The potency of bio-organic fertilizer containing local microorganism of Cibodas village, Lembang-West Java

A H Sodiq1*, M R Setiawati2, D A Santosa3, D Widayat2

1Doctoral Program, Faculty of Agriculture, Padjadjaran University, Indonesia
2Faculty of Agriculture, Padjadjaran University Jl. Jatinangor Km.12 Sumedang, Indonesia
3Department Soil Science and Land Resource, Faculty of Agriculture IPB University Jl. Meranti, IPB Campus Darmaga Bogor, 16680, Indonesia

*Corresponding author: abdul_hasyimsodiq@yahoo.co.id

Abstract. This experiment was conducted to determine the characteristics of biofertilizers usually called as Local Microorganism (LM) with the raw materials that is easily obtained in the village of Cibodas Lembang. This experiment included ten main raw materials as media for growing LM, including: Bamboo Root, Spring Onion, Broccoli Leaves, Banana Stump, Leaves of Water Hyacinth, Goat Manure, Rabbit Manure, Chicken Manure, Cow Manure and Rabbit Urine. The LM was enriched with material sugar and carbohydrates then incubated for 2 weeks. Parameters observed in the laboratory include IAA hormones, cytokines and gibberellins. The microorganism living in the LM i.e Total microorganism (Total Plate Count Aerob), Azospirillium, Azotobacter and Trichoderma were also analysed. The results showed that the LM with raw materials from chicken manure showed the highest hormone content in both IAA, Cytokinins (Zeatin), Cytokinins (Kinetin) and Giberelin with the following values: 141.28 ppm, 115.63 ppm, 126.49 ppm, 165.13 ppm, respectively. The same LM showed highest number of microorganisms based on TPC method and Trichoderma with a value of 3.75 x 10^8, 6.80 x 10^5 CFU/ml. As for the analysis of the LM goat manure contain the highest number of Azospirillium which population of 2.4 x 10^5 CFU/ml and the highest population of Azotobacter sp was found in LM of rabbit manure with a value of 6.95 x 10^3 CFU/ml.

Keywords: Azospirillium, Azotobacter, biofertilizers, Cytokinins, Gibberellins, IAA Hormones, Local Microorganisms, TPC Aerob, Trichoderma

1. Introduction
The changing paradigm of Indonesian society towards understanding healthy living continues to increase. [1] stated that the consumption pattern of balanced nutrition originating from vegetables began to develop since the 1990s. Vegetables are important in fulfilling food needs because they are one of the providers nutrients in the form of fiber, vitamins, proteins and minerals needed by the human body. In order to meet the needs of consumers for vegetables, farmers increase their production and the same time they have to maintain the quality and supply of products. Harvested area of vegetable increased by 3.87%, and production rose to 3.88% in 2016 compared to 2015 [2].

One things that needs to be observed from vegetable crops is the by-product of farmers. Vegetable waste the cultivation of producer in organic waste which can bring problems to the environmental if it is not managed properly. In fact, vegetable waste can be used as an alternative or substitute for inorganic...
fertilizers. According to [3] the application of biofertilizers to reduce the use of inorganic fertilizers is important to protect the environment from the adverse effects of excessive inorganic fertilizers.

Vegetable waste as well as livestock waste around our environment is a source of raw material for biological fertilizers known as Local Microorganisms (LM). LM is known to contain a number of microbes, macro and micro nutrients, and can produce phytohormones. Microbial communities can play a role in plant growth through several mechanisms, including increasing nutrient absorption into plants and can increase the competitiveness of rooting-transmitted pests and diseases [4].

Media sources for LM can vary according to the availability of raw materials at the farm level. The main components of LM media are sources of carbohydrates from rice washing water, sources of sugar is refined sugar and bacterial sources (fruit & vegetable waste, livestock waste). The diversity of raw materials will have an impact on the variation of microbial and phytohormone contents contained in LM. Therefore research was conducted to determine the characteristics of various kinds of LM with raw materials available in the Cibodas village of Lembang, West Java.

2. Material and Methods
The study was conducted in August to October 2018 in plastic houses (green house) Macakal Farmers Group, Cibodas-Lembang, Bandung. Analysis of functional microorganism living in the LM and analysis of plant growth hormones was carried out at the Environmental Biotechnology Laboratory of Indonesian Center for Biodiversity and Biotechnology (ICBB), Bogor, Indonesia.

