity values are provided in Annex 1, clause 3.

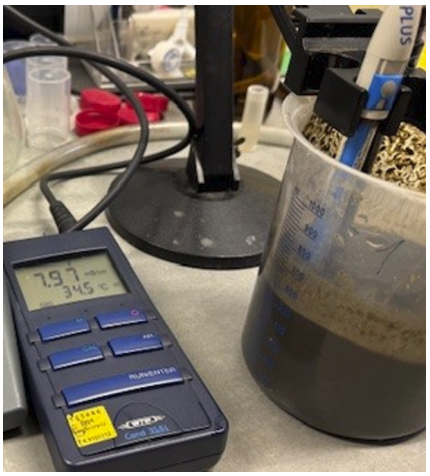

Figure 3.11. Measurement of conductivity value in the digested substrate from reactor No 1 (2024-11-11)

Figure 3.12. Measurement of conductivity value in the digested substrate from reactor No. 2 (2024-11-11)

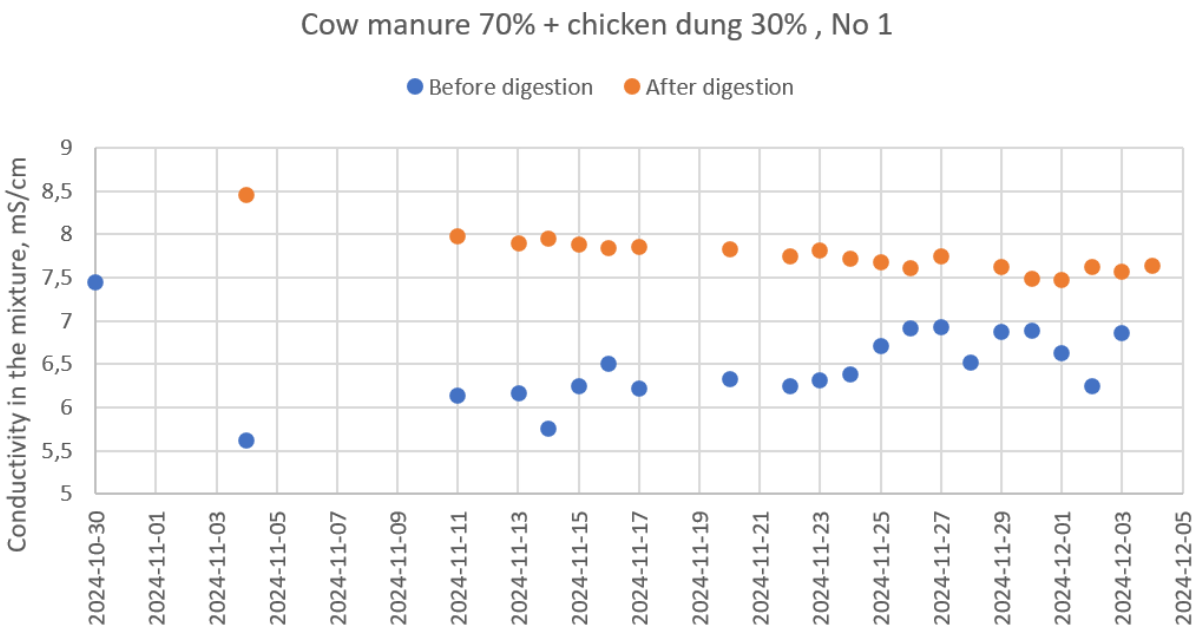

Figure 3.13. Conductivity values of substrate before and after digestion (reactor No. 1, Stage I)

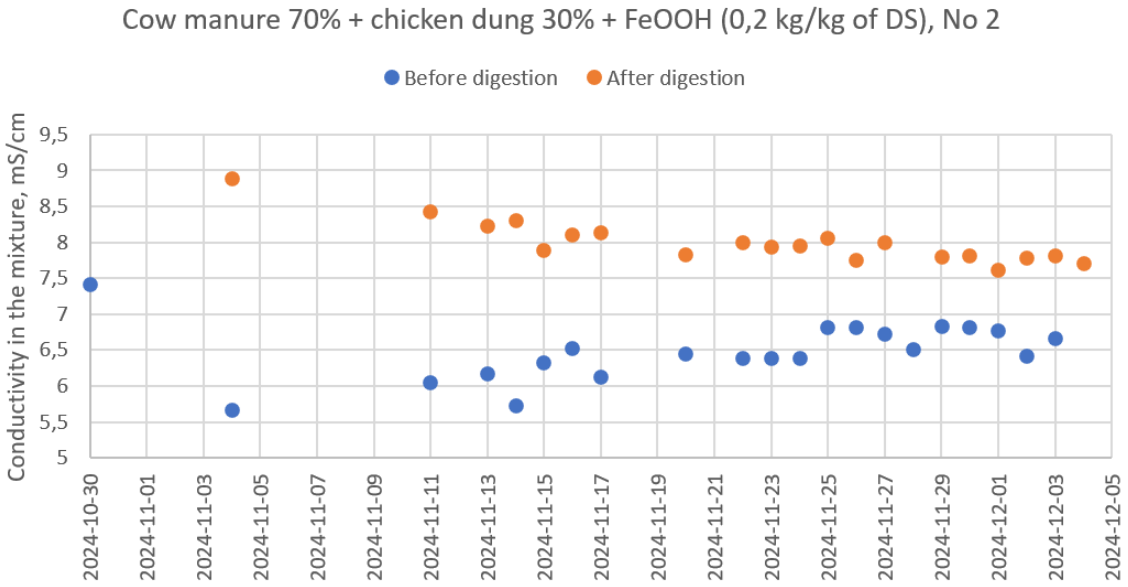

Figure 3.14. Conductivity values of substrate before and after digestion (reactor No. 2, Stage I)

The conductivity values of the substrate loaded to reactor No. 1 ranged from 5,6 to 7,4, with an average conductivity value of 6,5. The use of the additive did not increase the conductivity values, as the conductivity values of the substrate loaded to reactor No. 2 ranged from 5,7 to 7,4, with the same average conductivity value of 6,5.

The conductivity values in the digested substrate from reactor No. 2 were slightly higher. The conductivity values of the substrate unloaded from reactor No. 1 ranged from 7,5 to 8,5, with an average conductivity value of 7,77. The conductivity values of the substrate unloaded from reactor No. 2 ranged from 7,6 to 8,9, with an average conductivity value of 8,0.

3.1.4 Dry Solids and Volatile Solids

Samples of digested substrate from two reactors are presented in Figures 3.15–3.17. Values of dry solids (DS), volatile solids (VS), DS reduction and VS reduction are presented in Figures 3.18–3.23. Data on DS, VS, DS reduction and VS reduction values are provided in Annex 1, clause 4.

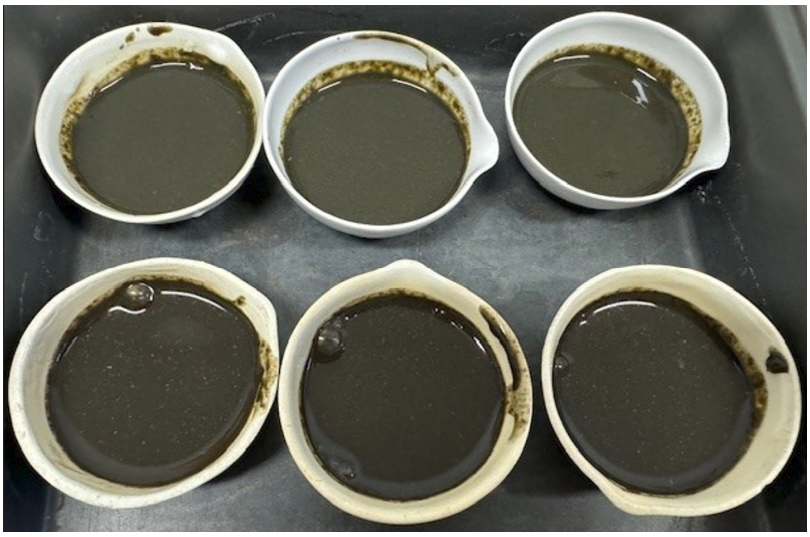

Figure 3.15. Samples of digested substrate from reactor No. 1 (top row) and from reactor No. 2 (bottom row).

Figure 3.16. Samples of digested substrate from reactor No. 1 (top row) and from reactor No. 2 (bottom row) after drying at 105 °C.

Figure 3.17. Samples of digested substrate from reactor No. 1 (top row) and from reactor No. 2 (bottom row) after heating at 550 °C.

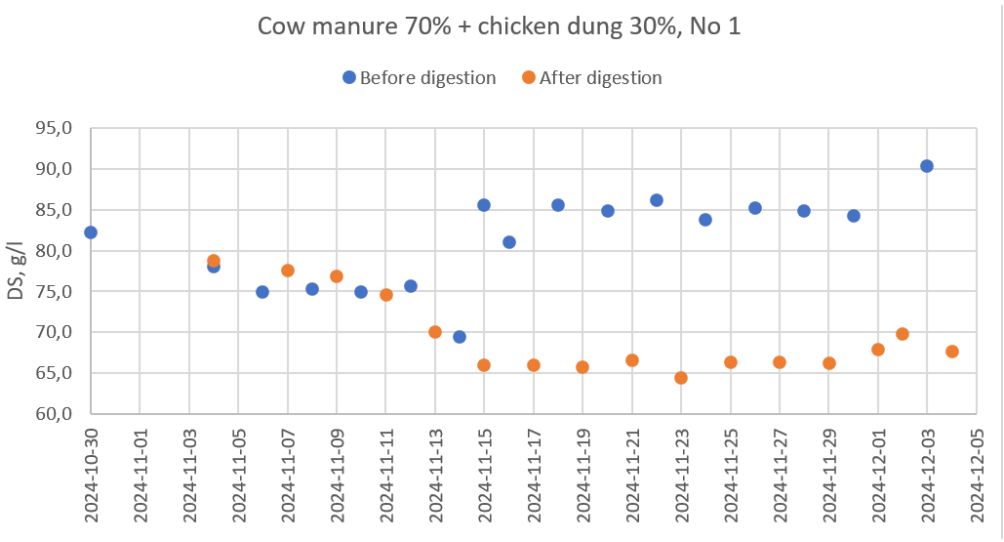

Figure 3.18. DS values of substrate before and after digestion (reactor No. 1, Stage I)

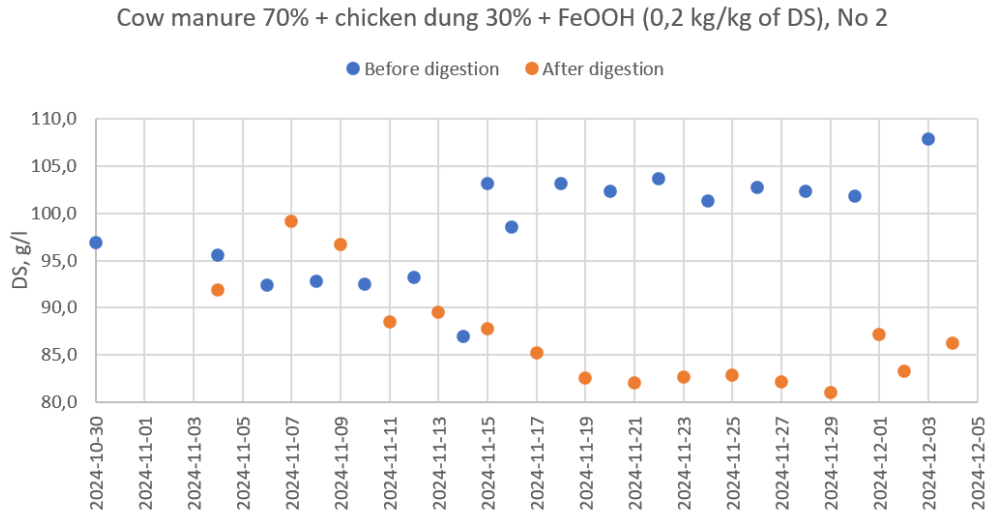

Figure 3.19. DS values of substrate before and after digestion (reactor No. 2, Stage I)

On the third and fifth day from the start of substrate daily loading, the dry matter concentration in the digested substrate from both reactors was from 2 % to 7 % higher than in the loaded substrate. Later, the DS concentration in the digested substrate from both reactors was always lower than in the loaded substrate.

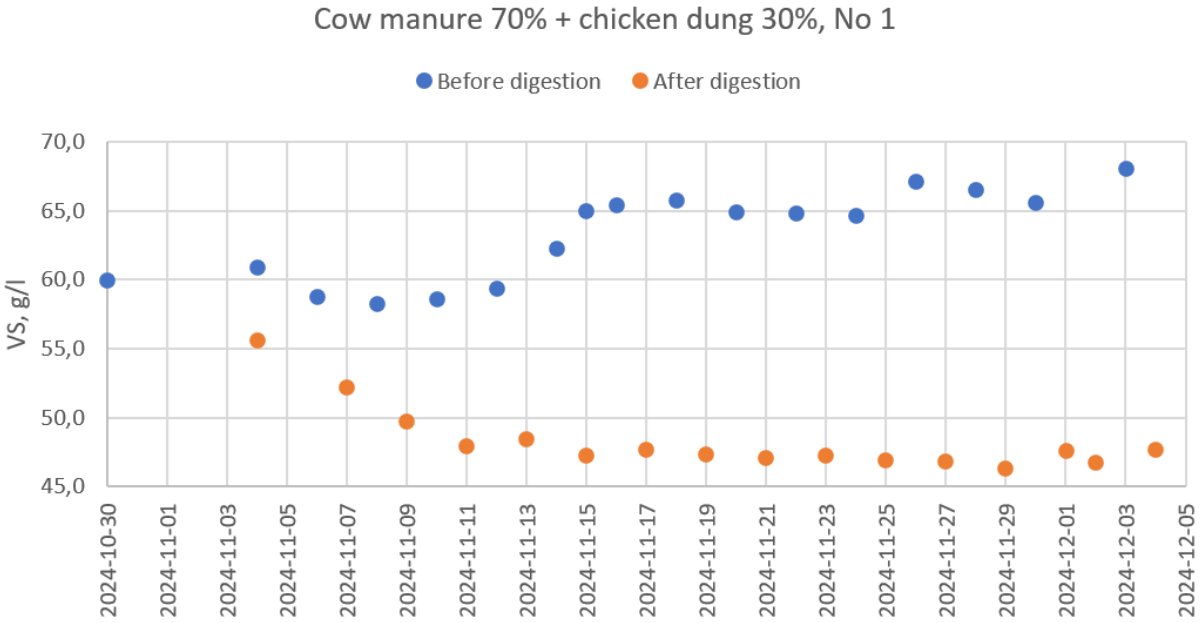

Figure 3.20. VS values of substrate before and after digestion (reactor No. 1, Stage I)

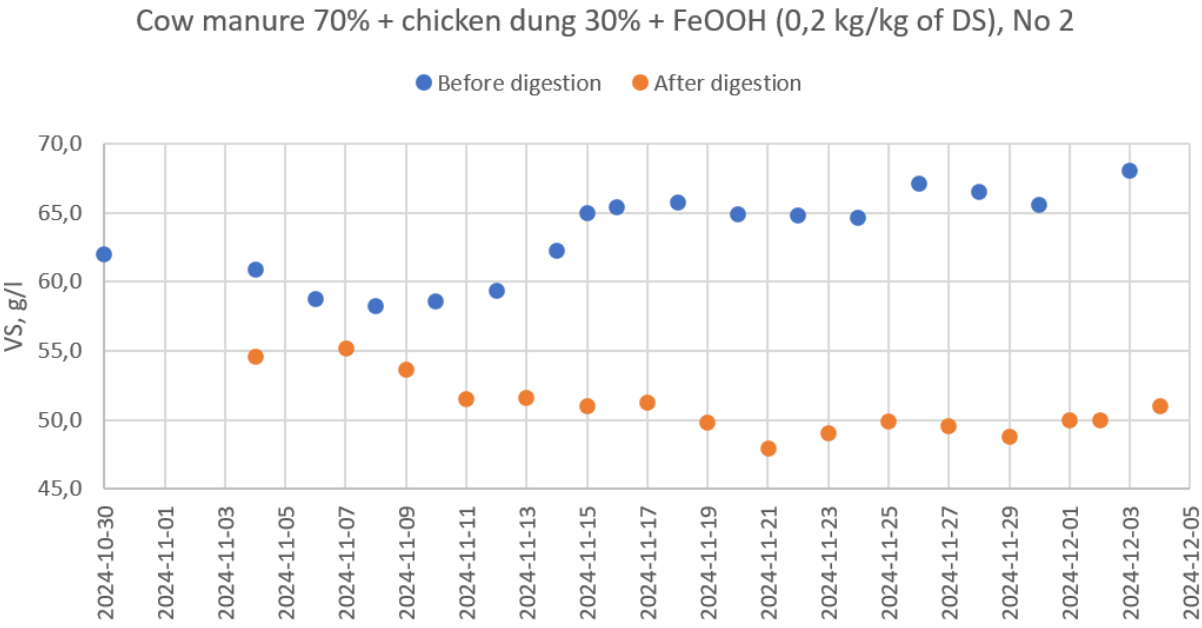

Figure 3.21. VS values of substrate before and after digestion (reactor No. 2, Stage I)

The VS concentration in the digested substrate from both reactors was always lower than in the loaded substrate.

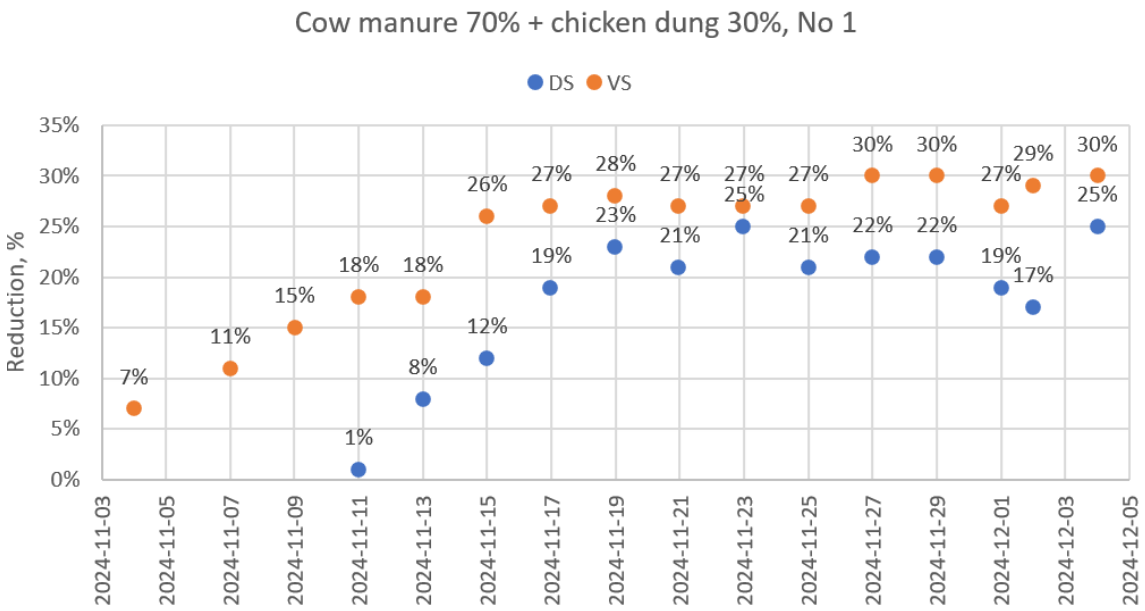

Figure 3.22. Reduction of DS and VS values in substrate from reactor No. 1, Stage I

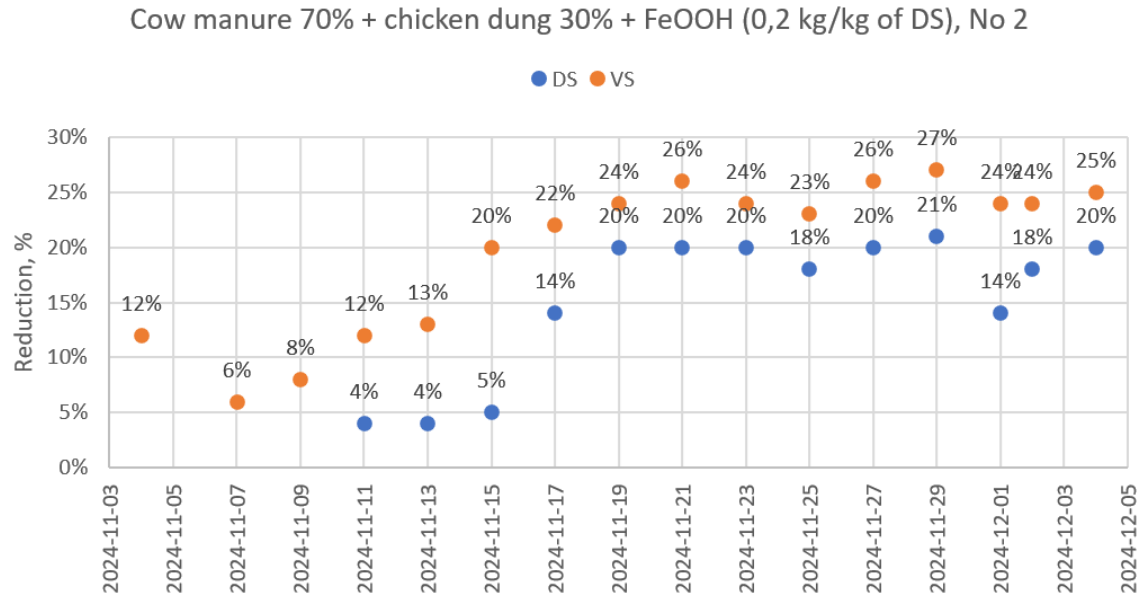

Figure 3.23. Reduction of DS and VS values in substrate from reactor No. 2, Stage I

A more stable DS reduction in both reactors was observed from day 15 after the start of substrate daily loading, and a more stable VS destruction was observed from day 11 after the start of substrate daily loading. Until that time, both DS reduction and VS destruction were increasing steadily. In the period from 2024-11-19 to 2024-12-04, the average DS reduction reached 22 % in reactor No. 1, and it reached 19% in reactor No. 2. In the period from 2024-11-15 to 2024-12-04, the average VS destruction reached 28% in reactor No. 1, and it reached 24% in reactor No. 2.

In the period from 2024-11-15 to 2024-12-04, the methane yield in reactor No. 1 ranged from 157 ml CH_4/g VS to 182 ml CH_4/g VS with the average value of 168 ml CH_4/g VS, and in reactor No. 2 it ranged from 142 ml CH_4/g VS to 171 ml CH_4/g VS with the average value of 159 ml CH_4/g VS. The average organic loading rate was equal to 2,2 kg VS/m^3/d.

3.1.5 Concentration of Ammonium in the Substrate

The concentration of ammonium in the samples was determined by the spectrophotometric method (ISO/TS 14256-1:2003). Values of ammonium concentration are presented in Figures 3.24 and 3.25, and data on ammonium concentration values are provided in Annex 1, clause 5.

