EFFECTS OF ULTRASONIC AND ENZYMATIC PRETREATMENTS ON ANAEROBIC DIGESTION OF TWO SEASONAL INFLOWS FROM MUNICIPAL WWTP

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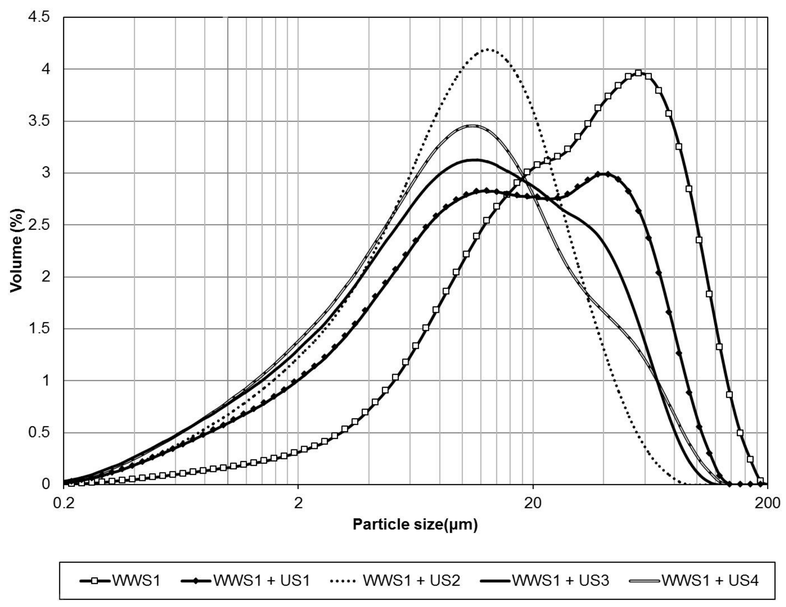
Abstract

The aim of this study was to use two seasonal flows of wastewater sludge of WWTP sludge of Šaleška Walley as alternative source of subtrate in agricultural biogas plant in period of deficit in substrates. Two batches of sludge recieved ultrasonic, hydrolytic and combinatorial pretreatments. For the experiment an upgraded AMPTS II to 5 l pilot scale was used. Temperature of 45 days long semi-continuous anaerobic digestion was set to 37 ± 2 °C. Reactors that were only dosed with sludge from municipal WWTP served as a control and were compared to reactors dosed with ultrasonicaly, hydroliticaly (enzymes from Novozymes) and combinatiorialy pre-treated sludge. Every fifth day the following parameters were monitored: pH, VS, TS, phosphorus and COD. Volatile organic acids (VOA), total inorganic carbon (TIC) and ratio VOA/TIC were measured with TIM 840 titrator (Hach Lange), total nitrogen and ammonium nitrogen with Skalar San++. Particle size was determined by laser particle sizert Fritsch Analysette 22. Organic loadings of anaerobic reactors were 2.35 g VS/l day, as inoculum biomass from the biogas plant Šijanec was used.

1. Physico-chemical changes of pretreated sludge

Figure 1: (left) Ultrasound homogenizator Hielschler used for pretreatment of wastewater sludge, **(right)** Anaerobic digester at WWTP Šaleška dolina.



