BIOGAS PRODUCING FROM VARIOUS SILAGES

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Introduction

Latvia cannot provide country with own produced energy and fossil energy resources are imported from other countries. There are 368500 ha of not used agriculture land in Latvia. Effective use of this land could help to obtain a significant amount of energy. One of the most advanced methods of energy production from biomass is anaerobic digestion.

The biogas is product of great value and it production technology does not increase carbon dioxide emission and is environmentally friendly. In recent years the biogas production is booming also in Latvia. There is need to use different raw materials in biogas plants.

Materials and methods

To find the yield potential of different biomass crops for biogas production, 2010 and 2011 years in our University research farm «Vecauce» (latitude N 56 ° 28 ', Longitude E 22 ° 53') were installed in field experiments from different crops. Testing a variety of annuals biomass plants were established: maize (Zea mays); sunflower (Helianthus annuus); amaranth (amaranth hybridus L.) and chopped mallow (Malva. crispa).

Silages from a variety of biomass plants was prepared in polyethylene bags immediately after harvest.

Fermented cow manure was used as inoculum in all 15 reactors. Only inoculum was filled in reactor R4 (control).

Materials and methods

The substrates from each type of raw materials and inoculums were analyzed for dry matter, organic matter, ash content and chemical composition. The investigation was measured by using standardized methods (VDI 4630).

The raw materials and inoculums were carefully weighed and thoroughly mixed. All digesters were connected to the gas storage facilities and taps; the digesters were operating in continuous mode at temperature at 38 ± 1^{o}C.

Materials and methods

Data of gas volume and composition was registered every day. The digesters were agitated every day to reduce floating layer.

The process of fermentation was measured in a single loading mode until the biogas stopped evolving.

Also the digestate was weighed and the pH value, dry matter, ash content and organic matter composition was determined.

Facilities

The dry matter was determined by «Shimazu» facility at temperature $120^{o}C$, the organic matter was determined by «Nabertherm» drying oven at temperature $550^{o}C$.

Facilities

Heating cameras «Memmert» obtained stable temperature. The composition of gas was determined by gas analyser «GA2000». The concentration of methane, oxygen, carbon dioxide and hydrogen sulphide in the biogas, pressure and normal calculated volume of gas was measured. The weighing scales “Kern 16KO2 FKB” were used to determine raw materials and digestate weight; the pH stationary meter “PP-50” was used to determine the pH value.