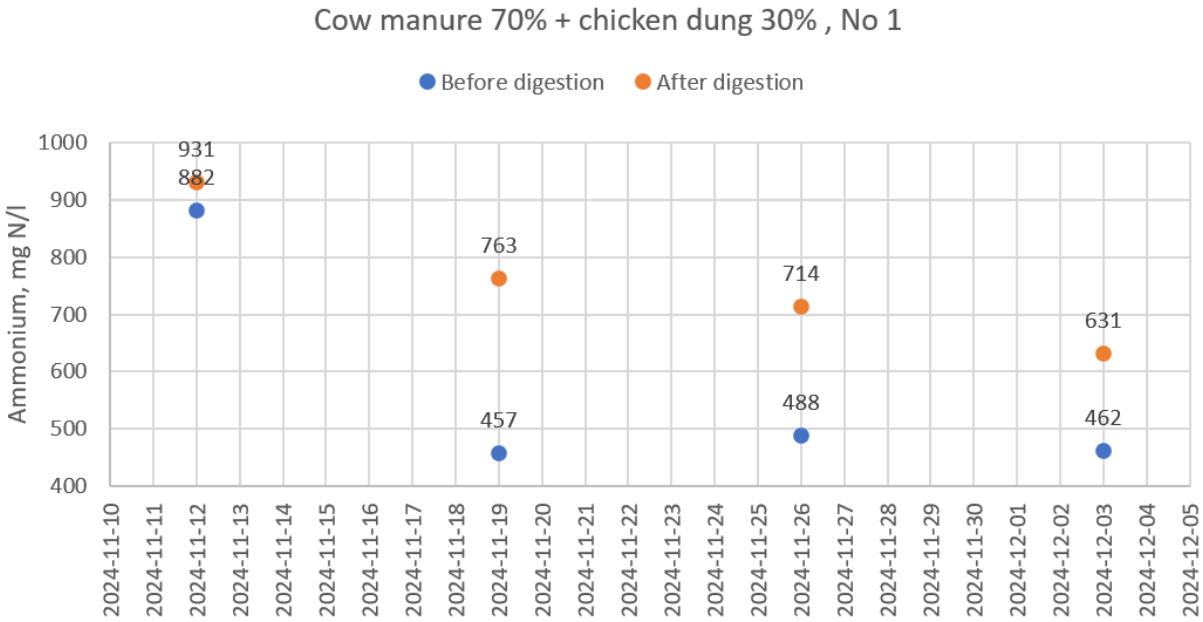

Figure 3.24. Values of ammonium concentration in substrate before and after digestion (reactor No. 1, Stage I)

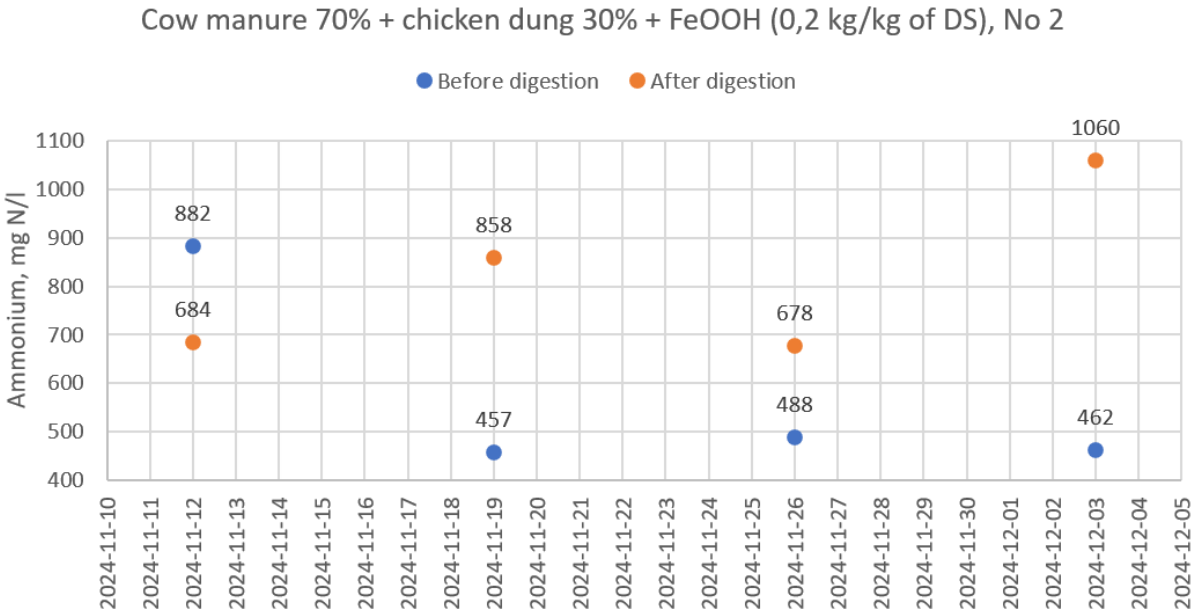

Figure 3.25. Values of ammonium concentration in substrate before and after digestion (reactor No. 2, Stage I)

The ammonium concentration in the loading substrate was about 2 times higher in the initial phase of the Stage I compared to the later phases of the Stage I. The highest ammonium concentration in

the loading substrate reached 882 mg N/l. The ammonium concentration in the unloaded substrate from reactor No. 1 ranged from 631 mg N/l to 931 mg N/l, with an average value of 760. The ammonium concentration in the unloaded substrate from reactor No. 2 ranged from 678 mg N/l to 1060 mg N/l, with an average value of 820. It seems that the ammonium nitrogen concentrations did not have an inhibitory effect on the anaerobic digestion process, as the reference indicates that the inhibiting concentration of ammonia nitrogen at pH >7,6 is 1000–3000 mg N/l (Akunna J. C., 2019).

3.1.6 Sediments in Digested Substrate

After pouring out the content of substrate, sediments remain. A larger amount of them is from reactor No. 2. A visual comparison of the sediments is given in the Figures 3.26 and 3.27.

Figure 3.26. Sediments from reactor No. 1 (2024-11-14).

Figure 3.27. Sediments from reactor No. 2 (2024-11-14).

The sediments from reactor No. 2 seems to be the additive that is used. The same situation repeats every day.
The sediments from reactor No. 2 were dried and tested with SciAps X-200 XRF Analyzer using X-ray. A photo of dried sediments is presented in Figure 3.28, and material report is presented in Annex 2.

Figure 3.28. Dried sediments from reactor No. 2 (2024-11-22)

3.2 Results of the Stage II (2024-12-04–2025-01-08)

The first reactor (No. 1) contained substrate with SBGx Plus, and the second reactor (No. 2) contained substrate with SBGx.

3.2.1 Biogas production

As the gasholders rises (Figure 3.1), the pressure changes. Thus, when measuring the volume of biogas, the influence of pressure was evaluated according to the relationship presented in Figure 3.2.

Biogas production and biogas quality are presented in Figures 3.29–3.32, and data on hourly biogas production are provided in Annex 3, clause 1.

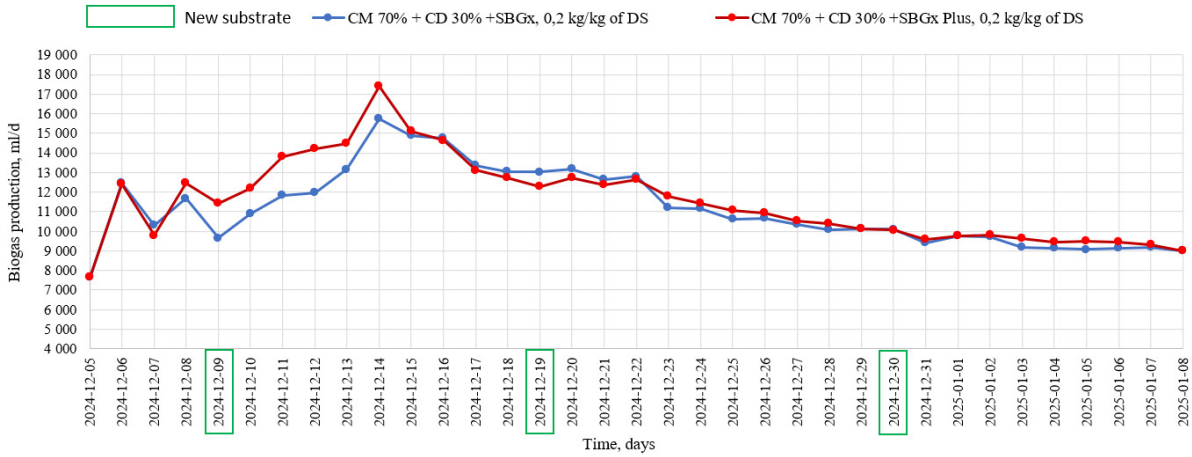

Figure 3.29. Biogas production, Stage II: CM – cow manure, CD – chicken dung

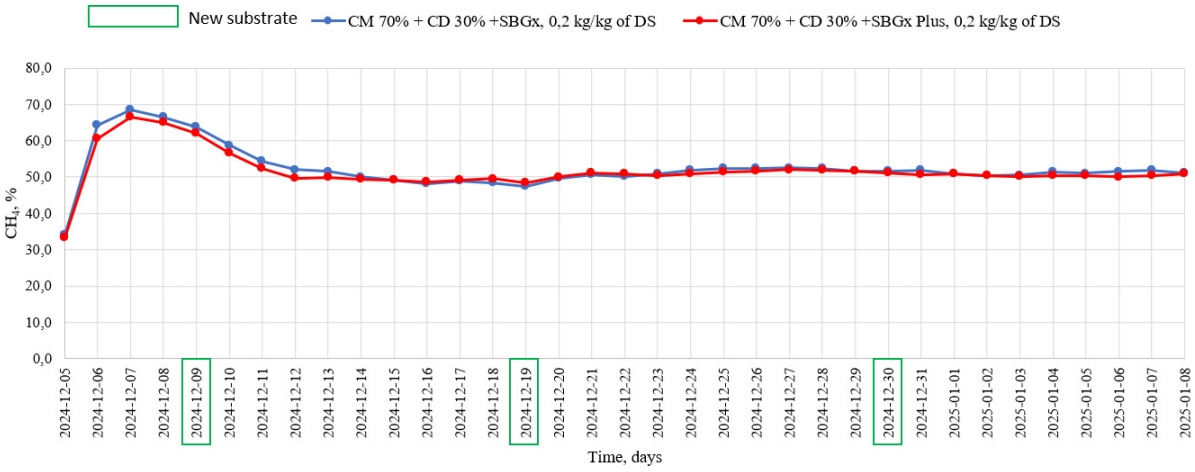

Figure 3.30. Methane content in biogas, Stage II: CM – cow manure, CD – chicken dung

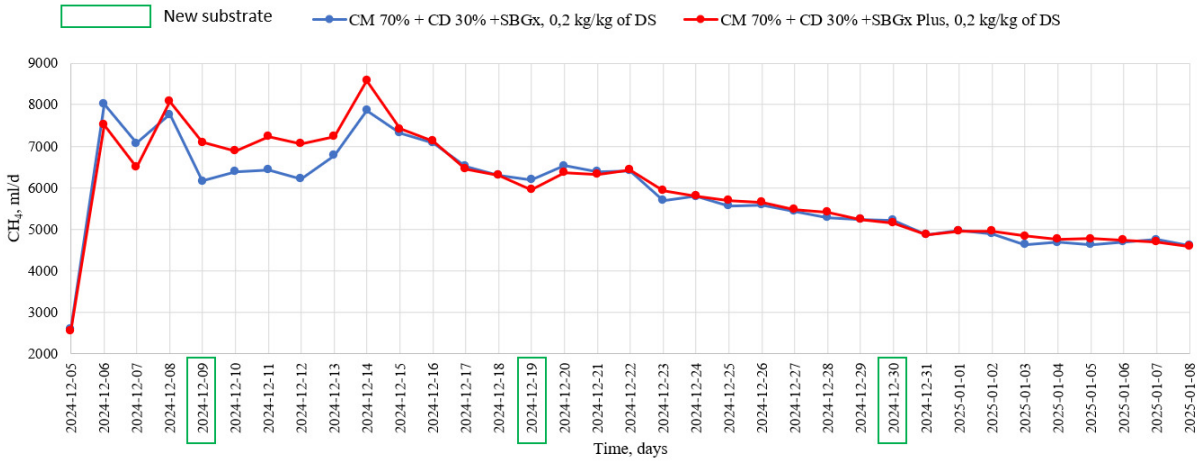

Figure 3.31. Methane production, Stage II: CM – cow manure, CD – chicken dung

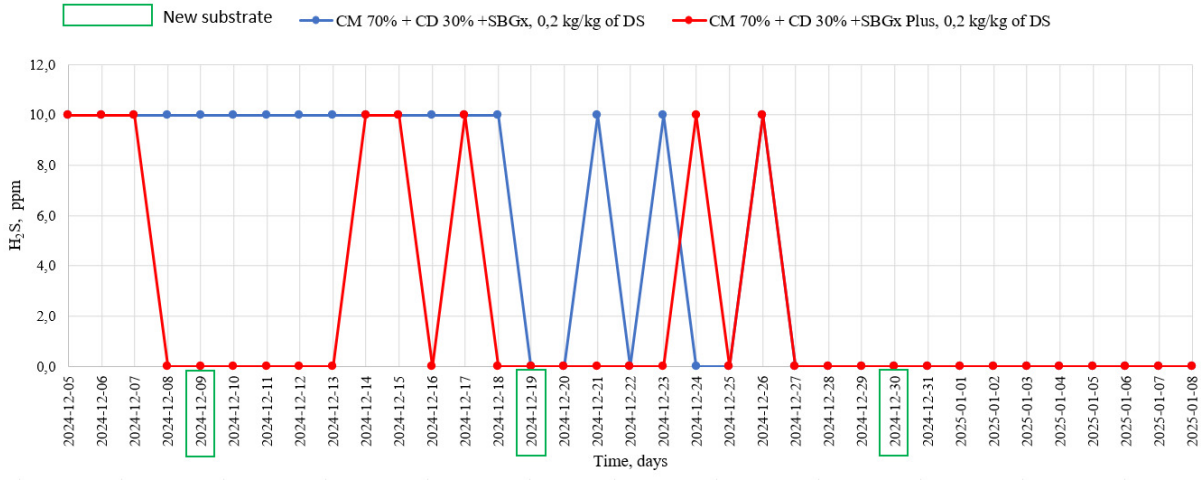

Figure 3.32. Concentration of hydrogen sulphide in biogas, Stage II: CM – cow manure, CD – chicken dung

Biogas production and quality were analysed during the period from 2024-12-04 to 2025-01-08 (31 days), when daily substrate loading into the reactors was performed.

In reactor No. 1, when SBGx Plus additive was used, a total of 361 l of biogas was produced during the analysed period, and in reactor No. 2, when SBGx additive was used, a total of 349 l of biogas was produced, i.e., 3,4 % less than in reactor No. 1. The average daily biogas production in reactor No. 1 was 11,6 l/d, and in reactor No. 2 it was 11,3 l/d.

The methane content in biogas from reactor No. 1 was on average 50,9 % (maximum value was 62,0 %), and from reactor No. 2 was on average 51,4 % (maximum value was 63,8 %), i.e., 1,0 % more than in biogas from reactor No. 1.

The average daily methane production in reactor No. 1 was 5,9 l/d, and in reactor No. 2 it was 5,8 l/d, i.e., 2,5 % less than in reactor No. 1.

The average H_2S concentration in biogas from reactor No. 1 was 1,88 ppm, and in biogas from reactor No. 2 the average H_2S concentration was 4,74 ppm, i.e., 152 % more than in biogas from reactor No. 1.

3.2.2 pH Values in the Substrate

Measurement of pH values are presented in Figures 3.33 and 3.34. Values of pH are presented in Figures 3.35 and 3.36, and data on pH values are provided in Annex 3, clause 2.

Figure 3.33. Measurement of pH value in the digested substrate from reactor No. 1 (2024-12-14)

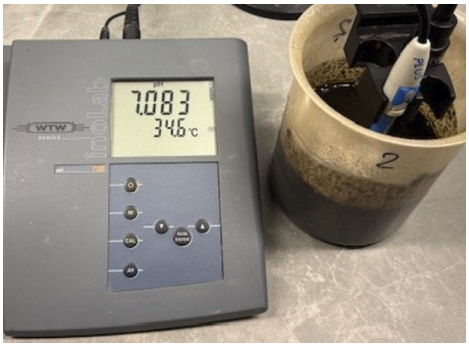

Figure 3.34. Measurement of pH value in the digested substrate from reactor No. 2 (2024-12-14)

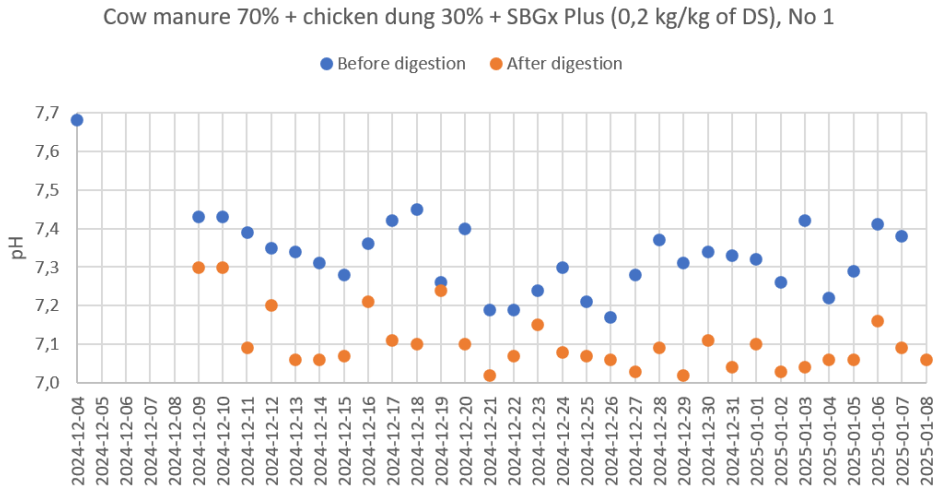

Figure 3.35. pH values of substrate before and after digestion (reactor No. 1, Stage II)

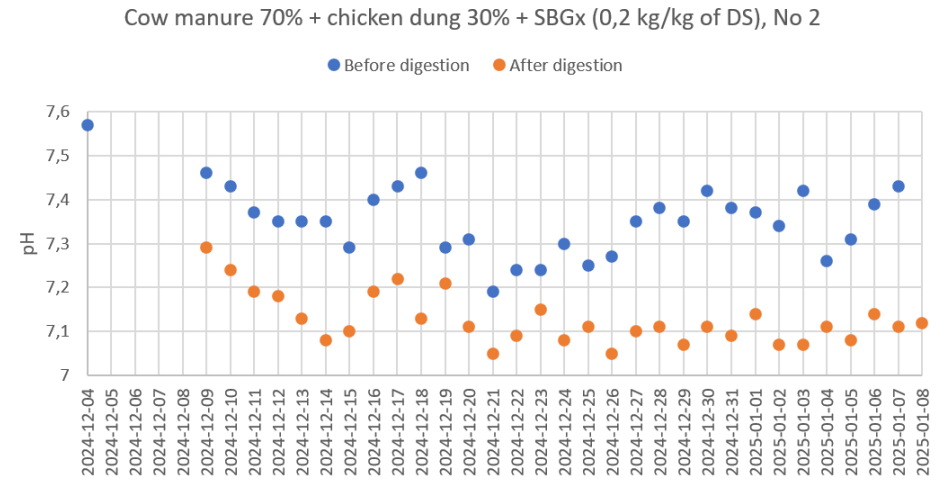

Figure 3.36. pH values of substrate before and after digestion (reactor No. 2, Stage II)

The pH values of the substrate loaded to reactor No. 1 ranged from 7,2 to 7,7, with an average pH value of 7,33. The pH values of the substrate loaded to reactor No. 2 ranged from 7,2 to 7,6, with an average pH value of 7,35.

The pH values of the substrate unloaded from reactor No. 1 ranged from 7,0 to 7,3, with an average pH value of 7,10. The pH values of the substrate unloaded from reactor No. 2 ranged from 7,1 to 7,3, with an average pH value of 7,13.

The determined pH values show that the substrate digestion environment was suitable in terms of pH for the efficient digestion process.

3.2.3 Conductivity Values in the Substrate

Measurement of conductivity values are presented in Figures 3.37 and 3.38. Values of conductivity are presented in Figures 3.39 and 3.40, and data on conductivity values are provided in Annex 3, clause 3.

Figure 3.37. Measurement of conductivity value in the digested substrate from reactor No. 1 (2024-12-14)

Figure 3.38. Measurement of conductivity value in the digested substrate from reactor No. 2 (2024-12-14)

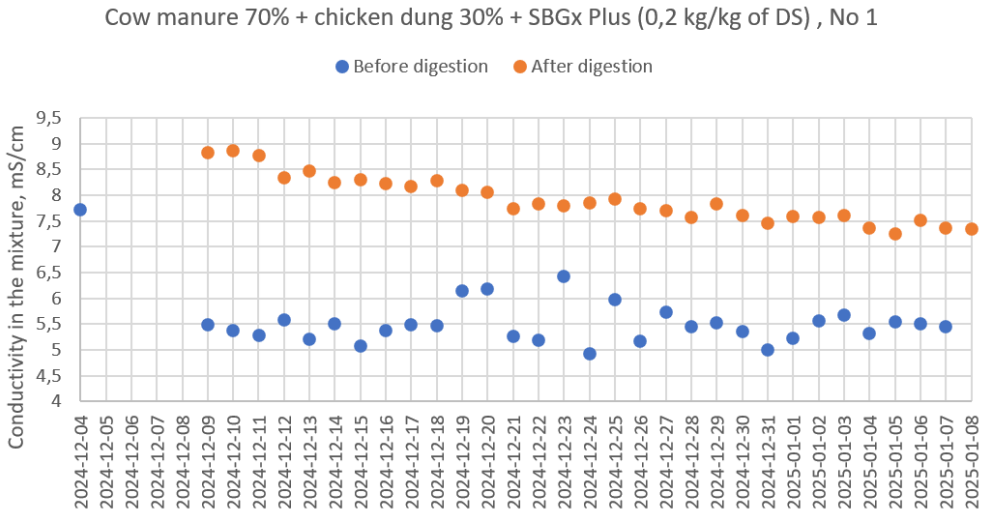

Figure 3.39. Conductivity values of substrate before and after digestion (reactor No. 1, Stage II)

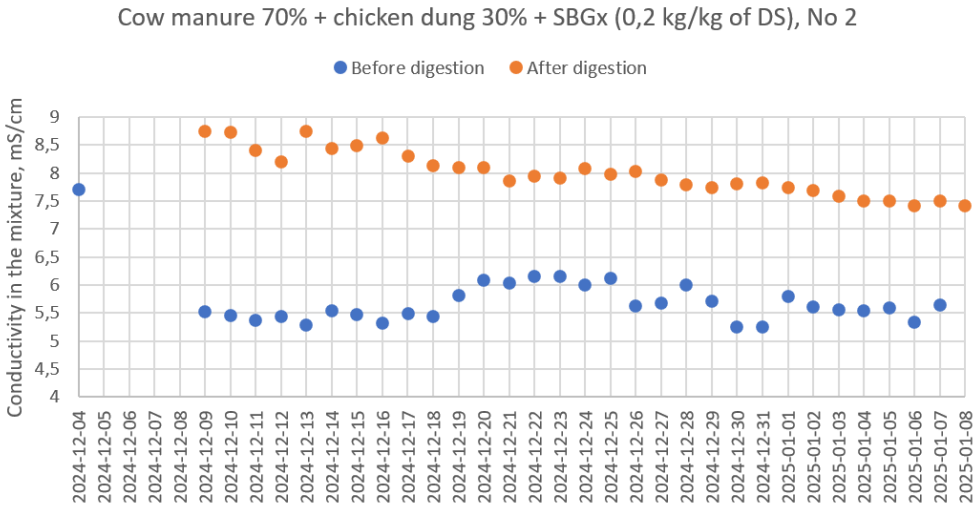

Figure 3.40. Conductivity values of substrate before and after digestion (reactor No. 2, Stage II)

The conductivity values of the substrate loaded to reactor No. 1 ranged from 4,9 to 7,7, with an average conductivity value of 5,6. The conductivity values of the substrate loaded to reactor No. 2 ranged from 5,2 to 7,7, with the average conductivity value of 5,7.

The conductivity values of the substrate unloaded from reactor No. 1 ranged from 7,2 to 8,9, with an average conductivity value of 7,9. The conductivity values of the substrate unloaded from reactor No. 2 ranged from 7,4 to 8,8, with an average conductivity value of 8,0.

3.2.4 Dry Solids and Volatile Solids

Samples of substrate and digested substrate from two reactors are presented in Figures 3.41–3.43. Values of dry solids (DS), volatile solids (VS), DS reduction and VS reduction are presented in Figures 3.44–3.49. Data on DS, VS, DS reduction and VS reduction values are provided in Annex 3, clause 4.

