Biochemical and physical properties of goat feces liquid biofertilizer fermented with chicken excreta combination and different fermentation condition

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Abstract. This research aims to evaluate the quality of goat feces liquid biofertilizer with chicken excreta addition by aerobic and anaerobic fermentation. The data obtained from the research were statistically analyzed with Completely Randomized Design (CRD) Factorial Pattern with two factors. The first factor was addition level of the chicken excreta (0, 10, 20, and 30%) and the other factor was fermentation treatment (aerobic and anaerobic) condition with 3 replications for each treatment. Fermentation was conducted for 14 days. The observed parameters consisted of the chemical parameter (organic-C, N, P, and K) and the physical parameter (pH, temperature, and the odor). The addition of various level of chicken excreta and fermentation treatments in the process of producing goat feces liquid biofertilizer indicate significantly effect to increase the organic-C, total-N, NH₄, P, K, compare with 5 and 10% liquid fertilizer treatment. The best quality of liquid biofertilizer produced by combining aerobic fermentation and the addition of 30% chicken excreta. Generally, chicken excreta able to increase the nitrogen and mineral content, and putting together with aerobic fermentation system of chicken excreta maximum to 30% can avoid overproduction of unpleasant odor.

1. Introduction
Nitrogen (N) availability in soil is usually limited and become a problem in organic agriculture production. Many farmers in Indonesia use chemical fertilizers to improve the growth of the plants. The application of chemical fertilizers without any substitution of organic fertilizers, in the long-term, will have adverse effects on the soil, such as hardening, decreasing pH, unbalanced elements in the soil, and decreasing water holding capacity [1]. Improvement of soil conditions can be performed with the addition of organic fertilizer. Organic fertilizer is a complete fertilizer contains macro and microelements. Although in small quantities, it will increase soil productivity and support the plant growth [2, 3].

Application of fresh feces on agricultural will cause problems such as odor, high pathogenic bacteria cause disease in plants, the growth of weed, and cause methane pollution. One effort to reduce the negative impact of chicken excreta is used as a raw material of fertilizer [4]. The goat feces have N, P and K content of 0.7 %; 0.4 % and 0.25 %, while chicken excreta has N, P and K contents of 1.5 %; 1.5 % and 0.8 %. Chicken excreta has higher N, P and K content or can be said to have better quality if used as fertilizer compared to goat feces. The biofertilizer which made from certain animal
feces such as goat has limited in N content and need to be improved by substitute with the other animal feces or chicken excreta [5].

Liquid biofertilizer as a supplement for the plant must have good nutrient content, the addition of chicken excreta is expected to improve the quality of liquid biofertilizer produced. This research aimed to know the quality of liquid biofertilizer which made by aerobic and anaerobic fermentation, to compare the better fermentation methods in degrading the organic material of goat feces and chicken excreta.

2. Material and methods

2.1. Material

The main material used in this research was goat feces which taken from the Faculty of Animal Science, Universitas Gadjah Mada, and chicken excreta which took from Pakem, Sleman, Yogyakarta. Some equipment such as bioreactor, aerator, scales, thermometer, pH meter, ruler, has used for making the biofertilizer, and some laboratory equipment was used to observe the biochemical properties of the product.

2.2. Methods

At the first step, liquid biofertilizer of goat feces with the addition of chicken excreta has been produced with each percentage according to the treatment. The ratio of goat feces with water is 1:2.5. The percentage of chicken excreta added to the biofertilizer was based on the weight of the goat feces. Chicken excreta was scaled according to the treatment percentage, which is 0, 10, 20, and 30 %. The mixture was then inputted into the plastic biodigester and added with 3 L of water and tied strong, kept for 2 days to facilitate the process of destruction. Each biodigester was added by 250 mL molasses and 250 mL of starter. Possibly gas formed was discharged through PVC channels. Fermentation was carried out for 14 days. The stirrer of the sample was performed at every day, including pH and the temperature observation.

The second step of the research was the observation of the quality of liquid biofertilizer. The parameters observed in the study were physical and biochemical. Physical parameters include the color, odor, temperature, and pH. The color and odor were observed after the harvest period. Temperature and pH of biofertilizer were observed daily. Chemical parameters include levels of C-organic, nitrogen, phosphorus and potassium.

