Water Science & Technology | 68.2 | 2013

Ammonium nitrogen removal in batch cultures treating digested piggery wastewater with microalgae *Oedogonium* sp.

Haiping Wang, Zhiquan Hu, Bo Xiao, Qunpeng Cheng and Fanghua Li

ABSTRACT

Due to the nutrient characteristics of the high concentration of available ammonium in digested piggery wastewater (DPW), microalgae can be used to treat DPW before its final discharge. Four green microalgae (*Hydrodictyaceae reticulatum* Lag, *Scenedesmus obliquus*, *Oedogonium* sp. and *Chlorella pyrenoidosa*) and three blue-green algae (*Anabaena flos-aquae*, *Oscillatoria amoena* Gom and *Spirulina platensis*) were used to remove the nutrients (N, P, C), especially ammonium nitrogen (NH_4^+-N), from diluted DPW with 300 mg/L algae density in batch tests. The microalgae with the best NH_4^+-N nutrient removal was then selected for further optimization of the variables to improve NH_4^+-N removal efficiency using a central composite design (CCD) experiment. Taking into account the nutrient removal efficiency, *Oedogonium* sp. showed the best performance (reduction of 95.9% NH_4^+-N, 92.9% total phosphorus (TP) and 62.5% chemical oxygen demand (COD)) based on the results of the batch tests. The CCD results suggested that the optimal values of variables were initial *Oedogonium* sp. density of 399.2 mg/L and DPW diluted by 16.3, while the predicted value of NH_4^+-N removal efficiency obtained was 97.0%.

Key words | ammonium nitrogen removal, central composite design, digested piggery wastewater, microalgae

Haiping Wang
Zhiquan Hu (corresponding author)
Bo Xiao
Qunpeng Cheng
Fanghua Li
School of Environmental Science and Engineering, Huazhong University of Science and Technology, Wuhan 430074, China
E-mail: *zhiquanhu@yahoo.com.cn*

INTRODUCTION

The pig industry is one of the main industries in the suburban economy of China (McOrist *et al.* 2011). Effluents from pig farming contain high concentrations of nitrogen, phosphorus, and organic matter in both soluble and particulate forms, the composition mainly depending on animal nutrition and farming practices. Anaerobic digestion is often attractive as the first treatment process for piggery wastewater due to the recovery of renewable energy (biogas) and the reduction of organic matter, waste volume and odors, through the fermentative degradation of organic constituents. However, levels of nutrients such as ammonia are not reduced during anaerobic digestion because the microorganisms employed generally lack sufficient autotrophic metabolism of inorganic nitrogen (Noike *et al.* 2004; Uludag-Demirer *et al.* 2008) Thus, it is necessary to treat digested piggery effluent effectively prior to disposal in order to avoid causing severe environmental problems such as eutrophication of water bodies which can lead to highly undesirable changes in the ecosystem structure and function (Novotny 1999), groundwater contamination, air pollution by ammonia gas volatilization, and soil degradation due to over-fertilization and also risks to human health (Godos *et al.* 2010).

Traditional bacterial nitrification–denitrification can be used to remove ammonia, but it requires the assimilation of extra organic carbon. Another important feature of anaerobic digestion is the high concentration of alkalinity involved. High alkalinity makes it difficult to apply advanced oxidation processes using ozone or peroxides because bicarbonate acts as a radical scavenger (Ma & Graham 2000; Currie *et al.* 2003). Additionally, the high complexity and energy inputs associated with these technologies have not promoted their widespread implementation in rural areas. Agricultural land disposal methods have traditionally been used to solve swine manure management, however, the recent intensive farming context has overtaxed the natural

doi: 10.2166/wst.2013.230

capacity of the farm surrounding lands to cope with piggery wastewaters. In this context, the development of cost-effective technologies, which support a simultaneous

NH_4^+-N removal efficiency using a central composite design (CCD).