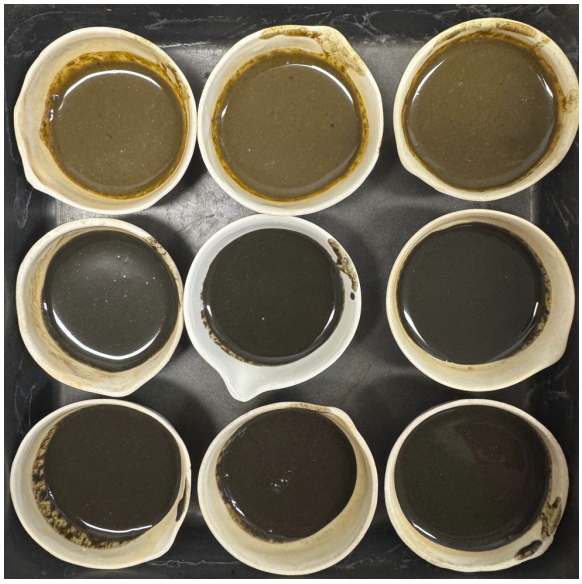

Figure 3.41. Samples of substrate (top row), digested substrate from reactor No. 1 (middle row) and from reactor No. 2 (bottom row).

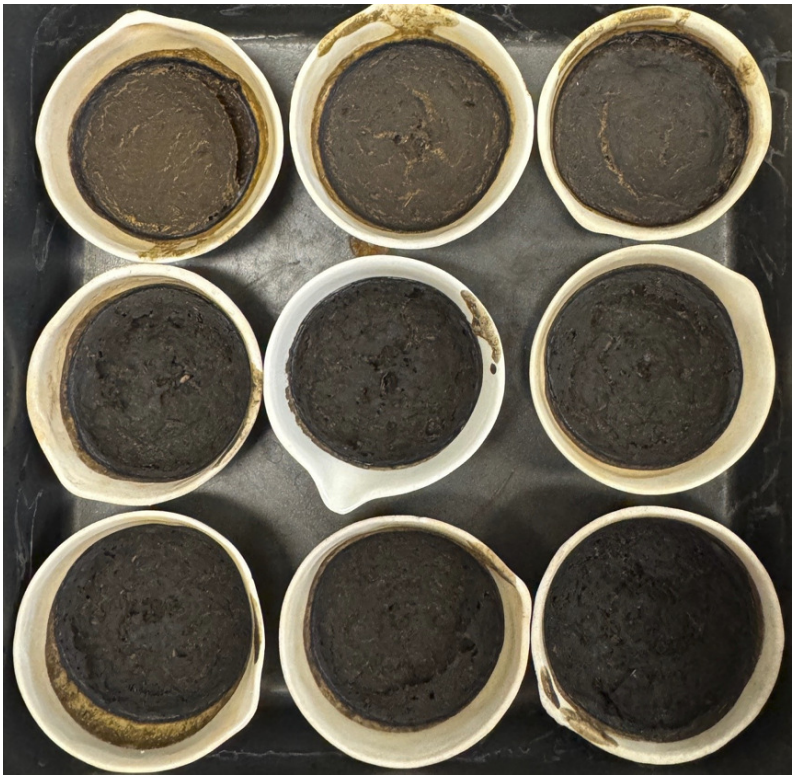

Figure 3.42. Samples of substrate (top row), digested substrate from reactor No. 1 (middle row) and from reactor No. 2 (bottom row) after drying at 105 °C.

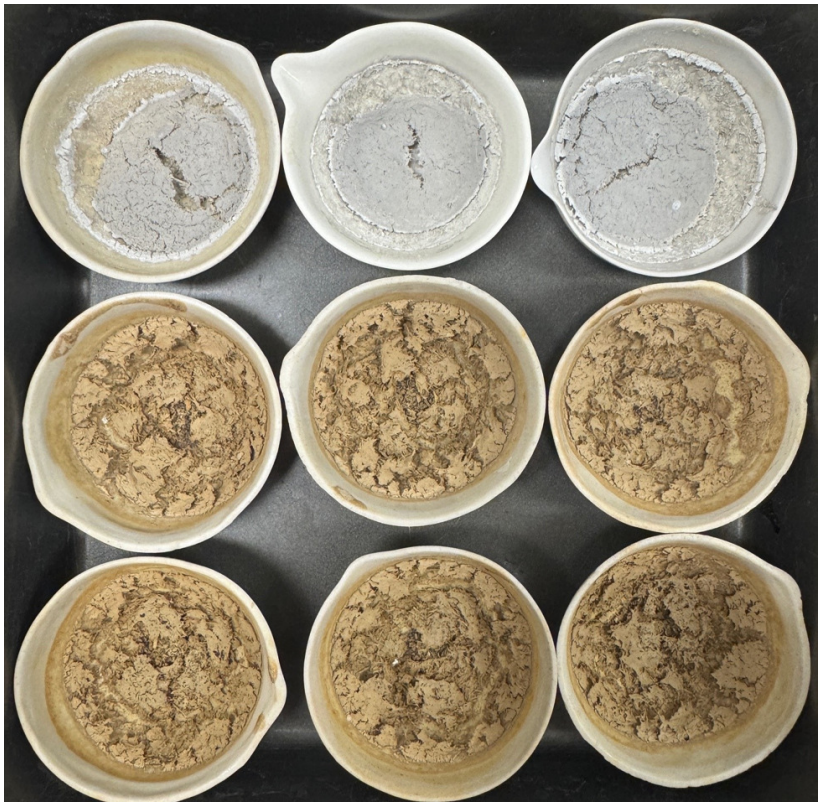

Figure 3.43. Samples of substrate (top row), digested substrate from reactor No. 1 (middle row) and from reactor No. 2 (bottom row) after heating at 550 °C.

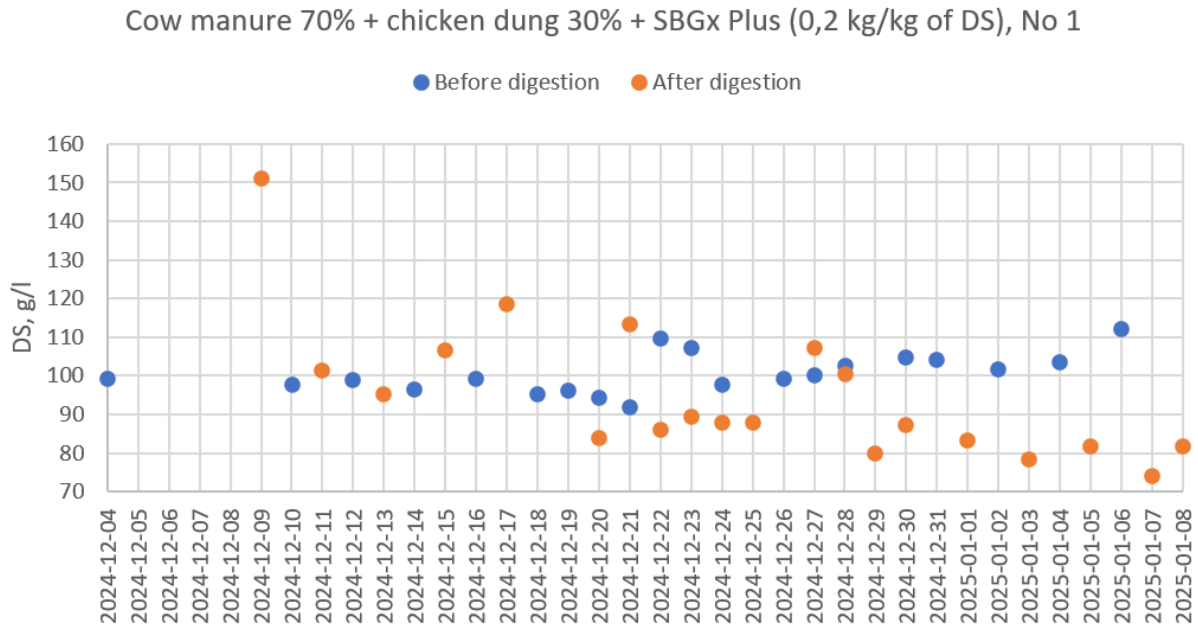

Figure 3.44. DS values of substrate before and after digestion (reactor No. 1, Stage II)

In the digested substrate from reactor No. 1, the dry matter concentration ranged from 4 % to 20 % higher than in the loaded substrate up until the nineteenth day after the start of substrate daily loading. Later, the DS concentration in the digested substrate from reactor No. 1 was always lower than in the loaded substrate.

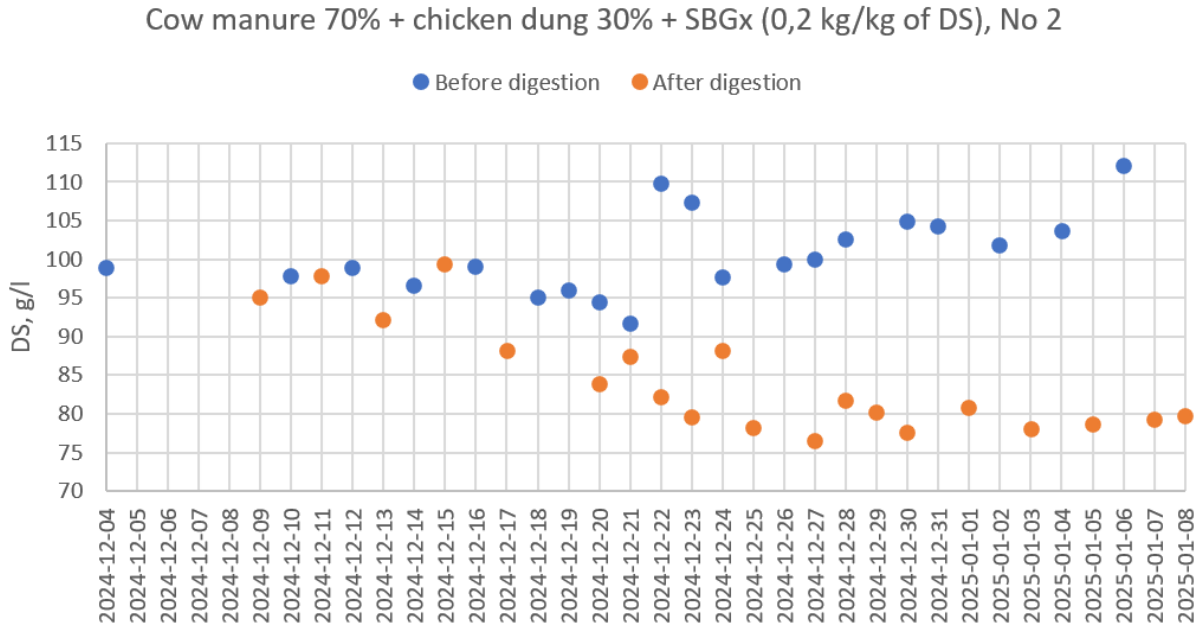

Figure 3.45. DS values of substrate before and after digestion (reactor No. 2, Stage II)

The DS concentration in the digested substrate from reactor No. 2 was always lower than in the loaded substrate except the seventh day after the start of substrate daily loading, when the dry matter concentration was higher by 3 % compared to the dry matter concentration in the loaded substrate.

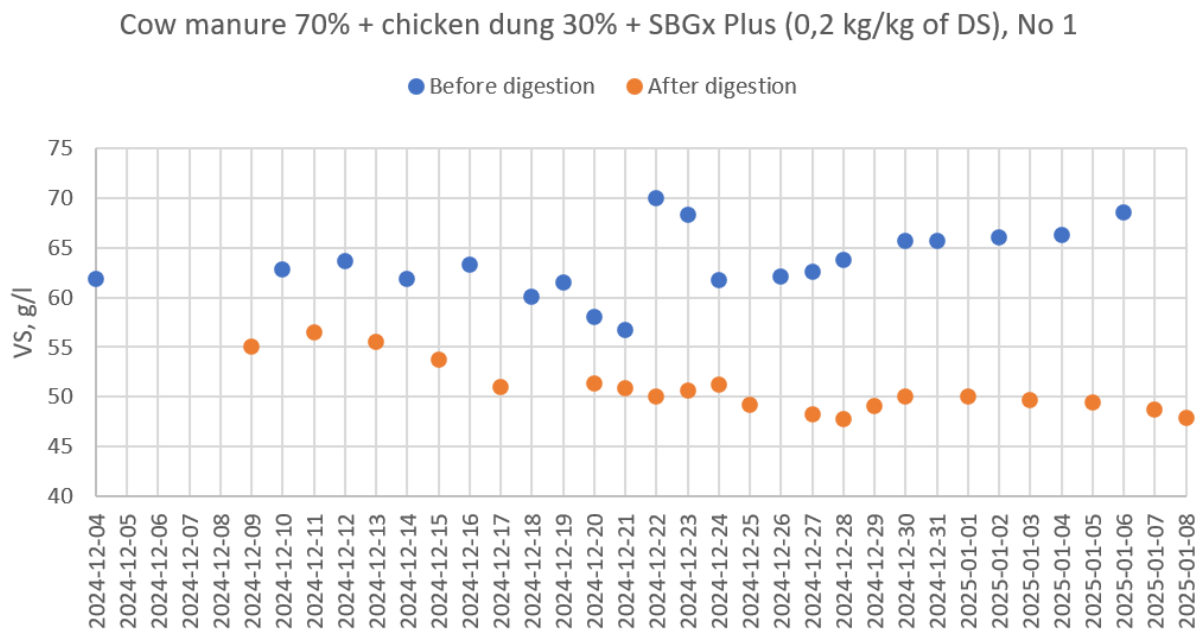

Figure 3.46. VS values of substrate before and after digestion (reactor No. 1, Stage II)

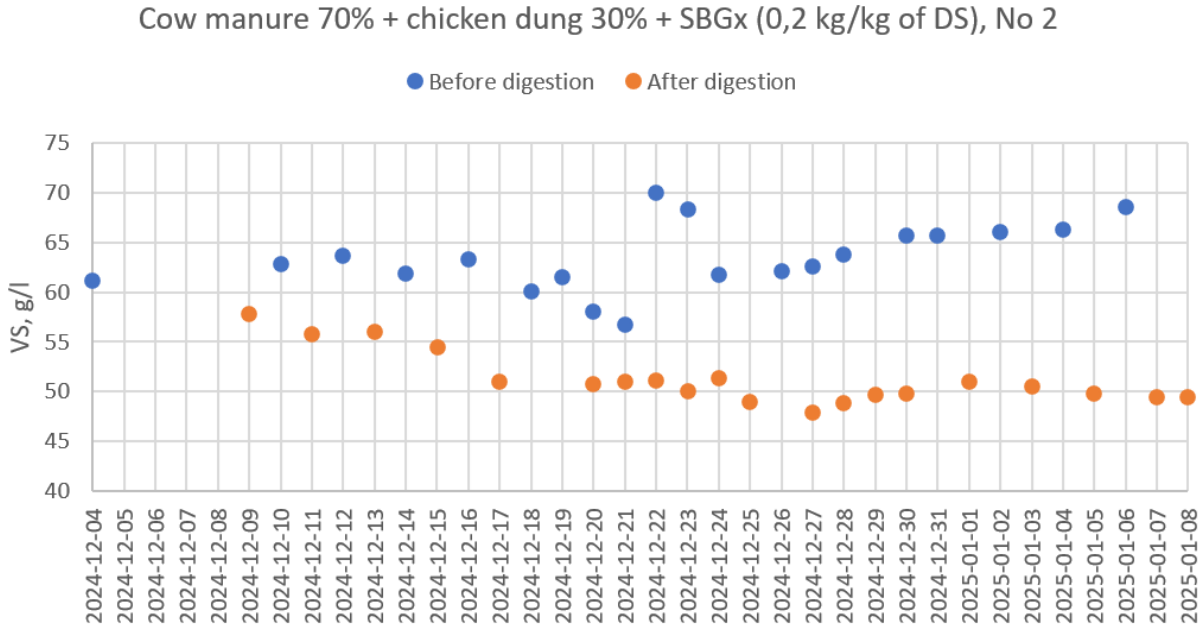

Figure 3.47. VS values of substrate before and after digestion (reactor No. 2, Stage II)

The VS concentration in the digested substrate from both reactors was always lower than in the loaded substrate.

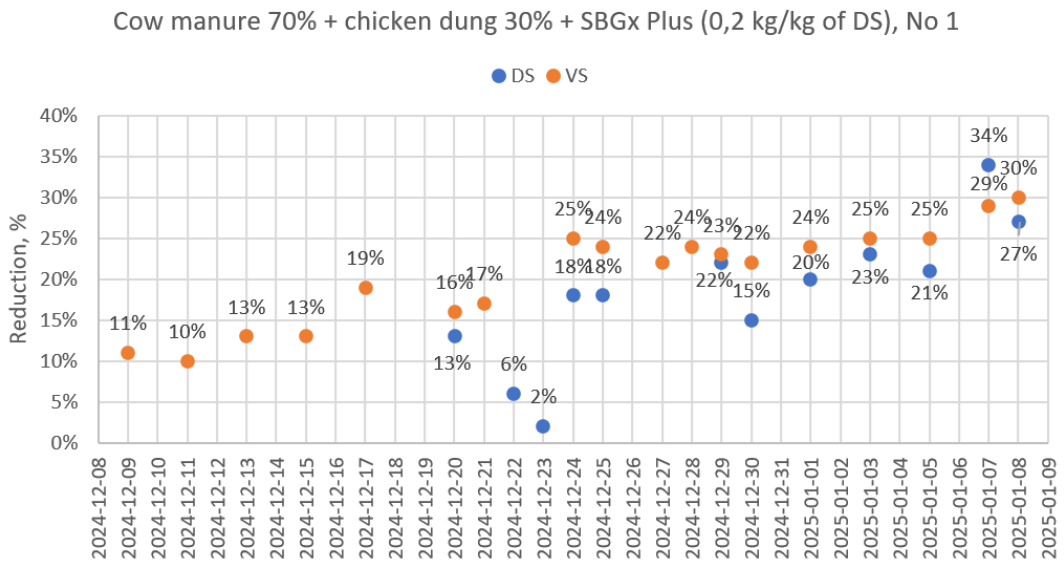

Figure 3.48. Reduction of DS and VS values in substrate from reactor No. 1, Stage II

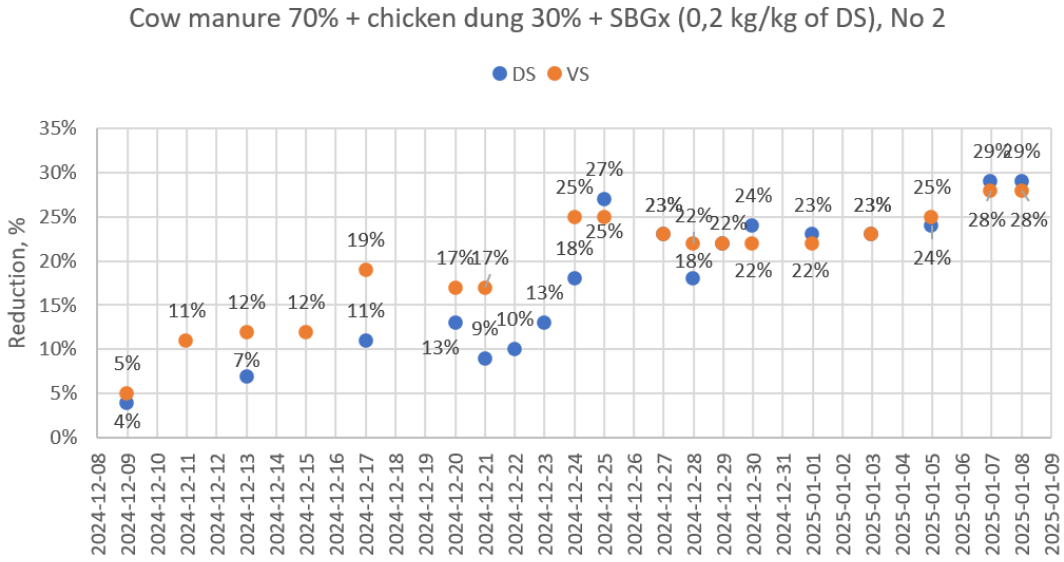

Figure 3.49. Reduction of DS and VS values in substrate from reactor No. 2, Stage II

A more stable DS reduction in both reactors was observed from day 16 after the start of substrate daily loading, and a more stable VS destruction was observed from day 9 after the start of substrate daily loading. Until that time, both DS reduction and VS destruction were increasing. In the period from 2024-12-24 to 2025-01-08, the average DS reduction reached 22 % in reactor No. 1, and it reached 24 % in reactor No. 2. In the period from 2024-12-17 to 2025-01-08, the average VS destruction reached 23% in both reactors.

In the period from 2024-12-17 to 2025-01-08, the methane yield in reactor No. 1 ranged from 129 ml CH_4/g VS to 195 ml CH_4/g VS with the average value of 159 ml CH_4/g VS, and in reactor No. 2 it ranged from 131 ml CH_4/g VS to 200 ml CH_4/g VS with the average value of 158 ml CH_4/g VS. The average organic loading rate was equal to 2,2 kg VS/m^3/d.

3.2.5 Concentration of Ammonium in the Substrate

The concentration of ammonium in the samples was determined by the spectrophotometric method (ISO/TS 14256-1:2003). Values of ammonium concentration are presented in Figures 3.50 and 3.51, and data on ammonium concentration values are provided in Annex 3, clause 5.

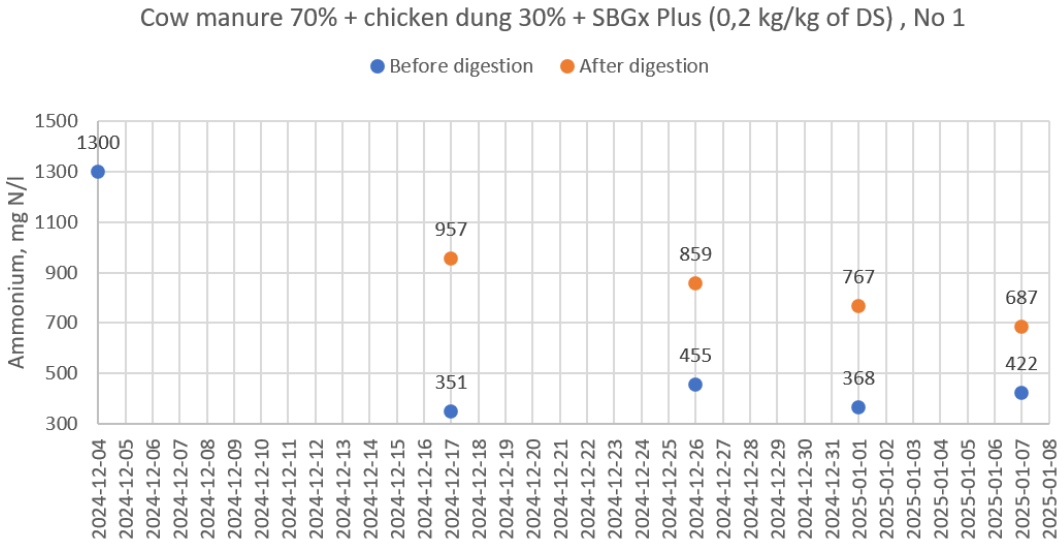

Figure 3.50. Values of ammonium concentration in substrate before and after digestion (reactor No. 1, Stage II)

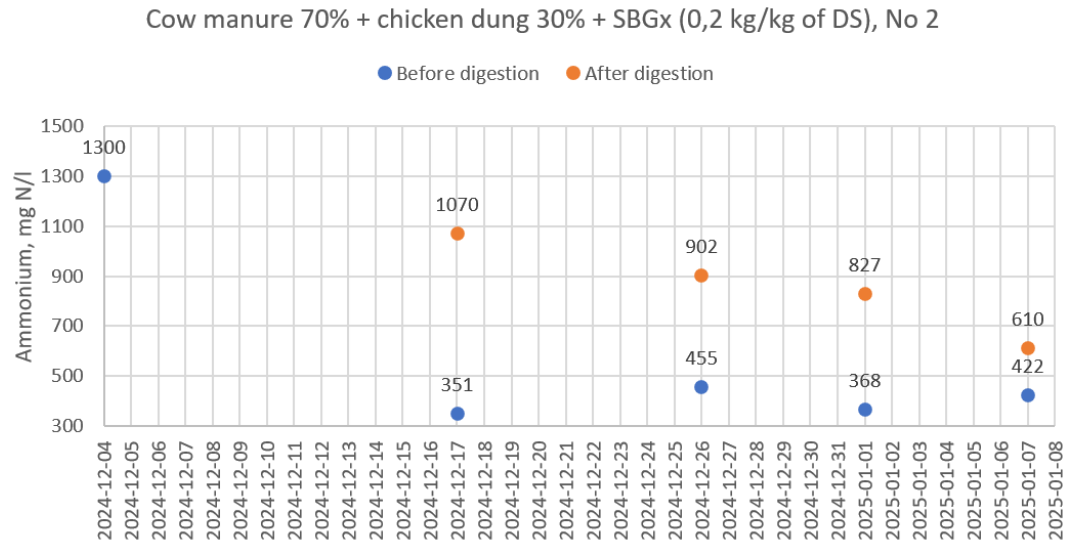

Figure 3.51. Values of ammonium concentration in substrate before and after digestion (reactor No. 2, Stage II)

The ammonium concentration in the loading substrate was about 3 times higher in the initial phase of the Stage II compared to the later phases of the Stage II. The highest ammonium concentration in the loading substrate was at the beginning of the test and it was 1300 mg N/l. The ammonium concentration in the unloaded substrate from reactor No. 1 ranged from 687 mg N/l to 957 mg N/l, with an average value of 818. The ammonium concentration in the unloaded substrate from reactor No. 2 ranged from 610 mg N/l to 1070 mg N/l, with an average value of 852. Even though the initial

ammonium nitrogen concentration was 1300 mg/l, it seems that the ammonium nitrogen concentrations did not have an inhibitory effect on the anaerobic digestion process, as the reference indicates that the inhibiting concentration of ammonia nitrogen at pH >7,6 is 1000–3000 mg N/l (Akunna J. C., 2019).

