The study of composting system and its use in supporting vegetable cultivation in Kepulauan Seribu - Jakarta

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Abstract. This study aims to test several organic fertilizer production technologies from household waste, and to have the authority to support the growth of vegetable plants cultivated in Kepulauan Seribu. Participatory assessment involving 10 selected cooperator. The assessment activity is carried out in two stages, namely: (1) testing of fertilizer production technology, and (2) testing of having fertilizers produced in crop system plants. Fertilizer production technologies studied include: (a) production technology using a mini composter, (b) production technology using a vermicompost system, and (c) production technology using a burial system. The variables observed included the speed of the production process based on the C/N ratio and fertilizer chemistry, including pH, macro and micro nutrient content. The plant treatment tests included: (a) selected solid fertilizer (compost) and (b) comparative compost (cow manure). The tested plants used included leaf vegetables (mustard greens, lettuce, kale and spinach), fruit vegetables (tomatoes and chilies), and root vegetables (shallots). The observation variables included the growth and yield variables. Observation data were analyzed using descriptive analysis. Based on the results of the study described above, it can be ignored that: (1) fertilizer production technology from organic waste using the vermicompost technology system produces organic fertilizer that is faster to produce, although not according to quality standards of organic fertilizers yet; (2) each of leaf vegetables (mustard greens, lettuce, spinach, and water spinach), and fruit vegetables (tomatoes and chilies), gave a good response to vermicompost, but had not to root vegetables (shallots).

1. Introduction

The Kepulauan Seribu Administrative Regency is one of the administrative areas of the Special Capital Region of Jakarta, whose territory includes a group of islands in the Jakarta Bay. The number of islands in the Kepulauan Seribu reaches 110, including sand islands and coral reefs that are not vegetated. Even though it is dominated by the non-agricultural sector, Kepulauan Seribu Islands have 17% of vegetable harvest area and 8% of fruit production from the total area of vegetable and fruit production in Jakarta [1]. However, most of the need for non-fishery food items such as carbohydrates, vegetables and fruits to be supplied from outside the island. This condition causes the level of food availability and insecurity in Kepulauan Seribu to be classified as high compared to several other areas in Jakarta Province.

When referring to the area of the island, Kepulauan Seribu also has the potential to be developed as agricultural land. However, the development of the agricultural sector in small sandy islands generally has many challenges, including the absence of mineral soils and organic fertilizers that can be used as planting media and fertilizers. Therefore, a comprehensive strategy is needed to deal with this. One
strategy that can be taken is through the use of organic waste. Organic waste management will not only support the development of the agricultural sector, but also reduce the waste problem, which is currently one of the main challenges for the development of the Kepulauan Seribu area. Organic fertilizer from household or yard organic waste, generally in the form of compost [2, 3, 4]. Compost production technology is generally through conventional composting systems [5, 6] or composting using earthworms as an agent that can accelerate the composting rate (vermicompost) [7, 8].

The problems that are very prominent in agricultural development in Kepulauan Seribu, especially those aimed at increasing the community's food self-sufficiency, are: (1) limited space or area of yards; (2) limited availability of production inputs, especially planting media, fertilizers, pesticides, and quality seeds; and (3) people still lack knowledge in cultivation practices. Therefore, it is necessary to implement a strategy of optimizing resources for each individual household in overcoming the three problems above.

The availability of sustainable organic fertilizers is one of the important factors in vegetable cultivation in archipelago areas such as Kepulauan Seribu. The provision of organic fertilizers independently by utilizing existing resources (organic waste) in households and the environment around settlements is thought to be one strategy that can solve this problem. The study on composting technique and the application of the compost to vegetables cultivation in Kepulauan Seribu have not been done. Based on this, it is necessary to figure out the effects of application of the compost to vegetables cultivation in Kepulauan Seribu, especially using the vermicompost.

2. Material and Methods
These experiments were conducted from April to November 2017 in Pramuka and Panggang Islands, Panggang Sub-district, Kepulau Seribu Selatan District, Jakarta Province, Indonesia. The scope of activities includes testing several household scale organic waste composting technologies and their utilization on seven types of vegetable crops (mustard greens, lettuce, spinach, water spinach, chilies, tomatoes and shallots) cultivated in pots in the yard.

2.1. Study of composting technique
The aspect of the study is composting technology which has the characteristics of fast, free of safe contamination, especially odors, and has good physical and chemical qualities in accordance with the Regulation of the Ministry of Agriculture. The composting technology studied includes (each treatment used 10 replications):
1) Composting using a mini composter,
2) Composting using worms (Vermicomposting),
3) Buried System Composting.

2.2. Study of selected compost application on plants
The studies were carried out on seven types of plants, namely four types of leafy vegetables (mustard greens, lettuce, spinach, and water spinach), two types of fruit vegetables (chilies and tomatoes), and root vegetables (shallots). The studies were arranged using a Complete Randomized Block Design (CRBD). Each treatment used 10 replications, and every replication consisted of six plant populations. The treatments that were studied included the used of:
1) Selected compost produced in the previous test, according to the recommended dosage,
2) Compost that available in the community.

