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POSSIBILITIES OF BEET USE FOR NEEDS OF A BIOGAS PLANT

Summary

In this study there are presented the results of works aiming at determination of efficiency of biogas received from beet leaves, scrap and beet at different degrees of contamination. The studies were conducted for fresh material and material put to ensilage. The studies have shown, that it is possible to obtain substrate of full value following the period of storage for biogas production.
***Key words**: sugar beet, biogas plant, chemical composition, ensilage*

MOŻLIWOŚĆ WYKORZYSTANIA BURAKÓW DLA POTRZEB BIOGAZOWNI

Streszczenie

Przedstawiono wyniki badań mające na celu określenie wydajności biogazu otrzymanego z liści buraczanych, zrzynek i buraków przy różnych stopniach zanieczyszczenia. Badania prowadzono dla materiału świeżego i poddanego zakiszaniu. Badania wskazują, że możliwe jest uzyskanie pełnowartościowego substratu po okresie przechowywania dla produkcji biogazu.
***Słowa kluczowe:** burak cukrowy, biogazownia, skład chemiczny, zakiszanie*

1. Introduction

Generation of power based on renewable sources constitutes last years an intensively developing branch of science and economy [5]. Apart from the commonly known and applied: solar energy, energy from water and wind, combustion of fuels of vegetal origin and production of biofuel, production of biogas becomes more and more interesting. In Poland its production has at present a marginal share in production of renewable energy, but in Europe, in particular in Germany, production of biogas has a significant share in production of energy [4].

The technology of biogas production is constantly improved and does not generate any technical problems. Assuring of continuity of substrates delivery is the prerequisite of proper operation of the biogas plant [9]. In spite of developing many different manners of biogas obtaining, the information for practitioners concerning the opportunities of assuring continuity of substrates delivery for biogas plants is still incomplete.

Agrarian products are among the others the materials used for biogas production. Apart from the commonly used: corn, cereals, animals' droppings, a bigger and bigger interest is being paid to beets, both in the form of ensilages as well as fresh roots and leaves. Possible is the use of the whole plants, only leaves, as well as pulp and molasse [2]. Their acquisition in the period of vegetation season does not constitute any problem, there is an opportunity to replace one substrate with other ones depending on development phases [3]. In many respects interesting is the possibility of the use of sugar beets for the needs of biogas plants.

Lately (in Poland particularly started from the moment of accession to the European Union) there has occurred a considerable drop in the number of sugar factories and the decrease of the volume of produced sugar (introduction of sugar quotas), what has resulted in limitation of the area of beets' cultivation. In particular, in the conditions of Polish agriculture, where traditional cultivation of beets is the longest one in Europe, such changes negatively affect situation of farms. The possibility to use beets as substrate for biogas plants would allow to maintain profitability of agrarian production. These activities are supported by the studies of farmers, who managed to create modifications of beets particularly suitable for biogas production. They are characterized by the lowered content of sugar and bigger smoothness of the external root's surface, what decreases contamination of harvested beets. A commonly known technology of cultivation and cropping of beets, creates favourable conditions for their production for power purposes. Moreover, beets constitute a valuable element of crops rotation, and their production would be an alternative for maintaining fields in farming culture.

2. Purpose and course of the studies

The conducted studies aimed at determining the opportunities of the most effective use of beets as substrate for biogas plants, both in the fresh as well as in preserved form, fixing and selecting of the optimum manner of storage and determining the volumes of loss while storing.

For the studies there were used sugar beets of Janow variety (KHBC). Raw material was analysed directly after the crop, and the remaining part was ensilaged. In order to assure fixed conditions of ensilaging, the biological material was pressed with the use of a special pressing machine ensuring a constant compacting degree of all the samples, made according to own design. Compacting machine is show in the drawing 2. Colleted material differed in the degree of contamination.

Ensilaging was conducted in microsiloes of PVC of the capacity 10 dcm^3. Tanks are presented in the drawing 1. Samples of ensilage from leaves, leaves with crowns strap) and whole plants of different degree of contamination were

taken after 6 weeks. All the studies were conducted in 3 repetitions. Average values are shown in the table.

Source: own studies

Fig. 1. View of microsiloes for samples' silage
Rys. 1. Widok mikrosilosów do zakiszania próbek

Source: own studies

Fig. 2. View of the device for compacting the silage
Rys. 2. Widok urządzenia do zagęszczania kiszonki

3. Discussion of the results

The composition of the collected samples for fresh material is presented in the table 1, and the composition of the collected samples for ensilaged material is presented in table 2.

Table 1. The chemical composition of leaves, scrap and beet
Tab. 1. Skład chemiczny liści, zrzynek i buraków

	Yield	Dry mass [%]	Crude ash [%]	Organic substance [%]	Crude protein [%]	Crude fat [%]	Crude fibre [%]	BNW [%]
Clean leaves	210	9,15	12,30	87,70	21,30	4,39	9,14	52,87
Leaves medium contaminated	243	12,93	32,16	67,84	20,93	7,11	8,83	30,97
Highly contaminated leaves	274	17,70	37,11	62,89	18,30	6,11	7,14	31,34
Fresh clean scrap	300	14,31	21,43	78,57	16,71	3,73	19,43	38,70
Fresh scrap moderately sanded	334	18,97	30,41	69,59	15,90	3,63	19,90	30,16
Fresh scrap highly contaminated	379	22,16	41,31	58,69	14,70	3,73	20,11	20,15
Whole clean beet	612	20,74	17,73	82,27	10,16	3,90	17,30	50,91
Whole beet medium contaminated	639	24,10	27,14	72,86	12,40	4,11	18,90	37,45
Whole beet strongly contaminated	654	26,14	30,16	69,84	14,30	4,92	9,16	41,46

