Occurrence of Estrogenic Compounds at Swine Waster Treatment Plant

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ABSTRACT

The aim of the present study was to quantitatively characterize the substances that were contributing to the estrogenic activity in a pilot scale swine wastewater treatment process. The estrogenic activity was measured with an in vitro gene expression bioassay using MVLN cells. Various potential estrogenic substances were detected and quantified using liquid chromatograph-mass spectrometer (LC/MS) and liquid chromatograph tandem mass spectrometer (LC/MS/MS). The treatment process consisted of a series of up-flow anaerobic sludge blanket (UASB) and trickling filter. To further identify the substances contributing to the estrogenic activity in the wastewater, the sample extracts were fractionated into twelve fractions by HPLC. The estrogenic activity was detected in fractions 1, 2, 3, and 10. Estrogen (E1), 17β-Estradiol (E2), 4-Nonylphenol (NP), and 4-Octylphenol (OP) were detected in these fractions, indicating that these substances were responsible for the observed estrogenic activity. The ratios of E2-EQ to other substances derived from chemical analysis using MVLN cells were compared with those obtained by bioassay analysis. The estrogenic activity was lower in the raw swine wastewater, and E1, E2, NP, and OP were detected in the bioassay results. However, when E1 and E2 were compared with the control, the estrogenic activity was lower than the control. The results suggest that the estrogenic activity was mainly derived from E1 and E2. These analysis results also indicate that the estrogenic activity in the swine wastewater were mainly derived from natural estrogens, such as E1 and E2. The existence of unknown estrogenic substances in swine wastewater was also indicated. The removal rate of estrogenic activity following treatment was over 97%. Trickling filter plays a major role in the removal of estrogenic activity. The removal rates of estrogenic compounds ranged from 44% to 99%.

INTRODUCTION

A number of estrogenic compounds have been found in aquatic environments and their effects on normal endocrine functions of aquatic organisms are of concern. Importance of further investigation about the occurrence of natural estrogens in agricultural systems is emphasized. Livestock wastewater is a major source of estrogenic substances in aquatic ecosystems. Although the effects of estrogenic compounds to aquatic biota require a better understanding of the source and fate, few studies have reported the occurrence and fate of estrogenic compounds in livestock waste. Moreover, there is little information on the removal of estrogenic compounds from agricultural wastewater. The aim of the present study was first, to measure the estrogenic activity in water in vivo gene expression bioassay using MVLN cells. The estrogenic activity was measured by the calculation of E2-eq concentration, using the estrogen-response element (ERE) reporter gene of the MVLN cells.

RESULTS AND DISCUSSION

Calculation of E2-EQ equivalent concentration

The estrogenicity was calculated into the estrogenic activity in various fractions and their potencies were obtained.

Occurrence of E2-EQ and BOD in each treatment steps

The comparison between E2-EQ and E2-EQ in each fractions

The removal rate of BOD was over 89%. UASB outlet sample contained raw swine wastewater. The estrogenic activity was also found. The estrogenic activities were over 97%. Trickling filter performed high removal of estrogenic activity as UASB. E1 and E2-EQ were removed 44% and 97%, respectively. These results revealed that the major causal substances to the estrogenic activity were natural estrogens such as E1 and E2. The existence of unknown estrogenic substances in swine wastewater was also indicated. The removal rate of estrogenic activity following treatment was over 97%. Trickling filter plays a major role in the removal of estrogenic activity. The removal rates of estrogenic compounds ranged from 44% to 99%.