Non-traditional cup-plant crop as a prospective substitute for maize at biogas production

Biogas is a renewable fuel produced from the decomposition of organic materials at anaerobic digestion in special units known as biogas plants. The application of biogas is oriented to heat or electricity generation using the combustion process. After anaerobic digestion an organic residue so-called digestate is produced. Until know, the most cultivated plant for biogas production is maize due to its high productivity and very favorable properties for anaerobic digestion. However, its cultivation requires the use of expensive inputs (fertilizers and intensive agro-technics), which combined with its slow growth in the first half of the vegetation period, makes the area where this crop is cultivated to have a tendency to erosive processes, especially on sloping soils. Therefore, finding new alternative crops, able to compete with maize as biogas feedstock, is very desirable. One such prospective, little known non-traditional energy crop could be cup-plant (*Silphium perfoliatum* L.), which is a perennial, 220–340 cm tall, bright yellow flowering crop, offering great ecological advantages over maize as lower erosion risk and significantly lower energy and economic cost at cultivation.

At the study of comparison between cup-plant and maize in areas with less favorable conditions for maize cultivation, the findings showed high biomass (12–18 t/ha DM) and methane yields (3,600–4,250 Nm^3/ha) at cup-plant, which means that this crop can be considered as a promising novel crop for biogas production in replacement of maize. Although, the study recorded that cup-plant had higher requirements on most of the necessitated nutrients (calcium 11x, magnesium 3.5x, potassium 1.8x, cobalt 5x, iron 2x and manganese 2x) and lower requirements in others (nitrogen, cooper and zinc) when comparing to maize, it exists the possibility to increase cup-plant yields using nutrients from compensative fertilizing by mean of digestate application into the soil. Digestate, a mixture of liquid and solid materials containing diluted and fixed nutrients, can be used as a cheap fertilizer.

The analysis of digestate utilization as fertilizer in maize and cup-plant showed that digestate compensates the greater part of nutrient needs in both crops. In the case of cup-plant, the annual fertilization can cover more than 100 % N needs and more than 75 % K needs. Nevertheless, it was recorded a low coverage in case of sulphur, calcium and magnesium (40–55 %), that is necessary to add using mineral fertilization, especially when there is a low soil content. Therefore, it can be assumed that the increasing proportion of cup-plant use in biogas plants as a raw material for anaerobic digestion will increase the content of these elements in the digestate. In relation to maize, digestate fertilization can cover nutrition needs far better, but with the exception of nitrogen (75 %) and sulphur (50 %). A suitable level of nutrient content in the raw material has a favorable effect on biogas production, especially on increased methane fraction. The recorded high nutrients content in cup-plant can estimate an important influence of biomass mixture (maize and cup-plant) on methane yields. Really, the results showed a gain of methane yield comparable to maize.

In conclusion, based on our results, the cultivation of unconventional cup-plant is quite recommended as a prospective substitute for maize at biogas production, especially for soil conditions less-favorable for maize cultivation.

Sergej Us?ak, Jakub Mu?oz
Crop Research Institute, Prague, the Czech Republic

Publication

Cup-plant potential for biogas production compared to reference maize in relation to the balance needs of nutrients and some microelements for their cultivation.
Ustak S, Munoz J
J Environ Manage. 2018 Dec 15