FAUNA OF MALAYSIA

Madinah Adrus
Abdul Kadir Abu Hashim
Muhamad Aidil Zahidin
Muhammad Abdul Latiff Abu Bakar
Mohd Tajuddin Abdullah

WILDLIFE MANAGEMENT AND SUSTAINABILITY

#Selamatkan Harimau Malaya

PERHILITAN

Wildlife Management and Sustainability

Published in Malaysia by / *Diterbitkan di Malaysia oleh*

DEPARTMENT OF WILDLIFE AND NATIONAL PARKS (PERHILITAN)
PENINSULAR MALAYSIA
KM 10, Jalan Cheras
56100 Kuala Lumpur, Malaysia

https://www.wildlife.gov.my
E-mail: pakp@wildlife.gov.my

Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available from the National Library of Malaysia

ISBN 978-967-5557-55-2

Design: PERHILITAN
Layout: PERHILITAN

Design by / *Rekaan Oleh : Percetakan Rita*
Printed in Malaysia by / *Dicetak di Malaysia oleh :*

10

SAGO WASTEWATER: CHARACTERIZATION AND DEGRADATION BY TiO_2 PHOTOCATALYSIS

DEVAGI KANAKARAJU*, WONG SOON PANG, & MUHAMMAD MASHUR BESAR

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

*Corresponding author: kdevagi@unimas.my

ABSTRACT

One of the major sectors which have been contributing to the deterioration of water resources as well as accumulation of solid wastes is agriculture. One of the most important crops for starch production is sago palm. It is known that more than 90% of sago-planting areas are found in the state of Sarawak, Malaysia. Heavy consumption of water by sago starch production mills have resulted in large volumes of sago effluent. Direct release of sago wastewater into water bodies may be inappropriate due to the high amount of organic material, and suspended solids. There are also growing concerns about the solid wastes which include sago roughage (*hampas*), and sago bark. Hence, an effective method or protocol becomes necessary to tackle issues related to this agro industry. Titanium dioxide (TiO_2) photocatalysis is known for its potential to effectively treat various types of wastewater. However, there remains a paucity of studies on sago wastewater abatement over TiO_2 photocatalysis. The objective of this study is to investigate the potential of TiO_2 photocatalysis for the degradation of sago wastewater. Discussion pertaining to the properties of sago wastewater and solid residues, performance of TiO_2 photocatalysis and recommendation for future studies are outlined.

Keywords: Advanced oxidation process, Effluent, Agriculture, Environment

INTRODUCTION

Many countries including Malaysia are struggling to cope with water deterioration or depletion issue. Agriculture sector being the backbone in terms of economic return to our country, has inevitably contributing to water pollution as well as generation of solid wastes. Amongst various crops, crops for starch production are mainly concentrated in the state of Sarawak. In Sarawak, the highest starch producing crop known as sago palm (*Metroxylon sagu*), consume more than 90% of the total planting areas (Singhal *et al.*, 2008, Bujang, 2015). The sago residues from sago starch processing mills are abundantly available. Wastewater effluent generated during sago debarking and sago processing is generally discharged into nearby rivers (Awg-Adeni *et al.*, 2010). Typically, a sago mill which consumes 1,000 logs/day is known to generate approximately 400 tons of effluents (Bujang, 2008). About 94-97% of the bulk of the sago wastewater is liquid, while the remaining portion is solid waste referred as roughage or 'hampas'. Sago bark (SB) is another solid waste generated during the debarking step of starch extraction process. Deposition or dumping of SB on land is the most common practice among most of the mill operators to address the disposal

problem of this solid waste. Although such practice provides a short term solution, potential environmental problems could however emerge in the long term.

Sago effluent which is complex, acidic and emits obnoxious odour is usually characterised by elevated chemical oxygen demand (COD), biochemical oxygen demand (BOD) and total suspended solids (TSS) ranging from 780-5130 mg/L, 910-1300 mg/L, and 19-20,000 mg/L, respectively (Ibrahim *et al.*, 2006, Rashid *et al.*, 2010). Sago wastewater may lead to pollution mainly owing to its high organic content (Ulhiza *et al.*, 2018). As the direct discharge of sago wastewater effluent may cause issues related to environmental deterioration, its treatment for either re-using or improving its discharged water quality has been the main goals of the sago mill operators.

Biological methods such as anaerobic fluidized beds and filters (Saravanane *et al.*, 2001, Parthiban *et al.*, 2008), three-phase fluidized bed bioreactor (Rajasimman &Karthikeyan, 2007), and hybrid upflow anaerobic sludge blanket reactor (Banu *et al.*, 2006) have been commonly applied to treat sago wastewater. Given that the efficiency of biological methods to completely degrade the effluent are poor, other alternative treatments are needed to improve the water quality of sago wastewater (Sangeetha *et al.*, 2015). Titanium dioxide (TiO_2) photocatalysis a non-biological method could be a desirable alternative to degrade organic present in the sago effluent. TiO_2 photocatalysis has emerged as an effective method for the degradation of various biorecalcitrant compounds in water and wastewater (Gaya & Abdullah, 2008, Chong *et al.*, 2010).