Data were analyzed using a Completely Randomized Design (CRD) Factorial Pattern with two factors. The first factor was addition level of the chicken excreta (0, 10, 20, and 30%) and the other factor was fermentation treatment (aerobic and anaerobic) condition with 3 replications for each treatment.

3. Results and discussion

3.1. Biochemical properties.

The value of C-organic, N-organic, and N-total content of liquid biofertilizer was written in Table 1.

| Excreta addition (E) | Aerobic fermentation (F1) | Anaerobic fermentation (F2) |
|---------------------|---------------------------|-----------------------------|
|                     | C-organic | N-total | N-organic | C-organic | N-total | N-organic |
| 0 % (0)             | 0.84 ± 0.1 a | 0.28 ± 0.10 b | 0.21 ± 0.01 b | 0.78 ± 0.08 c | 0.26 ± 0.01 d | 0.20 ± 0.01 e |
| 10 % (1)            | 0.96 ± 0.06 b | 0.34 ± 0.00 e | 0.23 ± 0.01 i | 0.98 ± 0.04 f | 0.30 ± 0.01 g | 0.20 ± 0.00 h |
| 20 % (2)            | 1.28 ± 0.04 c | 0.39 ± 0.05 j | 0.23 ± 0.05 j | 0.99 ± 0.16 l | 0.34 ± 0.04 j | 0.20 ± 0.03 j |
| 30 % (3)            | 1.28 ± 0.054 k | 0.46 ± 0.00 l | 0.25 ± 0.01 k | 1.16 ± 0.01 m | 0.43 ± 0.01 k | 0.24 ± 0.02 k |

Note: Different superscripts on the same column, significantly different (P<0.05)
Different superscripts on the same line, significantly different (P<0.05)
From the statistical analysis, we can understand that fermentation condition and the treatment of excreta addition were gave the significantly effect to the C-organic content of liquid biofertilizer (P<0.05) and showed an interaction between the two treatments. The treatment of aerobic fermentation showed significantly higher content of C-organic compare to the anaerobic fermentation. The lower content of C-organic in the liquid biofertilizer was due to the dilution process of feces and excreta by water. Furthermore, the evaporation and release of C-organic content to the air during the fermentation process suggested effected to decrease the level of C-organic in the liquid biofertilizer [6].

The aerobic fermentation treatment showed significantly higher to the content of N-total values compare to the anaerobic fermentation treatment. N-total content with aerobic fermentation treatment and 30% excreta addition showed the highest total N-content. The aerobic fermentation treatment showed better N-total, the nitrogen element in the liquid biofertilizer making material is still largely organic, while the decomposition of optimal organic matter under aerobic conditions is in accordance with the previous research [1], that biological decomposition and waste stability require large amounts of dissolved oxygen, depending on the ingredients. The data of N-organic content has similar pattern with N-total of the liquid biofertilizer. The NH$_4$ and NO$_3$ content were written in Table 2.

Table 2. The NH$_4$ and NO$_3$ content in the liquid biofertilizer.

| Excreta addition (E) | Aerobic fermentation (F1) | Anaerobic fermentation (F2) |
|---------------------|--------------------------|-----------------------------|
|                     | NH$_4$                   | NO$_3$                      | NH$_4$                   | NO$_3$ |
| 0 % (0)             | 0.06 ± 0.01              | 29.87 ± 8.55               | 0.05 ± 0.00              | 35.47 ± 17.11 |
| 10 % (1)            | 0.11 ± 0.00              | 24.27 ± 6.47               | 0.10 ± 0.00              | 41.07 ± 3.23 |
| 20 % (2)            | 0.15 ± 0.00              | 39.20 ± 0.00               | 0.13 ± 0.01              | 33.60 ± 9.96 |
| 30 % (3)            | 0.20 ± 0.01              | 31.73 ± 16.16              | 0.18 ± 0.00              | 39.20 ± 19.39 |

The treatment of aerobic fermentation resulted the higher NH$_4$ concentration compared with anaerobic fermentation. By the addition of 30% of excreta, the concentration of NH$_4$ reached the highest one. Amino acids from digested protein was suggested involved in ammonification to form ammonia gas and then react with water and formed ammonium (NH$_4^+$). This NH$_4^+$ was then readily available for bacteria and plants in the environment. Research regarding to the relation between bacteria and N in the environment have been perform previously [7-9]. The level of NO$_3^-$ in all treatments was observed very low concentration. Nitrogen was suggested to be absorbed by plant roots in the form of NO$_3^-$ (nitrate) and NH$_4^+$ (ammonium), but nitrate is immediately reduced to ammonium through an enzyme containing molybdenum (Mo). The average organic Phosphor and Potassium content can be seen in Table 3.

