

The Effect of Merapi Volcanic Ash Addition on the Quality of Liquid Organic Biofertilizer Made from Goat and Sheep Feces

**Nanung Agus Fitriyanto¹, Kinanthi Hening Swari Jayeng Sashanti¹,
Bambang Suwignyo¹, Nafiatul Umami¹, Yuny Erwanto¹**

¹Faculty of Animal Science, Universitas Gadjah Mada, Bulaksumur, Yogyakarta 55281,
Indonesia

Corresponding email: nanungagusfitriyanto@ugm.ac.id

ABSTRACT

The liquid manure from livestock feces that made for biofertilizer is one of the alternatives way of organic agriculture that has to be increased the efficiency and due to the cheaper labor purposes. Moreover, it can increase the content of plant nutrient such as Nitrogen, Potassium, and especially Phosphor. Ash gives a positive effect on the plant through indirect influence on the ground by increasing the availability of Phosphor content. Goat and sheep feces contain an amount of plant nutrients and can be utilized as liquid organic biofertilizer. Due to containing some minerals, Merapi Volcanic ash has a potential to improve the quality of liquid organic biofertilizer. This research was conducted to determine the effect of Merapi volcanic ash on the improvement of quality for liquid organic biofertilizer made from goat and sheep feces. This research was performed at the Faculty of Animal Science, Universitas Gadjah Mada. The data were statistically analyzed using Randomized Complete Design (CRD) pattern of factorial with the parameter of the volcanic ash proportion (0%, 1%, 3% and 5%), and the feces type (goat and sheep). This research was described the physical, chemical, biological, and microbiology aspects of the biofertilizer product. The data showed that the addition of volcanic ash to the liquid organic biofertilizer had given a good effect on the levels of organic carbon and phosphor contents of the product. Moreover, stem diameter of *Ipomoea reptans*, the number of leaves, dry weight, and the length of the root which added by the product has showing increased. Biofertilizer with the addition of 5% with volcanic ash in goat feces gave a better effect on the plant growth.

Keywords: Goat feces, Sheep feces, Liquid organic biofertilizer, Merapi volcanic ash.

INTRODUCTION

Nowadays, organic agriculture production of crops has become a significant sector industry in Indonesia. The products that resulted from lesser amounts of chemical fertilizers and chemicals application have been receiving attention for unharmed and healthy vegetables and other agriculture crops (Leaungvutiviroj *et al.*, 2010). One of the significant challenges in organic culture is to provide sufficient soil nitrogen availability to reach maximum yield potential. Application of manure-based solid and liquid organic compost are common organic production technical methods. However, the low Nitrogen (N) mineralization rate is typical of compost limits its N contribution to the plant. Hartz *et al.*, (2000) reported that a high compost application rate could make a significant contribution to soil N availability, but in practice, the application rate is constrained by cost and by the potential for water quality degradation from high phosphorus (P) loading (Sharpley *et al.*, 1994). Some of the liquid organic fertilizers from animals manure have come to the market. However, there is little data

available on their N mineralization characteristics or the challenges they pose for application through a drip system (Hartz *et al.*, 2010).

Recently, the method of utilizing livestock waste as organic fertilizer for agricultural crops is rapidly increased. Utilization of goat and sheep feces processed into organic fertilizer has a good long-term effect for the soil, which can improve the structure of soil organic content. This is because of the feces of goats and sheep have various types of nutrient content needed by the soil. In addition, organic biofertilizer produces agricultural products that are safe for health. To produce a large amount of solid organic fertilizer, it needs a lot of man power. This will lead to increase labor costs and require sufficient land (bulky). Although organic fertilizers can be produced by farmers themselves, in order to make organic fertilizer applications more efficient and cheaper labor usage, one alternative is to make biofertilizer or liquid fertilizer from livestock feces.

Indonesia is a region which surrounded by the most active volcanoes in the world. Volcanoes are scattered in various islands in Indonesia. At the end of 2010, the eruption of Mount Merapi in Yogyakarta has caused damages to the surrounding environment. However, one of the long-term positive impacts of volcanic eruptions is that it can fertilize the land, so it benefits to the farmers. Volcanic ash is a volcanic material that is sprayed into the air during an eruption. In general, the composition of volcanic ash consists of Silica and Quartz. Volcanic Ash contains the minerals needed by soil and plants with the highest total element composition of Ca, Na, K and Mg, other macro elements in the form of P and S, while the micro elements consist of Fe, Mn, Zn, Cu (Anda and Wahdini, 2010). The minerals have the potential to increase the mineral reserves of the soil, enrich the chemical arrangement and improve the soil physical properties so they can be used as material to improve the soil nutrients or underground soils (Sedyarso and Suping, 1987). This study aims to determine the effect of the addition of volcanic ash in different proportions (0%, 1%, 3%, and 5%) on the organic biofertilizer quality made from goat and sheep feces.

