Morphometric traits of Black Soldier Fly larvae in slaughterhouse waste and rice bran growing medium

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Abstract. This study investigated the effects of utilizing a mixture of slaughterhouse waste and rice bran as a growing medium on the morphometric traits of Black Soldier Fly (BSF) larvae. The research followed a completely randomized design with five treatment groups, namely T0: 100% slaughterhouse waste (control), T1: 75% slaughterhouse waste + 25% rice bran, T2: 50% slaughterhouse waste + 50% rice bran, T3: 25% slaughterhouse waste + 75% rice bran, and T4: 100% rice bran. The morphometric traits examined in this study included the larvae body length at 19 days (LBL19), larvae body width at 19 days (LBW19), larvae body length at 29 days (LBL29), and larvae body width at 29 days (LBW29). The results demonstrated that using slaughterhouse waste as the sole medium (T0) could support the growth of BSF larvae, but the morphometric traits of larvae in T0 were relatively modest. Interestingly, when RB was used to replace SW partially, it had a dose-dependent effect. T1 significantly improved ($P < 0.05$) LBL19, LBL29, and LBW29. Conversely, the morphometric traits of BSF larvae in T2 and T3 did not exhibit significant changes ($P > 0.05$) compared to the control. Moreover, the use of T4 significantly enhanced ($P < 0.05$) all morphometric traits of BSF larvae (LBL19, LBW19, LBL29, and LBW29). In conclusion, this study reveals the significant potential of BSF in managing slaughterhouse waste. Furthermore, employing a growing medium consisting of 75% slaughterhouse waste and 25% rice bran emerges as a practical approach to strike a harmonious balance between effective waste management and fostering the development of BSF larvae.

Keywords: Bioconversion, Black Soldier Fly, Waste Management

1 Introduction

The increasing global population and the demand for food production have brought agricultural and livestock industries to the forefront of the world's economic landscape [1, 2]. However, the rapid expansion of agri-food industries has been accompanied by significant challenges, such as producing enormous quantities of organic waste. Slaughterhouses,

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integral components of the meat production supply chain, are particularly noteworthy. These facilities produce vast amounts of organic waste materials, which poses a formidable environmental challenge when not managed effectively [3, 4].

The Black Soldier Fly (BSF), a non-pest insect, has gained recognition for its unique ability to convert organic waste into valuable biomass. BSF larvae efficiently digest organic matter, transforming it into nutrient-rich insect biomass [5]. These larvae possess numerous applications, including animal feed and aquaculture feed [6]. The residue of the BSF growing medium could also be applied as a biofertilizer [7].

The success of BSF farming in a sustainable waste management system hinges significantly on selecting a suitable growing medium. A growing medium must provide essential nutrients for the larvae while also serving as a substrate for them to thrive. Various organic waste materials, such as agricultural and food by-products, have been explored as potential growing media for BSF larvae [8-10]. However, the potential of slaughterhouse waste in this role remains an intriguing and largely unexplored avenue. Slaughterhouse waste comprises diverse nutrient-rich components, including rumen contents and residual animal tissues [11]. This waste material can be a valuable resource for growing BSF larvae.

On the other hand, rice bran also offers the potential as a supplementary growing medium for BSF larvae. It provides essential proteins, lipids, and carbohydrates, which are vital for the healthy growth and development of the larvae [12]. A carefully balanced combination of these two waste streams may create a more suitable growing medium than either component alone. Therefore, this study investigated the effects of utilizing a mixture of slaughterhouse waste and rice bran as a growing medium on the morphometric traits of BSF larvae.

2 Materials and methods

2.1 Slaughterhouse waste preparation

Slaughterhouse waste was obtained from a slaughterhouse unit in Batu City, Indonesia. The waste used in this study primarily consisted of bovine rumen contents. A batch of five kilograms of slaughterhouse waste was carefully assembled and placed in a plastic container. Subsequently, a microbial starter solution was prepared by combining 5 ml of EM-4 with 15 grams of sugar in one liter of tap water. This solution was then introduced into the slaughterhouse waste, ensuring thorough mixing. The container was securely sealed, and the slaughterhouse waste was left to ferment at room temperature for seven days.

2.2 Hatching medium

The hatching medium was prepared by blending 200 grams of rice bran with 200 ml of milk waste, which was placed in a plastic container. In the center of the hatching medium, a plastic cup with a 5 cm diameter was placed. BSF eggs were obtained from a smallholder BSF breeding unit in Malang Regency, Indonesia. A total of 0.5 grams of BSF eggs were delicately arranged on top of the plastic cup, lined with a tissue. These BSF eggs were allowed to hatch over 3-4 days. Once the BSF larvae had successfully hatched, they naturally descended into the hatching medium. After seven days, the larvae were transferred to the growing medium according to the treatments.

2.3 Growing medium

The treatments used in this study were growing mediums of BSF larvae, consisting of different ratios of slaughterhouse waste and rice bran. These treatments included: T0: 100%

slaughterhouse waste (control), T1: 75% slaughterhouse waste + 25% rice bran, T2: 50% slaughterhouse waste + 50% rice bran, T3: 25% slaughterhouse + 75% rice bran, and T4: 100% rice bran. The growing medium was added weekly, with each replicate receiving 500 grams. Before being fed to the BSF larvae, the growing medium was mixed with tap water at a 1:1 ratio.

