

UPTAKE OF HEAVY METALS FROM PALM OIL MILL EFFLUENT SLUDGE AMENDED SOILS IN WATER SPINACH

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Abstract: Palm oil mill effluent (POME) sludge is generated in great amount in Malaysia and often regarded as pollutant and waste material. This study is aimed at utilizing POME sludge for growing plants. Five different treatments (POME sludge:soil ratio) were performed to evaluate the potential of POME sludge application on the growth and uptake of heavy metals, namely Cr, Cd, Cu, Zn, Fe, Mn and Ni in water spinach. Flame Atomic Absorption Spectrophotometer (FAAS) was used to determine the levels of these metals in water spinach. It was found that the concentration of heavy metals in water spinach has increased with the increasing POME sludge loadings for all metals with the exception of Cu. Elevated levels of accumulated Fe in water spinach were recorded between 200.84-660.67 mg/kg, while Cu accumulation was the least, ranging between 41.67-75.00 mg/kg. The yield of water spinach has also increased when the amount of POME sludge increased. Concentrations of Mn, Ni, Zn, Fe, Cd and Cr in water spinach have surpassed the maximum permitted levels. However, among the metals being investigated, only Mn, Fe and Ni have shown significant differences ($P < 0.05$) for the mean concentration between these five treatments. No toxicity symptoms were observed on the water spinach. This may indicate the ability of water spinach to tolerate high heavy metals contents. This study suggests that an appropriate amount of POME sludge should be added onto soil to enhance the production of water spinach and to avoid unnecessary accumulation of metals, which may impose health risks to the consumers. Application of POME sludge in agricultural practices may offer a sustainable option in managing this waste material.

Keywords: Palm oil, biomass, soil, agriculture, waste.

Introduction

Agricultural residues contribute to the largest amount of biomass resources in Malaysia and one of the major contributors is the palm oil industry. Malaysia is one of the world's largest palm oil producing country other than Indonesia. According to Wu *et al.* (2009), in 2003, 3.79 million hectares were used for oil palm cultivation, which occupies more than one-third of the total cultivated areas in Malaysia. The residues of the palm oil industry include palm oil mill effluent (POME), empty fruit bunch, palm kernel shells and mesocarp fibres (Sumathi *et al.*, 2008). The accumulation of oil palm biomass from palm oil industry, which is approximately 40 million tonnes per year (Mohammad *et al.*, 2012), has been

constantly growing with increasing global demand for crude palm oil.

The amount of wastewater sludge or better known as POME sludge generated during the production of crude palm oil is abundant. Statistics published in 2008 has shown that at least 44 million tonnes of POME was generated in Malaysia (Wu *et al.*, 2010). It has been estimated that the production of 1 tonne of crude palm oil generates about 2.5-3.5 m³ of POME (Ahmad *et al.*, 2015; Jefferson *et al.*, 2016). In general, utilization of sludge in agriculture is considered as one of the best waste management options as it improves the soil's aggregate stability, porosity and water infiltration rate, and supplies organic matter and major nutrients, such as N and P to the soil