3.2.6 Sediments in Digested Substrate

After pouring out the content of substrate, sediments remain. A visual comparison of the sediments is given in the Figures 3.52 and 3.53.

Figure 3.52. Sediments from reactor No. 1 (2024-12-11).

Figure 3.53. Sediments from reactor No. 2 (2024-12-11).

The sediment from the reactors seems to be the additives that are used. The same situation repeats every day.

The sediments from reactors No. 1 and No. 2 were dried and tested with SciAps X-200 XRF Analyzer using X-ray. Material reports are presented in Annexes 4 and 5.

3.3 Comparison of the Results of Stages I and II

3.3.1 Biogas production

Biogas production rate of Stages I and II is presented in Figure 3.54, and comparison of biogas production rate of Stages I and II is presented in Table 3.1.

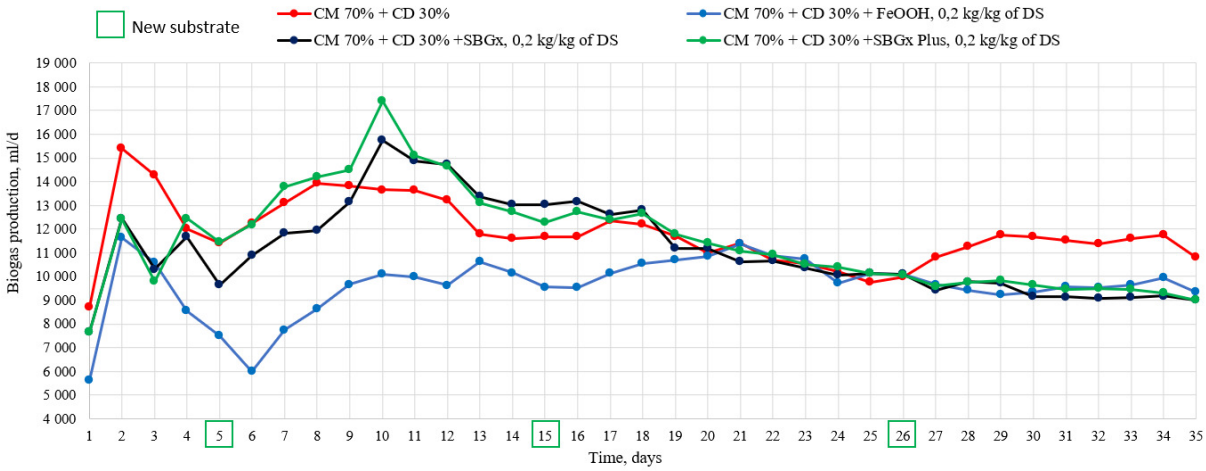

Figure 3.54. Biogas production, Stages I and II: CM – cow manure, CD – chicken dung

Table 3.1. Comparison of biogas production of Stages I and II during entire test period: CM – cow manure, CD – chicken dung

No	Substrate composition	Biogas production					
		Total, l/31 d	Average, l/d	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	364	11,7	-	21,3%	4,3%	0,8%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	300	9,7	-17,6%	-	-14,0%	-16,9%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	349	11,2	-4,1%	16,3%	-	-3,3%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	361	11,6	-0,8%	20,3%	3,4%	-

Table 3.1 shows that the highest amount of biogas was produced during the entire test period when the substrate was digested without additives. Practically the same amount of biogas was produced when using the SBGx Plus additive, which was only 0,8 % lower than without any additive. Meanwhile, the total amount of biogas produced when using the SBGx additive was 4,1 % lower than without the additive, and the total amount of biogas produced when using the FeOOH additive was 17,6 % lower than without the additive.

Figure 3.54 shows that after a 5-day adaptation period, when substrate daily loading was started, the highest biogas production rate was observed when the substrate was digested without additives and when the substrate was digested with SBGx Plus. After 15 days from the start of substrate daily loading, the biogas production rate became the same in all cases. The amount and comparison of biogas produced during the first 15 days from the start of substrate daily loading is presented in Table 3.2.

Table 3.2. Comparison of biogas production of Stages I and II during the first 15 days from the start of substrate daily loading: CM – cow manure, CD – chicken dung

No	Substrate composition	Biogas production					
		Total, l/15 d	Average, l/d	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	188	12,5	-	30,6%	-3,1%	-6,5%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	144	9,6	-23,4%	-	-25,8%	-28,4%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	194	12,9	3,2%	34,7%	-	-3,5%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	201	13,4	6,9%	39,6%	3,6%	-

Table 3.2 shows that the highest amount of biogas was produced during the first 15 days from the start of substrate dosing when the substrate was digested with the SBGx Plus additive. A similar amount of biogas was also produced when the SBGx additive was used, which was 3,5 % lower than when the SBGx Plus additive was used. The amount of biogas produced during 15 days without using any additive was 6,5 % lower than when the SBGx Plus additive was used, and the amount of biogas produced when using the FeOOH additive was 28,4 % lower than when the SBGx Plus additive was used.

Methane content in biogas of Stages I and II is presented in Figure 3.55, and comparison of methane content in biogas of Stages I and II is presented in Table 3.3.

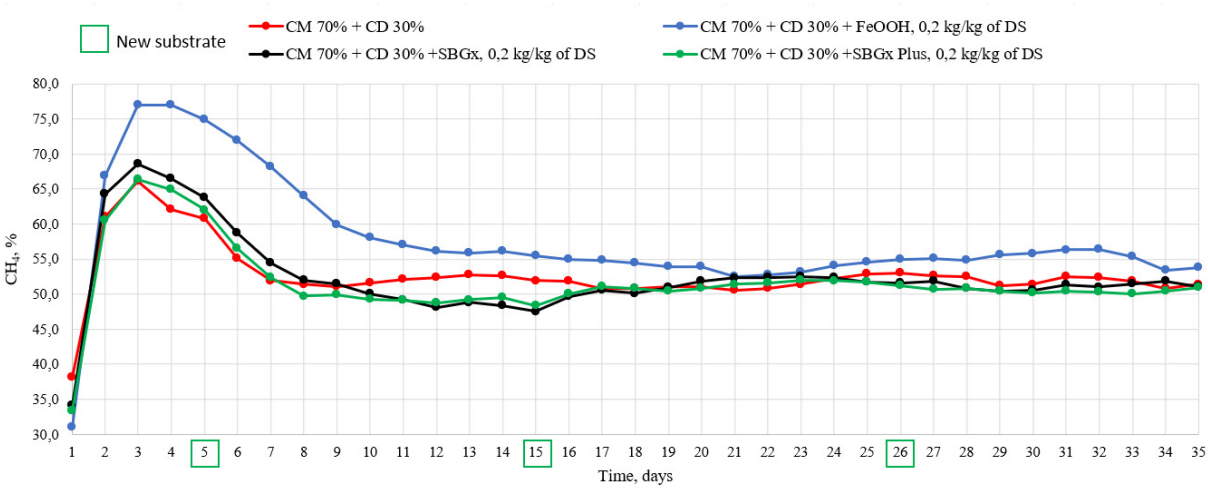

Figure 3.55. Methane content in biogas, Stages I and II: CM – cow manure, CD – chicken dung

Table 3.3. Comparison of methane content of Stages I and II: during entire test period CM – cow manure, CD – chicken dung

No	Substrate composition	CH_4 content in biogas					
		Max, %/31 d	Average, %	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	60,8	52,1	-	-7,8%	1,4%	2,4%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	74,9	56,5	8,4%	-	9,9%	11,0%

No	Substrate composition	CH_4 content in biogas					
		Max, %/31 d	Average, %	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	63,8	51,4	-1,3%	-9,0%	-	1,0%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	62,0	50,9	-2,3%	-9,9%	-1,0%	-

Figure 3.55 and Table 3.3 show that after a 5-day adaptation period, when the substrate was supplied, the highest methane content in biogas was observed when digesting the substrate with the FeOOH additive, the maximum value of which reached 74,9 %, and the average value over the entire test period was 56,5 %. After 16 days from the start of substrate daily loading, the methane content in biogas became the same in all cases. When no additive was used, the average methane content in biogas was 7,8 % lower than when using the FeOOH additive, and when using the SBGx and SBGx Plus additives, the average methane content in biogas was 9,0 % and 9,9 % lower than when using the FeOOH additive, respectively.

Methane production rate of Stages I and II is presented in Figure 3.56, and comparison of production rate of Stages I and II is presented in Table 3.4.

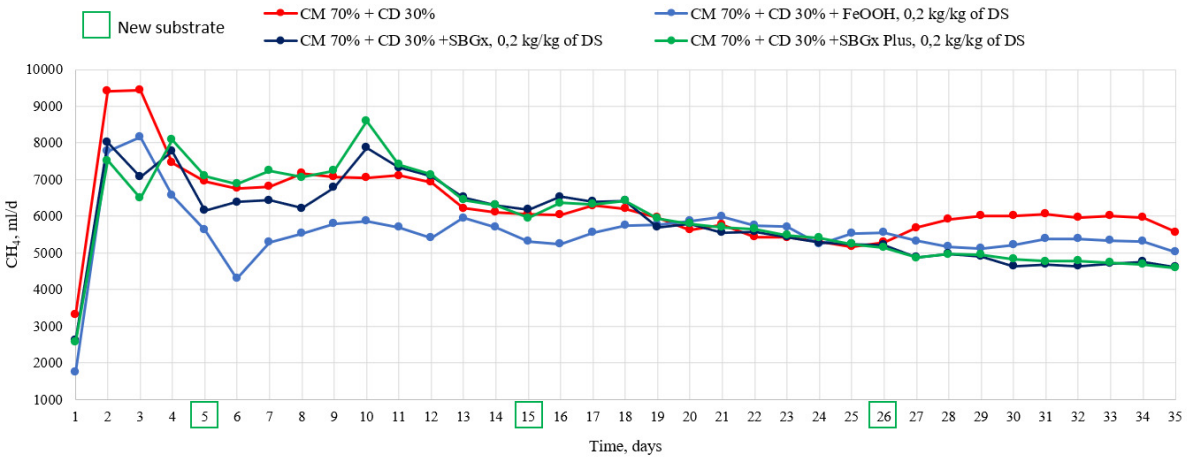

Figure 3.56. Methane production, Stages I and II: CM – cow manure, CD – chicken dung

Table 3.4. Comparison of methane production rate of Stages I and II during entire test period: CM – cow manure, CD – chicken dung

No	Substrate composition	CH_4 production					
		Total, l/31 d	Average, l/d	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	190	6,1	-	11,8%	6,1%	3,3%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	170	5,5	-10,5%	-	-5,0%	-7,6%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	179	5,8	-5,8%	5,3%	-	-2,7%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	184	5,9	-3,2%	8,2%	2,8%	-

Although the average methane content in biogas was recorded as the highest when the FeOOH additive was used, the methane production rate over the entire test period was the lowest (170 l CH_4/31 d, Table 3.4). The highest methane production rate over the entire study period was recorded when the substrate was digested without additives (190 l CH_4/31 d). When using the SBGx and SBGx Plus additives, the methane formation rate was 5,8 % and 3,2 % lower, respectively, than without additives, and when using the FeOOH additive, the methane formation rate was 10,5 % lower than without additives.

Figure 3.56 shows that after 14 days from the start of substrate daily loading, the methane production rate became the same in all cases. The methane production rate during the first 14 days from the start of substrate daily loading is presented in Table 3.5.

Table 3.5. Comparison of methane production rate of Stages I and II during the first 14 days from the start of substrate daily loading: CM – cow manure, CD – chicken dung

No	Substrate composition	Biogas production					
		Total, l/14 d	Average, l/d	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	92	6,6	-	19,5%	0,0%	-3,2%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	77	5,5	-16,3%	-	-16,3%	-18,9%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	92	6,6	0,0%	19,5%	-	-3,2%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	95	6,8	3,3%	23,4%	3,3%	-

Table 3.5 shows that the highest methane production rate during the first 14 days from the start of substrate dosing occurred when the substrate was digested with SBGx Plus. A similar methane formation rate was observed when SBGx was used and when no additive was used, which was 3,2 % lower than when SBGx Plus was used. When FeOOH was used, the methane formation rate for 14 days was 18,9 % lower than when SBGx Plus was used.

H_2S concentration in biogas of Stages I and II is presented in Figure 3.57, and comparison of H_2S concentration in biogas of Stages I and II is presented in Table 3.6.

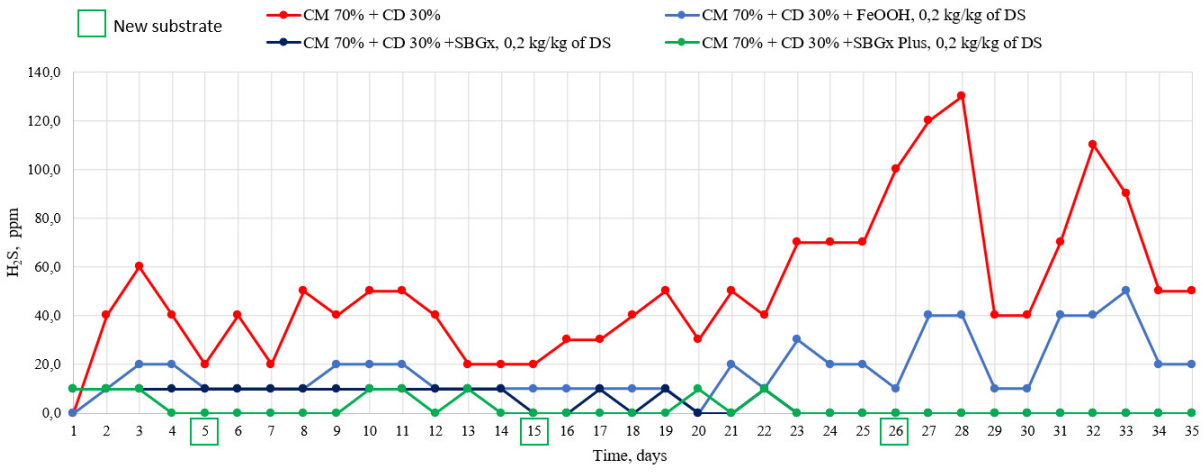

Figure 3.57. Concentration of hydrogen sulphide in biogas, Stages I and II: CM – cow manure, CD – chicken dung

Table 3.6. Comparison of H_2S concentration of Stages I and II during entire test period: CM – cow manure, CD – chicken dung

No	Substrate composition		H_2S concentration in biogas				
		Max, ppm/ 31 d	Average, ppm	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	130	52,2	-	188%	1001%	2677%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	50	18,1	-65%	-	282%	863%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	10	4,74	-91%	-74%	-	152%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	10	1,88	-96%	-90%	-60%	-

Figure 3.57 and Table 3.6 show that after a 5-day adaptation period, when the substrate was supplied, the lowest H_2S concentration in biogas was observed when digesting the substrate with the SBGx Plus additive, the maximum value of which reached 10 ppm, and the average value over the entire test period was 1,88 ppm. When using the SBGx and SBGx Plus additives, the average H_2S concentration in biogas was 91 % and 96 % lower, respectively, than without using any additive, and when using the FeOOH additive, the average H_2S concentration in biogas was 65 % lower than without using any additive.

3.3.2 Dry Solids and Volatile Solids

Dry solids and volatile solids before digestion, as well VS reduction of Stage I and Stage II are presented in Figures 3.58–3.60, and comparison of VS reduction of Stages I and II is presented in Table 3.7.

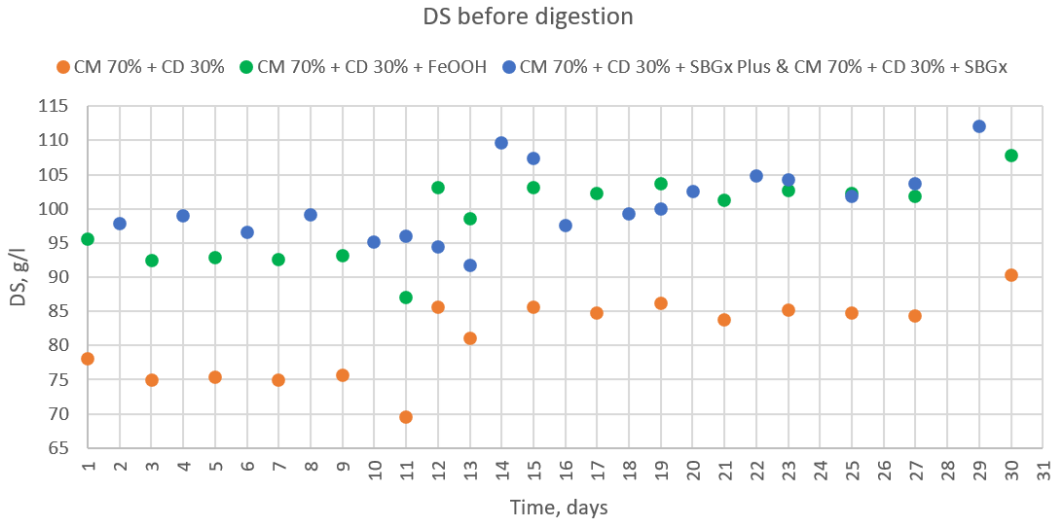

Figure 3.58. DS values of substrate before digestion, Stages I and II: CM – cow manure, CD – chicken dung

The use of additives resulted in an initial dry matter concentration of 42 % higher than in the case without additives (69,4 g DS/l). The difference between the DS concentration when using FeOOH in Stage I (98,6 g DS/l) and the DS concentration when using SBGx and SBGx Plus in Stage II (100,7 g DS/l) was only 2,1 %.

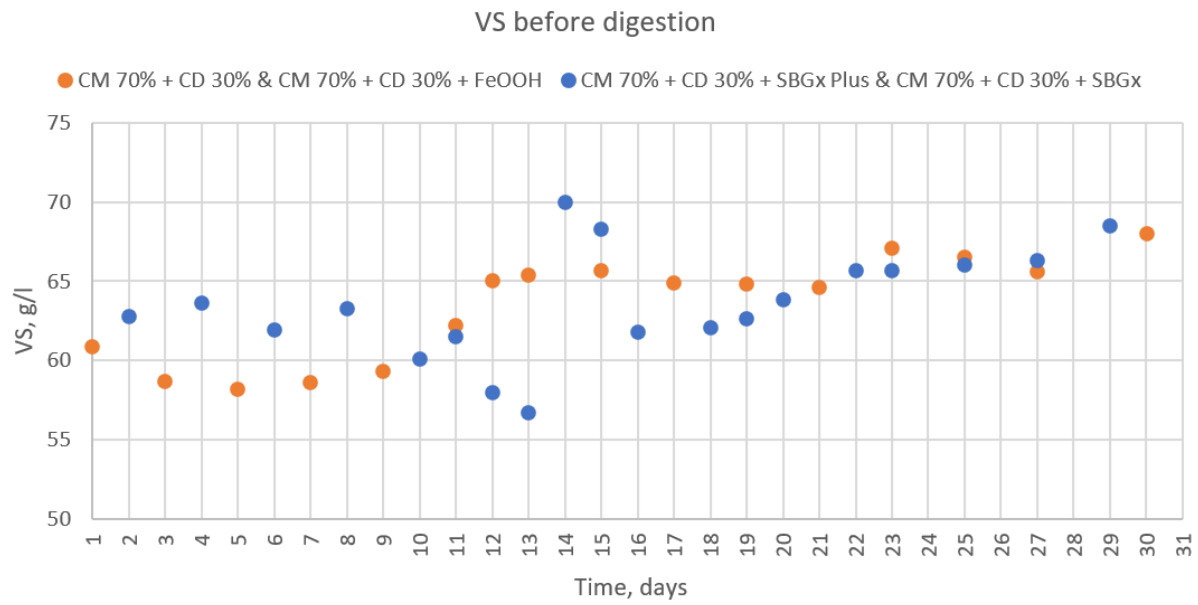

Figure 3.59. VS values of substrate before digestion, Stages I and II: CM – cow manure, CD – chicken dung

The same VS concentration was maintained during the different stages of the test. The difference between the VS concentration when using the FeOOH additive in Stage I (63,4 g VS/l) and the VS concentration when using the SBGx and SBGx Plus additives in Stage II (63,6 g DS/l) was only 0,32 %. Considering that the initial VS content was the same during both stages of the test, the VS degradation achieved in the individual stages can be compared.

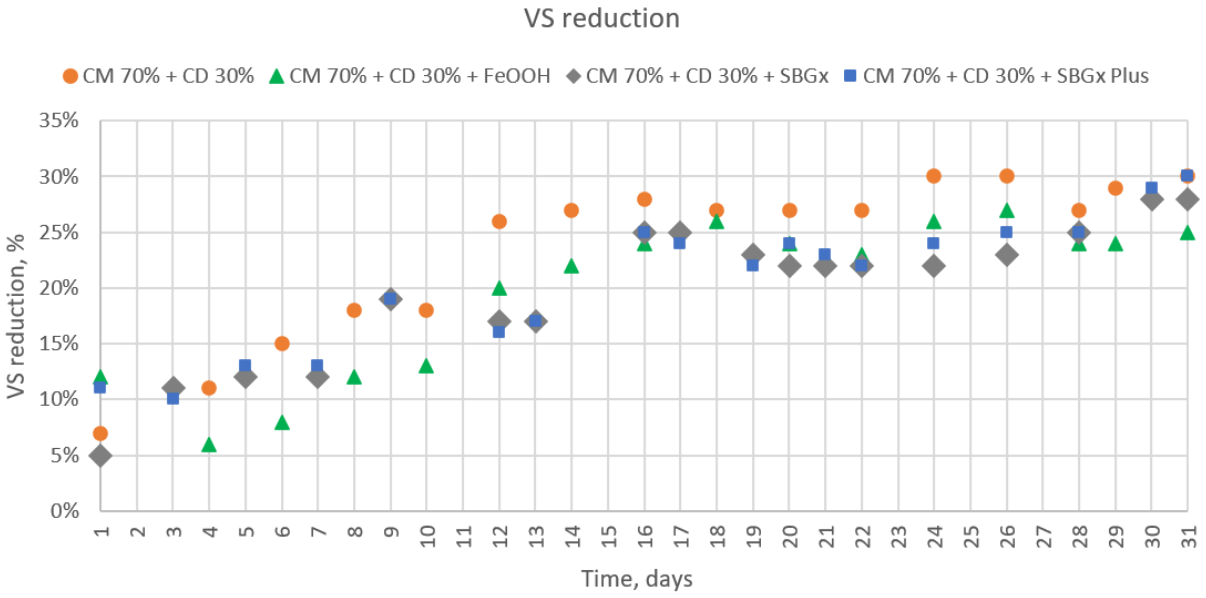

Figure 3.60. VS reduction during digestion, Stages I and II: CM – cow manure, CD – chicken dung

Table 3.7. Comparison of VS reduction of Stages I and II during entire test period: CM – cow manure, CD – chicken dung

No	Substrate composition		VS reduction				
		Max, %/31 d	Average, %	Compared to No. 1	Compared to No. 2	Compared to No 3	Compared to No 4
1	CM 70% + CD 30%	30	24	-	20%	26%	20%
2	CM 70% + CD 30% + FeOOH, 0,2 kg/kg of DS	27	20	-17%	-	5%	0%
3	CM 70% + CD 30% +SBGx, 0,2 kg/kg of DS	28	19	-21%	-5%	-	-5%
4	CM 70% + CD 30% +SBGx Plus, 0,2 kg/kg of DS	30	20	-17%	0%	5%	-

Figure 3.60 and Table 3.7 show that the highest average degradation of VS was observed when the substrate was digested without additives, the value of which was 24 % over the entire test period. When using the additives FeOOH and SBGx Plus, the average decomposition of VS was 17 % lower than when no additive was used, and when using the additive SBGx, the average decomposition of VS was 19 % lower than when no additive was used.