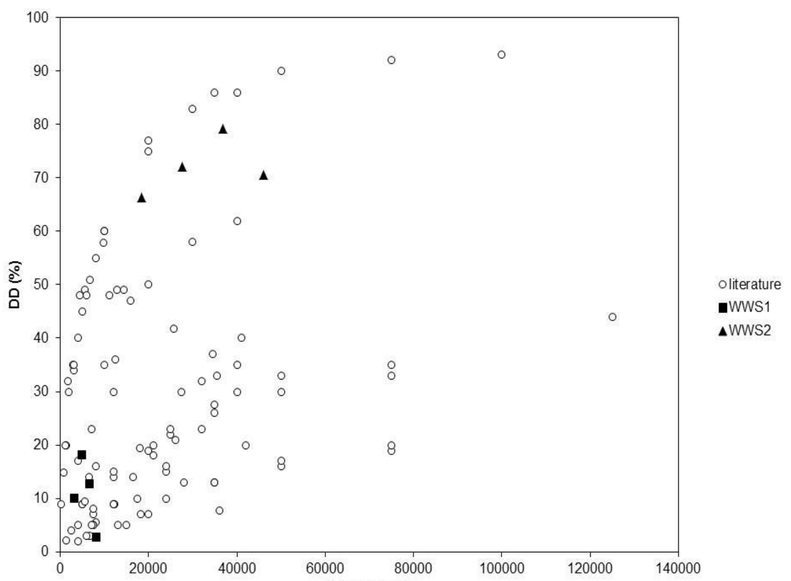
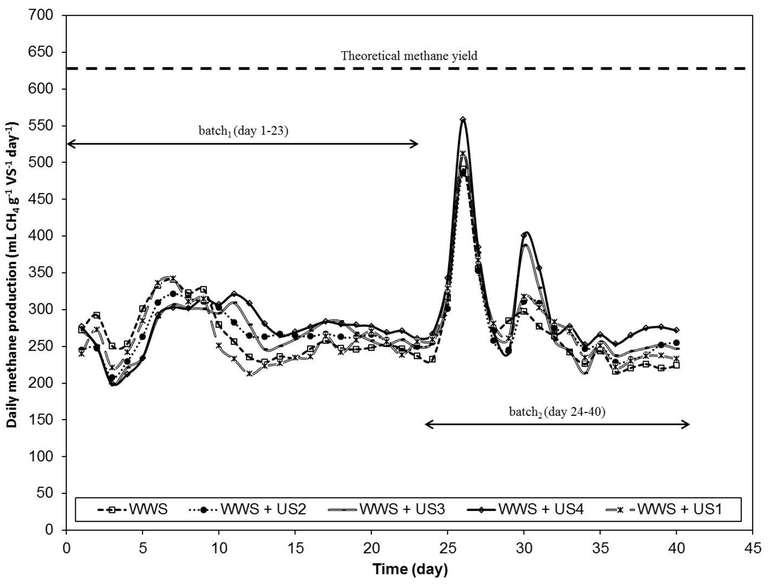


Figure 2: (left) Particle size distribution of WWS1 for different duration of ultrasonic pretreatment. **(right)** The relationship between specific energy of ultrasound and derived disintegration degree as observed from published literature (n=103).

2. Results and discussion



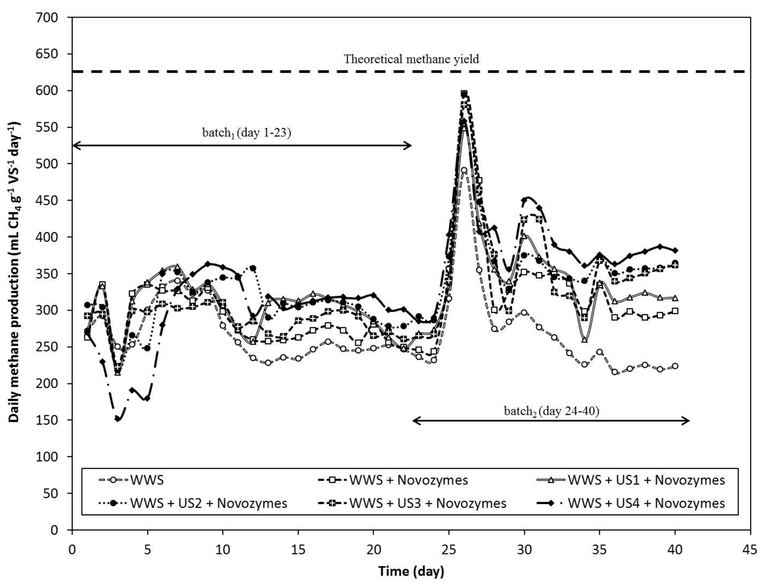


Figure 3: Daily methane production per gram volatile solids added during 40 day semi-continuous operation with inoculum from biogas plant Šijanec degrading two batches of wastewater sludge amended with (left) ultrasound and (right) with combination of ultrasound + hydrolytic enzymes.