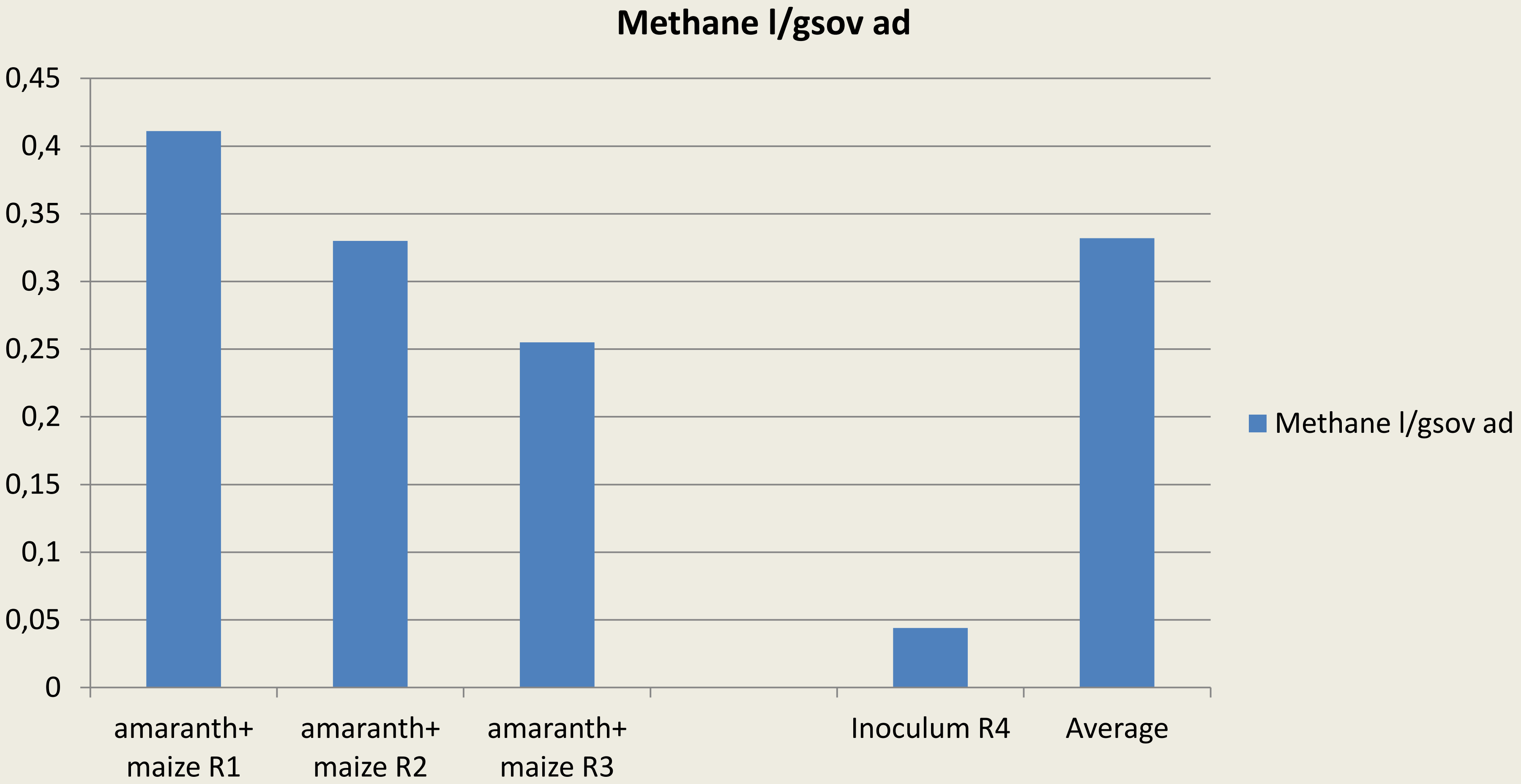
Results and discussion

Substrates and biogas parameters in anaerobic digestion process

Reactors	**R1-R3**	**R4 (inoculum)**	**R5-R8**	**R9-R12**	**R13-R16**
Substrate composition, %	96.15 IN 3.85 AMS	100 IN	96.15 IN 3.85 MMS	96.15 IN 3.85 ASS	96.15 IN 3.85 MSS
Substrate pH (start)	7.12-7.24	7.28	7.05-7.17	7.12-7.16	7.1-7.14
Substrate (start), g	520	500	520	520	520
Biomass added (start), g	20		20	20	20
Substrate total solids (start), %	18.01	5.44	24.09	32.28	16.16
Substrate volatile solids (start), % TS	86.98	80.2	77.52	83.81	88.48
Total solids added (start), g without inoculum	3.6	27.2	4.82	6.46	3.23
Volatile solids added (start), g without inoculum	3.13		3.74	5.41	2.86
Substrate pH (final)	7.1±0.3	7.08	7.11±0.22	7.17±0.10	7.12-7,17
Biogas(from substrate), l	3.73±0.45	2.32	5.07±1.075	6.11±0.5	4.03±1.79
Aver. methane (from substrate) content, %	60.14±9.7		56.13±9.5	60.51±7.1	58.18±5.8
Biogas (from added biomass), $l \cdot kg_{VSA}^{-1}$	552±28		734±185	634±135	597±240
Methane (from added biomass), $l \cdot kg_{VSA}^{-1}$	332±78		412±101	420±85	389±101