In total types of raw materials were used in this experiments, including: bamboo root, broccoli leaves, banana stump, leaves of water hyacinth, goat manure, rabbit manure, chicken manure, cow manure, rabbit urine. The main raw material is then added to the media contained sucrose (3 kg of sugar diluted in 3 liters of water) and source of carbohydrates.

LM is made from 2 kg wet weight of raw material mashed by chopping up to a maximum size of 10 mm then mixed with 600 ml of sugar solution then soaked in 4 liters from rice washing water in a 10 liter volume plastic container. The container is covered with paper and then incubated for 2 weeks. The pH and temperature are measured every day. After that, LM is filtered and then put in a plastic bottle. Furthermore, to find out the biological and phytohormone properties of LM made by quantification, a series of analyzes are carried out as presented in Tables 1.

| Parameters | Method          | Unit   |
|------------|-----------------|--------|
| TPC Aerob  | ICBB/MU/12.001.4 | CFU/ml |
| Azotobacter| ICBB/MU/12.001.9 | CFU/ml |
| Azospirillum| ICBB/MU/12.001.10 | CFU/ml |
| Trichoderma| ICBB/MU/12.001.6 | CFU/ml |
| Auxin      | HPLC            | ppm    |
| IAA        | HPLC            | ppm    |
| Zeatin     | HPLC            | ppm    |
| Kinetin    | HPLC            | ppm    |
| Gibberelin | HPLC            | ppm    |

3. Results and Discussion
3.1. Physical Properties LM
The observations pH of LM during the study can be seen in Figure 1. The pH results show a range of values from 3.5 to 5.9. Most of LM showed has a low pH. This is similar to the study of [5], where the pH of liquid organic fertilizer in the range of 3.68 - 4.65. Tthe daily observation of pH was also carried out but no significant change in pH was observed.
Based on Figure 1, the raw material of LM from bamboo roots showed the lowest pH value is 3.5 and the raw material for goat manure LM showed the highest pH value is 5.9. The lowest pH value produced by bamboo root raw material is due to the fact that the material from the plant contains large amounts of organic acid. Microbial activity and organic material derived from the rest of the plant is a cause of acidity in LM. [5] is stated that microbial activity in LM made from plant residues will increase H$_2$CO$_3$ levels in LM solution resulting in an increase in H$^+$ concentration.

The observation of pH LM showed that during of incubation the pH of LM were all in acidic conditions. In LM contains both microbes and various nutrients useful for plants growth. According to [6] organic matter is the main source of macro nutrients such as N, P and S and other essential micro nutrients which are very important for plant growth.

The temperature of LM for 14 days of observation fluctuated (Figure 2). In general, the temperature of several LM increased slightly at the 8th observation, but no difference compared with the temperature of the initial observation. The temperature conditions of the LM are seen to continue to decline until the 14th day, within a value range of 25-27°C. The temperature range indicated by various LM during the observation is fairly normal, where there is no increase or decrease in extreme temperatures. The temperature of LM is related with microbial activity. The microbial decomposed raw materials and released heat. [7] is stated that when raw material for LM has decomposed completely, microorganisms enter the death phase and the LM temperature will decrease.

**Figure 1.** pH of LM on the 14th day of incubation.

**Figure 2.** Temperature of LM on 1, 4, 8, 12 and 14 days of incubation
3.2. The Populations of Microorganisms

Table 2 shows the best results on TPC Aerob analysis is LM with the main raw material of chicken manure with a value of $3.75 \times 10^8$ CFU/ml, while as for Trichoderma the best results are indicated by the main raw material of chicken manure with a value of $6.80 \times 10^5$ CFU/ml. For the Azotobacter population the best results were shown by LM with the main raw material of rabbit manure with a value of $6.95 \times 10^3$ CFU/ml. Furthermore, in the analysis of Azospirillum the best results were shown by the main raw material of goat manure which is $2.4 \times 10^5$ CFU/ml.

