Chemical Engineering Journal 455 (2023) 140967

Contents lists available at ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Comprehensive study on removal of bisphenol-S and its metabolic fate using aquatic macrophytes

Nikita Yadav [a], Hyun-Jo Ahn [a], Niraj R. Rane [a,f], Mayur B. Kurade [a], Xiaofang Li [b], Young-Kwon Park [c], Moonis Ali Khan [d], Woo Jin Chung [e], Soon Woong Chang [e], Byong-Hun Jeon [a,*]

[a] Department of Earth Resources and Environmental Engineering, Hanyang University, 04763, Seoul, Republic of Korea
[b] Hebei Key Laboratory of Soil Ecology, Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, Shijiazhuang 050021, China
[c] School of Environmental Engineering, University of Seoul, Seoul 02504, Republic of Korea
[d] Chemistry Department, College of Science, King Saud University, Riyadh 11451, Saudi Arabia
[e] Department of Environmental Energy Engineering, Kyonggi University, 154-42 Gwanggyosan-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do 16227, Republic of Korea
[f] Department of Biotechnology, Dr. D.Y.Patil Arts, Commerce and Science College, Sant Tukaram Nagar, Pimpri, Pune 411018, India

ARTICLE INFO

Keywords:
Phytoremediation
Iris pseudacorus
Bisphenol-S
Biotransformation
Cytochrome P450 enzymes
Phytoreactor

ABSTRACT

Bisphenol-S (BPS) is recognized as an emerging contaminant due to its potential estrogenic properties and is frequently detected in aquatic environment. The safety and environmental behavior of BPS is controversial. Furthermore, the removal studies of BPS from aqueous environment are scarce. In this study, we assessed the phytoremediation potential of three aquatic macrophytes (*Iris pseudacorus, Ipomoea aquatica,* and *Typha angustifolia*) for BPS removal from secondary wastewater effluent. BPS at environmentally relevant concentration (0.005 mg/L) was removed 100 %, 97 % and 97.5 % with *I. pseudacorus, I. aquatica* and *T. angustifolia* respectively. Twelve biotransformed products of BPS were identified through gas chromatography mass spectrophotometry. The enzymatic analysis showed induction of both phase I (laccase, 315 %; peroxidase, 739 %, superoxide dismutase, 881 %; aminopyrine N demethylase, 60 %) and phase II enzymes (glutathione S-transferase, 592 %) in the plant roots after 7 days of BPS exposure. A lab-scale vertical phytoreactor was constructed with PVC tubes that completely removed BPS in 14 days along with nutrients (phosphorus and nitrogen) and inorganic (heavy metals) contaminants from the secondary wastewater effluent. An analysis of the microbial diversity in the phytoreactor effluent showed an enhanced relative abundance of the phyla Bacteroidetes (20 %) and Proteobacteria (44 %) after BPS exposure. This study is the first report highlighting the removal of BPS by aquatic macrophyte and its fate in aquatic environments.

1. Introduction

The extensive use of bisphenols in industries such as plastic manufacturing, food packaging, pharmaceuticals, and personal care products has attracted the attention of the scientific community because of their endocrine-disrupting effects on human health [1]. Bisphenol-S (BPS) is the primary replacement for bisphenol-A (BPA), a plastic additive that dominated the market for more than 100 years before its ban by the European Union in 2012 because of its reprotoxic and endocrine disrupting properties [2]. Toxicology studies have concluded that BPS exposure as low as 2 mg/kg adversely affects the male reproductive system (decrease in production and motility of spermatozoa along with alterations of testicular histology) in both rats and mice [3,4]. Other studies have reported that BPS exposure as low as 1.5 μg/kg

Abbreviations: BPS, Bisphenol-S; BPA, Bisphenol-A; CW, constructed wetland; ECs, endocrine disruptors; WWTPs, wastewater treatment plants; SOD, superoxide dismutase; HRP, horseradish peroxidase; GST, glutathione S-transferase; CYP450, cytochrome P450; SWE, secondary wastewater effluent; HPLC, high-performance liquid chromatography; GC-MS, gas chromatography-mass spectroscopy; COD, chemical oxygen demand; LC50/EC50, acute toxicity value; ChV, chronic toxicity value; TP, transformed products; PGPR, plant growth-promoting rhizospheric; ECOSAR, Ecological Structure Activity Relationships program; NIST, National Institute for Standard Technology.

* Corresponding author.
E-mail address: bhjeon@hanyang.ac.kr (B.-H. Jeon).

https://doi.org/10.1016/j.cej.2022.140967
Received 25 September 2022; Received in revised form 30 November 2022; Accepted 12 December 2022
Available online 14 December 2022

Chemical Engineering Journal

Supports *open access*

21.5
CiteScore

15.1
Impact Factor