3.4 Results of the Stage III (2025-01-08–2025-02-12)

The first reactor (No. 1) contained substrate with BC.Atox Scon 261467 (FeOOH), and the second reactor (No. 2) contained substrate with SBGx Plus.

3.4.1 Biogas production

As the gasholders rises (Figure 3.1), the pressure changes. Thus, when measuring the volume of biogas, the influence of pressure was evaluated according to the relationship presented in Figure 3.2.

Biogas production and biogas quality are presented in Figures 3.61–3.64, and data on hourly biogas production are provided in Annex 6, clause 1.

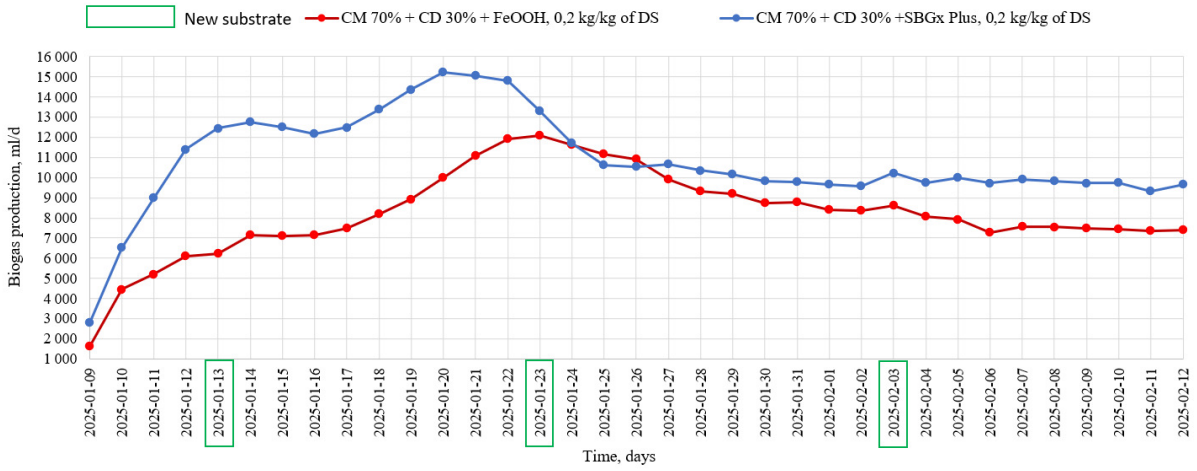

Figure 3.61. Biogas production, Stage III: CM – cow manure, CD – chicken dung

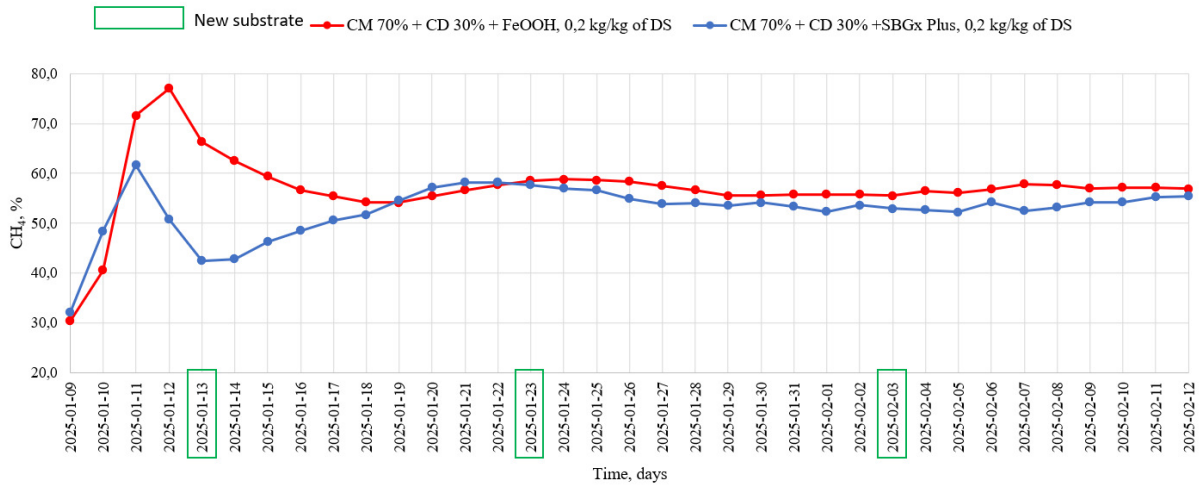

Figure 3.62. Methane content in biogas, Stage III: CM – cow manure, CD – chicken dung

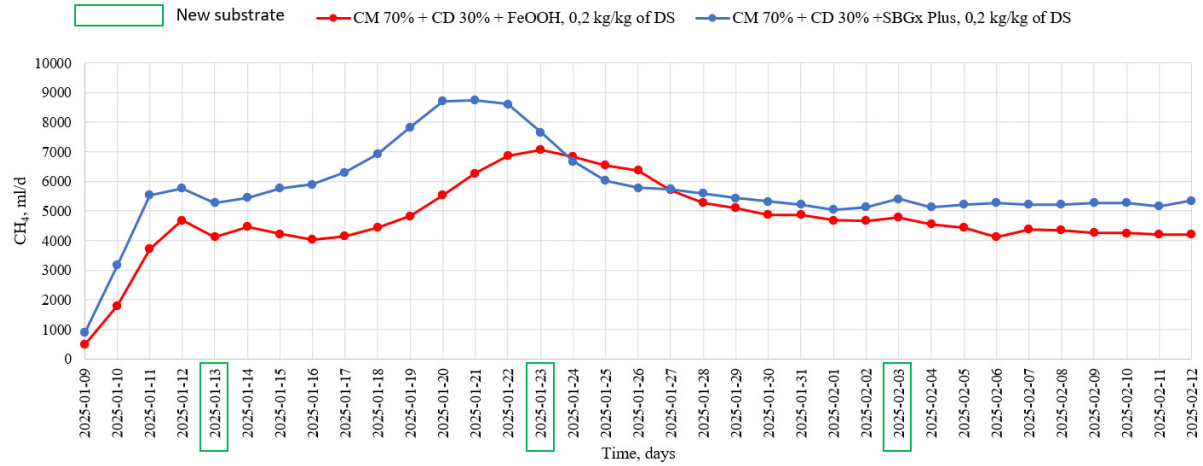

Figure 3.63. Methane production, Stage III: CM – cow manure, CD – chicken dung

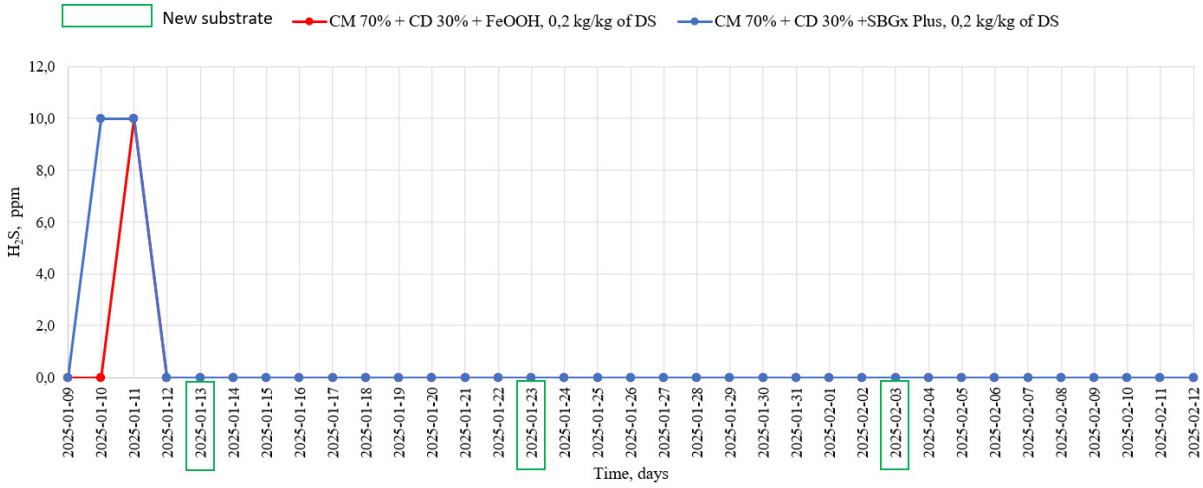

Figure 3.64. Concentration of hydrogen sulphide in biogas, Stage III: CM – cow manure, CD – chicken dung

Biogas production and quality were analysed during the period from 2025-01-13 to 2025-02-12 (31 days), when daily substrate loading into the reactors was performed.

In reactor No. 1, when FeOOH additive was used, a total of 270 l of biogas was produced during the analysed period, and in reactor No. 2, when SBGx Plus additive was used, a total of 349 l of biogas was produced, i.e., 29 % more than in reactor No. 1. The average daily biogas production in reactor No. 1 was 8,7 l/d, and in reactor No. 2 it was 11,3 l/d.

The methane content in biogas from reactor No. 1 was on average 57,1 % (maximum value was 66,3 %), and from reactor No. 2 was on average 53,2 % (maximum value was 58,2 %), i.e., 6,8 % less than in biogas from reactor No. 1.

The average daily methane production in reactor No. 1 was 5,0 l/d, and in reactor No. 2 it was 6,0 l/d, i.e., 20 % more than in reactor No. 1.

The average H_2S concentration in biogas from reactor No. 1 was 0,0 ppm, and in biogas from reactor No. 2 the average H_2S concentration was 0,0 ppm also.

3.4.2 pH Values in the Substrate

Values of pH are presented in Figures 3.65 and 3.66, and data on pH values are provided in Annex 6, clause 2.

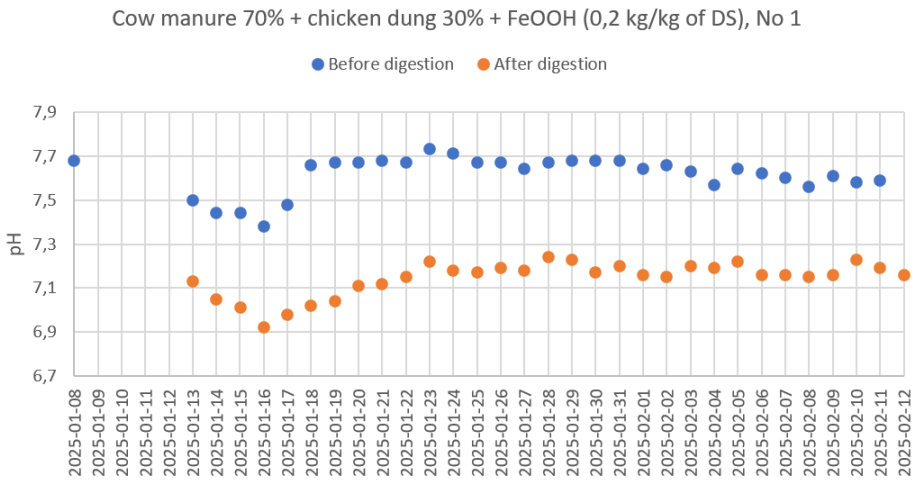

Figure 3.65. pH values of substrate before and after digestion (reactor No. 1, Stage III)

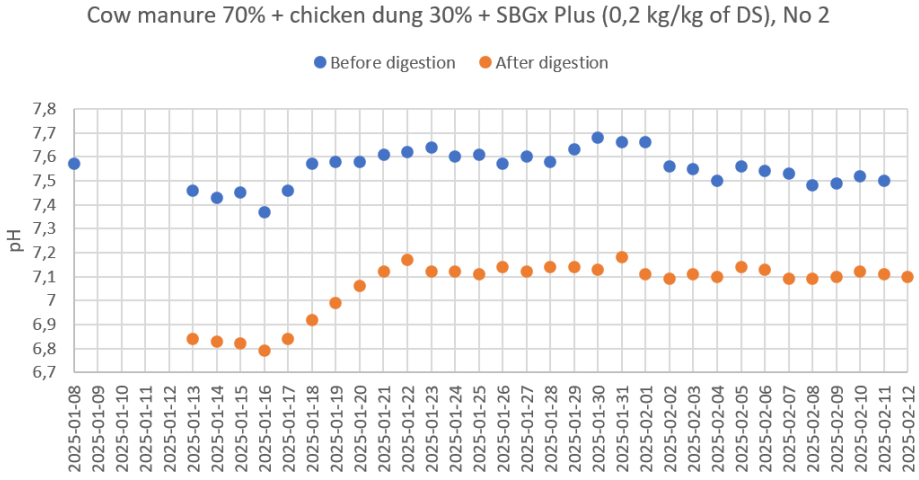

Figure 3.66. pH values of substrate before and after digestion (reactor No. 2, Stage III)

The pH values of the substrate loaded to reactor No. 1 ranged from 7,4 to 7,7, with an average pH value of 7,62. The pH values of the substrate loaded to reactor No. 2 ranged from 7,4 to 7,7, with an average pH value of 7,55.

The pH values of the substrate unloaded from reactor No. 1 ranged from 6,9 to 7,2, with an average pH value of 7,14. The pH values of the substrate unloaded from reactor No. 2 ranged from 6,8 to 7,2, with an average pH value of 7,06.

The determined pH values show that the substrate digestion environment was suitable in terms of pH for the efficient digestion process.

3.4.3 Conductivity Values in the Substrate

Values of conductivity are presented in Figures 3.67 and 3.68, and data on conductivity values are provided in Annex 6, clause 3.

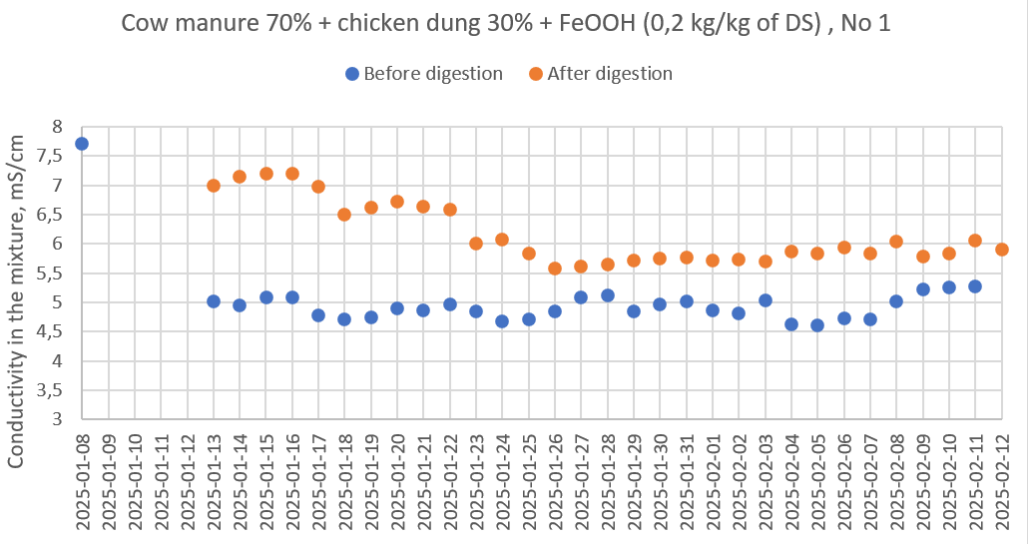

Figure 3.67. Conductivity values of substrate before and after digestion (reactor No. 1, Stage III)

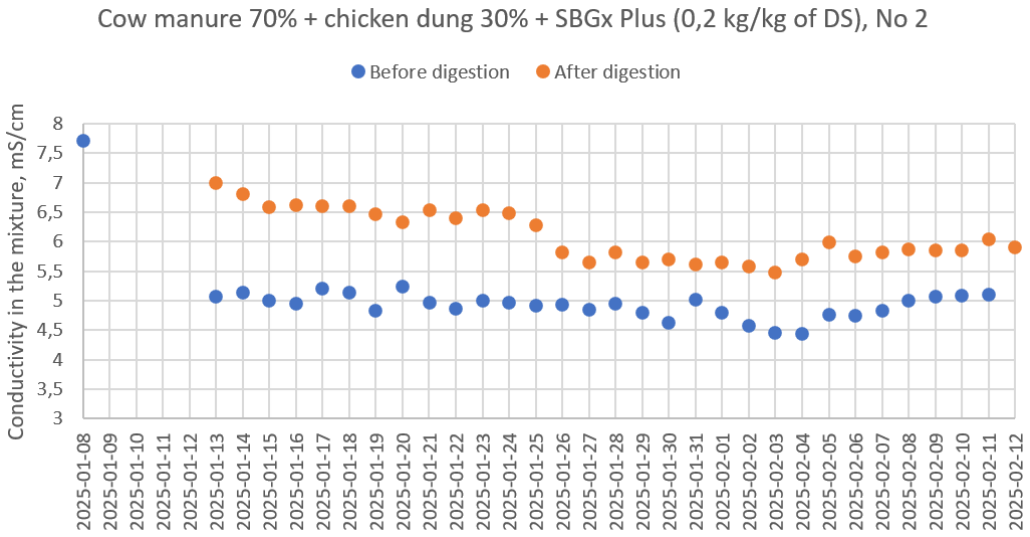

Figure 3.68. Conductivity values of substrate before and after digestion (reactor No. 2, Stage III)

The conductivity values of the substrate loaded to reactor No. 1 ranged from 4,6 to 7,7, with an average conductivity value of 5,0. The conductivity values of the substrate loaded to reactor No. 2 ranged from 4,4 to 7,7, with the average conductivity value of 5,0.

The conductivity values of the substrate unloaded from reactor No. 1 ranged from 5,6 to 7,2, with an average conductivity value of 6,2. The conductivity values of the substrate unloaded from reactor No. 2 ranged from 5,5 to 7,0, with an average conductivity value of 6,1.

3.4.4 Dry Solids and Volatile Solids

Values of dry solids (DS), volatile solids (VS), DS reduction and VS reduction are presented in Figures 3.69–3.74. Data on DS, VS, DS reduction and VS reduction values are provided in Annex 6, clause 4.

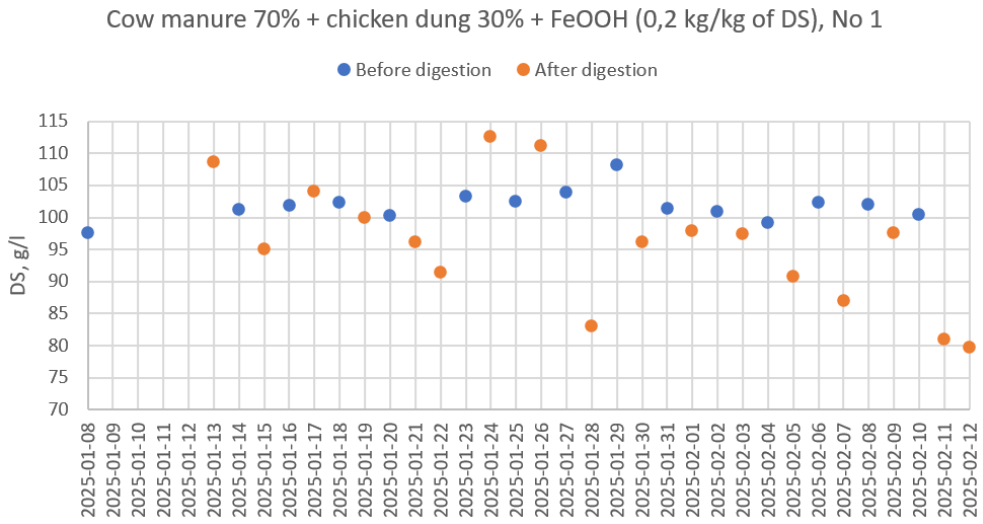

Figure 3.69. DS values of substrate before and after digestion (reactor No. 1, Stage III)

In the digested substrate from reactor No. 1, the dry matter concentration ranged from 2 % to 11 % higher than in the loaded substrate up until the fourteenth day after the start of substrate daily loading. Later, the DS concentration in the digested substrate from reactor No. 1 was always lower than in the loaded substrate.

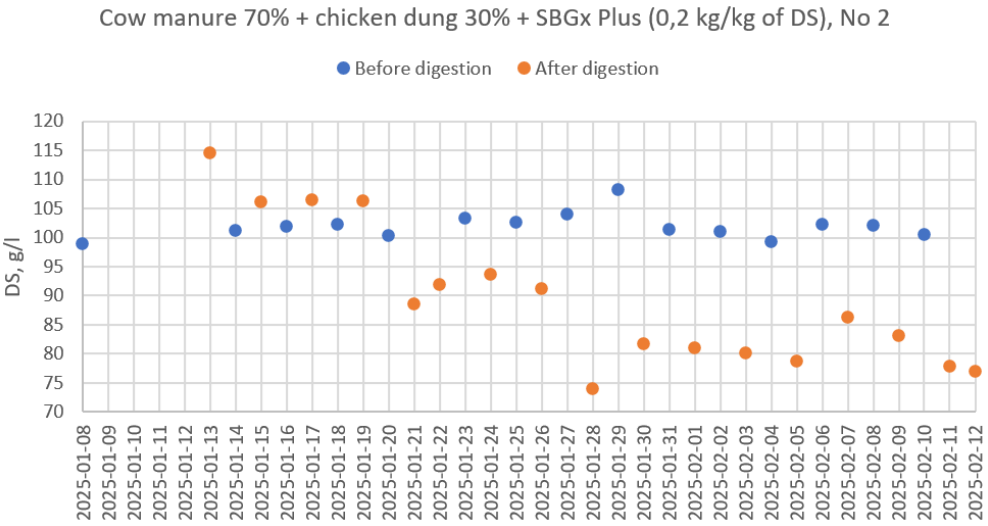

Figure 3.70. DS values of substrate before and after digestion (reactor No. 2, Stage III)

In the digested substrate from reactor No. 2, the dry matter concentration ranged from 4 % to 16 % higher than in the loaded substrate up until the seventh day after the start of substrate daily loading. Later, the DS concentration in the digested substrate from reactor No. 1 was always lower than in the loaded substrate.