Source: Own studies

Table 2. Chemical composition of leaves, scrap and beet following their ensilage
Tab. 2. Skład chemiczny liści, zrzynek i buraków po zakiszeniu

	Dry mass [%]	Crude ash [%]	Organic substance [%]	Crude protein [%]	Crude fat [%]	Crude fibre [%]	BNW [%]
Clean ensilaged leaves	20,19	13,80	86,20	21,21	5,26	11,34	48,39
Medium contaminated ensilaged leaves	14,33	35,15	64,85	19,93	8,16	11,31	25,45
Highly contaminated ensilaged leaves	20,41	39,17	60,83	18,01	7,01	9,19	26,62
Clean ensilaged scrap	21,46	23,48	76,52	15,93	4,51	21,36	34,72
Medium contaminated ensilaged scrap	20,10	33,60	66,40	14,91	4,94	22,17	24,38
Highly contaminated ensilaged scrap	25,19	43,16	56,84	13,91	5,11	23,12	14,70
Clean ensilaged beet	24,90	18,90	81,10	10,05	3,99	18,27	48,79
Medium contaminated ensilaged beet	26,17	29,43	70,57	12,01	5,16	12,37	41,03
Highly contaminated ensilaged beet	29,13	32,19	67,81	13,93	5,12	12,40	36,36

Source: Own studies

Table 3. Biogas efficiency from fresh and ensilaged materials
Tab. 3. Wydajność biogazu z materiałów świeżych i zakiszonych

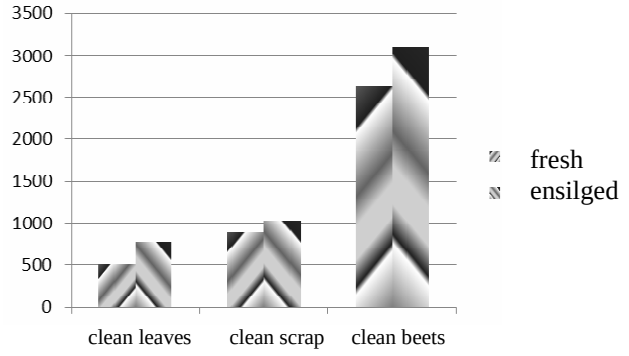
	Fresh material	Ensilaged material
Material	Volume of biogas in Nm^3 from 1ha	
Clean leaves	506,84	775,22
Moderately contaminated leaves	499,33	349,98
Strongly contaminated leaves	662,57	478,65
Clean scrap	886,74[a]	1031,05[b]
Moderately contaminated scrap	1022,46[a]	792,25
Strongly contaminated scrap	958,47	803,35
Clean beets	2629,74	3105,01
Moderately contaminated beets	2358,14	2409,09
Strongly contaminated beets	2506,66	2475,37

Source: own studies

On the basis of the taken material's composition, calculation of the volumes of biogas and biomethanol possibile to be obtained was done. Calculations were conducted pursuant to the methodology presented by Podkówka and Podkówka [7] and Węglarzy [8] based on determination of digestibility.

Statement of the volumes of biogas possible to be obtained from individual substrates in the fresh and ensilaged form (for yield given in the table 1) in conversion of yield per 1 ha is presented in the table 3. Efficiency of biogas from fresh and ensilaged material was compared.

For all the studied materials – leaves strap, beets – the increase of efficiency of biogas following ensilage of clean material was found. The highest increase of productivity was observed for leaves (following ensilage the increase amounted to 30%), a similar value was noted in case of scrap and whole beets (respectively 14 and 15%). The results are presented in the diagram 3. It can be observed, that the increase of the volume of obtained biogas is connected with the volume of contaminations: contamination of leaves amounted on average to 13,8%, of scrap 23,48% and beets 18,90%.



Source: own studies

Fig. 3. Biogas yield of Nm^3 of 1 ha for fresh material and silage with the highest degree of purity
Rys. 3. Wydajność biogazu w Nm^3 z 1 ha dla materiału świeżego i zakiszonego przy najwyższym stopniu czystości

The obtained results show, that it is possible to obtain both high efficiency from fresh material as well as storage for the winter period without any loose of efficiency. In the conducted studies the course of the process of ensilage corresponded to preservation in foil sleeves or in lagoons, where there does not occur any leakage of ensilage juices which, depending on the ensilaged material may, according to McDonald et al. [6] amount from 4,5-7%. In case of their leakage it results in lowering of the silage's efficiency.

In case of making a silage from material of higher contamination, there was observed a statistically considerable drop in biogas efficiency (connected with the drop of digestibility), similar conclusions are resented by Dorszewski et al. [1].

4. Conclusions

It is possible to ensure high quality of substrates for the need of a biogas plants also following the period of plants vegetation. Preparation of ensilage from leaves, beets, beets' leaves and scrap makes it possible to maintain high efficiency of biogas, and in case of material of high purity degree even the increase of efficiency as compared to fresh material was observed. The impact of purity of plant material on the quality of substrate for biogas production was observed. In the studies no additives controlling the process of ensilage were applied, as they may increase efficiency in particular in case of contaminated materials.

5. Bibliografia

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