The potential of *Trichoderma* spp. and *Pseudomonas auregenosa* as patchouli waste decomposer

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**Abstract.** Currently, waste from patchouli distillation process is unutilized. It is known that the waste still has high nutrient content and has the potential as raw material for organic fertilizers. In this study, we investigated the potential of *Trichoderma harzianum*, *T. asperelum*, and *Pseudomonas aeruginosa* as biodecomposer in patchouli waste composting process. The bio decomposers were inoculated to patchouli waste to determine the effect on composting process time, maturation and compost chemical properties. *T. harzianum* and *T. asperelum* were added to the compost raw material in the form of pellet (15 g). While *P. aeruginosa* added suspension at $10^8$ as much as 20 ml. The results showed that the inoculation of *T. harzianum*, *T. asperelum* and *P. aeruginosa* accelerated the decomposition process and improved the compost texture. Chemical properties analysis indicated that the compost produced meet Indonesia compost standarisation. This study revealed that *T. harzianum*, *T. asperelum* and *P. aeruginosa* are potential patchouli waste decomposers.

1. **Introduction**

Patchouli (*Pogostemon cablin* Benth) is one of the essential oil-producing plants which is an important export commodity for Indonesia. The oil is extracted from the leaves, stems and branches of the aromatic plant by distillation process. According to Salim and Srihartati [1], around 98% of the process is waste and unutilized. The distilled waste has high nutrient content and has the potential to be a good raw material for organic fertilizers [2]. There are advantages of organic fertilizer such as reduce the use of synthetic fertilizers, improve soil physical and chemical properties, and provide nutrients necessary for plant growth.

*Trichoderma* sp. and *Pseudomonas* sp. are well known bio decomposer. Sriwati *et al.*, [3] reported that *T. virens* improve physical properties and C/N ratio of cocoa pod compost. Another study revealed that *T. harzianum* act as bioconversion of organic solid waste to prepare compost within a short period. Trichoderma sp. also has ability to improve soil chemical properties by increasing level of C/N ratio [4, 5]. Gram negative bacteria such as *Pseudomonas* sp. has been reported as a promising bacteria to be
used for developing bio-decomposer as it enriched liquid organic fertilizer [6]. Furthermore Pan et al., [7] claimed that Pseudomonas sp. has a role on stabilize pH and C/N ratio of wheat straw compost.

The aim of this work is to investigate the potential of Trichoderma harzianum, T. asperelum, and Pseudomonas aeruginosa as biodecomposer in patchouli waste composting process. The microorganisms were inoculated both singly and in combination. The objectives are to determine the ability of tested microorganisms to accelerate composting process and to improve compost physical and chemical properties.

2. Materials and methods
2.1. Inoculum preparation
T.harzianum, T.asperelum, and P. aeruginosa inoculum were kindly provided by Plant disease Laboratory, Department of Plant Protection, Faculty of Agriculture, Syiah Kuala University, Indonesia. T. harzianum and T. asperelum, in the form of pellet, were prepared as described in Zikriah [8]. P. aeruginosa was sub cultured in golden snail (Pomacea canaliculata) broth. The snails that collected from paddy field were shelled (around 400 g) and boiled in 500 ml water. Two grams of commercial shrimp paste was added into the boiled water. The broth was subsequently filtered into a jar. After being closed properly the jar was immediately soaked in cold water. Five ml of P. aeruginosa suspension (10^6) was inoculated into snail broth and incubated at 28 °C for 7 days.

2.2. The effect of T.harzianum, T.asperelum, and P. aeruginosa on composting time
Chopped patchouli waste was mixed with mature cow manure with 2:1 ratio. Ten kg on the mixture was transferred into a plastic layered box with 40x30x30 cm in dimension. Fifteen g T. harzianum pellet was added into the mixture. The box was covered and incubated until the temperature is gradually decrease as an indicator of mature compost. Same technique was applied to single T. asperelum and P. aeruginosa treatments at 15 g and 20 ml, respectively. In combination treatments, T. harzianum and P. aeruginosa suspension with the dosages stated were added together to the mixture. Same preparation was applied to in combination treatment T. asperelum and P. aeruginosa. Control was prepare without any decomposer. All experiments were carried out in quintuplicate.

2.3. Compost maturation and chemical properties analysis
The maturation of compost was examined at the end composting process. The observation on compost maturation including texture, colour and smell.

A hundred g of sieved air dried compost was sent to Soil Chemistry Laboratory, Faculty of Agriculture, Syiah Kuala Univeristy, for chemical properties analysis. The parameter observed including water content, pH, total organic carbon, total nitrogen, C/N ratio, total phosphorus, total potassium, total calcium, and total magnesium.

2.4. Statistical analysis
The data on composting time was statistically analysed for Analysis of Variance (ANOVA). Significant differences between mean values were determined using Least Significant Different (P=0.05).