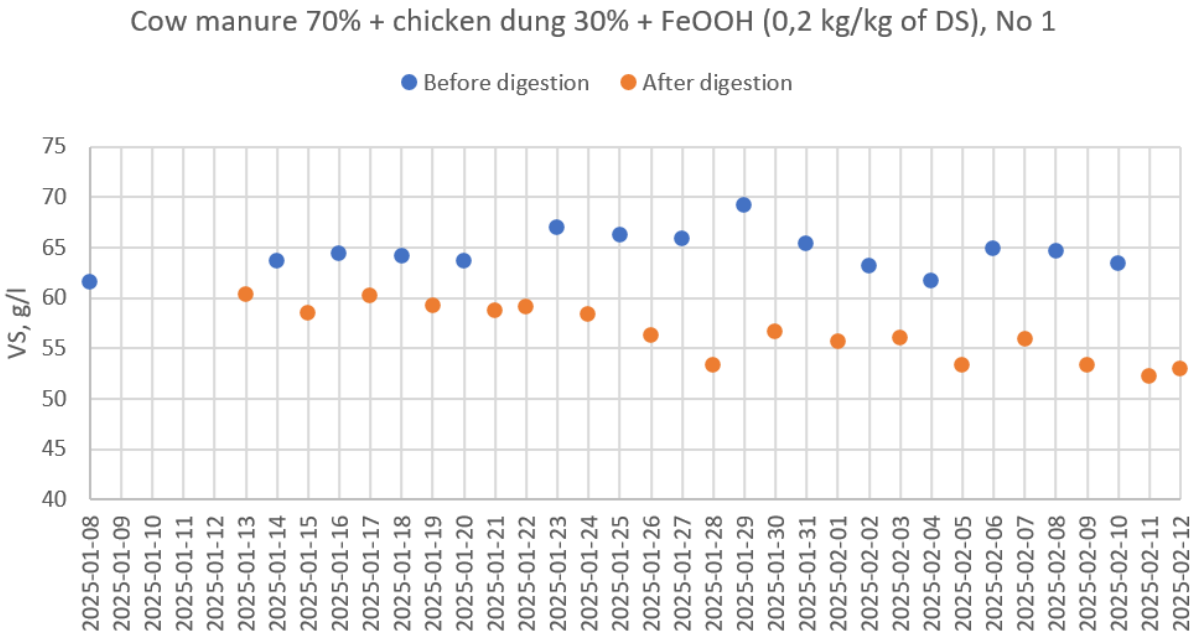

Figure 3.71. VS values of substrate before and after digestion (reactor No. 1, Stage III)

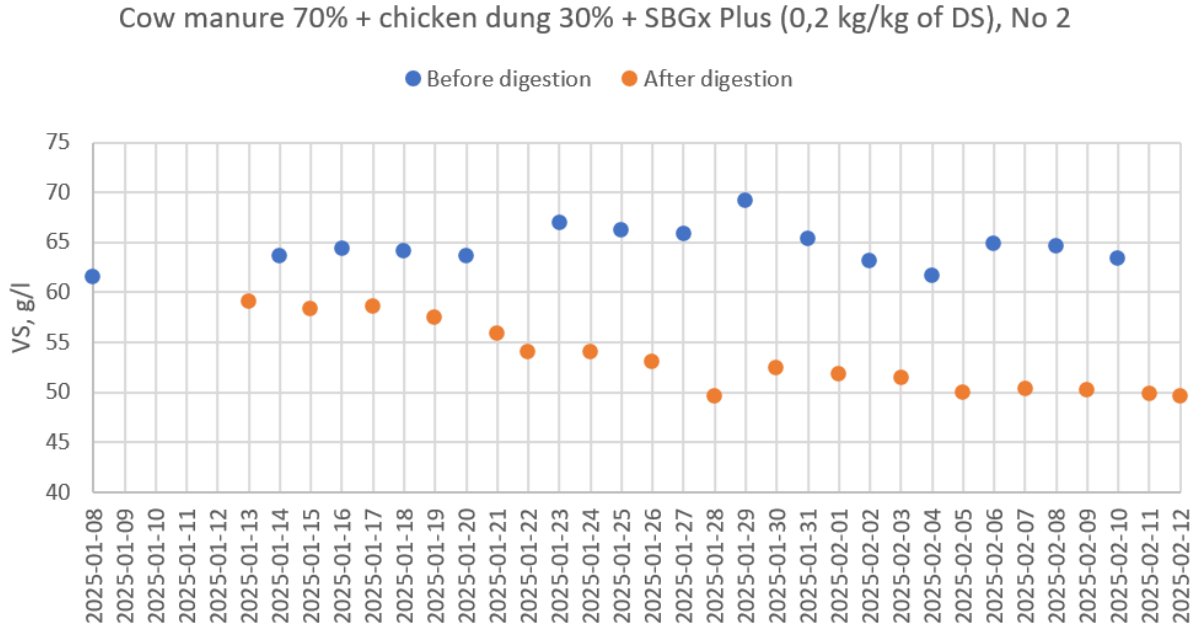

Figure 3.72. VS values of substrate before and after digestion (reactor No. 2, Stage III)

The VS concentration in the digested substrate from both reactors was always lower than in the loaded substrate.

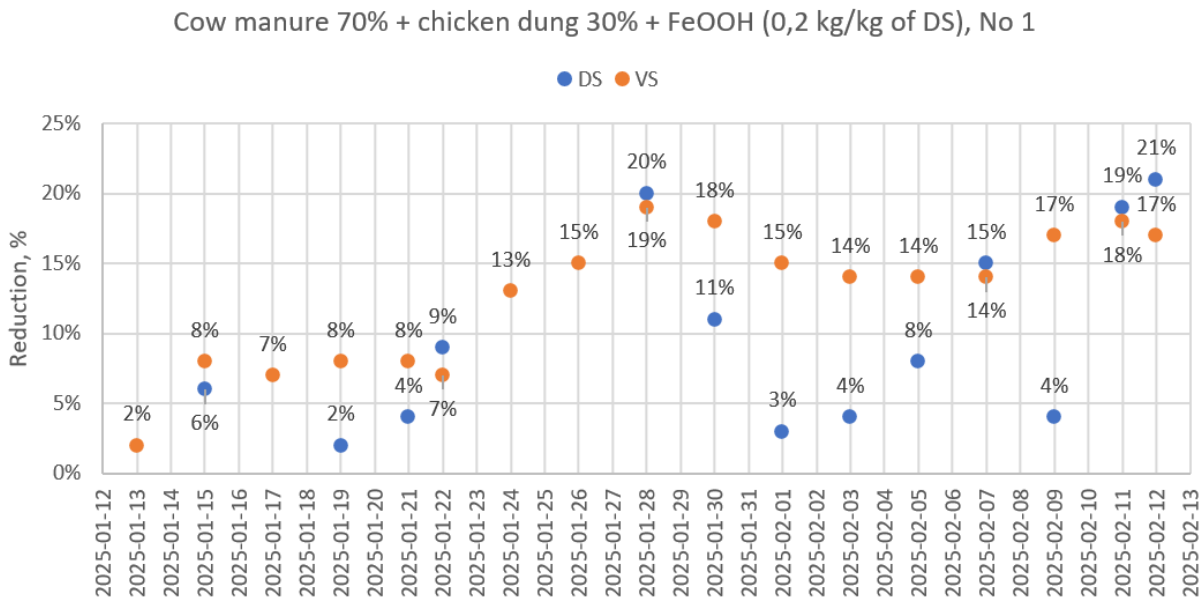

Figure 3.73. Reduction of VS values in substrate from reactor No. 1, Stage III

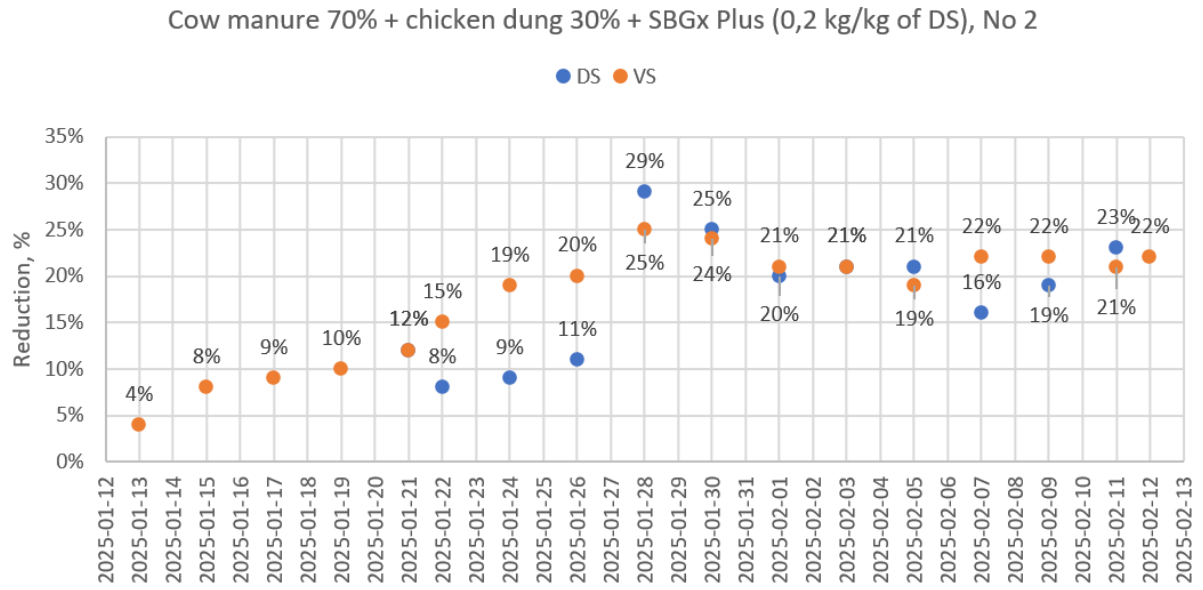

Figure 3.74. Reduction of VS values in substrate from reactor No. 2, Stage III

DS reduction in reactor No. 1 was unstable during all Stage III of the test. A more stable DS reduction in reactor No. 2 was observed from day 16 after the start of substrate daily loading, and a more stable VS destruction in both reactors was observed from day 12 after the start of substrate daily loading. Until that time, both DS reduction and VS destruction were increasing. In the period from 2025-01-28 to 2025-02-12, the average DS reduction reached 12 % in reactor No. 1, and it reached 22 % in reactor No. 2. In the period from 2025-01-24 to 2025-02-12, the average VS destruction reached 16 % in reactor No. 1, and it reached 21 % in reactor No. 2.

In the period from 2025-01-24 to 2025-02-12, the methane yield in reactor No. 1 ranged from 125 ml CH_4/g VS to 192 ml CH_4/g VS with the average value of 145 ml CH_4/g VS, and in reactor No. 2 it ranged from 145 ml CH_4/g VS to 188 ml CH_4/g VS with the average value of 158 ml CH_4/g VS. The average organic loading rate was equal to 2,2 kg VS/m^3/d.

3.4.5 Concentration of Ammonium in the Substrate

The concentration of ammonium in the samples was determined by the spectrophotometric method (ISO/TS 14256-1:2003). Values of ammonium concentration are presented in Figures 3.75 and 3.76, and data on ammonium concentration values are provided in Annex 6, clause 5.

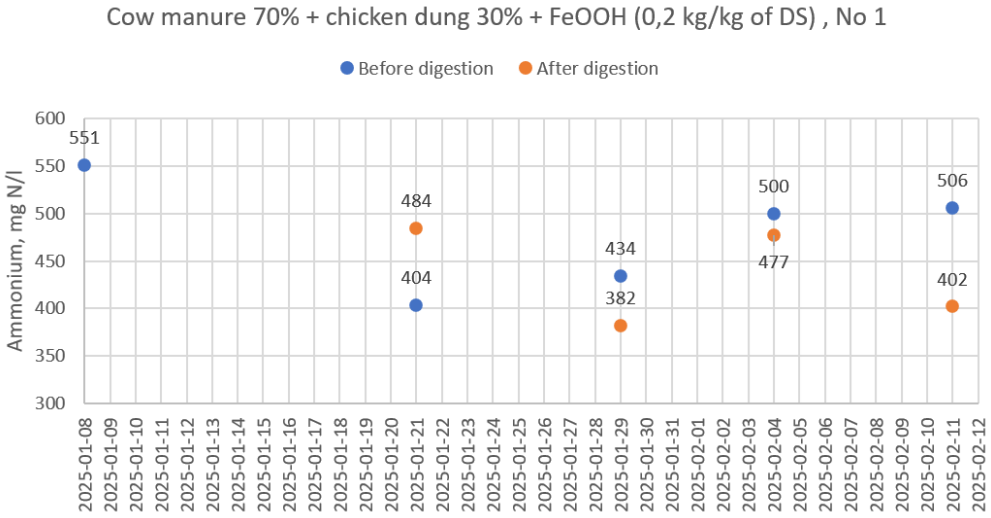

Figure 3.75. Values of ammonium concentration in substrate before and after digestion (reactor No. 1, Stage III)

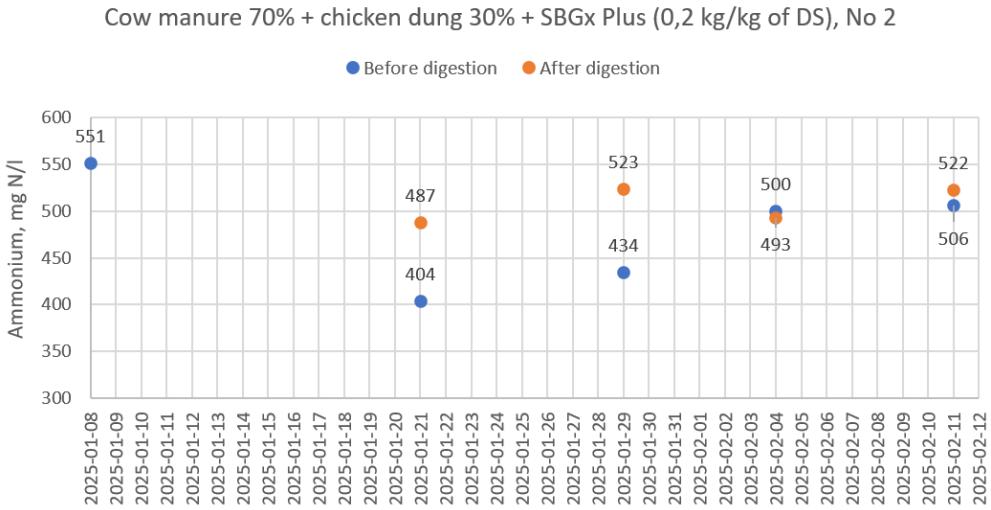

Figure 3.76. Values of ammonium concentration in substrate before and after digestion (reactor No. 2, Stage III)

The highest ammonium concentration in the loading substrate was 551 mg N/l in the initial phase of the Stage III. The ammonium concentration in the unloaded substrate from reactor No. 1 ranged from 382 mg N/l to 484 mg N/l, with an average value of 436. The ammonium concentration in the unloaded substrate from reactor No. 2 ranged from 487 mg N/l to 523 mg N/l, with an average value of 506. It seems that the ammonium nitrogen concentrations did not have an inhibitory effect on the anaerobic digestion process, as the reference indicates that the inhibiting concentration of ammonia nitrogen at pH >7,6 is 1000–3000 mg N/l (Akunna J. C., 2019).

3.4.6 Comparison by additive

Volatile solids before digestion as well as VS reduction of all three stages are presented in Figures 3.77–3.78.

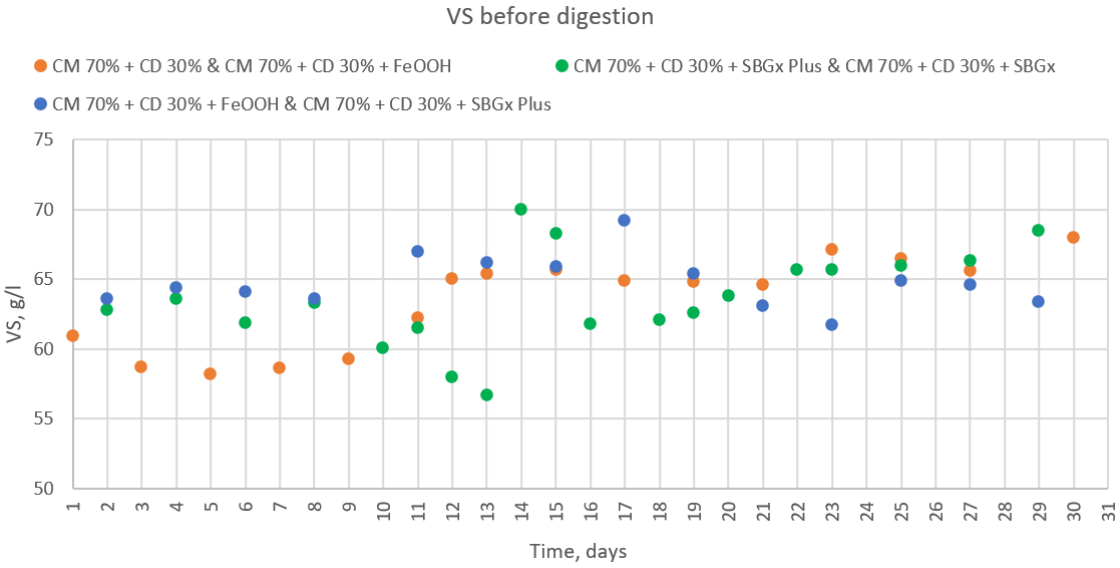

Figure 3.77. VS values of substrate before digestion, Stages I, II and III: CM – cow manure, CD – chicken dung

The same VS concentration was maintained during the different stages of the test. The difference between the VS concentration when the FeOOH additive was used in Stage I (63,4 g VS/l) and the VS concentration when the SBGx Plus additive was used in Stage II (63,6 g DS/l) was only 0,32 %. The difference between the VS concentration when the FeOOH additive was used in Stage I (63,4 g VS/l) and the VS concentration when the FeOOH and SBGx Plus additives were used in Stage III (64,8 g DS/l) was 2,2 %. Considering that the initial VS content during both stages of the test was similar, the VS degradation achieved in the individual stages can be compared.

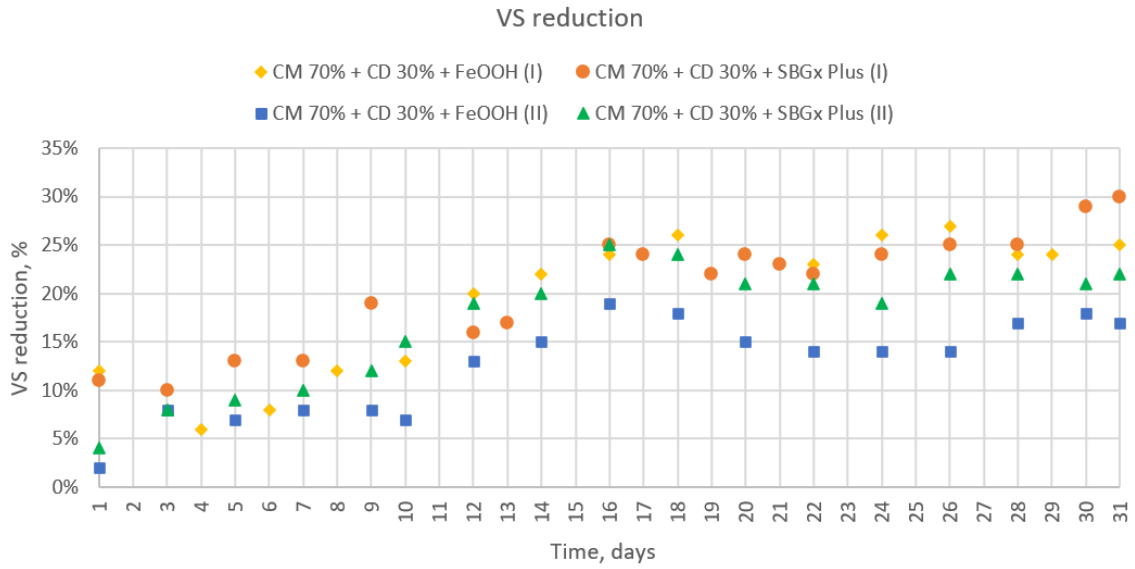

Figure 3.78. VS reduction during digestion, Stages I, II and III: CM – cow manure, CD – chicken dung

Figure 3.78 shows that when repeating the digestion test with the FeOOH additive, the decomposition of VS was lower: the average degradation of VS in the first case was 20 %, while in the second case it was only 13 %. Since the conditions of the first and second tests using the FeOOH additive were comparable, it is reasonable to assume that the decomposition of VS may be affected differently using the FeOOH additive. When using the SBGx Plus additive, the degradation of VS was similar in both cases – in the first case it was 20 %, in the second it was 18 %.

Biogas production rate when additive FeOOH was used is presented in Figure 3.79.

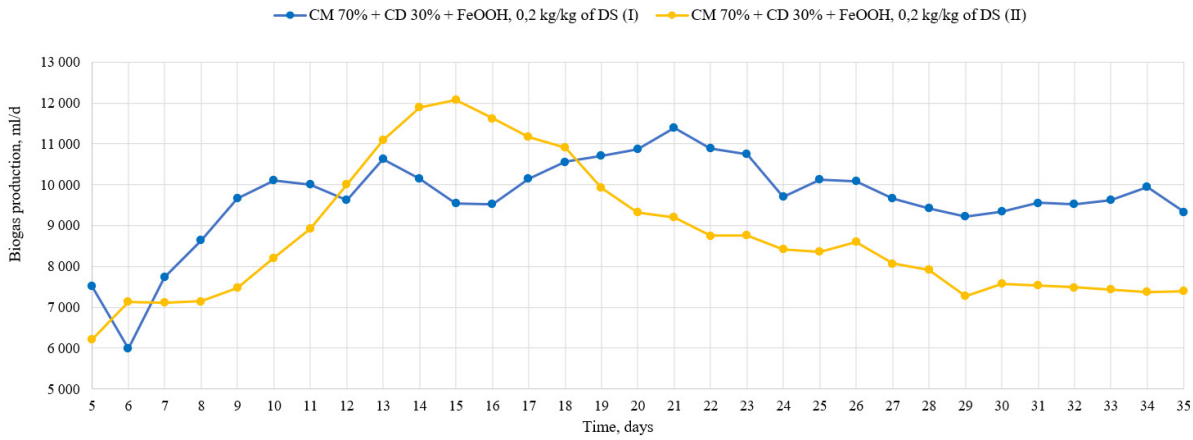

Figure 3.79. Biogas production when additive FeOOH was used: CM – cow manure, CD – chicken dung

Figure 3.79 shows that in the second case, when the FeOOH additive was used, biogas production rate began to decrease from the 19th day of the test, compared to the first case. An analysis of biogas production for two periods was performed, the results of which are presented in Table 3.8.

Table 3.8. Comparison of biogas production during different test periods when the FeOOH additive was used

Parameter	Biogas production using FeOOH			
	Days 5–18		Days 19–35	
	Average, l/d	Total, l	Average, l/d	Total, l
Run I	9,3	130	10,0	170
Run II	9,4	131	8,2	139
Difference	1,1%	0,8%	-18,0%	-18,2%

Table 3.8 shows that in both the first and second cases, biogas production rate was the same during the first 14 days from the start of substrate daily loading. Meanwhile, after 14 days, biogas production in the second case began to decrease, and during the remaining 17 days it was 18 % lower than in the first case. The lower biogas production could be due to lower decomposition of VS.
The total biogas production during the entire test period from the start of substrate daily loading was 300 l in the first case and 270 l in the second case, i.e., 10 % lower.

Methane content in biogas when additive FeOOH was used is presented in Figure 3.80.

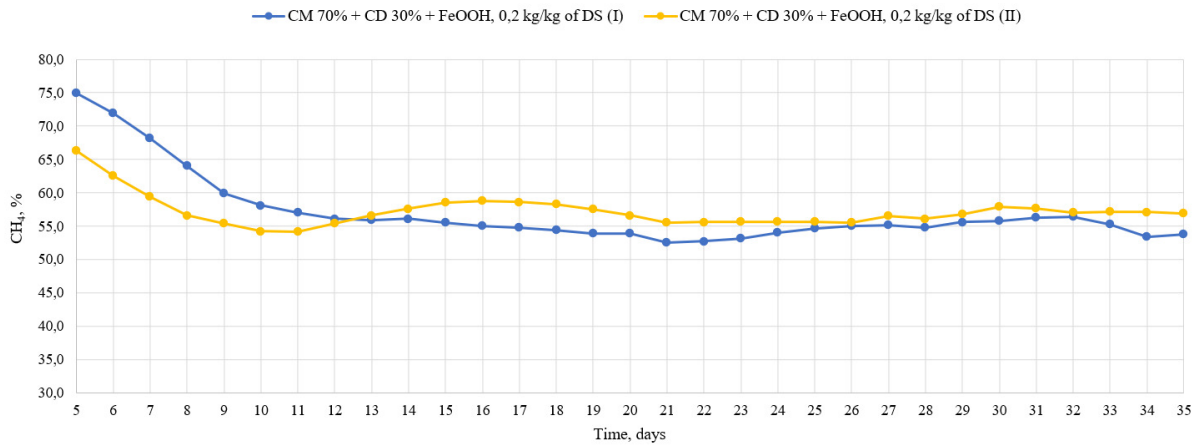

Figure 3.80. Methane content in biogas when additive FeOOH was used: CM – cow manure, CD – chicken dung

Figure 3.80 shows that in both cases where the FeOOH additive was used, the methane content in biogas was similar, and its average value was 57 %.

