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SOLID SUBSTRATE FERMENTATION OF SAGO WASTE AND ITS EVALUATION AS FEED INGREDIENT FOR RED HYBRID TILAPIA

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ABSTRACT

The increasing demand for fishmeal in aquaculture industry causes the rising cost of feed yearly. Here, we reported on the solid-state fermentation of sago waste inoculated with mixed microbial cultures, optimization of its fermentation parameters to improve the nutrient contents, and the use of the fermented sago waste as an ingredient in the formulation of fish feed diet. The use of *Bacillus amyloliquefaciens*, *Aspergillus niger*, and *Neurospora crassa* as inoculums gave the best, improved physiochemical properties and nutrient content of the fermented sago waste. The optimum conditions were 5 days, 28°C, pH 3, and sodium nitrate as a nitrogen source. Under the optimized conditions, moisture content, crude protein, and ash increases by 11.8%, 1.3%, and 5.1%; whereas dry matter and crude fiber decreases by 11.8% and 6.1%; respectively. The fermented sago waste prepared was further used as ingredient in the formulation of the fish feed diet and fed to red hybrid tilapia. Fish feed that contained up to 150 g kg^{-1} of fermented sago waste had a similar growth rate. Growth performance, specific growth rate, feed conversion ratio, and survival rate of tilapia fed were not of significant difference compared to control diet. The supplementation of the diets for 60 days resulted in 1.50 ± 0.48 g $fish^{-1}$ mean body weight gain with a specific growth rate of 0.68 ± 0.17% day^{-1}, feed conversion ratio of 2.33 ± 0.84, and survival rate of 80%. This concludes that fermented sago waste has the potential as a partial substitute for fishmeal.

Key words: *Aspergillus niger*, *Bacillus amyloliquefaciens*, mixed culture, *Neurospora crassa*, nutrient enhancement, Sago waste, solid-state fermentation

INTRODUCTION

Our environments are broadly exposed to pollution by agro-industrial by-products (Ali *et al*., 2011; Sarkar *et al*., 2012; Soliman *et al*., 2013; Anwar *et al*., 2014; Basappaji & Nagesha, 2014). According to Tan and Li (2017), global funding to solve the environmental issue regarding waste management had increased. Malaysia is the world's largest sago (*Metroxylon sagu*) starch exporter with 96% of starch production that came from the state of Sarawak (Uthumporn *et al*., 2014).

Residues from sago starch processing mills such as sago waste are often deposited as waste and reported to cause environmental problems (Bujang *et al*., 1996; Awg-Adeni *et al*., 2013; Lim *et al*., 2019). Awg-Adeni *et al.* (2013) stated that Sarawak produced approximately 7.1 tons (t) of starchy fibrous sago pith waste daily from a single sago starch-processing mill. The sago agro-industrial waste consists mainly of non-starch polysaccharides (NSP) or lignocellulosic materials such as cellulose, hemicellulose, and lignin (Lai *et al*., 2013). Lignocellulosic waste has many potentials to be converted to value-added products. Sago waste has the potential to be utilized as a carbon source in the production of valuable products (Vincent *et al*., 2015; Lim *et al*., 2019).

High fiber and low protein content may reduce the quality of sago waste to be accepted as aquaculture feed (Awg-Adeni *et al*., 2010). It is suggested that the pre-treatment of lignocellulosic biomass using microbes can be beneficial in the production of byproducts and often of high quality

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