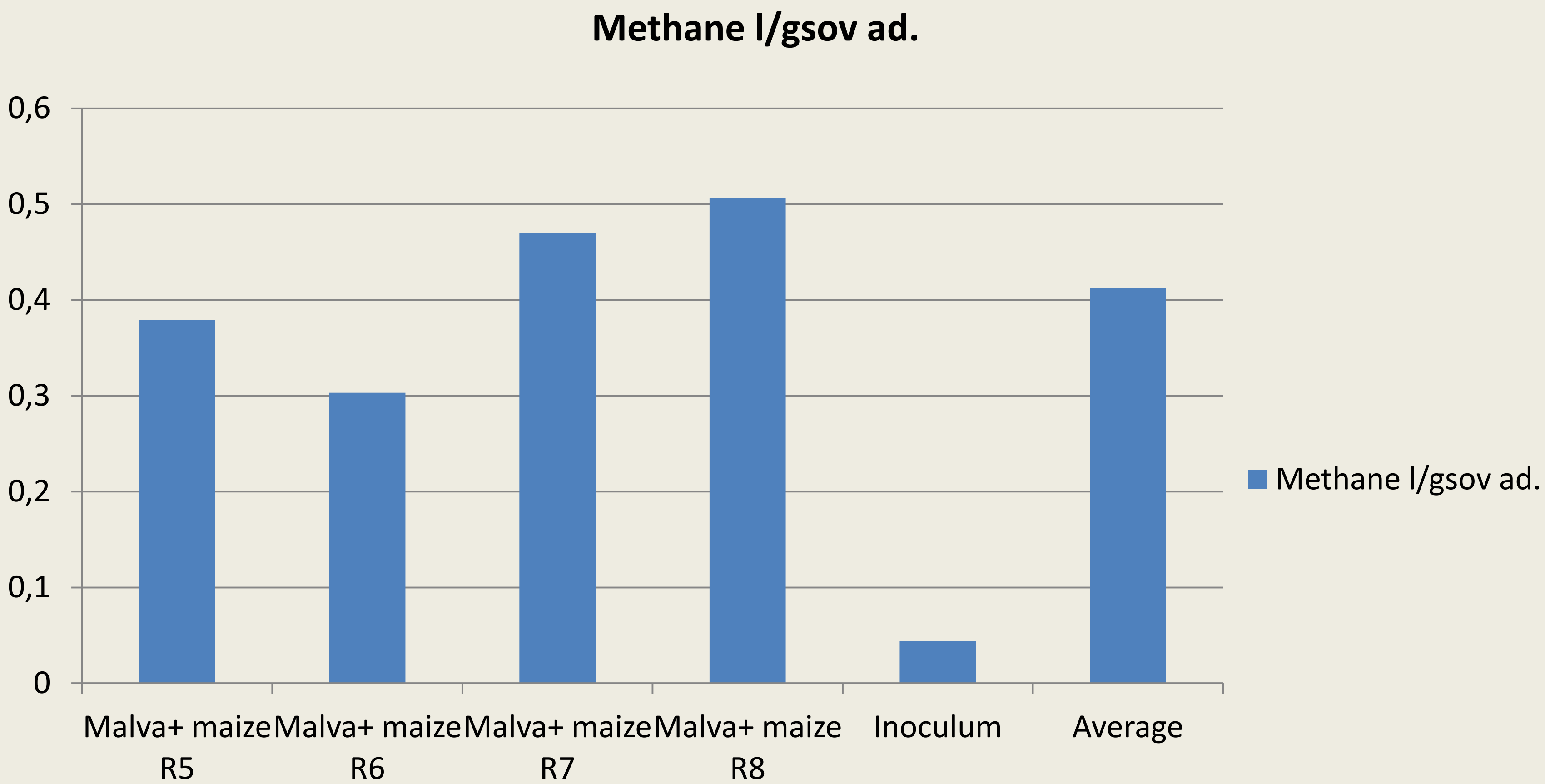
Notes: IN – inoculum, AMS – amaranth and maize silage, MMS – malva and maize silage, ASS – amaranth and sunflower silage, MSS- malva and sunflower silage; VSA – volatile solids added.