Methane production rate when additive FeOOH was used is presented in Figure 3.81.

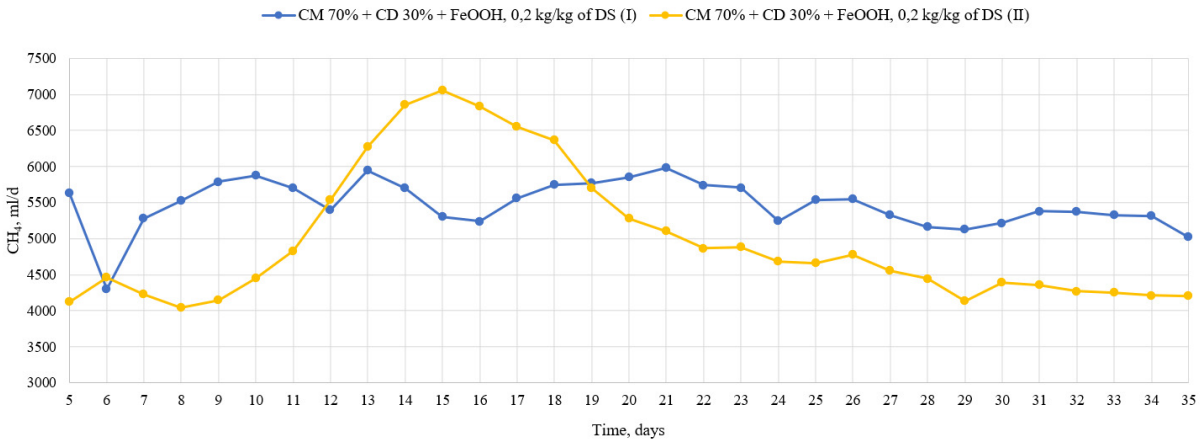

Figure 3.81. Methane production when additive FeOOH was used: CM – cow manure, CD – chicken dung

The methane production curves replicate the biogas production curves (Figures 3.79 and 3.81). The total methane production over the entire test period from the start of substrate daily loading was 170 l in the first case and 154 l in the second case, i.e., 8,9 % lower.

Biogas production rate when additive SBGx Plus was used is presented in Figure 3.82.

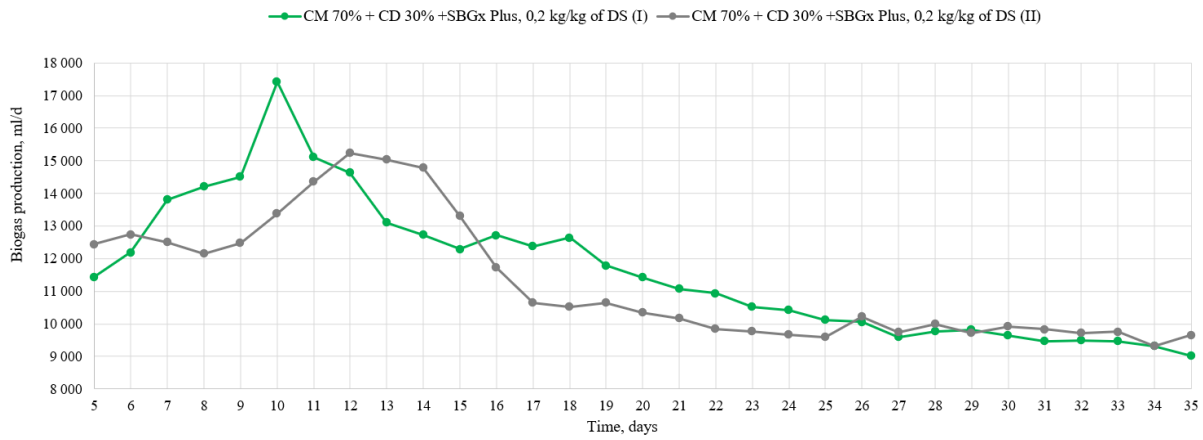

Figure 3.82. Biogas production when additive SBGx Plus was used: CM – cow manure, CD – chicken dung

Figure 3.82 shows that the trend of biogas production when using the SGBx Plus additive was similar in both cases. The total biogas production over the entire test period from the start of substrate daily loading was 361 l in the first case and 349 l in the second case, i.e., 3,3 % lower.

Methane content in biogas when additive SBGx Plus was used is presented in Figure 3.83.

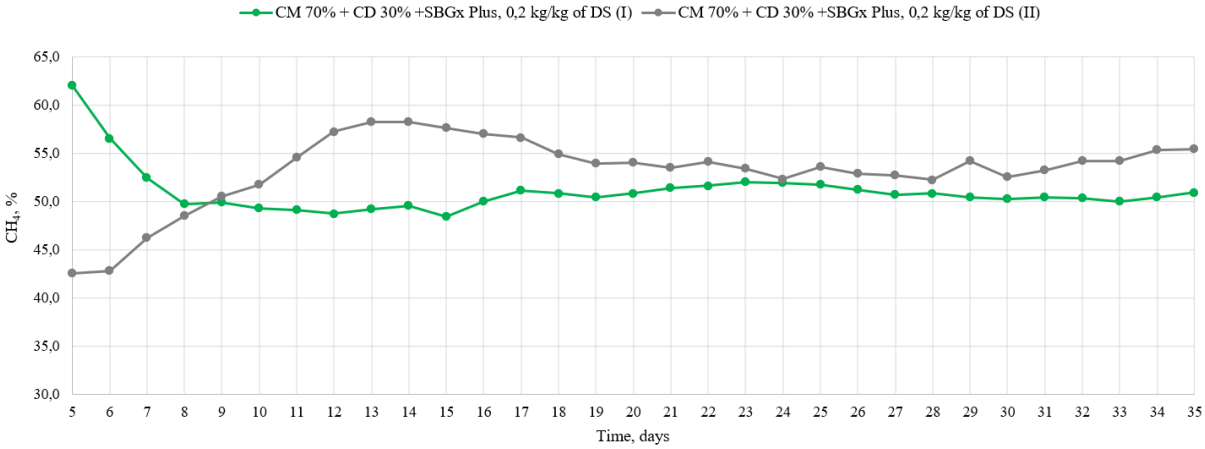

Figure 3.83. Methane content in biogas when additive SBGx Plus was used: CM – cow manure, CD – chicken dung

Figure 3.83 shows that in the second case, when the SBGx Plus additive was used, the methane content in biogas was higher than in the first case. The average methane content value over the entire test period from the start of substrate daily loading was 51 % in the first case and 53,2 % in the second case, i.e., 4,3 % higher.

Methane production rate when additive SBGx Plus was used is presented in Figure 3.84.

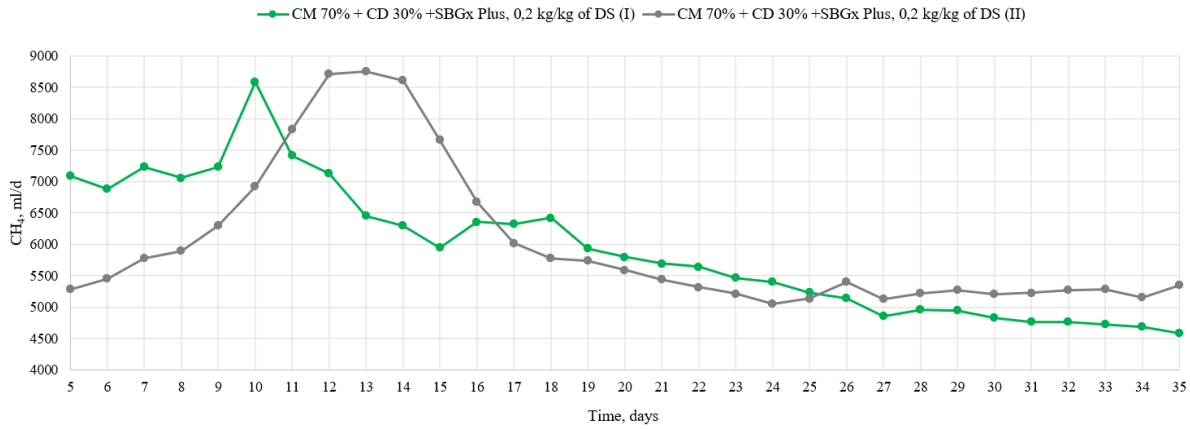

Figure 3.84. Methane production when additive SBGx Plus was used: CM – cow manure, CD – chicken dung

The total methane production when using SBGx Plus was similar in both cases throughout the test period from the start of substrate daily loading, and the difference was only 1,0 %. In the first case, 184 l of methane was produced, and in the second case, 186 l of methane was produced.

Conclusions

The use of the SBGx Plus additive did not reduce the total amount of biogas produced compared to the case without the additive, which was 364 l/31 d. Meanwhile, using the SBGx additive, the total amount of biogas produced was 4,1 % lower than without the additive (349 l/31 d), and using the FeOOH additive, the total amount of biogas produced was 17,6 % lower than without the additive (300 l/31 d).

After 15 days from the start of substrate daily loading, the biogas production rate became the same in all cases of Stages I and II. The highest amount of biogas during the first 15 days from the start of substrate daily loading was produced when digesting the substrate with the SBGx Plus additive, which was 201 l/15 d. Without using any additive, the amount of biogas produced for 15 days was 6,5 % lower than when using the SBGx Plus additive (188 l/15 d), and when using the FeOOH additive, the amount of biogas produced was 28,4 % lower than when using the SBGx Plus additive (144 l/15 d).

Although the average methane content in biogas (56,5 %) was recorded as the highest when the FeOOH additive was used, the methane production rate over the entire test period was the lowest (170 l CH_4/31 d). The highest methane production rate over the entire test period was recorded when the substrate was digested without additives (190 l CH_4/31 d). When using the SBGx and SBGx Plus additives, the methane production rate was 5,8 % and 3,2 % lower, respectively, than without additives, and when using the FeOOH additive, the methane production rate was 10,5 % lower than without additives.

After 14 days from the start of substrate daily loading, the methane production rate became the same in all cases of Stages I and II. The highest methane production rate during the first 14 days from the start of substrate daily loading occurred when the substrate was digested with the SBGx Plus additive (95 l CH_4/14 d). A similar methane production rate was observed when the SBGx additive was used and when no additive was used (92 l CH_4/14 d), which was 3,2 % lower than when the SBGx Plus additive was used. When the FeOOH additive was used, the methane production rate for 14 days (77 l CH_4/14 d) was 18,9 % lower than when the SBGx Plus additive was used.

Only SBGx Plus was more effective in terms of biogas production and methane production, and only during the first 14 days after the start of substrate daily loading. Compared to the case when no additive was used, biogas production increased by 6,9 % over 14 days, and the methane production rate increased by 3,3 %. Over the entire test period, biogas production was 0,8 % lower and methane production rate was 3,2 % lower with SBGx Plus than without any additive.

Using the SBGx Plus additive resulted in a 20 % higher biogas production rate and an 8,2 % higher methane production rate over the entire test period than using the FeOOH additive.

During the entire test period, the lowest H_2S concentration in biogas was observed when digesting the substrate with the SBGx Plus additive, the maximum value of which reached 10 ppm, and the average value over the entire test period was 1.88 ppm. When using the SBGx and SBGx Plus additives, the average H_2S concentration in biogas was 91 % and 96 % lower, respectively, than without using any additive, and when using the FeOOH additive, the average methane concentration in biogas was 65% lower than without using any additive. The results obtained show that the use of additives effectively reduces the H_2S concentration in biogas, especially SBGx Plus and SBGx.

The difference between the concentration of VS when using the FeOOH additive in Stage I (63,4 g VS/l) and the concentration of VS when using the SBGx and SBGx Plus additives in Stage II (63,6 g DS/l) was only 0,32 %. The highest average degradation of VS was observed when digesting the substrate without additives, the value of which was 24 % over the entire test period. When using

the FeOOH and SBGx Plus additives, the average degradation of VS was 17 % lower than when without any additive, and when using the SBGx additive, the average decomposition of VS was 19 % lower than when without any additive.

In Stage III, when FeOOH additive was used, a total of 270 l of biogas was produced during the analysed period, and when additive SBGx Plus was used, a total of 349 l of biogas was produced, i.e., 29 % more than with FeOOH.

In Stage III, the methane content was on average 57,1 % using FeOOH, and it was on average 53,2 % using SBGx Plus, i.e., 6,8 % less than with FeOOH. However, the average daily methane production rate was by 20 % higher when additive SBGx Plus was used: it was 5,0 l/d using FeOOH and it was 6,0 l/d using SBGx Plus.

In Stage III, the average H_2S concentration was 0,0 ppm in both cases when FeOOH and SBGx Plus additives were used.

In both cases of the test, when the FeOOH additive was used, the methane content in the biogas was similar, and its average value was 57 %. The total biogas production during the entire test period from the start of substrate daily loading in the second case (270 l) was 10 % lower than in the first case (300 l), and methane production was 8,9 % lower. During the first 14 days from the start of substrate daily loading, biogas production was the same. Meanwhile, after 14 days, biogas production in the second case began to decrease, and during the remaining 17 days it was 18 % lower than in the first case. The lower biogas production could be due to the lower degradation of VS, which in the first case was 20 %, while in the second case it reached only 13 %.

The average methane content value when using the SBGx Plus additive during the entire test period from the start of substrate daily loading was 51,0 % in the first case and 53,2 % in the second case; the difference was 4,3 %. Meanwhile, 3,3 % more biogas was produced in the first case (361 l) than in the second case (349 l). Thus, methane production was the same in both cases – 185 l during the entire test period from the start of substrate daily loading.

References

Akunna J. C., 2019. Anaerobic Waste Wastewater Treatment and Biogas Plants. A Practical Handbook. Taylor & Francis Group, LLC.

Annexes

Annex 1. Data of Stage I
Annex 2. Material report from the test of dried sediments from reactor No. 2 when FeOOH was used (Stage I).
Annex 3. Data of Stage II
Annex 4. Material report from the test of dried sediments from reactor No. 1 when SBGx Plus was used (Stage II).
Annex 5. Material report from the test of dried sediments from reactor No. 2 when SBGx was used (Stage II).
Annex 6. Data of Stage III

Annex 1. Data of Stage I

1. Data on hourly biogas production

Date	Time	Reactor No. 1	Reactor No. 2
		ml/h	ml/h
2024-11-04	09:00	500	356
	15:50	403	184
2024-11-05	09:00	469	230
	15:00	513	249
2024-11-06	09:00	545	325
	15:00	553	316
2024-11-07	09:00	600	364
	15:00	526	348
2024-11-08	09:00	594	413
	14:40	521	370
2024-11-09	10:20	577	424
	14:45	532	405
2024-11-10	10:26	580	424
	14:45	515	384
2024-11-11	10:00	561	414
	14:50	512	351
2024-11-12	12:00	499	445
	15:00	435	427
2024-11-13	09:00	493	441
	14:50	457	368
2024-11-14	09:00	500	408
	14:50	443	366
2024-11-15	14:50	486	397
	15:00	450	300
2024-11-16	09:15	522	432
	14:50	479	380
2024-11-17	10:25	518	450
	14:50	464	395
2024-11-18	09:00	527	479
	14:50	366	345
2024-11-19	09:00	470	470
	15:00	421	398
2024-11-20	09:00	503	498
	14:47	389	402
2024-11-21	08:00	470	477
	14:45	385	395
2024-11-22	09:00	453	470
	14:50	394	377
2024-11-23	10:05	440	420
	14:52	363	341
2024-11-24	14:05	404	421

Date	Time	Reactor No. 1	Reactor No. 2
		ml/h	ml/h
	14:50	452	452
2024-11-25	09:00	432	444
	14:50	366	349
2024-11-26	09:30	462	424
	14:50	407	327
2024-11-27	09:00	489	422
	14:50	409	310
2024-11-28	09:00	510	404
	14:50	424	321
2024-11-29	08:50	515	420
	14:50	404	299
2024-11-30	10:00	496	420
	14:50	416	312
2024-12-01	09:27	493	418
	14:50	408	322
2024-12-02	08:50	503	423
	14:50	421	335
2024-12-03	09:00	516	448
	14:50	407	310
2024-12-04	08:45	489	422
	11:40	340	293
Average		**471**	**383**
Min		**340**	**184**
Max		**600**	**498**

2. Data on pH values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-10-30	7,54		7,65	
2024-11-04	7,49	7,23	7,64	7,33
2024-11-05	7,42	7,20	7,40	7,34
2024-11-06		7,21		7,37
2024-11-07	7,34	7,15	7,38	7,28
2024-11-08	7,23	7,21	7,43	7,34
2024-11-09	7,25	7,19	7,35	7,30
2024-11-10	7,20	7,17	7,34	7,23
2024-11-11	7,21	7,17	7,44	7,29
2024-11-12	7,16	7,14	7,32	7,22
2024-11-13	7,35	7,17	7,45	7,27
2024-11-14	7,34	7,15	7,50	7,22
2024-11-15	7,32	7,11	7,43	7,20
2024-11-16	7,33	7,07	7,44	7,17
2024-11-17	7,32	7,11	7,42	7,17

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-11-18	7,33	7,15	7,48	7,22
2024-11-19	7,27	7,18	7,40	7,26
2024-11-20	7,38	7,13	7,49	7,22
2024-11-21	7,33	7,31	7,45	7,22
2024-11-22	7,36	7,01	7,51	7,18
2024-11-23	7,32	7,08	7,41	7,15
2024-11-24	7,32	7,09	7,40	7,14
2024-11-25	7,06	7,12	7,28	7,22
2024-11-26	7,14	7,04	7,23	7,20
2024-11-27	7,06	7,02	7,20	7,18
2024-11-28	7,05	7,07	7,19	7,22
2024-11-29	7,06	7,08	7,24	7,17
2024-11-30	7,02	7,02	7,18	7,18
2024-12-01	7,07	7,07	7,23	7,20
2024-12-02	7,03	7,04	7,22	7,22
2024-12-03	7,16	7,05	7,34	7,18
2024-12-04		7,11		7,23
Average	**7,25**	**7,12**	**7,38**	**7,23**
Max	**7,54**	**7,31**	**7,65**	**7,37**
Min	**7,02**	**7,01**	**7,18**	**7,14**

3. Data on conductivity values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-10-30	7,44		7,41	
2024-11-04	5,61	8,46	5,66	8,89
2024-11-11	6,14	7,97	6,05	8,43
2024-11-13	6,16	7,89	6,17	8,23
2024-11-14	5,75	7,95	5,73	8,30
2024-11-15	6,25	7,88	6,33	7,89
2024-11-16	6,50	7,84	6,52	8,10
2024-11-17	6,22	7,86	6,12	8,14
2024-11-20	6,32	7,82	6,44	7,82
2024-11-22	6,25	7,74	6,39	8,00
2024-11-23	6,31	7,81	6,38	7,94
2024-11-24	6,38	7,72	6,38	7,95
2024-11-25	6,71	7,68	6,82	8,06
2024-11-26	6,91	7,61	6,82	7,75
2024-11-27	6,92	7,74	6,72	7,99
2024-11-28	6,52		6,50	
2024-11-29	6,87	7,62	6,83	7,79
2024-11-30	6,88	7,48	6,81	7,81
2024-12-01	6,63	7,47	6,76	7,61
2024-12-02	6,25	7,62	6,42	7,78

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-03	6,86	7,57	6,66	7,81
2024-12-04		7,63		7,70
Average	**6,47**	**7,77**	**6,47**	**8,00**
Max	**7,44**	**8,46**	**7,41**	**8,89**
Min	**5,61**	**7,47**	**5,66**	**7,61**

4. Data on VS, DS, DS reduction and VS reduction

Date	Cow manure 70% + chicken dung 30%, No. 1						Cow manure 70% + chicken dung 30% + FeOOH (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2024-10-30	82,2		59,9				96,9		62,0			
2024-11-04	78,1	78,8	60,9	55,6	4%	7%	95,6	91,9	60,9	54,6	5%	12%
2024-11-06	74,9		58,7				92,4		58,7			
2024-11-07		77,6		52,2	-4%	11%		99,1		55,2	-7%	6%
2024-11-08	75,3		58,2				92,8		58,2			
2024-11-09		76,9		49,7	-2%	15%		96,7		53,6	-4%	8%
2024-11-10	75,0		58,6				92,5		58,6			
2024-11-11		74,6		47,9	1%	18%		88,5		51,5	4%	12%
2024-11-12	75,7		59,3				93,2		59,3			
2024-11-13		70,0		48,4	8%	18%		89,5		51,6	4%	13%
2024-11-14	69,5		62,2				87,0		62,2			
2024-11-15	85,6	66,0	65,0	47,2	12%	26%	103,1	87,8	65,0	51,0	5%	20%
2024-11-16	81,0		65,4				98,5		65,4			
2024-11-17		66,0		47,7	19%	27%		85,2		51,2	14%	22%
2024-11-18	85,6		65,7				103,1		65,7			
2024-11-19		65,7		47,3	23%	28%		82,6		49,8	20%	24%
2024-11-20	84,8		64,9				102,3		64,9			
2024-11-21		66,6		47,1	21%	27%		82,1		47,9	20%	26%
2024-11-22	86,1		64,8				103,6		64,8			
2024-11-23		64,4		47,2	25%	27%		82,7		49,0	20%	24%
2024-11-24	83,8		64,6				101,3		64,6			
2024-11-25		66,4		46,9	21%	27%		82,9		49,9	18%	23%

Date	Cow manure 70% + chicken dung 30%, No. 1						Cow manure 70% + chicken dung 30% + FeOOH (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2024-11-26	85,2		67,1				102,7		67,1			
2024-11-27		66,3		46,8	22%	30%		82,2		49,5	20%	26%
2024-11-28	84,8		66,5				102,3		66,5			
2024-11-29		66,2		46,3	22%	30%		81,0		48,8	21%	27%
2024-11-30	84,3		65,6				101,8		65,6			
2024-12-01		67,9		47,6	19%	27%		87,2		50,0	14%	24%
2024-12-02		69,8		46,7	17%	29%		83,3		50,0	18%	24%
2024-12-03	90,3		68,0				107,8		68,0			
2024-12-04		67,7		47,7	25%	30%		86,3		51,0	20%	25%
Average	**81,3**	**69,4**	**63,3**	**48,3**			**98,6**	**86,8**	**63,4**	**50,9**		
Max	**90,3**	**78,8**	**68,0**	**55,6**			**107,8**	**99,1**	**68,0**	**55,2**		
Min	**69,5**	**64,4**	**58,2**	**46,3**			**87,0**	**81,0**	**58,2**	**47,9**		

5. Data on ammonium concentration values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-11-12	882	931	882	684
2024-11-19	457	763	457	858
2024-11-26	488	714	488	678
2024-12-03	462	631	462	1060
Average	**572**	**760**	**572**	**820**
Max	**882**	**931**	**882**	**1 060**
Min	**457**	**631**	**457**	**678**

Annex 2. Material report from the test of dried sediments from reactor No. 2 when FeOOH was used (Stage I)

SciAps **Material Report** 18:10 am, 22/11/2024 #132

CHEMICAL ELEMENTS

P Phosphorus	8592 ppm	± 1834
S Sulfur	6628 ppm	± 1303
K Potassium	7055 ppm	± 237
Ca Calcium	>10%	
Ti Titanium	742 ppm	± 71
V Vanadium	ND	< 12
Cr Chromium	25 ppm	± 11
Mn Manganese	4058 ppm	± 146
Fe Iron	>10%	
Co Cobalt	ND	< 190
Ni Nickel	36 ppm	± 14
Cu Copper	ND	< 15
Zn Zinc	126 ppm	± 10
As Arsenic	12 ppm	± 2.8
Se Selenium	ND	< 2.1
Rb Rubidium	ND	< 2.8
Sr Strontium	369 ppm	± 8.0
Zr Zirconium	ND	< 11
Nb Niobium	ND	< 1.3
Mo Molybdenum	ND	< 2.0

