SHORT COMMUNICATION

NUTRITIVE VALUE OF BLACK SOLDIER FLY (*HERMETIA ILLUCENS*) LARVAE REARED ON LOCAL PALM OIL WASTES FOR ANIMAL FEEDS

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ABSTRACT. Black soldier fly (*Hermetia illucens*) has long been known to be an important insect for its significant capability of organic matter bioconversion. It can provide not only a high level of nutritional supplementation, but also has the potential reduction of feed cost. The purpose of this study was to determine its nutrient composition as animal feeds in general, where samples of local BSF larvae that grew on local palm oil wastes were chosen as substrate with 17.4% crude protein content for approximately 3 weeks at 30 ± 2 °C and 65 ± 5% relative humidity of natural condition. BSFL were killed by hot air oven drying and grinding where the mean percentage of the nutrient values of BSFL obtained were: crude protein 36%, crude fibre 15%, crude ash 18%, crude fat 28%, and dry matter 90%. From the feed safety aspect, heavy metals were determined with safe mean concentrations of Hg (0.03), Cd (0.6), As (0.2), Cr (3.5), and Pb (2.0) in ppm (2-5% RSD), respectively. There were no significant differences ($p > 0.05$) observed in the nutrients value after eight months of storage at room temperature for protein except for (35%) reduction in fat and (20%) in fibre contents. Screening of aflatoxin contaminations also showed to be below permissible level. Thus, the nutritive values of BSFL obtained in this study show a promising result comparable to other waste streams as substrate produced for animal feeds.

Keywords: Black soldier fly larvae (BSFL), animal feeds, palm oil wastes

INTRODUCTION

Available documentation of the nutritional composition and value of different insect species considered as candidates for use in animal feeds has become substantial (Makkar *et al*., 2014). The black soldier fly (BSF), *Hermetia illucens*, is a true fly (Diptera) of the family Stratiomyidae which now occurs worldwide in tropical and temperate regions (Sheppard *et al*., 1994). As BSF larvae (BSFL) contain high amounts of protein and have a well-balanced profile of essential amino acids (Henry *et al*., 2015), making it a beneficial factor in animal production strategy. Large-scale rearing of insects is a promising and innovative alternative as several insects' species can feed on various types of organic waste streams (Van Huis *et al*., 2017). However, the use of insects as an alternative protein source faces many challenges, including stability of product quality, price competitiveness with general protein sources and country-specific regulatory barriers (Sogari *et al*., 2019).

The continuity in this area of research needs to be promoted by respective authority in order to produce sufficient data on every aspect of BSF production. In this study, the recyclable organic material

of local palm oil wastes has relatively high protein content was chosen as substrate on the basis of their abundance in many Malaysian regions. Waste from the oil palm mill process includes palm oil mill effluent (POME), generated mainly from oil extraction, washing and cleaning up processes. POME contains cellulosic material, fat, oil, and grease (Singh *et al.*, 2010). The two main factors found to contribute to the BSFL composting process were volatile solids content of the substrate and nitrogen feeding rate as reported in other studies that, when a substrate was high in protein, the development of larvae was faster (Lalander *et al.*, 2019).

MATERIALS AND METHOD

Full matured BSFL pooled samples weighing more than 1 kg were received from a local producer in Jerantut, Pahang in 2018. The larvae had been reared on palm oil wastes in a medium-sized plastic tray as a source of nutrient in a natural environment of growing with normal daily temperature between 28 to 32 °C and relative humidity of 60 to 70%, during day time for approximately 3 weeks. As it has been established that larval density, feed rate, and feeding frequency have great impact on the efficiency of the process (Banks *et al.*, 2014), these parameters were not included in this study. The fresh palm oil wastes used were collected randomly from a palm oil mill in Jerantut, Pahang and mixed manually prior to feeding. The larvae samples were collected randomly from the trays, kept in plastic bags and immediately sent to the laboratory for analysis of their nutrient contents.

The samples were then partially dried at 103 ± 2 °C for 2 hours by forced-air drying oven according to FAO (2011) and as a killing method. It was then ground using Ultra Centrifugal Mill (Retsch, Germany) with sieve size of 1 mm then kept in the 100 mL plastic container at ambient temperature for further testing. For each test, samples with five replicates were used. The crude protein was determined using a sample (50 mg) combusted with oxygen in Dumas analyser (Elementar, Germany) in-house method (conversion factor 6.25). Crude fat was extracted using diethyl ether and determined by Velp solvent extractor. Crude fiber was analysed with a Velp fiber analyser using reagents as described Van Soest *et al.* (1991). Ash was determined by heating the samples in a muffle furnace set at 600 °C for three hours. While 0.25 g of each sample was used for heavy metals analysis (Hg, Cd, As, Cr, Pb) using in-house method which involve the presence of nitric acid, using microwave digestion (Milestone, Italy), Inductively-Coupled Plasma Mass Spectrometry (ICP-MS) NexION 300X (Perkin Elmer, USA) and Flow Injection Mercury System (FIMS 400) by Perkin Elmer, USA. A simple stability study was performed on the same stock sample kept under room temperature in the laboratory room area for at least 8 months in a 100 mL airtight plastic container and the same testing was carried out after the storage period. Screening of aflatoxins was done by ELISA method (R-Biopharm, Germany) and subjected to confirmatory test method using methanol as solvent extractor and detection by UPLC (Waters, USA) with fluorescence detector.

RESULTS AND DISCUSSION

The mean nutrient compositions of the palm oil wastes used were 17.4% crude protein, 1% crude fat, 29.8% crude fibre, and 15.1% ash. This study obtained relatively high value of crude protein as compared to soybean meal and other commonly used plant proteins in livestock (Willis, 2003). Range of crude protein values in this study were between 34.9 and 37.7% but is lower than the range of values (39 to 43%) reported for BSFL reared on various organic waste types (Spranghers *et al.*, 2017). However, it needs to be considered the effect of using Kjeldahl versus Dumas methods and conversion factor either of 6.25 or 4.76 for the determination of crude protein values. The final purpose is to achieve the high accuracy of feed formulation for each animal species concerned and at what rate can BSFL protein replace the common protein feeds in a safe and economic manner in future, for example in aquaculture (Belghit *et al.*, 2019).

From the aspect of food safety regarding insects as animal feed, Marone (2016) observed that insects are prone to accumulate toxins or heavy metals ingested through contaminated feed or water. However, in this study we detected below permissible levels based on general specifications for poultry feeds, after being stored at room temperature for eight months (SIRIM,2008; EC, 2013), i.e. Hg (0.03 ppm), Cd (0.6 ppm), As (0.2 ppm), Cr (3.5 ppm), and Pb (2.0 ppm), and with aflatoxins (<20 ppb).

At this point of this study, the crude protein content had reduced to 32% but still considered to be stable for quite a long storage period. It is assumed that the crude protein content can achieve a longer shelf life at low temperature storage. Magnitude of percentage reductions in fat (35%) and fibre (20%) contents of BSFL from this study however could not be made conclusive due to lack of stability data available for comparison. Factor to be considered is the killing method of larvae which is also a highly influential factor on BSF quality (Leni, *et al.*, 2019).

CONCLUSION

BSFL reared on local palm oil waste as substrate has shown a promising result in terms of basic animal feed quality needs. Crude protein of BSFL was shown to be stable for a relatively long storage period; however there was a 35% reduction in fat and 20% reduction in fiber contents.

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