Results and discussion



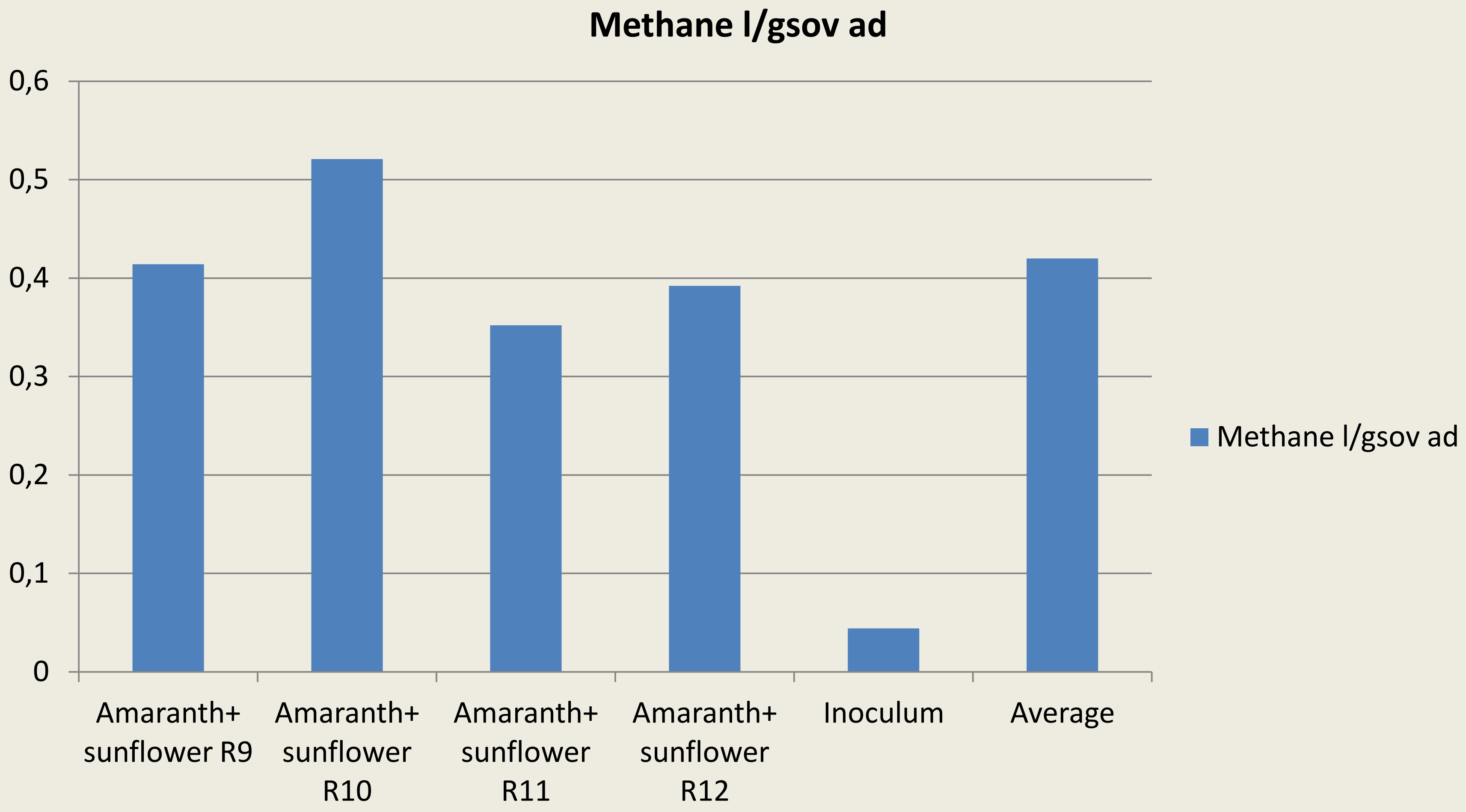
Methane yield in reactors R1-R3 containing amaranth + maize silage and control reactor R4