Table 2. Observation results total populations of Mikrob Aerob (TPC Aerob), Azotobacter, Azospirillum, Trichoderma

| Raw Materials LM | TPC Aerob CFU/ml | Azotobacter CFU/ml | Azospirillum CFU/ml | Trichoderma CFU/ml |
|------------------|------------------|--------------------|--------------------|-------------------|
| Bamboo Roots     | $1.20 \times 10^3$ | $1.3 \times 10^3$  | $< 1.8$            | $1.00 \times 10^2$ |
| Broccoli Leaves | $5.90 \times 10^6$ | $3.7 \times 10^3$  | $2 \times 10^3$    | $< 1 \times 10^2$ |
| Banana Stump     | $1.15 \times 10^5$ | $< 1 \times 10^2$  | $780$              | $< 1 \times 10^2$ |
| Water Leaves     | $1.14 \times 10^5$ | $1.25 \times 10^3$ | $400$              | $< 1 \times 10^2$ |
| Spring Onions    | $1.04 \times 10^5$ | $3.15 \times 10^3$ | $< 1.8$            | $< 1 \times 10^2$ |
| Goat Manure      | $1.09 \times 10^7$ | $4.05 \times 10^3$ | $2.4 \times 10^4$  | $< 1 \times 10^2$ |
| Rabbit Manure    | $6.85 \times 10^6$ | $6.95 \times 10^3$ | $4.7 \times 10^3$  | $< 1 \times 10^2$ |
| Chicken Manure   | $3.75 \times 10^8$ | $< 1 \times 10^2$  | $< 1.8$            | $6.80 \times 10^5$ |
| Cow Manure       | $2.48 \times 10^5$ | $1.50 \times 10^2$ | $< 1.8$            | $3.50 \times 10^2$ |
| Rabbit Manure    | $1.34 \times 10^5$ | $< 1 \times 10^2$  | $< 1.8$            | $< 1 \times 10^2$ |

The observation of the microbial population above shows that LM that has been made contains a variety of functional microbes. According to [8], the diversity of microbial populations indicates that many microbes play a role in the process of decomposition of LM organic matter. Azotobacter and Azospirillum in LM have a very important role in providing nitrogen for plant growth. According to [9], Azotobacter and Azospirillum are N$_2$ fixing bacteria that live freely in the soil and also produce plant growth-promoting substances such as gibberelin, cytokinin and indolacetic acid.

Population of Trichoderma sp. in LM made from raw chicken manure was the highest when it compared to other ingredients. Trichoderma sp. known to have antagonistic ability to several pathogenic fungi in vitro. The results of [10], showed that the inoculation of Trichoderma sp. able to inhibit the growth of C. capsici, Fusarium sp., and S. rolfsii fungi in a row of 68.2%, 53.9%, and 35.5%. Therefore LM made from raw chicken manure has the potential as a biofungicide to control the population of plant pathogenic fungi.

3.3. Phytohormone Observation

LM also contains several phytohormones which are useful in plant growth and productivity. [11] states that fitohormones can regulate plant growth. The phytohormon help the plant can also to resist drought condition and heavy metal contamination. In addition, they can protect plant against high salinity stresses, and help plants grow. Bacteria that are capable of producing gibberellins, namely: Azotobacter, Azospirillum, Pseudomonas, Acetobacter, Burkholderia and Bacillus [12].

3.3.1. Auxin (IAA)

The function of this auxin hormone is to help in the process of accelerating growth, both root growth and stem growth, accelerate germination, help in the process of cell division, accelerate fruit ripening, reduce the number of seeds in the fruit. This auxin hormone works synergistically with cytokinin and gibberelin hormone.
In Figure 3, the highest concentration of auxin hormone (IAA) is 141.28 ppm resulted from LM chicken manure, which subsequently contributed the second and third best is 140.11 ppm and 135.01 ppm was showed by LM goat manure and bamboo roots. The two best values are produced by raw materials from animal residues. This shows the raw materials from animal organic waste to produce LM with a high composition of the hormone auxin (IAA).

3.3.2. Cytokinins (Zeatin dan Kinetin)
Cytokinins are a group of plant hormones and growth regulators that encourage cell division (cytokinesis) in meristematic tissues. In addition to its main role as a regulator of cell growth and differentiation, cytokinins also influence shoot dominance, edge bud growth, and aging (senescence) leaves. There are two types of cytokines: the type of adenine and the type of phenylurea. Adenine type is represented by kinetin, zeatin, and BA. Phenylurea types, for example, are diphenylurea and tidiazuron (TDZ) which are not formed by plants. Cytokines can work locally or remotely. Usually cytokinins are transported through wooden vessels. In carrying out its physiological functions, cytokines often work in conjunction with auxin.

