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## The composition of micronutrients and toxic elements in household waste compost uses black soldier fly larvae (*Hermetia illucens*)

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# The composition of micronutrients and toxic elements in household waste compost uses black soldier fly larvae (*Hermetia illucens*)

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**Abstract.** Indonesia's population is increasing every year, so many household needs need to be met. As a result, a lot of household waste has accumulated in FDS (Final Disposal Sites). This condition is very disturbing to the health of the people living around the FDS. Therefore it is necessary to compost household waste which can minimize the pile of garbage in the FDS. One of the methods is using BSF larvae. BSF (Black Soldier Fly) larvae are larvae that can consume various kinds of organic waste, such as household waste, quickly. The experimental results show that household waste compost has micronutrients that comply with Indonesian composting standards (SNI 19-7030-200). Micronutrient elements from household waste compost using BSF are Zink (60.55ppm), Manganese (36.55ppm), and Boron (12.07 ppm). Also, compost from household waste using BSF, the toxic elements cannot be detected, so it is safe to be applied as a nutrient for plants.

## 1. Introduction

Garbage piles in Indonesia reach 175,000 tons every day. Waste management that is carried out is transported and dumped in the Final Disposal Site (FDS) as much as 69%, buried 10%, burned as much as 5%, composted as much as 7% and the rest is unmanaged as much as 7% [1]. Nugraha *et al.* [2] explained that based on the composition of waste, it is divided into (1) 60% organic waste, 2) 15% plastic, 3) paper (10%) and 15% other waste (metal, glass, cloth, leather). Organic waste is dominated by food waste (animal and vegetable products), vegetables, fruits, and other agricultural waste. Moreover, if organic waste is not handled properly, it becomes a source of disease, creating a bad smell so that it becomes a source of environmental pollution that can pollute groundwater and air (methane gas) causing global warming [2]. Based on statistical data, the percentage of selected waste has decreased in Lampung, namely from 16.29% in 2013 and 15.31% in 2014 or decreased by 1.16% [3]. This data illustrates that the people in Lampung are not consistent in carrying out waste management.

Waste technology is needed to overcome the above problems. One of the appropriate methods for composting household waste and urban organic waste is the BSF (*Black Soldier Fly*) Larvae method. According to Monita *et al.* [4], BSF larvae are one of the sustainable methods of managing organic waste that can reduce the burden on FDS. Kinasi *et al.* [5] added that, Black Soldier Fly larvae have the ability to consume various kinds of organic waste such as agricultural, animal, food waste and human and animal waste. Nguyen *et al.* [6] reported that at the larval stage BSF can reduce waste by



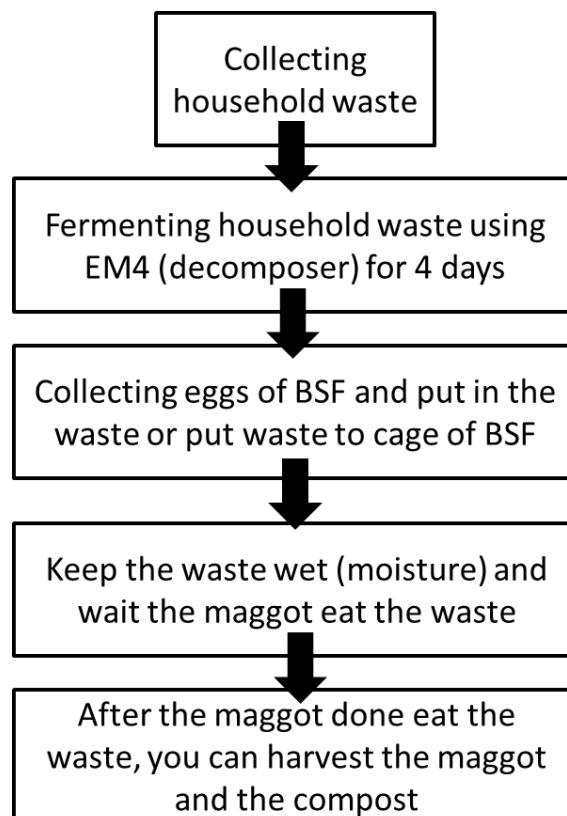
50%. In addition, Kinasi *et al.* [5] stated that BSF decomposes waste into biomass which contains high protein and fat. Abduh *et al.* [7], added that larvae have protein content in the range of 29-55% and 19-39% fat. Monita *et al.* [4] explained that the advantages of composting using BSF larvae are very fast decomposing food waste, at the final stage (prepupa) and last for 10-11 days. This is very beneficial in the decomposition process of composting. The compost's chemical content is generally divided into three groups: macronutrient, micronutrient, and toxic element. Micronutrients are essential elements for plant growth but are required in much smaller amounts than those of the primary nutrients; nitrogen, phosphorus, and potassium. The micronutrients are molybdenum (Mo), zinc (Zn), manganese (Mn), boron (B), iron (Fe), copper (Cu), and chloride (Cl). Moreover, toxic elements also needed to be analyzing as important information before using the compost as fertilizer. Therefore it is necessary to observe the micronutrient content in the composting agricultural waste results using BSF larvae.

