



Anaerobic treatment of sewage sludge containing selective serotonin reuptake inhibitors

Ove Bergersen^{a,*}, Kine Østnes Hanssen^b, Terje Vasskog^{b,c}

^a Norwegian Institute for Agricultural and Environmental Research (Bioforsk), Soil and Environment Division, N-1432 Ås, Norway

^b Department of Pharmacy, Faculty of Medicine, University of Tromsø, N-9037 Tromsø, Norway

^c Norut – Northern Research Institute, PO Box 6434, Tromsø Science Park, N-9294 Tromsø, Norway

HIGHLIGHTS

- ▶ No research has been done earlier on anaerobic degradation of SSRIs.
- ▶ Paroxetine and citalopram were found to be more or less completely reduced.
- ▶ Fluvoxamine, fluoxetine and sertraline were relatively stable from day 17 to 24.
- ▶ The results indicate that some SSRIs have a potential for accumulation under anaerobic treatment of sewage sludge.

ARTICLE INFO

Article history:

Received 6 February 2012

Received in revised form 20 April 2012

Accepted 21 April 2012

Available online 28 April 2012

Keywords:

Anaerobic treatment

Pharmaceuticals

Selective serotonin reuptake inhibitors

Sewage sludge

ABSTRACT

The selective serotonin reuptake inhibitors citalopram, sertraline, paroxetine, fluvoxamine and fluoxetine have been investigated in 10 l anaerobic lab-scale digesters with continuous stirring and mesophilic conditions at 37 °C to investigate whether they would be reduced or accumulated in sewage sludge depending on whether the bacteria present were able to use the SSRIs as a carbon source or not. The total SSRI concentration had a significant reduction in concentration during the anaerobic treatment process from theoretically 0.58 mg/l to 0.21 mg/l after 17 days. However, large differences in the reduction of the different compounds were found. Paroxetine and citalopram were found to be almost completely reduced at day 24 with reductions of 85% (citalopram) and 98% (paroxetine). Reductions of 32% (fluoxetine), 53% (fluvoxamine) and 38% (sertraline) indicate that these three compounds have a higher potential for accumulation. None metabolites of these compounds were found in the samples.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

In recent years, the occurrence of pharmaceuticals and personal care products (PPCPs) in the aquatic environment has been recognized as one of the emerging issues in environmental risk assessment (Daughton and Ternes, 1999; Heberer, 2002; Sanderson et al., 2004; Fent et al., 2006). Pharmaceuticals used in human medical care, such as analgesics, anti-inflammatory drugs, antibiotics, antidepressants and antiepileptic drugs, are not completely eliminated in the human body and can enter the municipal sewage sludge system both as the parent compound and as their biologically active metabolites. Several investigators have examined the removal of pharmaceutical compounds during the passage through municipal sewage treatment systems (e.g. Ternes, 1998; Simonich

et al., 2002; Carballa et al., 2004; Vasskog et al., 2008). The results show that influent and effluent concentrations and elimination rates for different compounds vary significantly. Various pharmaceutical compounds have been detected in the order of µg/l in sewage effluents, downstream of sewage treatment plants and in surface and groundwater (Heberer, 2002; Jux et al., 2002; Kolpin et al., 2002). Fate studies have also been performed of selected PPCPs through wastewater treatment systems, and during composting (Buyuksonmez and Sekeroglu, 2005; Xia et al., 2005).

In addition to sewage treatment plants, landfill sites where unused drugs and different personal care products have been disposed may release these compounds into the environment. There are several old landfill sites that were established when the disposal of such compounds through garbage was tolerated, and drugs have been detected in leachates from such municipal landfills (Holm et al., 1995). Soil may also be exposed to these chemicals when digested sewage sludge is applied as fertilizer on agricultural fields or treated wastewater is used for irrigation purposes or groundwater recharge.

* Corresponding author. Address: Bioforsk- Department for Soil and Environmental Research, Fredrik A. Dahls vei 20, N-1432 Ås, Norway. Tel.: +47 926 03 105; fax: +47 63 00 94 10.

E-mail address: ove.bergersen@bioforsk.no (O. Bergersen).