VERIFYING THE PROPERTIES OF GRASS HAYLAGE FROM ANAEROBIC PROCESSING

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Abstract. The paper focuses on the verification of grass haylage suitability as a substrate for the purposes of anaerobic processing at biogas stations. Samples from eleven biogas stations were tested; their dry matter and organic dry matter were quantified. The samples subjected to the process of mesophilic (38°C) anaerobic co-fermentation over the course of twenty-one days. Sludge from the waste water treatment plant process was used as an inoculation substrate. Biogas production and methane abundance were monitored during the test. The paper shows that grass haylage is a suitable substrate for use at a biogas station owing to its methane production and biogas quality.

Keys words: grass haylage, anaerobic processing, biogas and methane production

Introduction

Biogas stations are facilities generating heat by burning a renewable energy source, biogas; they can even produce heat and electricity by means of a cogeneration unit. Initially, these particular energies were primarily consumed at the site where they were produced; however, these days the electric energy is more often supplied to the grid and then distributed to end users.

The technological systems generating biogas differ in principle, depending on the properties of the material to be processed; what matters in particular is whether the material to be processed is dissolved or suspended. With suspended materials, the size and solid particle concentration are the most important properties. From this point of view, it is possible to divide the mechanisation reactors into reactors processing a dissolved substrate, reactors processing a suspended substrate and reactors processing solid materials.

Biogas stations produce biogas and a fermentation residue. Mechanisation reactors feed the biogas into a gas container and, from there, it is distributed for the purposes of further processing. The most efficient use of biogas at present is as a fuel for combustion engines connected to the unit producing electric energy, namely electric energy and heat cogeneration production. It is possible to use modified spark ignition, compression ignition engines, or gas turbines. The biogas can be used as a fuel for engines producing mechanical or electric energy. Both the waste heat from engine cooling and combustion products are used to heat anaerobic reactors, to produce warm water and for the purposes of heating. This is the most efficient use of biogas and it covers the energy requirements of biogas stations.

The Czech Republic has recently seen a reduction in the agricultural land used for crop or food production. Another potential use, closely linked to livestock farming, is also on the decline, owing to shrinking livestock numbers. One possible means of ensuring the economic and ecologic sustainability of the land is the use of subsidies and grants from European and national sources. However, if this is to be considered, then it is also necessary to take into account the product being generated, which is to say, grass haylage. With the continuing fall in livestock numbers, the potential use of this product within the energy sector takes on a considerable significance.

Material and methods

Method for establishing biogas production

Biogas production was measured in accordance with Directive VDI 4630: Fermentation of organic matters, establishing substrate characteristics, sample taking, definitions of substrate data and fermentation tests (VDI 4630: Vergärung organicher Stoffe, Substratcharakterisierung, Probenahme, Stoffdatenerhebung, Gärversuche).

The tests were conducted at eleven biogas stations over the course of twenty-one days and at a temperature of 38°C. Three samples of every substrate were tested and the final production was defined as an average of the three results. The average quantity of substrate tested was 20 g, the quantity of inoculation sludge was 300 g and its dry matter, 4%. The ammoniacal nitrogen content was less than 800 mg/kg of the inoculation sludge. During the twenty-one days over which the test was run, a fermentation test was also performed on the inoculation sludge in order to distinguish the biogas production from the very substrate itself.

Results and discussion

The test measurements recorded the daily biogas production and methane content at eleven selected biogas stations processing grass haylage. Methane production was chosen as the most informative parameter. The results were calculated on the basis of the daily biogas production and current methane abundance per total amount of methane generated. For the purposes of generalizing the results, the volume was calculated in cubic meters (0°C, $1{,}01325 \cdot 10^5$ Pa) and related to the weight unit of the dry matter. These values may relevantly be compared (Fig. 1).

The lowest specific methane production was found for the samples from the Kunčina biogas station, namely 0.293 $m^3 \cdot kg^{-1}$. These samples also contained the highest share of dry matter, at 54.7%. The samples from Dolní Dobrouč also demonstrated a low specific methane production value, at 0.330, and the sample dry matter was 44.85%. On the other hand, the highest production of methane was achieved from substrates with a dry matter of around 28%, namely the samples from Kouty, at 0.436, and Dlouhá Třebová, at 0.406. On the basis of these figures, it is possible to conclude that samples with a high dry matter content demonstrate a worse specific production of methane and therefore clearly mirror the impact of the processing technology and haylage storage.