Based on the analysis of the cytokinin (Zeatin and Kinetin) hormone content the best results was showed by LM chicken manure is 115.63 ppm and 126.49 ppm. These results indicate that chicken manure is still consistently showing the best results in phytohormone analysis. Whereas the second best results are was showed by LM goat manure is 105.23 ppm and 124.36 ppm. The third highest content of Zeatin is found in LM leaves of water hyacinth and kinetin in LM with raw materials from cow manure.
3.3.3. Gibberellin

Gibberellin or gibberellic acid are all members of the plant hormone group that have similar functions. GA is needed for most plant life and has the function of regulating germination, stem lengthening, flowering triggering, anther development, seed development and pericarp growth. In addition, this phytohormone also plays a role in responses to stimuli through physiological regulation associated with its biosynthetic mechanism. Gibberellins in plants can be found in two main phases, active gibberellins (bioactive GA) and inactive gibberellins. Biologically active gibberellins (bioactive GA) control various aspects of plant growth and development, including seed germination, extension rods, leaf expansion, and flowers and seed development. Exogenous application of gibberellins can increase the growth of chili plants [13].
Based on the results of the analysis of the hormone Gibberellin the best results were again shown by LM with raw material of chicken manure which has value of 165.13 ppm (Figure 6). That can be concluded that the produced with LM raw materials from chicken manure produced highest phytohormone compare with other raw materials.

4. Conclusion
Based on the results showed that the raw materials from chicken manure showed the highest hormone values both on IAA, Cytokinin (Zeatin), Cytokinin (Kinetin) and Gibberellin hormones respectively with the following values of: 141.28 ppm, 115.63 ppm, 126.49 ppm and 165.13 ppm. The LM from chicken manure showed also the highest TPC Aerob and Trichoderma values compared to other LM with a value of $3.75 \times 10^8$ CFU/ml, $6.80 \times 10^5$ CFU/ml. While the highest population of Azospirillum is indicated by the raw material from goat manure, which is $2.4 \times 10^5$ CFU/ml. Whereas Azotobacter sp. the highest population was found in LM with rabbit manure with a value of $6.95 \times 10^3$ CFU/ml.

5. References
[1] Aswatini, M. Noveria, Fitranita. 2008. Consumption of vegetables and fruit in the community in the context of fulfilling balanced nutrition. J. Indonesian Independence. 3(2): 97-119.

[2] [Kementan RI] 2017. Agricultural Statistics 2017. Jakarta (ID): Agricultural Data and Information Center. Ministry of Agriculture of the Republic of Indonesia. 362 hal.

[3] El-Habbasha, S.F., M.S. Abd El Salam, M.O. Kabesh. 2007. Response of two sesame varieties (Sesamum indicum L) to partial replacement of chemical fertilizers. JABS. 3(6): 563-571.

[4] Smith, S.E., D.J. Read. 1997. Mychorizal Symbiosis. London (UK): Academic Pr.

[5] Handayani, S.H., A. Yunus, A. Susilowati. 2015. Test the quality of liquid organic fertilizer from various kinds of local microorganisms (MOL). El-Vivo. 3(1): 54-60.

[6] Smith, J.L., R.I. Rapendick, D.F. Bezdicek, J.M. Lynch. 1993. Soil organic matter dynamics and crop residue management [editorial]. Soil Microbial Ecology. Marcel Dekker Inc (US). p: 65-94

Figure 6. Gibberellic concentration of several sources of LM on 14th days incubations
[7] Juanda, Irfan, Nurdiana. 2011. Effect and duration of fermentation on the quality of moles (local microorganisms). J. Floratek. 6(1): 140-143.

[8] Batara, L.N, I. Anas, D.A. Santosa, Y. Lestari. 2016. Application of local microorganisms (MOL) enriched with microbes is useful in the cultivation of rice systems of rice intensification (SRI) organic. J. Land and Climate. 40(1): 71-78.

[9] Hindersah, R., T. Simarmata. 2004. Azotobacter Rhizobacteria Potential in improving soil health. J Nature Indones. 5(2): 127-133.

[10] Alfizar, Marlina, F. Susanti. 2013. The antagonistic abilities of Trichoderma sp. against several types of in vitro pathogenic fungi. J. Floratek. 8(1): 45-51.

[11] Widyati, E. 2016. The role of phytohormone in plant growth and its implications for forest management. Galam. 2(1): 11-22.

[12] Mansour FA, Aldesusquy HS, Hamedo HA, 2004. Studies on plant growth regulators and enzymes production by some bacteria. Qatar Univ Sci J. 14(2): 281-288.

[13] Joo GJ, Gunes A, Turan M, Gulluce M. 2005. Gibberellins producing rhizobacteria increase endogeneous gibberellins content and promote growth of red peppers. J Miicrobiol. 43: 510-515.