

Comparison of biogas production from rapeseed and wheat residues in compound with cattle manure

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Introduction

Seventy million tons of agricultural crops are produced from 18 million hectares of agricultural lands in Iran every year. Since 80% of the crops (wt. basis) ends up as residues, therefore, about 50 million tons of crop residues are generated annually the majority of which is burnt on field leading to vast emissions of greenhouse gases (GHG) due to the incomplete combustion process. These residues could potentially be transformed into heat energy directly by adopting a burning process or indirectly by first transforming them into secondary fuel as hydrogen, bio-methane, methanol or ethanol.

Materials and Methods

The present study was conducted using, wheat and rapeseed straws dried at ambient temperature co-digested with fresh cow dung while the total solid content and detention time were kept constant. To conduct the Anaerobic Digestion (AD) experiments, cylinder reactors (13 L) were constructed and placed in a water bath equipped with a heater and sensor to maintain the temperature at 35 ± 2 °C. The biogas produced in the digester was investigated by measuring the displacement of the water in a measuring tube connected to the reactor. Gas samples were obtained from the sampling port and were analyzed gas chromatograph. The temperature for detector, injector and oven were 170, 110 and 50 °C respectively. Before the test, the first CH₄ and CO₂ net gases, peaks corresponding percentage was determined with respect to the retention time of the area. Then sample was compared with standard gas and samples gas percentage was determined. The residues were mechanically pretreated using a mill in order to increase the availability of the biomass to enzymes. After the pre-treatment, the material (<2 mm) was mixed with a different proportion of fresh cow dung. Initial Total Solids (TS) content in the reactor was adjusted at 9%. Factors such as PH, Volatile Solids (VS) were determined by the standard method.

Results and Discussion

A decrease in the process pH was observed in the first few days of the digestion and this is due to high volatile fatty acid (VFA) formation. These results were compatible with Sanaee moghadam *et al.* (2013). The results obtained showed that, the highest rate of VS reduction belonged to rapeseed residues at 52.22%. The lowest rate of VS reduction attributed to wheat residues at 36.79%. The rapeseed residues with 311.45 Lit.kg⁻¹ VS had the highest accumulated methane followed by wheat straw with 167.69.28 L kg⁻¹ VS in probability level of 5%. The average percentages of methane production for rapeseed straw and wheat straw during the 140 days experiment under mesophilic condition were 66% and 55%, respectively. Production of methane had delay and started after 46th day. Much reason may be possible. Inoculums used in this study were only fresh cattle dung. The mixture of fresh cattle dung and effluent of anaerobic digester or fresh rumen fluid may be decrease retention time and increase biogas production. According results of Budiyo the rumen fluid inoculated to biodigester significantly affected the biogas production. Rumen fluid inoculums caused biogas production rate and efficiency increase more than two times in compare to manure substrate without rumen fluid inoculums (Budyono *et al.*, 2010). The other reason was pretreatment. This study applied just mechanical pretreatment. According to Cecilia studies, different pretreatment combined with mechanical pretreatment decrease retention time and increase biogas production efficiency (Cecilia *et al.*, 2013). However, Zhang *et al.* claimed that it is hard to say which method is the best because each has its own strong point and weak point. Yet, until now, none of the pretreatment technologies has found a real breakthrough.

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Conclusions

According to this study, rapeseed residues had the highest level of methane production in comparison with wheat residues. The rapeseed residues combine with cattle dung had suitable potential to methane production. The 140 days, Biomaethane Potential (BMP) of rapeseed residues combine with cattle manure had 311. 45 Lit/kg vs. add. Moreover, it had high percentage of VS content reduction (52.22%). The high retention time was observed (140 day). One reason was lack of suitable inoculums and pretreatment. Furthermore, the lingo-cellulose nature of the crop residues, lower will be the biodegrade ability. Furthermore, the anaerobic co-digestion of rapeseed straw with cattle manure is feasible for production of methane.

Keywords: Biogas, Cattle manure, Rapeseed residues, Wheat residues