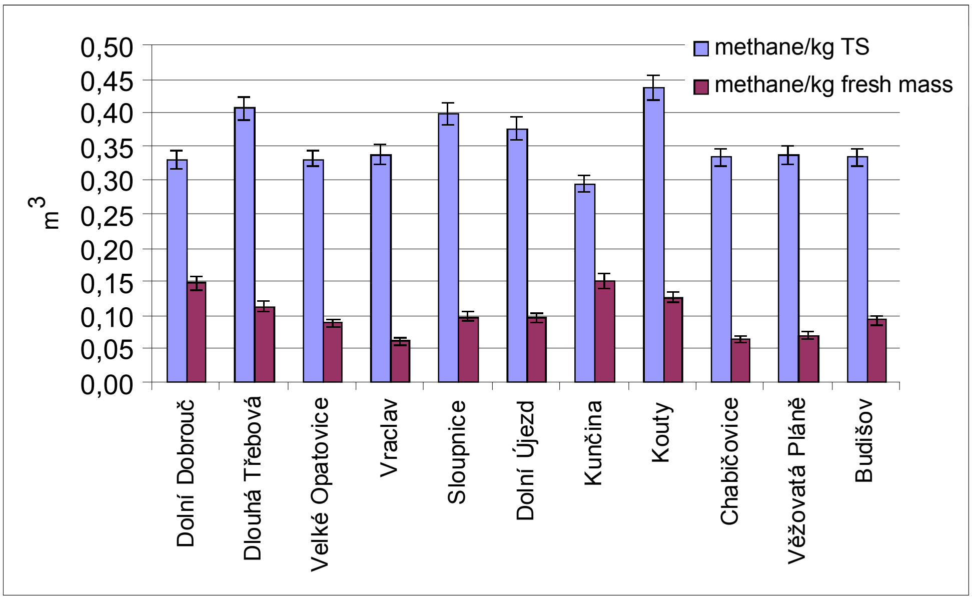
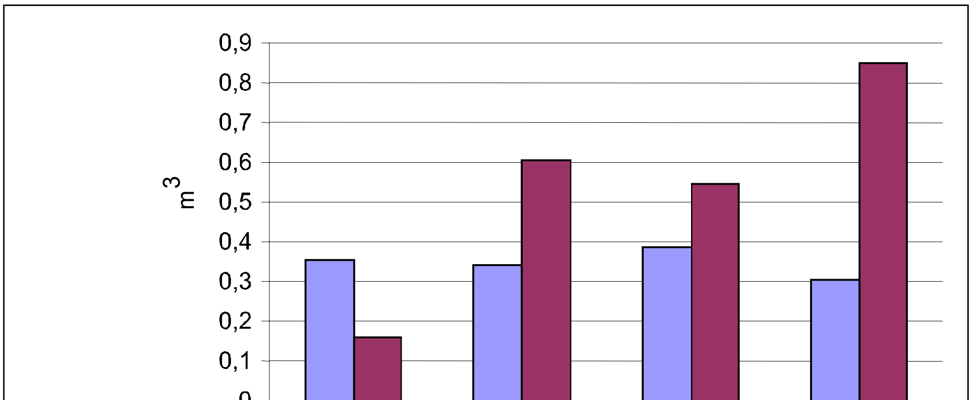


Fig. 1. Chart showing specific methane production from substrates at individual biogas stations



	Grass silage average	Sorghum silage Goliath H133 (Amon 2008)	Corn silage KWS 1393 (Amon 2008)	Corn silage PR37D25 (Oslaj 2010)
methane yield of kg TS	0.356	0.339	0.387	0.306
methane yield of m^2	0.160	0.607	0.546	0.848

Fig. 2. Chart showing specific production of methane in relation to weight unit and area-based yield

The specific production of grass haylage methane was then compared with other crops grown expressly for the purpose of energy production. In order for the comparison to provide optimal information, it was also necessary to take into account the average biomass yield per unit area. After converting the yield per quantity of dry matter, it is possible to establish the amount of methane corresponding to one square meter of the grown crop on the basis of the specific production.

As the permanent grasslands abound particularly in areas with worse climatic or morphological conditions, hybrids with shorter vegetation periods were chosen for the purposes of the comparison (Fig. 2).

The chart clearly shows that, for grass haylage, the production of methane per kilogram of dry matter is similar to the other substrates. However, it produces considerably less biomass per unit area. At present, no effort is being made to use permanent grassland intensively. Nevertheless, as permanent grassland mostly occurs on land that has scarcely any other use in agricultural terms, it therefore seems suitable to use the product in this way, since it is, at least, currently available.

Conclusion

At present, grass haylage is a material which sees little exploitation. Its typical use as a fodder for livestock is decreasing as a result of shrinking livestock numbers. At the same time, owing to grants, subsidies and the economic inefficiency of certain other crops, grasslands are on the rise. Anaerobic processing thus provides the possibility of using grass haylage for renewable energy sources, something which is now much favoured.

On the basis of the tests carried out on grass haylage using samples drawn from eleven biogas stations in the Czech Republic, it is clear that, at 0.356 per kilogram, the specific production of biogas is similar to that of other energy crops, such as, for instance, corn, at 0.387 and sorghum, at 0.339 [Amon 2008]. From this point of view, grass haylage seems to be a material which is suitable for anaerobic processing at biogas stations. When converted to the quantity of dry matter, the yield per hectare for grass haylage is considerably lower in comparison with the other crops. However, this drawback is compensated for by the very low climatic and agrotechnological growing requirements. Permanent grassland does not need to be ploughed, sowed or treated chemically and only requires manuring, mowing and processing. One of the manuring possibilities is the application of the digestate, which is the final step in the circulation of mineral substances.

Just as with other crops grown expressly for the purpose of energy production biomass yields can also be increased in grasslands. For instance, new varieties, developed with the focus directly on their use in the energy industry, a common way of improving other crops. Another method of intensifying the growth is monitoring and providing optimum nutrition, especially by supplying such macro-biogenous elements as phosphor, potassium and nitrogen.

References

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OCENA CECH SIANOKISZONKI Z TRAW POWSTAŁEJ W WYNIKU PRZETWARZANIA BEZTLENOWEGO

Streszczenie. Celem pracy jest ustalenie czy sianokiszonka z traw stanowi odpowiedni substrat w procesie przetwarzania beztlenowego w biogazowniach. Przebadano próbki z 11 biogazowni; policzono ilość suchej masy i organicznej suchej masy. Próbki poddano procesowi beztlenowej fermentacji mezofilicznej (38°C) w ciągu 21 dni. Osad z procesu oczyszczania ścieków został użyty jako substrat do wysiewania bakterii. Podczas badań monitorowano produkcję biogazu i ilość metanu. Niniejsza praca wskazuje, iż sianokiszonka z traw stanowi odpowiedni substrat dla biogazowni dzięki produkcji metanu i jakości biogazu.

Słowa kluczowe: sianokiszonka z traw, przetwarzanie beztlenowe, produkcja biogazu i metanu

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