

PAPER • OPEN ACCESS

## Chemical content of waste composting by black soldier fly (*Hermetia illucens*)

To cite this article: R A D Widyastuti *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **739** 012003

View the [article online](#) for updates and enhancements.

You may also like

- [Black soldier fly biowaste treatment and its recycle waste to produce chitosan](#)  
S Pintowantoro, Y Setiyorini, A M Aljauhari et al.
- [The effect of application of compost and frass from Black Soldier Fly Larvae \(\*Hermetia illucens\* L.\) on growth of Pakchoi \(\*Brassica rapa\* L.\)](#)  
D Agustiyani, R Agandi, Arinafril et al.
- [Frass Production From Black Soldier Fly Larvae Reared On Palm Oil Wastes](#)  
L Visvini, O Latifah, O H Ahmed et al.



The Electrochemical Society  
Advancing solid state & electrochemical science & technology

### 242nd ECS Meeting

Oct 9 – 13, 2022 • Atlanta, GA, US

Early hotel & registration pricing  
ends September 12

Presenting more than 2,400  
technical abstracts in 50 symposia

The meeting for industry & researchers in

**BATTERIES**  
**ENERGY TECHNOLOGY**  
**SENSORS AND MORE!**



**ECS Plenary Lecture featuring  
M. Stanley Whittingham,**  
Binghamton University  
Nobel Laureate –  
2019 Nobel Prize in Chemistry



# Chemical content of waste composting by black soldier fly (*Hermetia illucens*)

R A D Widyastuti<sup>1</sup>, A Rahmat<sup>2</sup>, H A Warganegara<sup>1</sup>, W S Ramadhani<sup>1</sup>, B Prasetyo<sup>3</sup> and M Riantini<sup>1</sup>

<sup>1</sup> Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia

<sup>2</sup> Research Center for Limnology, Indonesian Institute of Sciences, Indonesia

<sup>3</sup> Departments of Biological Education, Universitas Islam Negeri Raden Intan, Indonesia

Email: radianawidyatuti@yahoo.co.id

**Abstract.** Solid food waste from households and restaurants in urban areas currently be a severe problem. Mismanagement of solid food waste can promote disease. Black Soldier Fly larvae were known as new composting technology because they fast in the composting process. To decrease the volume of solid food waste that Black Soldier Fly larvae can be applied. This research aims to study the chemical content of the compost from composting by Black Soldier Fly larvae. The results show that the C-organic compost content is 18,37%, Total Nitrogen is 1.45%, Total Phosphor is 1.58%, and the pH is 6.8, C/N ratio is 12.66. Total Nitrogen, Total Phosphor, C/N ratio, and pH have fulfilled the requirements of the National compost standard of Indonesia (SNI). So, Compost from Black Soldier Fly larvae has high potential as a standard compost.

## 1. Introduction

One of the global issues currently taking the world community's attention is food waste (FW). Developing countries to developed countries try to develop various methods or approaches to solve this problem. FAO states that around 33% to 50% of the food that has been produced is not appropriately consumed [1;2]. Currently, the method commonly used to manage organic waste uses composting techniques. However, Simanungkalit et al. [3] explained that composting with microorganisms takes 5 weeks to 2 months in composting. Therefore, it is necessary to use organic waste decomposing organisms quickly. One of the organic waste processing uses biological agents in the form of larvae (maggot) from *Hermetia illucens* or better known as the Black Soldier Fly (BSF).

*Hermetia illucens*, generally well known as black soldier fly, is widely scattered globally, including Asia, Europe, and the southeastern United States [4;5;6]. The larvae of black soldier fly (BSF; *Hermetia illucens*) can grow on very dense populations on organic wastes, transform organic waste into valuable biomass, and produce the compost as residue [7].

The chemical content of compost by black soldier fly larvae still limited reported. The purpose of this research is to investigate the chemical content of compost from black soldier fly larvae.

## 2. Materials and Methods

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



Compost analysis was conducted in Soil Science Laboratory. The compost parameter was analysis namely: the pH was measured by a pH meter, the Walkley and Black method determined the organic C-organic content, N analysis was done by the Kjeldahl method, P analysis was done by the P Bray-1 method.

