EFFECT OF ENERGY GRASS ADDITIONS ON METHANE PRODUCTION AND HEAVY METAL FRACTIONATION DURING ANAEROBIC DIGESTION OF SEWAGE SLUDGE

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Keywords: sewage sludge; energy grass; anaerobic digestion; heavy metal speciation; stabilization process

Introduction

To avoid the potential toxicity and persistence of heavy metals in sludge, various methods have been used for the removal and dissolution of heavy metals prior to land application, including electrochemical techniques, chemical extraction, bioleaching, and biological removal (Demirbas et al., 2005; Ismail et al., 2014). However, all of these methods are inefficient and expensive and can easily yield destructive by-products. Anaerobic digestion is a widely used technology in the efficient treatment of sewage sludge and simultaneously generates renewable energy gas through conversion of the organic matters into short-chain volatile fatty acids (Ciba et al., 2003; Li et al., 2014a; Liu et al., 2012). *Pennisetum alopecuroides* has an abundance of carbon, and adding organic carbon into an anaerobic environment can increase organic matter, especially the humic acid content of the initial sludge, and can improve the efficiency of anaerobic digestion. few studies have focused on the effect of *Pennisetum alopecuroides* additions on methane yields and the distribution of metal species during the anaerobic digestion progress.

Methods

Three reactors (R1, R2 and R3) with a working volume of 6.5Lwere set up with helix-type stirrers, which were set at a rate of 60 rpm (rotations per minute) with 10min stirring and 5 min continuous breaking. The three identical reactors were all operated in batch mode at 35±1 ^{o}C for 30 days. The biogas volumes were recorded daily using a wet gas meter. The methane content of the biogas was an important anaerobic digestion parameter, which was measured using a gas chromatograph (Agilent Technologies 6890N, CA, USA).

A chemical fractionation of the heavy metal in the sludge samples was performed according to Tessier et al. (1979) with some modification. The mobility of heavy metals is usually used to evaluate its migration possibility into the environment (Achiba et al., 2009). Therefore, an analysis of heavy metal mobility is important for evaluating the environmental impacts from land application.

Results

Moderate additions of *Pennisetum alopecuroides* could effectively increase the methane content and increase the methane yields by an extraordinary 11.8%. The target heavy metals in the water-soluble and exchangeable fraction were further reduced, and the dominant species were

concentrated in Fe-Mn oxide-bound and organic and sulfide-bound fractions.Compared with the control, the mobility factor of the target heavy metals after anaerobic digestion with the addition of *Pennisetum alopecuroides* showed significantly lower values. These results demonstrate that the proper addition of bioenergy grass could not only enhance anaerobic digestion but could also decrease the mobility of heavy metals and enhance the stabilization of heavy metals in sludge during anaerobic digestion, which is beneficial for subsequent land application of sewage sludge.

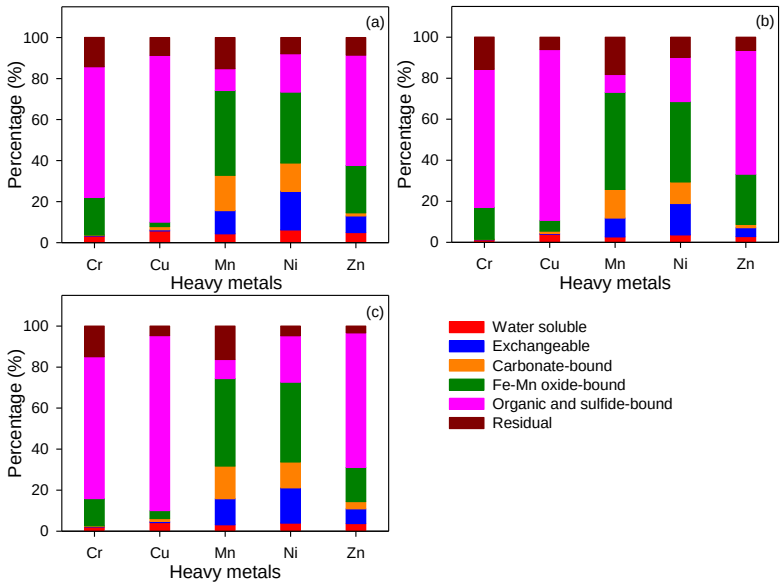

Fig.1 Metals speciation in the solid phase of sludge after digestion R1 (a), R2 (b) and R3 (c)

Conclusion

The distribution of chemical species during anaerobic digestion of sewage sludge in the presence of *Pennisetum alopecuroides* has been studied**.** Adding a moderate amount of *Pennisetum alopecuroides* would increase the biogas yield, where as overdosing would not benefit biogas production. The addition of *Pennisetum alopecuroides* could considerably change the chemical species during anaerobic digestion and would increase the content of the organic-sulfide bound and residual fractions. A moderate addition of *Pennisetum alopecuroides* could better stabilize the heavy metals in sludge and effectively decrease the risk to ecosystem and environment for land application.

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