INSTRUMENT INFO

SERIAL # X200-30320

TEST INFO

BARCODE

SAMPLE ID
R3

1/2

CHEMICAL ELEMENTS

Ag Silver	ND	< 4.2
Cd Cadmium	ND	< 6.3
Sn Tin	ND	< 7.7
Sb Antimony	ND	< 15
Te Tellurium	ND	< 19
Ba Barium	288 ppm	± 45
La Lanthanum	ND	< 172
Ce Cerium	ND	< 220
Pr Praseodymium	ND	< 443
Nd Neodymium	ND	< 514
Hg Mercury	ND	< 1.9
Pb Lead	13 ppm	± 4.0

Annex 3. Data of Stage II

1. Data on hourly biogas production

Date	Time	Reactor No. 1	Reactor No. 2
		ml/h	ml/h
2024-12-09	08:45	464	387
	14:45	515	444
2024-12-10	08:45	506	451
	15:00	512	458
2024-12-11	09:00	581	505
	14:45	557	457
2024-12-12	08:45	603	501
	15:00	558	486
2024-12-13	08:45	605	540
	14:45	586	549
2024-12-14	09:30	706	667
	14:58	784	612
2024-12-15	10:10	635	630
	14:58	608	582
2024-12-16	08:45	627	631
	14:45	562	566
2024-12-17	08:45	565	575
	14:45	492	505
2024-12-18	08:45	541	558
	14:45	496	498
2024-12-19	08:45	522	569
	14:45	482	465
2024-12-20	08:45	548	568
	14:45	475	488
2024-12-21	10:45	474	481
	14:45	452	465
2024-12-22	10:50	541	553
	14:45	452	433
2024-12-23	11:00	500	480
	14:45	442	395
2024-12-24	09:55	494	484
	14:50	406	393
2024-12-25	08:45	483	462
	14:45	398	385
2024-12-26	09:25	471	462
	14:45	403	379
2024-12-27	10:45	445	442
	14:45	402	377
2024-12-28	09:50	450	435
	14:45	370	360
2024-12-29	10:15	431	434

Date	Time	Reactor No. 1	Reactor No. 2
		ml/h	ml/h
	14:45	380	371
2024-12-30	10:00	428	434
	14:45	381	368
2024-12-31	10:30	403	400
	14:45	381	357
2025-01-01	10:20	410	418
	14:45	392	361
2025-01-02	09:30	418	420
	14:45	378	352
2025-01-03	09:30	415	397
	14:45	354	328
2025-01-04	10:00	409	396
	14:45	333	317
2025-01-05	14:33	391	380
	14:45	565	250
2025-01-06	08:45	407	389
	14:45	364	350
2025-01-07	08:45	402	396
	14:45	345	341
2025-01-08	08:45	396	395
	14:45	329	332
Average		**475**	**449**
Min		**329**	**250**
Max		**784**	**667**

2. Data on pH values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-04	7,68		7,57	
2024-12-09	7,43	7,30	7,46	7,29
2024-12-10	7,43	7,30	7,43	7,24
2024-12-11	7,39	7,09	7,37	7,19
2024-12-12	7,35	7,20	7,35	7,18
2024-12-13	7,34	7,06	7,35	7,13
2024-12-14	7,31	7,06	7,35	7,08
2024-12-15	7,28	7,07	7,29	7,10
2024-12-16	7,36	7,21	7,40	7,19
2024-12-17	7,42	7,11	7,43	7,22
2024-12-18	7,45	7,10	7,46	7,13
2024-12-19	7,26	7,24	7,29	7,21
2024-12-20	7,40	7,10	7,31	7,11
2024-12-21	7,19	7,02	7,19	7,05
2024-12-22	7,19	7,07	7,24	7,09

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-23	7,24	7,15	7,24	7,15
2024-12-24	7,30	7,08	7,30	7,08
2024-12-25	7,21	7,07	7,25	7,11
2024-12-26	7,17	7,06	7,27	7,05
2024-12-27	7,28	7,03	7,35	7,10
2024-12-28	7,37	7,09	7,38	7,11
2024-12-29	7,31	7,02	7,35	7,07
2024-12-30	7,34	7,11	7,42	7,11
2024-12-31	7,33	7,04	7,38	7,09
2025-01-01	7,32	7,10	7,37	7,14
2025-01-02	7,26	7,03	7,34	7,07
2025-01-03	7,42	7,04	7,42	7,07
2025-01-04	7,22	7,06	7,26	7,11
2025-01-05	7,29	7,06	7,31	7,08
2025-01-06	7,41	7,16	7,39	7,14
2025-01-07	7,38	7,09	7,43	7,11
2025-01-08		7,06		7,12
Average	**7,33**	**7,10**	**7,35**	**7,13**
Max	**7,68**	**7,30**	**7,57**	**7,29**
Min	**7,17**	**7,02**	**7,19**	**7,05**

3. Data on conductivity values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-04	7,71		7,71	
2024-12-09	5,49	8,82	5,52	8,75
2024-12-10	5,38	8,87	5,46	8,73
2024-12-11	5,28	8,76	5,37	8,41
2024-12-12	5,57	8,33	5,43	8,20
2024-12-13	5,21	8,47	5,28	8,74
2024-12-14	5,50	8,25	5,54	8,44
2024-12-15	5,07	8,29	5,47	8,48
2024-12-16	5,38	8,23	5,32	8,62
2024-12-17	5,49	8,16	5,48	8,30
2024-12-18	5,47	8,28	5,43	8,13
2024-12-19	6,15	8,09	5,81	8,09
2024-12-20	6,18	8,05	6,09	8,10
2024-12-21	5,26	7,74	6,03	7,86
2024-12-22	5,19	7,83	6,16	7,95
2024-12-23	6,42	7,79	6,16	7,91
2024-12-24	4,93	7,84	6,00	8,07
2024-12-25	5,98	7,92	6,11	7,98
2024-12-26	5,16	7,74	5,62	8,02
2024-12-27	5,72	7,69	5,68	7,87

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-28	5,45	7,56	6,00	7,78
2024-12-29	5,52	7,83	5,70	7,74
2024-12-30	5,36	7,61	5,24	7,80
2024-12-31	5,00	7,46	5,24	7,83
2025-01-01	5,23	7,59	5,79	7,73
2025-01-02	5,56	7,57	5,60	7,69
2025-01-03	5,68	7,60	5,56	7,58
2025-01-04	5,31	7,37	5,53	7,49
2025-01-05	5,55	7,24	5,59	7,50
2025-01-06	5,50	7,52	5,33	7,41
2025-01-07	5,44	7,37	5,64	7,49
2025-01-08		7,35		7,42
Average	**5,55**	**7,91**	**5,71**	**8,00**
Max	**7,71**	**8,87**	**7,71**	**8,75**
Min	**4,93**	**7,24**	**5,24**	**7,41**

4. Data on VS, DS, DS reduction and VS reduction

Date	Cow manure 70% + chicken dung 30% + SBGx Plus (0,2 kg/kg of DS), No. 1						Cow manure 70% + chicken dung 30% + SBGx (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2024-12-04	99,2		61,9				98,9		61,1			
2024-12-09		151,2		55,1	-52%	11%		95,0		57,8	4%	5%
2024-12-10	97,8		62,8				97,8		62,8			
2024-12-11		101,3		56,5	-4%	10%		97,8		55,8	0%	11%
2024-12-12	98,9		63,6				98,9		63,6			
2024-12-13		95,3		55,5	4%	13%		92,2		56,0	7%	12%
2024-12-14	96,5		61,9				96,5		61,9			
2024-12-15		106,6		53,7	-10%	13%		99,4		54,5	-3%	12%
2024-12-16	99,1		63,3				99,1		63,3			
2024-12-17		118,6		51,0	-20%	19%		88,1		51,0	11%	19%
2024-12-18	95,1		60,1				95,1		60,1			
2024-12-19	96,0		61,5				96,0		61,5			
2024-12-20	94,4	84,0	58,0	51,4	13%	16%	94,4	83,8	58,0	50,8	13%	17%
2024-12-21	91,7	113,2	56,7	50,9	-18%	17%	91,7	87,3	56,7	51,0	9%	17%
2024-12-22	109,7	86,0	70,0	50,1	6%		109,7	82,1	70,0	51,1	10%	
2024-12-23	107,3	89,5	68,3	50,6	2%		107,3	79,6	68,3	50,1	13%	
2024-12-24	97,6	87,9	61,8	51,2	18%	25%	97,6	88,2	61,8	51,4	18%	25%
2024-12-25		87,8		49,2	18%	24%		78,2		49,0	27%	25%
2024-12-26	99,3		62,1				99,3		62,1			
2024-12-27	100,0	107,1	62,6	48,3	-8%	22%	100,0	76,5	62,6	47,9	23%	23%
2024-12-28	102,5	100,5	63,8	47,8	0%	24%	102,5	81,7	63,8	48,9	18%	22%
2024-12-29		79,8		49,1	22%	23%		80,2		49,7	22%	22%

Date	Cow manure 70% + chicken dung 30% + SBGx Plus (0,2 kg/kg of DS), No. 1						Cow manure 70% + chicken dung 30% + SBGx (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2024-12-30	104,8	87,2	65,7	50,0	15%	22%	104,8	77,5	65,7	49,8	24%	22%
2024-12-31	104,2		65,7				104,2		65,7			
2025-01-01		83,3		50,0	20%	24%		80,7		51,0	23%	22%
2025-01-02	101,8		66,0				101,8		66,0			
2025-01-03		78,2		49,7	23%	25%		78,0		50,5	23%	23%
2025-01-04	103,6		66,3				103,6		66,3			
2025-01-05		81,8		49,4	21%	25%		78,7		49,8	24%	25%
2025-01-06	112,1		68,5				112,1		68,5			
2025-01-07		74,2		48,7	34%	29%		79,3		49,4	29%	28%
2025-01-08		81,8		47,9	27%	30%		79,7		49,4	29%	28%
Average	**100,7**	**94,8**	**63,6**	**50,8**			**100,7**	**84,2**	**63,6**	**51,2**		
Max	**112,1**	**151,2**	**70,0**	**56,5**			**112,1**	**99,4**	**70,0**	**57,8**		
Min	**91,7**	**74,2**	**56,7**	**47,8**			**91,7**	**76,5**	**56,7**	**47,9**		

5. Data on ammonium concentration values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2024-12-04	1300		1300	
2024-12-17	351	957	351	1070
2024-12-26	455	859	455	902
2025-01-01	368	767	368	827
2025-01-07	422	687	422	610
Average	**579**	**818**	**579**	**852**
Max	**1300**	**957**	**1300**	**1070**
Min	**351**	**687**	**351**	**610**

Annex 4. Material report from the test of dried sediments from reactor No. 1 when SBGx Plus was used (Stage II)

SciAps **Material Report** 15:19 pm, 10/01/2025 #229

SOIL

Soil

INSTRUMENT INFO

SERIAL #	X200-30320
DISPLAY_SIGMA	2.0
LOD_SIGMA	3.0

TEST INFO

BARCODE

SAMPLE ID
R3

CHEMICAL ELEMENTS

P	Phosphorus	ND	< 7215
S	Sulfur	5034 ppm	± 1829
K	Potassium	7078 ppm	± 334
Ca	Calcium	7.3768%	± 0.1035
Ti	Titanium	1288 ppm	± 112
V	Vanadium	39 ppm	± 13
Cr	Chromium	5149 ppm	± 103
Mn	Manganese	7957 ppm	± 291
Fe	Iron	>10%	
Co	Cobalt	ND	< 406
Ni	Nickel	257 ppm	± 34
Cu	Copper	206 ppm	± 24
Zn	Zinc	2500 ppm	± 66
As	Arsenic	15 ppm	± 8.8
Se	Selenium	ND	< 4.0
Rb	Rubidium	ND	< 5.5
Sr	Strontium	21 ppm	± 3.3

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CHEMICAL ELEMENTS

Zr Zirconium	ND	< 33
Nb Niobium	ND	< 2.2
Mo Molybdenum	129 ppm	± 4.5
Ag Silver	ND	< 5.1
Cd Cadmium	ND	< 17
Sn Tin	33 ppm	± 6.8
Sb Antimony	ND	< 18
Te Tellurium	ND	< 21
Ba Barium	359 ppm	± 54
La Lanthanum	ND	< 204
Ce Cerium	ND	< 268
Pr Praseodymium	ND	< 549
Nd Neodymium	ND	< 641
Hg Mercury	ND	< 3.2
Pb Lead	307 ppm	± 16

Annex 5. Material report from the test of dried sediments from reactor No. 1 when SBGx was used (Stage II)

SciAps **Material Report** 15:25 pm, 10/01/2025 #230

SOIL

Soil

INSTRUMENT INFO

SERIAL #	X200-30320
DISPLAY_SIGMA	2.0
LOD_SIGMA	3.0

TEST INFO

BARCODE

SAMPLE ID
R3

CHEMICAL ELEMENTS

P Phosphorus	1.2118%	± 0.2187
S Sulfur	6219 ppm	± 1705
K Potassium	6565 ppm	± 293
Ca Calcium	>10%	
Ti Titanium	1111 ppm	± 101
V Vanadium	26 ppm	± 11
Cr Chromium	2280 ppm	± 52
Mn Manganese	8014 ppm	± 277
Fe Iron	>10%	
Co Cobalt	ND	< 373
Ni Nickel	343 ppm	± 35
Cu Copper	344 ppm	± 28
Zn Zinc	1517 ppm	± 46
As Arsenic	ND	< 9.5
Se Selenium	ND	< 3.3
Rb Rubidium	ND	< 5.2
Sr Strontium	47 ppm	± 3.7

1/2

CHEMICAL ELEMENTS

Zr Zirconium	ND	< 29
Nb Niobium	ND	< 2.2
Mo Molybdenum	120 ppm	± 4.3
Ag Silver	ND	< 5.1
Cd Cadmium	ND	< 17
Sn Tin	36 ppm	± 6.9
Sb Antimony	ND	< 18
Te Tellurium	ND	< 22
Ba Barium	205 ppm	± 52
La Lanthanum	ND	< 205
Ce Cerium	ND	< 115
Pr Praseodymium	ND	< 548
Nd Neodymium	ND	< 639
Hg Mercury	ND	< 2.7
Pb Lead	155 ppm	± 12

Annex 6. Data of Stage III

1. Data on hourly biogas production

Date	Time	Reactor No 1	Reactor No 2
		ml/h	ml/h
2025-01-13	08:45	258	521
	14:45	268	507
2025-01-14	08:45	294	523
	14:45	306	553
2025-01-15	09:00	295	523
	14:45	301	515
2025-01-16	08:45	289	500
	14:45	322	525
2025-01-17	08:55	302	511
	14:45	340	547
2025-01-18	14:13	337	554
	14:45	495	658
2025-01-19	09:13	363	593
	14:45	404	618
2025-01-20	08:45	404	625
	14:45	490	715
2025-01-21	09:20	456	636
	14:45	483	599
2025-01-22	08:45	489	625
	14:45	514	591
2025-01-23	09:45	512	573
	14:45	471	488
2025-01-24	08:45	490	501
	14:45	467	450
2025-01-25	09:15	461	452
	14:45	482	413
2025-01-26	14:19	453	437
	14:45	522	492
2025-01-27	08:45	425	453
	14:45	383	419
2025-01-28	09:30	389	438
	14:45	385	407
2025-01-29	08:45	388	431
	14:45	371	400
2025-01-30	08:45	374	423
	14:45	337	371
2025-01-31	08:45	369	417
	14:45	352	377
2025-02-01	10:10	355	410
	14:45	334	370
2025-02-02	14:07	347	399

Date	Time	Reactor No 1	Reactor No 2
		ml/h	ml/h
	14:45	376	398
2025-02-03	08:45	374	443
	14:45	314	375
2025-02-04	09:40	345	415
	14:45	304	371
2025-02-05	09:20	337	425
	14:45	307	388
2025-02-06	08:15	306	416
	14:45	296	377
2025-02-07	08:45	323	428
	14:45	295	371
2025-02-08	13:30	315	411
	14:45	302	372
2025-02-09	09:35	320	418
	14:45	285	360
2025-02-10	09:30	314	418
	14:45	294	366
2025-02-11	08:40	319	401
	14:45	273	350
2025-02-12	08:50	316	416
	14:45	284	361
Average		**366**	**465**
Min		**258**	**350**
Max		**522**	**715**

2. Data on pH values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2025-01-08	7,68		7,57	
2025-01-13	7,50	7,13	7,46	6,84
2025-01-14	7,44	7,05	7,43	6,83
2025-01-15	7,44	7,01	7,45	6,82
2025-01-16	7,38	6,92	7,37	6,79
2025-01-17	7,48	6,98	7,46	6,84
2025-01-18	7,66	7,02	7,57	6,92
2025-01-19	7,67	7,04	7,58	6,99
2025-01-20	7,67	7,11	7,58	7,06
2025-01-21	7,68	7,12	7,61	7,12
2025-01-22	7,67	7,15	7,62	7,17
2025-01-23	7,73	7,22	7,64	7,12
2025-01-24	7,71	7,18	7,60	7,12
2025-01-25	7,67	7,17	7,61	7,11
2025-01-26	7,67	7,19	7,57	7,14

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2025-01-27	7,64	7,18	7,60	7,12
2025-01-28	7,67	7,24	7,58	7,14
2025-01-29	7,68	7,23	7,63	7,14
2025-01-30	7,68	7,17	7,68	7,13
2025-01-31	7,68	7,20	7,66	7,18
2025-02-01	7,64	7,16	7,66	7,11
2025-02-02	7,66	7,15	7,56	7,09
2025-02-03	7,63	7,20	7,55	7,11
2025-02-04	7,57	7,19	7,50	7,10
2025-02-05	7,64	7,22	7,56	7,14
2025-02-06	7,62	7,16	7,54	7,13
2025-02-07	7,60	7,16	7,53	7,09
2025-02-08	7,56	7,15	7,48	7,09
2025-02-09	7,61	7,16	7,49	7,10
2025-02-10	7,58	7,23	7,52	7,12
2025-02-11	7,59	7,19	7,50	7,11
2025-02-12		7,16		7,10
Average	**7,62**	**7,14**	**7,55**	**7,06**
Max	**7,7**	**7,2**	**7,7**	**7,2**
Min	**7,4**	**6,9**	**7,4**	**6,8**

3. Data on conductivity values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2025-01-08	7,71		7,71	
2025-01-13	5,02	6,99	5,07	6,99
2025-01-14	4,95	7,14	5,14	6,80
2025-01-15	5,08	7,19	5,00	6,58
2025-01-16	5,09	7,19	4,94	6,62
2025-01-17	4,78	6,97	5,21	6,60
2025-01-18	4,71	6,50	5,14	6,60
2025-01-19	4,75	6,61	4,82	6,47
2025-01-20	4,90	6,72	5,24	6,32
2025-01-21	4,87	6,63	4,96	6,54
2025-01-22	4,96	6,58	4,86	6,39
2025-01-23	4,85	6,01	5,00	6,53
2025-01-24	4,68	6,07	4,97	6,48
2025-01-25	4,70	5,83	4,91	6,28
2025-01-26	4,85	5,58	4,93	5,81
2025-01-27	5,08	5,61	4,85	5,65
2025-01-28	5,11	5,64	4,94	5,81
2025-01-29	4,84	5,71	4,79	5,64
2025-01-30	4,97	5,75	4,63	5,69
2025-01-31	5,02	5,76	5,02	5,61

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2025-02-01	4,86	5,72	4,79	5,65
2025-02-02	4,81	5,73	4,58	5,57
2025-02-03	5,04	5,70	4,46	5,48
2025-02-04	4,63	5,86	4,43	5,70
2025-02-05	4,61	5,84	4,76	5,98
2025-02-06	4,72	5,94	4,75	5,75
2025-02-07	4,71	5,84	4,82	5,82
2025-02-08	5,02	6,03	4,99	5,86
2025-02-09	5,22	5,79	5,07	5,85
2025-02-10	5,25	5,83	5,08	5,85
2025-02-11	5,27	6,05	5,10	6,04
2025-02-12		5,91		5,91
Average	**5,00**	**6,15**	**5,00**	**6,09**
Max	**7,7**	**7,2**	**7,7**	**7,0**
Min	**4,6**	**5,6**	**4,4**	**5,5**

4. Data on VS, DS, DS reduction and VS reduction

Date	Cow manure 70% + chicken dung 30% + SBGx Plus (0,2 kg/kg of DS), No. 1						Cow manure 70% + chicken dung 30% + SBGx (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2025-01-08	97,5		61,6				98,8		61,6			
2025-01-13		108,6		60,3	-11%	2%		114,5		59,1	-16%	4%
2025-01-14	101,2		63,6				101,2		63,6			
2025-01-15		95,1		58,5	6%	8%		106,0		58,4	-5%	8%
2025-01-16	101,9		64,4				101,9		64,4			
2025-01-17		104,1		60,2	-2%	7%		106,4		58,6	-4%	9%
2025-01-18	102,3		64,1				102,3		64,1			
2025-01-19		100,0		59,2	2%	8%		106,2		57,5	-4%	10%
2025-01-20	100,3		63,6				100,3		63,6			
2025-01-21		96,2		58,7	4%	8%		88,6		55,9	12%	12%
2025-01-22		91,4		59,1	9%	7%		91,8		54,1	8%	15%
2025-01-23	103,3		67,0				103,3		67,0			
2025-01-24		112,5		58,4	-9%	13%		93,6		54,0	9%	19%
2025-01-25	102,5		66,2				102,5		66,2			
2025-01-26		111,1		56,3	-8%	15%		91,1		53,1	11%	20%
2025-01-27	103,9		65,9				103,9		65,9			
2025-01-28		83,0		53,3	20%	19%		74,0		49,6	29%	25%
2025-01-29	108,1		69,2				108,1		69,2			
2025-01-30		96,1		56,6	11%	18%		81,6		52,4	25%	24%
2025-01-31	101,4		65,4				101,4		65,4			
2025-02-01		97,9		55,6	3%	15%		80,9		51,8	20%	21%
2025-02-02	100,9		63,1				100,9		63,1			
2025-02-03		97,4		56,0	4%	14%		80,1		51,4	21%	21%

Date	Cow manure 70% + chicken dung 30% + SBGx Plus (0,2 kg/kg of DS), No. 1						Cow manure 70% + chicken dung 30% + SBGx (0,2 kg/kg of DS), No. 2					
	DS, g/l		VS, g/l		Reduction, %		DS, g/l		VS, g/l		Reduction, %	
	Before digestion	After digestion	Before digestion	After digestion	DS	VS	Before digestion	After digestion	Before digestion	After digestion	DS	VS
2025-02-04	99,2		61,7				99,2		61,7			
2025-02-05		90,8		53,3	8%	14%		78,6		50,0	21%	19%
2025-02-06	102,3		64,9				102,3		64,9			
2025-02-07		86,9		55,9	15%	14%		86,2		50,3	16%	22%
2025-02-08	102,0		64,6				102,0		64,6			
2025-02-09		97,6		53,3	4%	17%		83,1		50,2	19%	22%
2025-02-10	100,4		63,4				100,4		63,4			
2025-02-11		80,9		52,2	19%	18%		77,8		49,8	23%	21%
2025-02-12		79,7		52,9	21%	17%		77,0		49,6	23%	22%
Average	**102,1**	**95,8**	**64,8**	**56,5**			**102,1**	**89,3**	**64,8**	**53,3**		
Max	**108,1**	**112,5**	**69,2**	**60,3**			**108,1**	**114,5**	**69,2**	**59,1**		
Min	**99,2**	**79,7**	**61,7**	**52,2**			**99,2**	**74,0**	**61,7**	**49,6**		

5. Data on ammonium concentration values

Date	Reactor No. 1		Reactor No. 2	
	Before digestion	After digestion	Before digestion	After digestion
2025-01-08	551		551	
2025-01-21	404	484	404	487
2025-01-29	434	382	434	523
2025-02-04	500	477	500	493
2025-02-11	506	402	506	522
Average	**479**	**436**	**479**	**506**
Max	**551**	**484**	**551**	**523**
Min	**404**	**382**	**404**	**487**