ABSTRACT

The need for innovative resource-based technology in faecal management has led to the adoption of black soldier fly (BSF) technology in faecal treatment. Faecal matter processing through BSF technology offers a promising alternative for sustainable sanitation and faecal sludge management option. However, valorising faecal matter alone using BSF is not adequate for proper faecal treatment. A co-digestion strategy for faecal waste with other organic wastes has hence been proposed for efficient faecal treatment. However, there is insufficient knowledge in substrate co-digestion rationing rates to scale up the extant black soldier fly larvae (BSFL) systems for optimum waste conversion. This study was carried out to evaluate the process performance of BSF during faecal treatment when co-digested with kitchen waste. The study aimed to determine the BSF waste conversion efficiency, to model the optimal BSF larval growth as a factor of time, and to establish the performance for a fabricated BSF solar drier. Fresh faecal matter and kitchen waste were used to co-digest substrates for the treatment process. The substrate mix was prepared in faecal matter to kitchen waste ratio (FM: KW) 1:0, 4:1, 2:1, 1:1, and 0:1. The co-digested substrates (1000g) were processed in rectangular plastic containers (26x13x11cm) using 5g of 5-day old larvae in triplicates. Larval growth and development time were significantly affected by the substrate mix ratios. One hundred larvae were randomly picked at three-day intervals from each treatment (in triplicate) to monitor the larval weight gain across the treatment process. Larval days to 50% pupation, mean pupal yield, waste reduction rate (WR), bioconversion rates (BR), and feed conversion rates (FCR) were monitored for the process performance. The larval development time ranged between 16 and 20 days, with the shortest time observed with faecal matter (1:0) and substrate (1:1), while kitchen waste (0:1) took the longest time. The mean prepupal yield of 41.88 ± 2.2, 65.73 ± 8.9, 67.19± 3.2, 72.78 ±17.5, and 70.31 ± 8.5 g was achieved for the five substrates, respectively. The WR of the larvae ranged from 76.31 ± 4.2% to 92.46 ± 2.6% and were affected significantly by the substrate co-digestion ratios ($p<0.05$). Similarly, the BR varied between 7.77 ± 0.4% and 14.71 ± 2.2%, and FCR varied between 5.50 ± 0.8 and 10.20 +0.8 ($p<0.05$). A fabricated BSF solar drier was used to dry the larvae for further processing into feed or storage. The larvae dried using the solar drier recorded (0.247 ± 0.12) µg/ml carbohydrates, 38.01% fat content, and protein content of 38.04%. This study affirms the performance efficacy of BSFL to sufficiently convert faecal substrates when co-treated with kitchen waste, promoting a circular economy. It therefore, illustrates that a co-digestion strategy has the potential to boost and

enhance sustainable faecal waste management for future applications. In addition, interrelation between larvae processing methods and larval nutritional composition is highly significant therefore, further research be done to examine these relations in terms of the qualitative characteristics like changes in micronutrient profiles, fatty acid and amino acid of the dried larvae.