Table 3. The Phosphor and Potassium content of liquid biofertilizer

| Excreta addition (E) | Aerobic fermentation (F1) | Anaerobic fermentation (F2) |
|---------------------|--------------------------|-----------------------------|
|                     | Phosphor                 | Potassium                   | Phosphor                 | Potassium |
| 0 % (0)             | 0.024 ± 0.009            | 0.42 ± 0.00                 | 0.022 ± 0.006            | 0.31 ± 0.01 |
| 10 % (1)            | 0.047 ± 0.005            | 0.44 ± 0.02                 | 0.042 ± 0.017            | 0.31 ± 0.01 |
| 20 % (2)            | 0.057 ± 0.005            | 0.46 ± 0.03                 | 0.046 ± 0.001            | 0.32 ± 0.02 |
| 30 % (3)            | 0.058 ± 0.004            | 0.46 ± 0.01                 | 0.065 ± 0.000            | 0.37 ± 0.02 |
| Mean                | 0.44 ± 0.02$^a$          | 0.33 ± 0.03$^a$             |                           |           |

Information: Different Superscript at the same row, indicate the significantly (P<0.05)

From the statistical analysis showed that the addition of chicken excreta had a significant effect to increase the phosphorus content of liquid bio-fertilizer (P<0.05) and did not show any interaction between the two fermentations condition. Phosphorus is a nutrient needed in large quantities so that its existence becomes one of the limitations of crop production. However, if P given excessive will decrease the quality of plants because P soil becomes unbalanced will also increase the soil pH. The data of potassium content in the sample gave a similar pattern. Aerobic fermentation produces liquid
biofertilizer with higher potassium content. The addition of 30% chicken excreta increased potassium content.

3.2. Physical Properties.
The physical properties of liquid biofertilizer from all treatments has written in the Table 4.

| Treatments | Concentration Excreta (E) (%) | Odor                  | Color         | pH  | Temperature (°C) |
|------------|-------------------------------|-----------------------|---------------|-----|------------------|
| Aerob (1)  | 0 % (0)                       | Goat feces            | Dark brown    | 6   | 25.86            |
|            | 10 % (1)                      | Goat feces and chicken excreta | Dark brown | 6   | 25.88            |
|            | 20 % (2)                      | Goat feces and chicken excreta | Dark brown | 6   | 25.89            |
|            | 30 % (3)                      | Goat feces and chicken excreta | Dark brown | 6   | 25.92            |
| Anaerob (2)| 0 % (0)                       | Goat feces            | Dark brown    | 6.07| 26.84            |
|            | 10 % (1)                      | Goat feces and chicken excreta | Dark brown | 6   | 26.87            |
|            | 20 % (2)                      | Goat feces and chicken excreta | Dark brown | 6.07| 26.84            |
|            | 30 % (3)                      | Goat feces and chicken excreta | Dark brown | 6.14| 26.94            |

The physical properties of resulted product of the liquid biofertilizer was written in Table 4. The addition of 30% excreta has resulted in dominant odor in the product both in aerobic and anaerobic fermented liquid fertilizer. The average pH of observed liquid biofertilizer during harvest was 6. There was no increasing in temperature during fermentation process in both condition and different level of excreta addition.

4. Conclusion
The treatment of chicken excreta addition and fermentation condition of liquid biofertilizer from goat feces gave no significant effect on several physical and biochemical parameter including color, odor, pH, temperature, N-organic content, and NO₃ levels. In some parameters, the addition of chicken excreta and fermentation condition on goat feces, gave significant effect on the chemical parameters of C-organic, N-total, NH₄, P content, and K content.

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