Quality Nutrient Identification In Liquid Organic Fertilizer (Goat Urine And Banana Stumps) And Its Application On Growth Of Chili (*Capsicum Frutescens*)

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Abstract.

Agricultural waste such as goat manure and urine could be a source of environmental pollution and a source of disease if it can't be processed into beneficial fertilizer. The use of organic fertilizers could increase plant growth and can prevent land quality degradation, but some of the weaknesses in the application of organic fertilizer are the lack of information on nutrient content and its effects on plant growth. The aim of this research is to analyse the fermentation periods for producing the highest macro nutrient in liquid organic fertilizer made from goat urine and banana stumps. The results showed that the effect of the fermentation periods gave different results of macro nutrients. The recommendation for fermentation periods required to produce the highest macro nutrient content was P2 (21 days), the percentage value of nutrients in (P2: 21 days) were Nitrogen (1.83%), Phosphorus (0.56%) and Potassium (1.20%). The research results also showed that the P4 treatment (20 mL of liquid organic fertilizer) giving the highest value on several parameters in chili (height, number of leaves, fresh weight, root length, number of flower and fruits). P1 and P3 recommended for appearance of flowers (30 DAT) and P4 recommended for stimulating fruit primordia.

Keyword: *Banana stumps, goat urine, liquid organic fertilizer and quality nutrient identification.*

I. INTRODUCTION

Agricultural activities can't be separated from crop waste and livestock waste products. Livestock farming is an economic activity that have several impacts, positively and negatively. Goats as a livestock produce two types of waste, solid waste and liquid waste product. Negative impact of liquid waste product caused several pollutants such as methane gas (CH_4), methane were used as a medium for the growth of disease-causing microorganisms [1]. Solid waste product from goats has been widely used as organic fertilizer in agriculture, but liquid waste product (urine) has not been optimally utilized. Goat urine production reaches 0.6-2.5 litres per day, if it left unchecked it will have an impact on the surrounding environment and caused unpleasant scent and pungent st nch [2]. Integrated agriculture and livestock in Pondoknongko Village, Kabat District, Banyuwangi Regency in 2023 has carried out 5 goats which produce waste in the form of urine about 3 litres per day, in 1 week producing 21 litres and in 1 month producing 90 litres. In 2024, the number of goats reached 8 livestock that produced 4.8 litres of urine per day, in 1 week producing 33.6 litres and in 1 month producing 144 litres. The urine produced in the integrated agriculture and livestock of Pondoknongko Village were not handled properly.Goat urine has potential value as nutrient enhancer. The chemical content in goat urine consists of high levels of N and K nutrients that are easily absorbed by plants, it is contain natural hormones for plant growth. Goat urine contains twice as much Nitrogen (N) as solid livestock manure. Potassium (K) content is five times higher when compared to solid livestock manure.

Goat urine has been proven to be free from harmful parasitic microorganisms such as salmonella bacteria, making it safe to use as liquid organic fertilizer [3]. Liquid fertilizer is simply defined as organic fertilizer resulting from fermentation from several organic materials. Organic fertilizer commonly derived decomposition of organic materials. Fermentation is one way to change organic materials into simpler materials by utilizing microbial activity. Fermentation conditions are carried out in anaerobic conditions. Anaerobic fermentation is the process of decomposing organic materials without involving free oxygen, the quality of the fertilizer depended on the conditions and types of microbes that are active during the

decomposition and fermentation process. Successful fermentation were indicated by several indicators, especially in the scent which no longer smells of urine. The smell of urine has changed to a sour smell. It has a darker colour and the ingredients included have rotted and dissolved [3].One of the raw materials with abundant quantities and high organic content is banana stumps. Banana stump located in bottom part of the plant and hidden in the soil. Usually people only use the fruit and leaves, even though banana stump has organic content and local microorganisms that can be used as organic fertilizer for plants [4]. Banana stumps known contain several microbes that decompose organic materials. These decomposing microbes are located on the outer and inner parts of the banana stumps.

