

# **Biomass and biogas productivity from perennial herbaceous crops as an environmentally friendly source of energy**

## **Abstract**

Renewable energy is becoming a widely debated topic, identify different biomass sources that are acceptable for biomass production, easy to grow, cheap and offers high yields that will be suitable for energy feedstock, that is the subject of many researchers. This doctoral thesis contains the results of field research and laboratory analysis of perennial herbaceous crops (PHC), including cup plant (*Silphium perfoliatum* L.) and willow-leaf sunflower (*Helianthus salicifolius* A. Dietr). Research was conducted at the Department of Genetics, Plant Breeding and Bioresource Engineering and Department of Environmental Engineering, University of Warmia and Mazury in Olsztyn, Poland. *Silphium perfoliatum* and *Helianthus salicifolius* are from the Asteraceae family, native to North America and both are semi-woody perennial crops. The aim of the research was to assess the yield and quality of biomass as well biogas potential and economic analysis of PHC species depending on the fertilization type and doses of nitrogen which was applied. Determination of biomass yield/quality and other selected parameters were determined by cutting whole plants manually every year in September. Moreover, measurements on biomass quality, chemical composition and biogas properties of PHC species were studied. In addition, the most recent literature in the researched field was analyzed to compare the obtained results.

Based on obtained results, the three-year mean dry matter yield ( $8.0 \text{ Mg ha}^{-1} \text{ y}^{-1} \text{ DM}$ ) of *Silphium perfoliatum* was significantly higher compared to the *Helianthus salicifolius* by 16.3%. The highest biomass yield of *Silphium perfoliatum* ( $16.3 \text{ Mg ha}^{-1} \text{ y}^{-1} \text{ DM}$ ) was obtained in 2021 with mineral fertilization at  $170 \text{ kg ha}^{-1} \text{ N}$ . As well, it can be concluded that application of different forms of fertilization (organic, mineral) and N fertilization level ( $85$  and  $170 \text{ kg ha}^{-1} \text{ N}$ ) significantly influenced most of the chemical and thermophysical features. The present thesis clearly shows that biogas, methane and energy potential yield of *Silphium perfoliatum* was higher, compared to the *Helianthus salicifolius* biomass.

The obtained results allowed to supplement the knowledge on the use of *Silphium perfoliatum* and *Helianthus salicifolius* as a source of green renewable energy and offers a wide information about their features and characteristics based on complex analyzes made in this research. This PhD thesis is a collection of four papers describing the experiments carried out during the research period. The detailed information can be found at published papers in very good JCR Journals as: Industrial Crops and Products (1), Energies (2) and Energy (1).