The compost's quality data from BSF will be compared with SNI 19-7030-2004 (National Standard of Indonesia for compost), Perhutani Standard, and Who standard. Moreover, the data will also compare to data from compost with aerobic decomposition process reported by Sahwan et al. [8]; Compost A is compost from waste food of Housing Rajawali, and Compost B is waste food of Housing Puspitek.



**Figure 1.** Broodstock of Black Soldier Fly



**Figure 2.** Food for Black Soldier Fly

### **3. Results and discussion**

Compost is the product of the biological degradation process from organic matter in aerobic conditions, which has a stable condition. Compost from Organic Fraction of Municipal Solid Waste is becoming very commonly used in agriculture as a soil conditioner and a fertilizer, and it causes the rise of its characterization issue [9]. Some of the compost's high quality even produces high quality for

certain plants rather than the chemical fertilizer. Some plants produce a bigger size of fruits or leaves than the regular fertilizer.

These are because compost has several benefits, such as soil-borne plant pathogen suppression, biological weed control, and plant nutrient availability [10]. The study from Weindorf et al. [11] successfully quantified the positive effects of compost on soil physical properties for the parameter of Coefficient of Linear Extensibility (COLE), water content, infiltration rate, and secondary properties.

One of the methods of the composting process is to take advantage of the Black soldier fly activity. Black soldier fly seems to be one of the best candidates for biodegradation [12]. From the result of this research, it was found that compost from black soldier fly has a larger value of C-Organic is 18.37%, which is higher compare to C-organic in Compost A (9.33%) and Compost B (11.62). Data of N-Total in Compost BSF (1.45%) is higher compare to Compost A (0.71%) and Compost B (1.08%). Linear with C-organic and N-total, P-total in Compost BSF is higher than P-total in Compost A and B.

**Table 1.** Parameters matching the compost from Black Soldier Fly with SNI standard

| No | Parameters   | Compost BSF                          | Compost A                              | Compost B | Indonesian Standard           | Perhutani | WHO 1980 |
|----|--------------|--------------------------------------|--|-----------|-------------------------------|-----------|----------|
| 1. | pH           | 6.8*                                 | 7.5                                    | 5.8       | 6.8-7.49                      | 6.6-8.2   | 6.5-7.5  |
| 2. | C-Organic(%) | 18.37*                               | 9.33                                   | 11.62     | 9.8-32                        | 14.5-27.1 | 5-8      |
| 3. | N-Total (%)  | 1.45*                                | 0.71                                   | 1,08      | 0.4 -                         | 0.6-2.1   | 0.4-3.5  |
| 4. | P-Total (%)  | 1.58*                                | 0.17                                   | 0,12      | 0.10-                         | 0.3-1.8   | 0.3-3.5  |
| 5. | C/N Ratio    | 12.66*                               | 13                                     | 11        | 10-20                         | 10-20     | 10-2-    |
|    |              | <i>source:<br/>Research<br/>data</i> | Source: Sahwan <i>et al.</i> ,<br>2011 |           | <i>SNI 19-<br/>7030- 2004</i> |           |          |

Compost A and Compost B, which are from the organic waste from the residential area. For the pH and C/N ratio parameter. Compost BSF is larger than Compost B but still lower than Compost A.

One parameter to assess the level of compost maturity is the C/N ratio. Microbes need carbon as an energy source in the process of decomposing organic matter. At the same time, Nitrogen is needed by microbes as a food source for the formation of body cells. Both of these elements are needed in large quantities in a specific balanced composition. For a good composting process, the raw materials C / N ratio is 30, and the compost is said to be ripe if the C/N ratio drops to less than 20 [13-17]. The compliance of the initial C/N ratio mainly influenced the maturity of the final compost [18].

However, Compost BSF complies with several predetermined standards such as Indonesian Standard (SNI), Perhutani, and WHO 1980. The advantage of using BSF for composting is that the decomposition time only takes 1 week, while conventional composting takes 1 month or more than 1 month. Composting using BSF can remain a lot of C-organic.