The seedlings of plants were transplanted into new media non steril (existing soil + manure/compost + husk fuel = 2: 1: 1 + 10% Dolomit) in a chamber measuring 44.5 cm x 35.5 cm x 15.5 cm for leafy vegetables and shallots, and in a polybag measuring 35 cm x 35 cm for fruit vegetables. Fertilization using 1 g.L⁻¹ standard fertilizer (Nitrogen, Phosphate, and Potassium/NPK) was done after the seed had already grown. Refertilization using NPK was done seven days before transplanting, with similar doses with the early fertilization, and continued with the same fertilizer dosage every seven days except for shallot.
2.3. Observation and Data Analysis

Some text. The variables observed were the processing speed and chemical characteristics of the fertilizer produced, including the C/N ratio, pH, C content, complete macro and micro nutrient content. The observed plant growth variables were some vegetative and generative growing parameters, namely high and crop yields. Observation data were analyzed descriptively.

3. Result and Discussion

3.1. Study of composting technique

Based on the observations it is known that the composting technique which is considered to produce faster is the technique of using worms as waste decomposers. Vermicompost can be produced from the age of one week, while composting with the other two techniques tends to take a longer time. Until entering a month of incubation period, the waste from the composting system with mini composter and buried composting did not give optimal results, even this condition lasted up to four months (Figure 1).

![Figure 1](image)

*Figure 1*. The conditions of compost from the three composting techniques: (a) vermicompost at an incubation period of 2 weeks-1 month; (b) compost with a mini composter at an incubation period of 1 month; and (c) compost with stockpiling technique at an incubation period of 4 months.

Thus, the compost chosen for further testing is vermicompost. The results of the chemical analysis of vermicompost are shown in Table 1. It was known that in general vermicompost produced in Kepulauan Seribu still contains macro and micro elements for plants that are relatively smaller than vermicompost for commercial production in general, and not as well as when compared to standard solid organic fertilizers.

The techniques for making vermicompost are quite diverse, such as using a wooden tub, plastic tub, cement tub, tarpaulin, or a mound system [10]. However, in this study the techniques that have been used are relatively simple and easy to apply at the household scale. Thus, eating household waste will be more optimal in its management. Researchers also informed that vermicompost with raw materials derived from household waste can provide compost quality which tends to be better that others compost [9, 10]. The composting technique with vermicomposting produces compost with the same macro
nutrient content, pH, and cation exchange capacity as an ordinary composting system. However, it is suspected that it contains better micro nutrients and phytohormones than compost from ordinary composting [9, 11, 12].

**Table 1.** The results of chemical analysis of vermicompost produced from Kepulauan Seribu with the chemical content of others organic fertilizers and

| No | Element         | Vermicompost of Kep. Seribu | Commercial Vermikompos * | Solid fertilizer quality standards** | Liquid fertilizer quality standards** |
|----|-----------------|-----------------------------|--------------------------|------------------------------------|--------------------------------------|
| 1  | C-organic (%)   | 6.85                        | 29.33                    | min. 15                             | min. 6                               |
| 2  | C/N             | 13                          | 15.33                    | 15 - 25                             | nd                                   |
| 3  | Moisture content (%) | 81.19                | 11.57                    | 15 - 25                             | nd                                   |
| 4  | Heavy metal:    |                             |                          |                                    |                                      |
|    | As (ppm)        | nd                          | nd                       | max. 10                             | max. 2.5                             |
|    | Hg (ppm)        | nd                          | nd                       | max. 10                             | max. 0.25                            |
|    | Pb (ppm)        | 4                           | nd                       | max. 50                             | max. 12.5                            |
|    | Cd (ppm)        | td                          | nd                       | max. 2                              | max. 0.5                             |
|    | Al total (ppm)  | 6 448                       | 15 886                   | nd                                 | nd                                   |
| 5  | pH H2O          | 7.9                         | 7.0                      | 4 - 9                               | 4 - 9                                |
| 6  | Macronutrients: |                             |                          |                                    |                                      |
|    | (N+P2O5+K2O) (%)|                             |                          | max. 4                              |                                      |
|    | N (%)           | 0.52                        | 2.45                     | nd                                 | 3 - 6                                |
|    | NH4             | nd                          | 0.20                     | nd                                 | nd                                   |
|    | NO3             | nd                          | 0.11                     | nd                                 | nd                                   |
|    | PO4             | nd                          | nd                       | nd                                 | nd                                   |
|    | P2O5 (%)        | 0.12                        | 1.60                     | nd                                 | 3 - 6                                |
|    | K               | nd                          | nd                       | nd                                 | nd                                   |
|    | K2O (%)         | 0.08                        | 1.69                     | nd                                 | 3 - 6                                |
|    | Ca total (%)    | 0.40                        | 2.82                     | nd                                 | nd                                   |
|    | Mg total (%)    | 0.08                        | 1.24                     | nd                                 | nd                                   |
|    | S total (%)     | 16                          | nd                       | nd                                 | nd                                   |
| 7  | Micronutrients: |                             |                          |                                    |                                      |
|    | Fe total (ppm)  | 3 884                       | 6 290                    | max. 9 000                          | 90 - 900                             |
|    | Mn (ppm)        | 122                         | 863                      | max. 5 000                          | 250 - 5 000                          |
|    | Zn (ppm)        | 41                          | 44.91                    | max. 5 000                          | 250 - 5 000                          |
|    | Cu (ppm)        | 8                           | 58.33                    | nd                                 | 250 - 5 000                          |
|    | B (ppm)         | 34                          | 33                       | nd                                 | 125 - 2 500                          |
|    | Co (ppm)        | nd                          | nd                       | nd                                 | 5 - 20                               |
|    | Mo (ppm)        | nd                          | nd                       | nd                                 | 2 - 10                               |
|    | Na total (%)    | 0.05                        | nd                       | nd                                 | nd                                   |
| 8  | CEC (cmol/kg)   | 7.67                        | nd                       | nd                                 | nd                                   |