TiO_2 photocatalysis has emerged as a promising wastewater treatment technology with key advantages including the operation at ambient conditions, low cost, lack of mass transfer limitations and the possibility of utilising solar irradiation as a photon source (Pekakis *et al.*, 2006). Semiconductor TiO_2 has been widely applied in the photocatalytic treatments to induce oxidative and reductive reactions on its surface (Chong *et al.*, 2010, Kanakaraju *et al.*, 2018a). Despite the established importance of TiO_2 photocatalysis in wastewater purification be it natural or synthetic wastewater, there is limited evidence of whether this technique is capable to degrade sago wastewater.

Study area: Sago Mill in Pusa, Sarawak

Sago palm is the species of the genus of *Metroxylon* which belongs to the Palmae family (Awg-Adeni *et al.*, 2010). At present, this species of sago palm is grown commercially in Malaysia, New Guinea, Philippines and Indonesia. The state of Sarawak besides being the world's biggest exporter of sago also possesses the largest sago growing areas in Malaysia. Figure 1 shows the sago palms found in Pusa, Sarawak. About 44,700 tons of sago starch were exported to Peninsular Malaysia, Singapore, Taiwan, Hong Kong and other countries in 2007 (Awg-Adeni *et al.*, 2010). In Sarawak, the total export earnings between US$ 3.4 million to US$ 10.8 million were generated from annual export of pure sago starch, which typically fluctuates between 30,000 to 50,000 tons (Bujang, 2014). Five major sago planting areas in Sarawak include Mukah, Pusa-Saratok, Oya-Dalat, Igan and Balingan (Andriana & Abdullah, 2010). Generally, the sago industries are located along rivers to ease transportation of sago logs (Figure 2).

REFERENCES

Aziz, N. A. A., Palaniandy, P., Aziz, H. A., Dahlan, I. (2016). Review of the mechanism and operational factors influencing the degradation process of contaminants in heterogeneous photocatalysis. *Journal of Chemical Research*, 40, 704-712.

Department of Environment (DOE). 2010. *Environmental requirements: A guide for investor* (11th ed.). Putrajaya, Malaysia: Department of Environment.

Ethaib, S., Omar, R., Mazlina, M. K. S. Radiah, A. B. D., & Syafiie, S. (2016). Microwave-assisted dilute acid pretreatment and enzymatic hydrolysis of sago palm bark. *BioResources, 11*(3), 5687-5702.

Gaya, U. I., & Abdullah, A. H. (2008). Heterogeneous photocatalytic degradation of organic contaminants over titanium dioxide: A review of fundamentals, progress and problems. *Journal of Photochemistry and Photobiology C: Photochemistry Reviews, 9*(1), 1-12.

Ibrahim, S., Vikineswary, S., Al-Azad, S., & Chong, L. L. (2006). The effects of light intensity, inoculums size, and cell immobilisation on the treatment of sago effluent with *Rhodopseudomonas palustris* strain B1. *Biotechnology and Bioprocess Engineering, 11*, 377-381.

Kanakaraju, D., Glass B. D., & Oelgemöller, M. (2018a). Advanced oxidation process-mediated removal of pharmaceuticals from water: A review, *Journal of Environmental Management, 219*, 189-207

Kanakaraju, D., Wong, S.P. (2018b). Photocatalytic efficiency of TiO_2-biomass loaded mixture for wastewater treatment. Journal of Chemistry. 2018: 14 pages (Article ID 4314969)

Karim, A. A., Tie, P. L., Manan, D. M. A., & Zaidul, I. S. M. (2008). Starch from the sago (*Metroxylon sagu)* palm tree-properties, prospects, and challenges as a new industrial source for food and others uses. *Comprehensive Reviews in Food Science and Food Safety, 7*(3), 215-228.

Parthiban, R., Iyer, P. V. R., & Sekaran, G. (2008). Anaerobic tapered fluidized bed reactor for treatment of sago industry effluent. *Indian Chemical Engineer, 50*(4), 323-333.

Pekakis, P. A., Xekoukoulotakis, N. P., & Mantzavinos, D. (2006). Treatment of textile dye house wastewater by TiO_2 photocatalysis. *Water Research, 40*, 1276-1286.

Rajasimman, C. ,& Karthikeyan, M. (2007). Starch wastewater treatment in a three-phase fluidized bed bioreactor with low density biomass support. *Journal of Applied Sciences and Environmental Management, 11*(3), 97-102.

Rashid, W. A., Musa, H., Wong, S. K., & Bujang, K. (2010). The potential of extended aeration system for sago effluent treatment. *American J ournalof Applied Sciences, 7*(5), 616-619.

Sangeetha, V., Sivakumar, V., Sudha, A., Devi, K. S. P. (2014). Optimisation of process parameters for COD removal by coagulation treatment using box-Behnken design. *International Journal of Engineering and Technology, 6*(2), 1053-1058.

Saravanane, R., Murthy, D. V. S., & Krishnaiah, K. (2001). Anaerobic treatment and biogas recovery for sago wastewater management using a fluidized bed reactor. *Water Science & Technol ogy44*(6), 141-146.

Singhal, R. S., Kennedy, J. F., Gopalakrishnan, S. M., Kaczmarek, A., Knill, C. J., & Akmar, P. F. (2008). Industrial production, processing, and utilization of sago palm-derived products. *Carbohydrate Polymers, 72*(1): 1-20.

Ulhiza, T. A., Puad, N. I. M., Azmi, A. S. (2018). Optimization of culture conditions for biohydrogen production from sago wastewater by Enterobacter aerogenes using Response Surface Methodology. International Journal of Hydrogen Technology. 43(49): 22148-22158.