MATERIALS AND METHODS

Biofertilizer production. These following steps were the method for biofertilizer production: (1) *Separating unused materials.* Firstly, separation of unused materials such as plastic waste, wood, and the stone was performed. Separation have be done carefully due to it determine the smooth process and the quality of biofertilizer product. (2) *Cutting of the materials.* The size reduction was done to expand the surface of the material (feces, vegetables, and rotten vegetables) so that the material can be easily and quickly decomposed into biofertilizer. (3) *Mixing of solid materials.* Solid materials include feces, fruit, rotten vegetables, and volcanic ash was mixed to blended. This solid material was input in the flour sack and was strongly bonded. (4) *Mixing all ingredients.* The solid material in the mixed sack was inserted in a 15 kg tray and added with water. EM4 was then added and continued by stirring. (5) *Stirring.* Stirring was done every day for one week at each afternoon. The end of the rope that ties the sack was pulled up and down to facilitate stirring. (6) *Fermentation.* The incubation was done for one week (7 days) or until the temperature was constant. Tray closed tightly during the fermentation. (7) *Separation of liquids and solids materials.* After seven days of fermentation, the product was then harvested, and biofertilizer was ready for use.

The ratio between solids and water was 1: 2. The required water was 10 kg from a 15 kg of total mixture. Moreover, the other materials needed was 5 kg. The solid material consisted of feces, vegetables and rotten vegetables, the volcanic ash of Mount Merapi, and EM4.

Research design. The design of the research is shown in Table 1.

Table 1. Research design

Treatment	Composition of biofertilizer materials										Total	
	Water		EM4		Rotten vegetables		Feces		Volcanic Ash		%	kg
	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg
0% VA+SF	66.67	10	0.83	0.125	3.33	0.5	29.7	4.38	0	0	100	15
1% VA+SF	66.67	10	0.83	0.125	3.33	0.5	28.17	4.22	1	0.15	100	15
3% VA+SF	66.67	10	0.83	0.125	3.33	0.5	26.17	3.93	3	0.45	100	15
5% VA+SF	66.67	10	0.83	0.125	3.33	0.5	24.7	3.63	5	0.75	100	15
0% VA+GF	66.67	10	0.83	0.125	3.33	0.5	29.7	4.38	0	0	100	15
1% VA+GF	66.67	10	0.83	0.125	3.33	0.5	28.17	4.22	1	0.15	100	15
3% VA+GF	66.67	10	0.83	0.125	3.33	0.5	26.17	3.93	3	0.45	100	15
5% VA+GF	66.67	10	0.83	0.125	3.33	0.5	24.7	3.63	5	0.75	100	15

VA : Volcanic Ash
 SF : Sheep Feces
 GF : Goat Feces

Observed parameters. The parameters observed in this study were divided into physical, chemical, biological, and microbiological parameters. (1) *Physical parameters.* Physical parameters were done directly to biofertilizer at every day by observing the color, odor, pH, and temperature. (2) *Chemical parameters.* Observation of chemical parameters were performed by testing the C-Organic, Nitrogen, Phosphorus, and Potassium contents of biofertilizer. Nitrogen content was measured by using the Kjeldahl method. Moreover, Phosphor content was measured using UV Spectrometer. (3) *Biological parameters.* The biological parameters were performed by observing and measuring the productivity of the crops such as high of the plant, stem diameter, total wet weight, dry weight, root length, and a number of the leaf. Plant height was measured from the surface of the ground to the highest leaves of the plant. The diameter of the stem was measured on the stem section of the most basic joint area. (4) *Microbiological parameters.* This parameters were performed by observing the number of microbial colonies of biofertilizer after harvest by Total Plate Count (TPC) method.

Statistic. Statistical analysis of the results was performed by a 2x4 factorial design, and Duncan's new multiple range tests were used to evaluate differences among means. A significant difference indicates that the P value was not greater than 0.05.

RESULTS AND DISCUSSION

Physical parameters. The observations were performed to the product of biofertilizer after harvest was observed brown and the odor was typical of livestock feces. The observational data of odor and color are listed in Table 2.

Table 2. Physical observation of biofertilizer

Treatment	Odor	Color
0% VA+SF	Typically feces	Brown
1% VA+SF	Typically feces	Brown
3% VA+SF	Typically feces	Brown
5% VA+SF	Typically feces	Brown
0% VA+GF	Typically feces	Brown
1% VA+GF	Typically feces	Brown
3% VA+GF	Typically feces	Brown
5% VA+GF	Typically feces	Brown

The observations on biofertilizer showed similar color and odor that did not differ between treatments. The color of liquid fertilizer was yellowish brown. The smell of liquid fertilizer was quite stung because it was made from waste and waste material.