Notes: * Data source [9]  
** Base on Permentan No.24/SR.140/4/2011  
nd = no data  
td = no detected.
3.2. **Study of selected compost application on plants**

The studies were carried out on seven types of plants, namely four types of leafy vegetables (mustard greens, lettuce, spinach, and water spinach), two types of fruit vegetables (chilies and tomatoes), and root vegetables (shallots). Based on the observations on the growth of leaf vegetable plants, it was known that in general vermicompost that was applied had an influence on the growth in height, number of leaves, and plant wet weight which tends to be lower on all indicator plants compared to cow manure (Figure 2). Only a few parameters in certain indicator plants have a higher growth effect, namely the number of leaves and harvest weight of spinach, and height and weight of harvested water spinach. It is known that spinach and water spinach are indicator plants that are very sensitive in responding to growth compared to the use of mustard greens and lettuce. This means that the vermicompost is suitable for use in the cultivation of leafy vegetables. However, there is still a need for a nutrition enrichment strategy or a more appropriate application method so that vermicompost can function optimally or optimally.

![Figure 2](image-url)

**Figure 2.** The height growth (cm), number of leaves, and yield weight (g) of leafy vegetables applied with vermicompost and cow manure: (a) mustard greens; (b) lettuce (c) spinach; and (d) water spinach.

Slightly different from the effect of vermicompost on fruit vegetables, namely chilies and tomatoes. It can be seen that fruit yields obtained from plants applied with vermicompost tend to be much better (more) than using cow manure (Figure 3). The harvest data was obtained up to six times the chili harvest and nine times the tomato harvest. In chili plants, although the height of the plants applied with vermicompost was lower, the yield was higher than using cow manure. Whereas in tomato plants, all growth parameters, namely plant height, number of branches, and fruit yield, were always higher in plants applied with vermicompost than those applied with cow manure. Similar studies also reported that the application of vermicompost to chili, tomato, pakcoy and lettuce plants...
gave a growth effect that tended to be better than comparison compost or liquid organic fertilizers from the minicomposter system [9].

![Figure 3](image1.png)

**Figure 3.** The height growth (cm), numbers of branch, and yield weight (g) of fruit vegetables applied with vermicompost and cow manure: (a) chilli and (b) tomato.

Based on observations on shallot plants, the use of vermicompost has a lower growth effect than the use of cow manure, both in the number and weight of tubers (Figure 4). This is presumably because the availability of nutrients for onions is more fulfilled when using cow drum fertilizer, especially P and K. The results of other studies reported that the use of vermicompost can increase the weight of sweet potato tubers compared without using vermicompost [13]. Other researchers also reported that the vegetative growth of cayenne pepper, namely the growth of plant height, number of leaves, leaf area, stem diameter and number of plant branches was also known to increase significantly with the application of vermicompost [14].

![Figure 4](image2.png)

**Figure 4.** The number of bulbs, weight of bulb per clump (g), and weight of bulb (g) of shallot applied with vermicompost and cow manure.

4. **Conclusions**

Fertilizer production technology from household organic waste carried out in the Kepulauan Seribu, with the vermicompost technology system, produces organic fertilizer which is faster to produce, namely in less than 1 month of the incubation process, although chemically it does not meet the quality standard requirements for organic fertilizers. All growth and yield of leafy vegetables (mustard greens, lettuce, spinach and kale), and fruit vegetables (tomatoes and chilies), respond well to vermicompost, but not
root vegetables (shallots). Thus, vermicompost has the potential to be developed and utilized for cultivating vegetables in the Kepulauan Seribu, especially by making improvements in both production techniques and application.

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