The addition of microorganisms from the fermentation of banana stumps as decomposers is useful for accelerating the breakdown of organic materials that can work effectively. Several types of microbes that have been identified in banana stumps included *Bacillus sp.*, *Aeromonas sp.*, and *Aspergillus nigger*. These microbes are what usually decompose organic materials. Microbes in banana stumps will act as organic materials that will be composted. Furthermore, dried banana stems contain 66.2 g of carbohydrates, and fresh banana stems contain 11.6 g of carbohydrates. High carbohydrate content will stimulate the development of microorganisms in fermentation process [4].Based on the description above, banana stumps is one of local microorganisms sources for making liquid fertilizer. In this research, banana stumps are fermented into solutions and and mixed with goat urine as main material for making liquid organic fertilizer. Local microorganism solutions contain several bacteria that have the potential to be organic material decomposers, growth stimulants, as agents for controlling pests and plant diseases, and contain macro and micro nutrients. Researcher in this research wanted to identify the effect of fermentation periods on the quality of macro nutrients (N, P, K) in liquid organic fertilizer made from goat urine and banana stumps. The initial step taken is the fermentation process of liquid organic fertilizer. The following is analysis of macro nutrients N, P, and K. After obtaining the results of nutritional content, liquid organic fertilizer will be applied to Chili plants by observing their growth response.

II. MATERIALS AND METHODS

2.1 Preparation of Local Microorganism Solution

Material needed for production of local microorganism solution were done by finely chopping the banana stumps after being cleaned, weighed as much as 1 kg and dissolving 1 kg of brown sugar in 1 Litres of boiled water. Mix all the material needed: 1) 5 Litres of rice water, 2) 1 Kg of chopped banana stumps, and 3) 1 Liter of brown sugar solution. After every material were mixed, the final stage is fermentation for 14 days. After 14 days of fermentation, local microorganism solution will be formed and ready to used. It can be identified by the characteristics of scent like an alcohol.

2.2 Preparation of Liquid Organic Fertilizer

Material needed for Liquid Organic Fertilizer: 1) 10 L of urine (put into a drum as a container), 2) 10 mL of EM4 and 3) 100 mL of Local Microorganism Solution. After all the ingredients are put into the drum (container), stir all the solution by using stick until evenly mixed. After that, put into 20 sterile bottle for fermentation, each sterile bottle contained of 500 mL Liquid Organic Fertilizer.

2.3 Fermentation

Fermentation is carried out anaerobically so that the tightness of the container closure needs to be ensured, because any leaks or gaps will cause air to enter and caused fermentation failure [4]. Fermentation process were carried out in a place away from direct sunlight, having good air circulation, and far from sources of contamination [5]. Fermentation period and analysis carried out with 4 treatments: P0 (7 days), P1 (14 days), P2 (21 days), and P3 (28 days).

2.4 Macro nutrient analysis and comparison

Laboratory analysis will be tested on liquid organic fertilizer that has been completely fermented by testing the nutrient content of N, P and K. The quality comparison standards for Liquid Organic Fertilizer used are based on the Decree of the Minister of Agriculture, Republic of Indonesia No. 261/KPTS/SR.310/M/4/2019 Concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers and Soil Improvements that can be seen in Table 1.

Table 1. Quality Standards for Liquid Organic Fertilizer

No.	PARAMETER	UNIT	QUALITY STANDART
1.	Macro nutrient: $N + P_2O_5 + K_2O$	% (w / v)	2 – 6

2.5 Application of liquid organic fertilizer on chili

The application of liquid organic fertilizer on chili were conducted by giving different concentrations consisting of 5 levels; P0= Control, P1= 5 mL, P2= 10 mL, P3= 15 mL, P4= 20 mL. Each treatment was replicated 4 times to obtain 20 experimental units. The experiment used a completely randomized design. The parameter observed were plant height, number of leaves, fresh weight, root length, time of flower emerge, number of flower and number of fruits. Data from observations data from each treatment that will be obtained is processed statistically using normality and homogeneity test. If the sample were normally distributed and homogeneous, the analysis will be continued by one-way analysis of variance (ANOVA). If the variance analysis results are significant, it will be continued by using Honestly Significant Difference Test (5% level).

III. RESULT AND DISCUSSION

1.1. Macro Nutrient Content (Nitrogen, Phosphorus, and Potassium) of Liquid Organic Fertilizer

Analysis of macronutrients (Nitrogen, Phosphorus, and Potassium) in liquid organic fertilizer made from goat urine and banana stumps conducted in Marine and Fisheries Laboratory of Trunojoyo University, Madura. The results showed different macronutrient content in each sample tested. The following are the results of the laboratory analysis (Table 2).