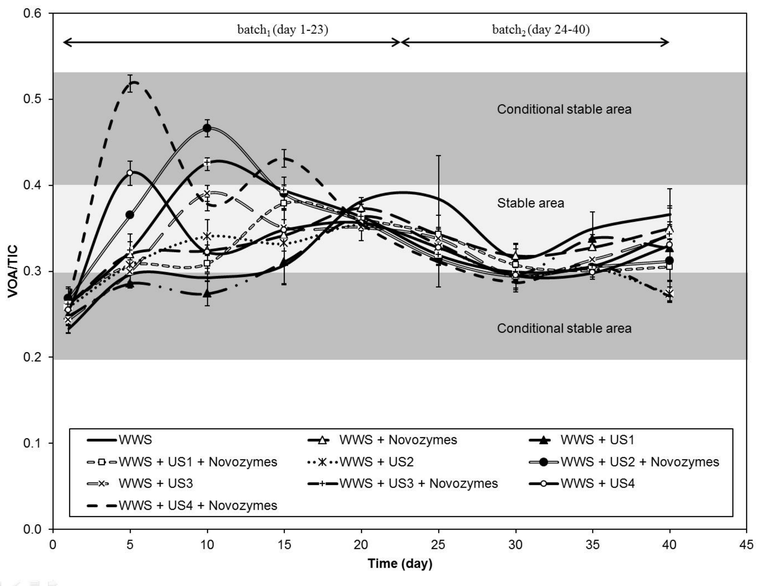
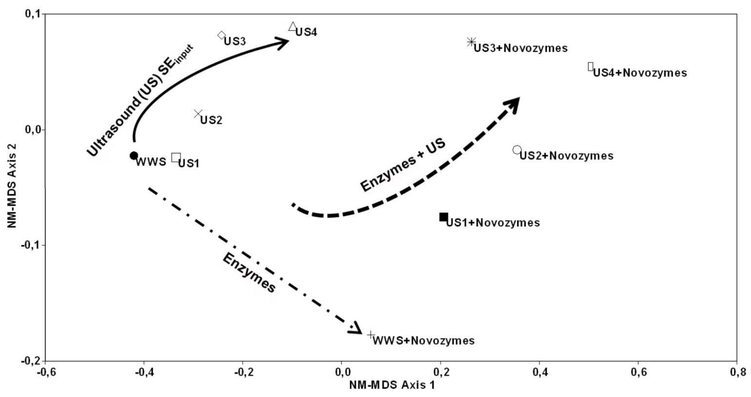


Figure 4: Changes in VOA/TIC ratio in effluent during 40 days semi-continuous anaerobic digestion of WWS1 (batch 1) and WWS2 (batch 2) with different pretreatments.



INCREASE IN CUMULATIVE METHANE YIELDS:

- + 25,2 % for combinatorial pretreatment,
- +14,9 % for enzymatic pretreatment,
- + 7,5 % for ultrasonic pretreatment

Figure 5: NM-MDS ordination showing relationships between daily methane production rates from 40 day semi-continuous experiments using WWS pretreated with US or hydrolytic enzymes Novozymes and a combination of ultrasonic and enzymatic pretreatments Stress = 0.003. Each experimental pretreatment introduced a characteristic pattern.

3. Conclusions and future prospectives

- Watewater sludge can be used as an alternative additional substrate in biogas plants when dealing with lack of energy crops.
- Ultrasound pretreatment in this study is energeticaly not sustainable due negative balance in cost of ultrasonic pretreatment and surplus in methane.
- Sustainability of enzymatic pretreatment was positive, however dependent on maximum costs for purchase, transportation, storage and handling.
- Future reasearch will be focused on effects on industry scale, where efficiency of ultrasound is higher and daily variations in sludge properties are considered.