3. Results and discussion
3.1. The effect of T. harzianum, T. asperelum and P. aeruginosa on composting time
T. harzianum, T. asperelum and P. aeruginosa that inoculated on patchouli and mature cow manure has a significant effect on composting time. Figure 1. shows that the addition of decomposer microorganisms accelerate the composting time. Without any decomposers (control), 70 days were needed to decompose the organic material into compost. However, with the presence of microorganism decomposer the process was up to 10 days faster. The fastest composting time reached by the application of single P. aeruginosa and the combination of T. harzianum and P. aeruginosa , 55 and 57 days, respectively. While the application of T. harzianum, T. asperelum (singly) and the combination of T. asperelum and P. aeruginosa shorten the composting process to 60 days.
Figure 1. The effect of *T. harzianum*, *T. asperelum* and *P. aeruginosa* on composting time. The decomposer microorganisms were added to the mixture of patchouli waste and mature cow manure both singly and in combination. Different letters above the bars indicate significant difference between treatments at the level of P<0.05.

The finding is in line with Lopez et al., [9] that *Trichoderma* spp. reduce the decomposition period of rice straw, leaf litters, carabao manure, and carbonized rice hull mixture from 45 to 36 days. Similar finding also reported by Sarangi and Lama [10] with *T. viridae* inoculation. This shows that *Trichoderma* spp. is an excellent decomposer that act as compost activator [9].

3.2. Compost maturation analysis

The maturation of the compost was examined when the composting process was end. The observation on compost maturation including texture, colour, and smell are presented in Table 1.

| Treatment (s) | Texture                          | Colour         | Ammonia smell |
|--------------|----------------------------------|----------------|---------------|
| Control      | Still in the form of rough       | Dark brown     | no            |
| *P. auregenosa* | crumb                             | Dark brown     | no            |
| *T. harzianum* | crumb                            | Dark brown     | no            |
| *T. asperelum* | crumb                            | Dark brown     | no            |
| *T. harzianum* + *P. aeruginosa* | crumb                         | Dark brown     | no            |
| *T. asperelum* + *P. aeruginosa* | crumb                         | Dark brown     | no            |

Table 1 indicates that the addition of *T. harzianum*, *T. asperelum*, and *P. aeruginosa* in patchouli waste composting process did not have effect on compost colour. Even without decomposer microorganisms at the end of composting process distinctive compost colour, which is dark brown, is produced. However, decomposer microorganisms’ activity seem to have a role in compost texture. Patchouli waste that treated with the decomposers have more fine texture that in control. Both
Table 2. Chemical properties of decomposed patchouli waste inoculated with *T. harzianum*, *T. asperelum*, and *P. aeruginosa* compared to Indonesian compost standardization (SNI 19-7030-2004).

| Observed parameters | Unit | Control | TH | TA | PA | TH+PA | TA+PA | SNI standard |
|---------------------|------|---------|----|----|----|-------|-------|--------------|
| Water content       | %    | 16.82   | 14.94 | 16.82 | 17.56 | 16.82 | 17.65 | Max. 50      |
| pH                  |      | 9.37    | 9.34 | 9.45 | 9.46 | 9.40 | 9.33 | 6.8-7.49     |
| C-Organic           | %    | 17.86   | 20.65 | 20.30 | 18.69 | 19.76 | 18.69 | 9.8-32       |
| N-Total             | %    | 1.67    | 1.80 | 1.80 | 1.78 | 1.82 | 1.65 | ≥ 0.4        |
| C/N                 | %    | 10.69   | 1.47 | 11.27 | 10.50 | 10.85 | 11.32 | 10-20        |
| P₂O₅ Total          | %    | 0.78    | 0.18 | 0.64 | 0.72 | 0.15 | 0.03 | ≥ 0.1        |
| K₂O Total           | %    | 0.56    | 1.13 | 2.59 | 0.47 | 0.55 | 1.26 | ≥ 0.2        |
| CaO Total           | %    | 0.77    | 0.74 | 0.66 | 0.72 | 0.87 | 0.79 | Max. 25.5    |
| MgO Total           | %    | 1.68    | 1.68 | 1.69 | 1.69 | 1.70 | 1.67 | Max. 0.6     |

To understand that chemical properties of compost tested, the values for each parameter were compared to compost specification issued by Indonesian Standardisation Body known as Standar Nasional Indonesia (SNI) [14]. According to standard values, patchouli waste compost in this study meet most of the criteria’s except for pH and total magnesium. However, according to Sapareng et al., [15] C/N ratio is a significant parameter when compost is about to be applied as fertilizer on the soil. Carbon provides both an energy source and the basic building block making up about 50 percent of the mass of microbial cells [16]. Nitrogen is a crucial component of the proteins, nucleic acids, amino acids, enzymes and co-enzymes necessary for cell growth and function. C/N ratio of compost tested meets the compost standard value.

4. Conclusion

In summary, *T. harzianum*, *T. asperelum* and *P. aeruginosa* are potential decomposers of patchouli waste. The addition of the decomposers to the raw material accelerated composting process time and improved the compost texture. On the other hand, they did not give a substantial effect on compost chemical properties. More

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*Trichoderma* sp. and *Pseodomonas* sp. are well known biodecomposer and generally used as effective decomposer to produce organic fertilizer [11]-[13].

3.3. Chemical composition analysis of compost

Sieved air dried compost was sent to Soil Chemistry Laboratory, Faculty of Agriculture, Syiah Kuala University, for chemical properties analysis. The parameter observed including water content, pH, total organic carbon, total nitrogen, C/N ratio, total phosphorus, total potassium, total calcium, and total magnesium (Table 2)
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