Influences of symbiotic bacteria on black soldier fly larvae vermicomposting efficiency and nutrient accumulation in chicken manure

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Introduction Black soldier fly larvae (BSFL) are distinguished by their high consumption of decaying organic matter such as food waste, dead animals, and animal manure (Rehman et al., 2017; Xiao et al., 2018). They can reduce nitrogen-rich wastes by 75% and reduce 50% of poultry, dairy and pig manure (Rehman et al., 2017). In addition, prepupae have high nutritional value, containing 40% protein and 35% lipid. Also, it was previously investigated that symbiotic microbes have synergistic effects on the development of insect biomass(Liu et al., 2017). Therefore, this study was designed to investigate the effects of egg-associated and gut microbiome of BSF on larvae development when reared in chicken manure (CHM). Moreover, the individual strains and mixed bacterial colonies, that might improve the waste vermicomposting efficiency and nutrition spectra of BSFL, were also herein examined.

Material and methods

Single or mixture of symbiotic bacterial strains from BSF egg and gut, were inoculated as supplements into 500 g fresh chicken manure (CHM) with a proportion of 1% (v/w) in the treatments, respectively, whereas a control group was prepared with only BSFL (Table 1). Five hundred 6-day-old BSFL were inoculated into each waste-bacterial mixture, as well as into 500 g fresh CHM without bacterial supplementation, as the control. Each treatment was set up in three replicates and kept in the greenhouse for approximately 14 days, at 28 °C with 60% to 70% relative humidity. After 14 days, conversion rate and reduction rate of CHM, and weight gain rate of BSFL, were observed and recorded using the previously described methodology (Xiao et al., 2018).

Results and discussion

The results showed that BSFL inoculated with different mixtures of symbiotic bacteria achieved the highest manure reduction rate(waste conversion efficiency) of 52.91% was reached when synergetic bacteria were mixed at a ratio of 1:1:1:2 (T_8). whereas the highest BSFL weight gain of 28.57% when symbiotic bacteria were mixed at a ratio of 4:1:1:1 (T_3), This means that it will reduce more chicken manure and get more black soldier fly larvae as animal feed instead of fish meal.

Conclusions

It was revealed that symbiotic bacteria isolated from egg and gut of BSFL improved chicken manure BSFL vermicomposting efficiency and contributed to the nutrient accumulation in *H. illucens* larvae. it is highly recommended to the BSFL production farmer and industry to implement specific BSF egg-associated and gut bacterial strains to help in the BSFL biomass production, waste reduction.

References

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Table 1. Complex ratio of the four strains

Synthetic community	The ratio of bacterial strains (v/v)			
	FE01	FE04	FE08	BSF-CL
T_1	1	1	1	1
T_2	2	1	1	1
T_3	4	1	1	1
T_4	1	2	1	1
T_5	1	4	1	1
T_6	1	1	2	1
T_7	1	1	4	1
T_8	1	1	1	4
T_9	1	1	1	2
T_{10}	0	0	0	1
T_{11}	0	0	0	0

Table 2. The conversion efficiency of *H. illucens* larvae assisted by the synthetic colonies (mean ± standard error; n= 3). Mean values followed by the same letter in the same column do not vary significantly ($P < 0.05$).

Treatments	Conversion rate (%)	Weight gain rate of BSFL (%)	Manure reduction rate (%)
T_1	7.06 ± 0.17^{a}	-13.05*	50.01 ± 0.24^{bc}
T_2	9.51 ± 0.07^{c}	17.1*	51.85 ± 0.23^{d}
T_3	10.44 ± 0.35^{c}	28.57*	49.24 ± 0.08^{ab}
T_4	9.85 ± 0.05^{c}	21.31*	49.22 ± 0.24^{ab}
T_5	10.01 ± 0.09^{c}	23.28*	48.59 ± 0.11^{a}
T_6	8.59 ± 0.05^{b}	5.79*	49.82 ± 0.15^{abc}
T_7	7.97 ± 0.16^{b}	-1.85*	50.62 ± 0.41^{c}
T_8	9.58 ± 0.20^{c}	17.98*	52.91 ± 1.02^{d}
T_9	8.07 ± 0.21^{b}	-0.62*	48.68 ± 0.56^{a}
T_{10}	9.55 ± 0.48^{c}	17.61*	52.13 ± 0.40^{d}
T_{11}	8.12 ± 0.11^{b}	0.00	49.36 ± 0.56^{abc}

*Weight gain of BSFL is in relation to the control.