The pH observations of biofertilizer at the harvest time was observed 7.6. According to Harada *et al.*, (1993) a good pH for the composting process is 5.5 to 7.5. Whereas experiments conducted by another researcher on composting of liquid biofertilizer from cow rumen fluid ranged from 5.30 to 7.19. So, the pH of biofertilizer after harvest is slightly above from the normal range. The pH value affects the activity of microorganisms in biofertilizer medium. Composting that produces fertilizers more alkaline because of the microbial activity breaks down the acids into CO₂ and releases many of the basic cations (K⁺, Ca⁺, Mg²⁺) of mineralization in aerobic condition. On the 6th day of bio-fermentation, some of the treatments reached the highest pH 8. At that condition, the breakdown of protein to produce amino acid compounds to be converted to ammonia occurred.

On the other hands, observations showed the average biofertilizer temperature with goat feces was 29°C and from sheep, feces was 28.5°C. The average biofertilizer temperature which measured at every afternoon on each treatment was not significantly different. The average biofertilizer temperature was quite high on day 3rd to the day 6th.

Microbiological parameters. The number of colonies observing by Total Plate Count (TPC) from biofertilizer products was written in Table 3.

Table 3. The number of colony from the product of biofertilizer

Treatment	Colony number (CFU/ml)
0% VA+SF	3.75 x 10 ⁵
1% VA+SF	4.4 x 10 ⁵
3% VA+SF	5.3 x 10 ⁵
5% VA+SF	5 x 10 ⁵
0% VA+GF	2.2 x 10 ⁵
1% VA+GF	3.4 x 10 ⁵
3% VA+GF	1.9 x 10 ⁵
5% VA+GF	1.9 x 10 ⁵

In general, the number of the colony from the biofertilizer product which made from sheep feces resulted in higher of microorganisms biodiversity. The largest number of the colony was observed at the biofertilizer produced from sheep feces with the addition of 3% of Merapi Volcanic ash.

Chemical parameters. Chemical parameters of the biofertilizer product were written in Table 4.

Table 4. Chemical Parameters of the biofertilizer product

Treatment	Organic Carbon (%)	Nitrogen Content (%)	Phosphor Content (%)	Potassium Content (%)
0% VA+SF	0.54	0.08	0.030	0.285
1% VA+SF	0.52	0.08	0.030	0.285
3% VA+SF	0.49	0.08	0.030	0.285
5% VA+SF	0.49	0.08	0.032	0.288
0% VA+GF	0.49	0.07	0.020	0.248
1% VA+GF	0.52	0.08	0.020	0.256
3% VA+GF	0.47	0.07	0.025	0.233
5% VA+GF	0.51	0.08	0.023	0.233

There was an interaction between the proportion of ash and feces species against the C-organic content ($P < 0.05$). C-organic content with goat feces with the proportion of 0% ash shows the highest value. C-organic content on biofertilizer written in Table 4. The type of livestock feces showed a significant difference ($P < 0.05$) to the N content of biofertilizer. In the biofertilizer from goat feces, it has an average of Nitrogen content higher compared to the biofertilizer from sheep's feces. Compared to the sheep, goats are more efficient in ruminant and more efficiently in utilizing Nitrogen at the feed. The high bacterial populations on goat rumen will support the process of protein degradation, resulting in ammonia concentration resulting higher. The result of Nitrogen content in biofertilizer shown in Table 4. Based on the type of cattle feces and the proportion of volcanic ash, phosphorus levels showed a significant difference ($P < 0.05$), but there was no interaction between species of animal and volcanic ash. The type of livestock showed a significant difference ($P < 0.05$). Biofertilizer with goat feces containing potassium was higher than sheep's feces. The proportion of 1% volcanic ash has the highest potassium content than others. Potassium Content (%) in biofertilizer can be seen in Table 4.

Biological parameters. Stem diameter of *Ipomoea reptans*, the number of leaves, dry weight, and the length of the root which added by the product has showing increased. Biofertilizer which gives a better effect on the plant growth was biofertilizer which made by the addition of 5% with volcanic ash in goat feces.

CONCLUSIONS

The addition of volcanic ash at different levels in the process of bio-fermentation to become biofertilizer has give the same effect on Nitrogen content, Potassium, the diameter of the stem and the number of spinach leaves. The addition of volcanic ash in the animal feces becomes biofertilizer gave different effects on C-organic content, Phosphor, the diameter of stem spray spinach, the number of leaves, wet weight of spinach, dry weight, and roots of spinach tree. The treatment has the best biofertilizer quality that is fertilizer addition of 5% ash with using goat feces.

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