Results and discussion



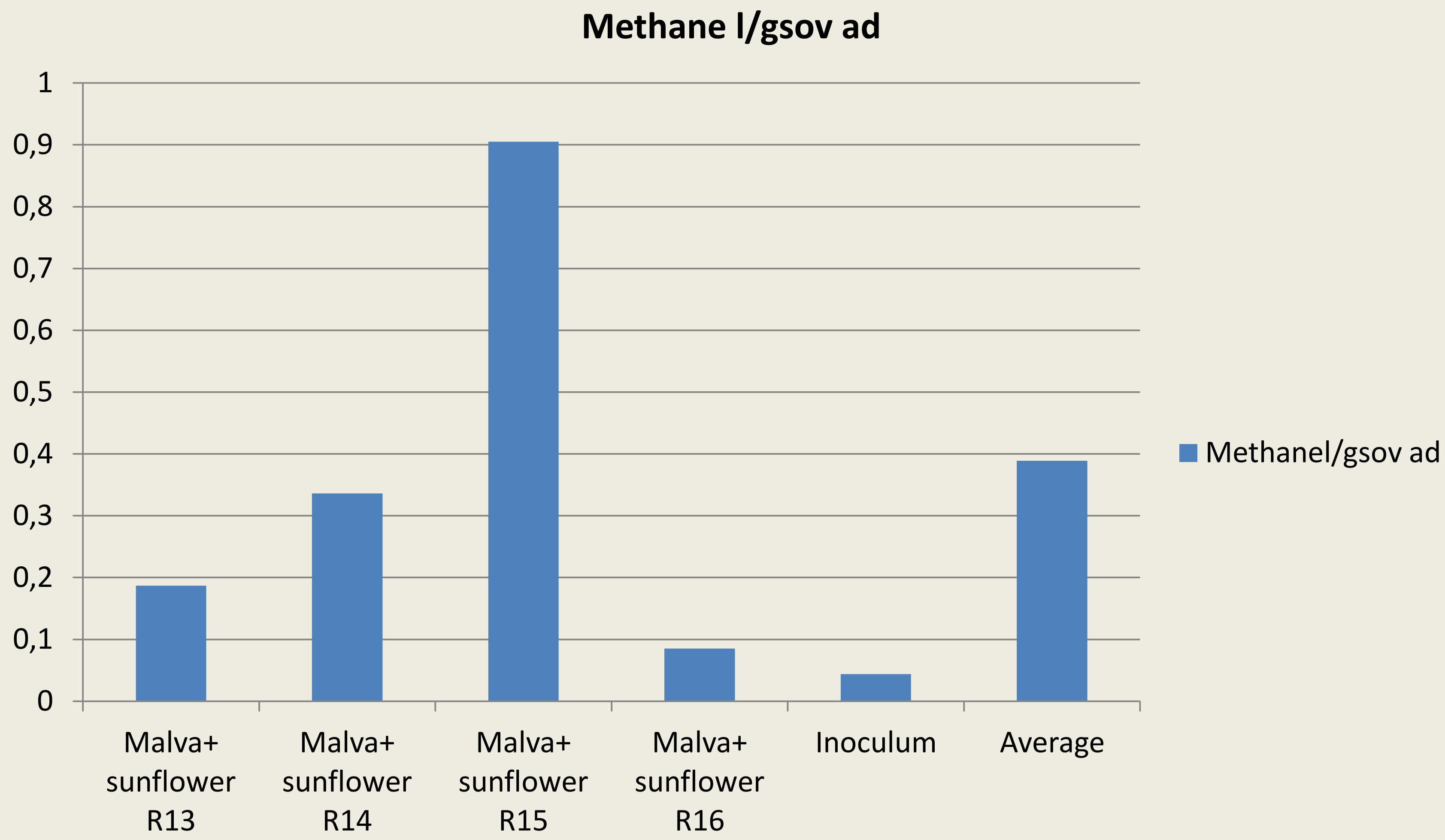
Methane yield in reactors R5-R8 containing malva + maize silage and inoculum alone