2.4 Measurement of morphometric traits

This study involved the measurement of various morphometric traits, including larvae body length at 19 days (LBL19), larvae body width at 19 days (LBW19), larvae body length at 29 days (LBL29), and larvae body width at 29 days (LBW29). From each replicate, 25 larvae were carefully isolated from the growing medium. Subsequently, the morphometric traits were measured using a ruler with centimeter units.

2.5 Data analysis

The data on morphometric traits were initially organized and tabulated using Microsoft Excel. Subsequently, a one-way analysis of variance was applied for data analysis. A significance level of $P < 0.05$ was employed to identify significant differences. In cases where significant effects were observed, a Duncan post hoc test was executed to distinguish means among treatments. Data analysis was carried out using IBM SPSS Statistics 22.

3 Results and Discussion

The effects of utilizing a mixture of slaughterhouse waste and rice bran as a growing medium on the morphometric traits of BSF larvae are presented in Table 1. The results demonstrated that using slaughterhouse waste as the sole medium (T0) could support the growth of BSF larvae. Still, the morphometric traits of larvae in T0 were relatively modest compared to other treatments.

Table 1. Effects of utilizing a mixture of slaughterhouse waste and rice bran as a growing medium on the morphometric traits of Black Soldier Fly larvae [1]

Treatments	LBL19 (cm)[3]	LBW19 (cm)[3]	LBL29 (cm)[3]	LBW29 (cm)[3]
T0[2]	7.29 ± 1.24[a]	2.06 ± 0.43[a]	11.46 ± 0.36[a]	3.19 ± 0.22[a]
T1[2]	9.95 ± 1.02[c]	2.35 ± 0.54[a]	14.28 ± 2.48[bc]	3.70 ± 0.32[b]
T2[2]	8.16 ± 0.90[ab]	2.31 ± 0.34[a]	11.64 ± 0.51[a]	3.33 ± 0.08[a]
T3[2]	7.51 ± 0.72[a]	2.09 ± 0.18[a]	12.55 ± 0.13[ab]	3.45 ± 0.18[ab]
T4[2]	9.41 ± 1.01[bc]	2.92 ± 0.29[b]	15.19 ± 0.38[c]	4.29 ± 0.11[c]
SEM	0.311	0.103	0.409	0.098
P value	0.006	0.037	0.001	0.001

[1]Data were presented as means of four replicates, and each replicate consisted of measurement on 25 Black Soldier Fly larvae

[2]T0: 100% slaughterhouse waste, T1: 75% slaughterhouse waste + 25% rice bran, T2: 50% slaughterhouse waste + 50% rice bran, T3: 25% slaughterhouse waste + 75% rice bran, T4: 100% rice bran

[3]LL19: larvae length at 19 days, LW19: larvae width at 19 days, LL29: larvae length at 29 days, LW29: larvae width at 29 days

[a-c]different superscripts in the same column showed significant differences ($P < 0.05$)

This finding indicates that while slaughterhouse waste is a suitable medium, there may be better conditions for achieving the most significant growth and development in BSF larvae. This observation could be related to the nutrient composition in slaughterhouse waste that may need to fully meet the nutritional requirements of the larvae for optimal growth. The slaughterhouse waste had a total lignocellulose content of 87% [13]. These lignocellulosic components are predominantly resistant to digestion by BSF larvae, resulting in suboptimal growth and development [14, 15].

One of the most interesting findings is the dose-dependent effect of rice bran when used to substitute slaughterhouse waste. The use of 25% rice bran in T1 significantly improved ($P < 0.05$) LBL19, LBL29, and LBW29. This result indicated that adding rice bran can enhance the growth and development of BSF larvae. Rice bran contained a total Kjeldahl nitrogen of 22,471 mg/kg [16], while slaughterhouse waste only had a total Kjeldahl nitrogen of 2,083 mg/kg [13]. The presence of nitrogen in the substrate is of utmost importance in facilitating the decomposition of slaughterhouse waste that is rich in lignocellulose. Nitrogen is essential for the proliferation of microorganisms and the enzyme production for lignocellulose degradation [17]. Consequently, supplemental nitrogen from the inclusion of rice bran will enhance the morphometric traits of BSF larvae.

Conversely, in T2 and T3, where higher proportions of rice bran were used (50% and 75%, respectively), the morphometric traits of BSF larvae did not exhibit significant changes ($P > 0.05$) compared to T0 (0% rice bran). This result indicates that there may be an optimal ratio of rice bran to slaughterhouse waste that maximizes the growth of BSF larvae. On the other hand, using 100% rice bran in T4 significantly enhanced ($P < 0.05$) all morphometric traits of BSF larvae compared to control. This finding suggests that using rice bran as a sole medium can effectively grow BSF larvae, leading to substantial improvements in larval size and development. Consistent with this finding, Somarny et al. [18] also noted that rice bran is among the substrates that have the capacity to be utilized for the mass production of BSF larvae.

4 Conclusion

In conclusion, this study reveals the significant potential of BSF in managing slaughterhouse waste. Furthermore, employing a growing medium consisting of 75% slaughterhouse waste and 25% rice bran emerges as a practical approach to strike a harmonious balance between effective waste management and fostering the development of BSF larvae.

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