#### 4. Conclusion

This research concludes that the C-organic compost content is 18,37%, Total Nitrogen is 1.45%, Total Phosphor is 1.58%, and the pH is 6.8, C/N ratio is 12.66. Total Nitrogen, Total Phosphor, C/N ratio, and pH have fulfilled the requirements of the National compost standard of Indonesia (SNI). So, Compost from Black Soldier Fly larvae has high potential as a standard compost and fast composting process.

#### Acknowledgment

The authors express their gratitude to the Faculty of Agriculture, University of Lampung that supported the fund for this research.

#### Authorships

The main authors in this article are R A D Widyastuti and Ali Rahmat. Authors co-contributor H A Warganegara, W S Ramadhani, B Prasetyo and M Riantini

## References

- [1] FAO 2013 Food Wastage Footprint: Impacts on Natural Resources Food and Agriculture Organization of the United Nations, Rome.
- [2] Fersiz S and Veli S 2015 Aerobic decomposition of food waste with different ratios of solids at ambient temperatures and evaluation of CO<sub>2</sub> emissions *J. Mater. Cycles Waste Manag.* **17** 748–755.
- [3] Simunangkalit R D M, Suriadikarta D A, Saraswati R, Setyorini D and Hartatik W 2012 Pupuk Organik dan Pupuk Hayati. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian. Jawa Barat.
- [4] Brammer C A, and von Dohlen C D 2007 Evolutionary history of Stratiomyidae (Insecta: Diptera): The molecular phylogeny of a diverse family of flies *Mol. Phylogenet. Evol.* **43** 660–673
- [5] Sheppard D C, Tomberlin J K, Joyce J A, Kiser B C, Sumner SM 2002 Rearing methods for the black soldier fly (Diptera: Stratiomyidae) *J. Med. Entomol.* **39** 695–698
- [6] Martínez-Sánchez A, Magaña C, Saloña M, Rojo S 2011 First record of *Hermetia illucens* (Diptera: Stratiomyidae) on human corpses in Iberian Peninsula *Forensic Sci. Int.* **206** 1–3
- [7] Van Huis A 2013 Potential of insects as food and feed in assuring food security *Annu. Rev. Entomol.* **58** 563–583
- [8] Sahwan F L, Wahyono S, and Suryanto F 2011 Kualitas kompos sampah rumah tangga yang dibuat dengan menggunakan komposter aerobik *J. Tek. Ling* **12** 233–240.
- [9] Cesaro A, Belgiorno V and Guida M 2015 Compost from organic solid waste: Quality assessment and European regulations for its sustainable use. Resources, *Conservation and Recycling* **94** 72-79
- [10] Stoffella PJ and Kahn B.A. eds. 2001 Compost utilization in horticultural cropping systems CRC press
- [11] Weindorf D C, Zartman R E and Allen B L 2006 Effect of compost on soil properties in Dallas, Texas. *Compost science & utilization* **14** 59-67
- [12] Čičková H, Newton G L, Lacy R C and Kozánek M 2015 The use of fly larvae for organic waste treatment *Waste management* **35** 68-80
- [13] Golueke C G 1977 Biological Processing: Composting and Hydrolysis; In Handbook of Solid Waste Management. Van Nostrand Reinhold Company, New York
- [14] Haug RT 1980 Compost Engineering, Principles and Practice, An Arbor Science Publisher Inc., Michigan
- [15] Tchobanoglous G, Theisen H and Vigil S 1993 Integrated Solid Waste Management, Engineering Principles and Management Issues, Mc Graw-Hill Inc., USA
- [16] Epstein E 1997 The Science of Composting. Technomic Publishing Company Inc., USA.
- [17] Wahyono S, Sahwan FL and Suryanto F 2003 Menyulap Sampah Menjadi Kompos. Pusat Pengkajian dan Penerapan Teknologi Lingkungan BPPT, Jakarta
- [18] Guo R, Li G, Jiang T, Schuchardt F, Chen T, Zhao Y and Shen Y 2012 Effect of aeration rate, C/N ratio and moisture content on the stability and maturity of compost. *Bioresour. Technology* **112** 171-178