Results and discussion



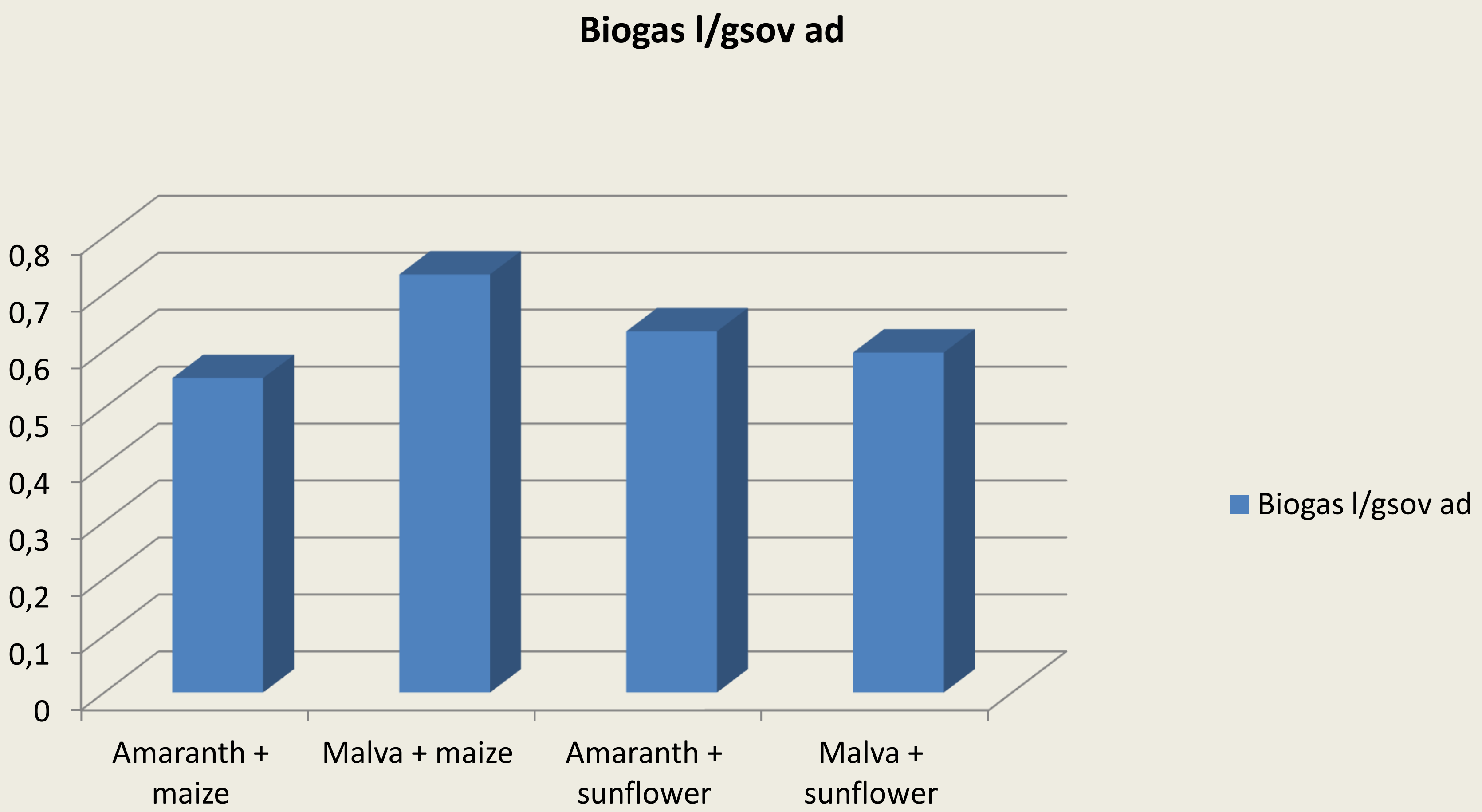
Methane yield in reactors R9-R12 containing amaranth+sunflower silage and inoculum alone

Results and discussion



Methane yield in reactors R13-R16 containing malva + sunflower silage and inoculum alone

Results and discussion



Biogas yields from various silages

Conclusions

1. Average specific biogas yield 552 $l \cdot kg_{VSA}^{-1}$ and methane yield $332_{\pm 0.078}$ $l \cdot kg_{VSA}^{-1}$ was obtained in anaerobic fermentation of amaranth and maize silage.

2. The highest specific biogas production yield 734 $l \cdot kg_{VSA}^{-1}$ and methane yield $412_{\pm 0.01}$ $l \cdot kg_{VSA}^{-1}$ was observed during mallow and maize silage anaerobic fermentation.

3. Average specific biogas yield 634 $l \cdot kg_{VSA}^{-1}$ and methane yield $420_{\pm 0.085}$ $l \cdot kg_{VSA}^{-1}$ was obtained in anaerobic fermentation of amaranth and sunflower silage.

4. Average specific biogas yield 597 $l \cdot kg_{VSA}^{-1}$ and methane yield $389_{\pm 0.41}$ $l \cdot kg_{VSA}^{-1}$ was obtained in anaerobic fermentation of mallow and sunflower silage.

Conclusions

5. Investigated average specific methane content, without incalculation of inoculums, was 60.14%, 56.13%, 60.51% and 58.18% in biogas from amaranth + maize silage, malva + maize silage, amaranth + sunflower silage or sunflower + malva silage respectively.

6. Biogas and methane yields from investigated silages were good and such silages can be used for biogas production in Latvia.

Thank you for attention!

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