## 2. Materials and methods

The research was conducted from March-July 2020 in Labuhan Marungai Subdistrict, Lampung Timur Regency, and Soil Science Laboratory, University of Lampung. The feed of black soldier fly larvae is a waste of orange/lime/ lemon (jeruk) without peel and ambarella fruit (kedondong) fermented using EM4.

Compost analysis was conducted in Integrated Laboratory and technology innovation center. The compost parameter was analysis namely: Copper (Cu), Zinc (Zn), Manganese (Mn), Iron (Fe), aluminum (Al), Nickel (Ni), Boron (B) Cadmium (Cd), Cobalt (Co), Chromium (Cr), that all parameters were measured using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES 715-ES.)

The compost's quality data from BSF will be compared with SNI 19-7030-2004 (National Standard of Indonesia for compost. The data will also be compared to data from compost with aerobic decomposition process reported by Sahwan *et al.* [8].



**Figure 1.** Step for composting process

### 3. Results and Discussions

Micronutrients optimize plant nutrition, increase stress resistance, stimulate growth [9]. As micronutrients, boron (B), iron (Fe), zinc (Zn), and manganese (Mn) are concerned with nutrient management of potatoes [10]. The results of micronutrient analysis on composting household waste using BSF larvae showed that the highest micronutrient element was Zinc (60.55 ppm). Also, the second-highest nutrient element is Mn (36.55 ppm) and Boron (12.07 ppm). Due to the metabolic role of Zn in the synthesis of proteins, enzyme activation, and metabolism, zinc deficiency reduces the quality and performance of potatoes [11]. In other words, manganese has an essential metabolic role in nitrate-reducing enzyme activity and activation of the enzyme involved in the carbohydrate metabolism; thus, its deficiencies decrease photosynthesis and reduce crop yield and quality [12, 13]. Boron is acknowledged as the second most limiting micronutrient in South Asia's crop production after Zn [14]. Boron deficiency is reportedly causing sterility in wheat [15] and generally affects the performance attributes of most other (non-gramineous) rotation crops in rice-based systems [16]. The Fe content in this compost is 0.04% and Al (0.03%). This shows that the application of agricultural fertilizers using BSF larvae does not add to Al and Fe's saturation in the soil.

**Table 1.** Micronutrients from household waste compost using the BSF method

Parameter	Household Waste Compost with BSF	Household Waste Compost with Aerobic Composter Sahwan <i>et al.</i> [8]	Indonesian National Standard (SNI 19-7030-200)
Zn	60.55 ppm	46 ppm	< 500 ppm
Mn	36.55 ppm	250 ppm	< 0.10 % (1.000 ppm)
B	12.07 ppm		
Fe	0.04 %	3820 ppm	< 2%
Al	0.03%	-	< 2.2%
Ni	5.15 ppm	-	< 62 ppm
Cu	6.08 ppm	6 ppm	< 100 ppm
Cd	Not available	-	< 3 ppm
Co	Not available	6 ppm	< 34 ppm
Cr	Not available	-	

When compared with the Indonesian national standards regarding compost quality standards, it can be seen that household waste compost using BSF has a micro nutrient content fulfil the Indonesian national standard. This is in accordance with the compost quality standards. Excessive micro nutrients in the soil will be toxic to plants. Tsonev and Lidon [17] stated that, Zn will be toxic to plants if it has a high concentration in the soil. Increase in Zn in the soil at low soil pH conditions. However, Zn is an essential micro nutrient that has a role as a co-factor for more than 300 types of enzymes that play a role in nucleic acid metabolism, cell division and protein synthesis [18]. In addition, according to Tsonev and Lidon [17], Zn is a micronutrient that is important in various plant physiological processes.

Based on the data from the comparison of compost making with BSF and compost making with composter aerobically, the manganese content in BSF compost is lower than compost making with composter. However, for Zink compost from BSF has higher value.

### 4. Conclusions

Based on the research results, it shows that the micronutrients in compost of household waste using BSF larvae have nutrient availability in accordance with Indonesian SNI standards (SNI 19-7030-200). In addition, composting household waste using BSF larvae does not contain any toxic elements. This can be useful for supplying nutrients to plants. Micronutrient elements from household waste compost using BSF are Zink (60.55 ppm), Boron (12.07 ppm) and Manganese (36.55 ppm). Zink and Mn have

high nutrient elements compared to other nutrients, but are in accordance with Indonesian composting standards.

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### Authorships

Ali Rahmat is the main contributor in this article.

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