Table 2. Result of macro nutrient analysis

No.	Parameter	Treatment			
		P0	P1	P2	P3
1.	Nitrogen	$1,25^{c}$	$1,37^{bc}$	$1,83^{a}$	$1,50^{b}$
2.	Phosphorus	$0,22^{b}$	$0,30^{b}$	$0,56^{a}$	$0,37^{b}$
3.	Potassium	$0,68^{b}$	$0,78^{b}$	$1,20^{a}$	$0,85^{b}$

Based on the results of the ANOVA test ($\alpha < 0.05$) and analysis of honestly significant difference (HSD) at 5% it was found that P2 treatment (21 days of fermentation) shows the best treatment, indicated by the notation and value of each parameter tested. The results of nutritional content analysis are then compared with the standards of Minister Agriculture. Here are the comparison table (table 3).

Table 3. Result of macro nutrient comparison

No.	Parameter	Treatment (fermentation periods)			
		P0	P1	P2	P3
1.	Nitrogen	$1,25^{c}$	$1,37^{bc}$	$1,83^{a}$	$1,50^{b}$
2.	Phosphorus	$0,22^{b}$	$0,30^{b}$	$0,56^{a}$	$0,37^{b}$
3.	Potassium	$0,68^{b}$	$0,78^{b}$	$1,20^{a}$	$0,85^{b}$
	Total (%)	2,15	2,45	**3,59**	2,72
	Decree of Minister Agriculture Republic of Indonesia No. 261/KPTS/SR.310/M/4/2019	2 - 6%			

The comparison results show that P2 has the highest total nutrient percentage of 3.59%. This result is in accordance with the quality standards set by the Decree of Minister Agriculture Republic of Indonesia No. 261/KPTS/SR.310/M/4/2019. By comparing the laboratory test results of Liquid Organic Fertilizer with the parameters set in No. 261/KPTS/SR.310/M/4/2019, it can be observed that the content of Liquid Organic Fertilizer made from goat urine and banana stumps were qualified on macro nutrient standards. This comparison can be used as a basis to support certification for Liquid Organic Fertilizer.The percentage of Nitrogen, Phosphorus, and Potassium in liquid organic fertilizer of goat urine and banana stumps in treatments P0, P1, P2 were increased and decreased in P3. It can be related to the fermentation process of organic fertilizer. Phase 1 during the fermentation period, there were development of microorganisms in the

initial condition (adaptation phase), which began when inoculation is carried out on the fertilizer medium. Phase 2 called the exponential growth of microorganisms because it influenced by the nutrients or food available for rapid cell division of microorganisms and the value of nutrients obtained were getting higher. So that during the fermentation process, the percentage of nutrients increases along with the increasing number of microbes contained in the components of liquid organic fertilizer. Phase 3 microorganisms population remains in optimal development and the nutrient content obtained also increases. Phase 4 occurs when fermentation were getting longer, the percentage of nutrients produced were decreased.

The reason were because the longer fermentation periods, the liquid fertilizer will lose some of its nutrients. The content of nutrient sources needed by the available microorganisms begins to decrease so the fermentation periods were not optimal anymore [3]. The addition of EM-4 in liquid organic fertilizer also caused the decomposition of protein in goat urine into amino acids. EM-4 is a mixed inoculant of microorganisms which is able to accelerate the maturity of organic fertilizer in the decomposition process of organic material so that the decomposition interval for organic fertilizer reaches maturity quickly [6]. Based on literature studies, banana stumps contained quite high nutrients with a complete composition; carbohydrates and proteins, thus allowing the development of microorganisms that decompose organic matter. These decomposing microbes are found locally on the outer and inner parts of banana stumps. The types of microbes that have been identified in banana stumps included *Bacillus sp., Aeromonas sp.,* and *Aspergillus niger* [7]. Furthermore, the microorganisms in banana stumps and EM-4 decompose the proteins contained in the raw material into amino acids by the microorganisms to produce ammonia (NH_{3-}) and ammonium (NH_{4^+}) compounds, which causes an increase in Nitrogen content in liquid organic fertilizer [6]

1.2. Chili plant growth responses

The following result is the data analysis on chili plant growth parameters consisting of plant height (table 4) and number of leaves (table 5).

Table 4. Height of Plant

No	Parameters	Treatment (liquid organic fertilizer concentration)				
	Height of Plant (cm)	P0	P1	P2	P3	P4
1.	15 DAT	17.25^{a}	18.50^{a}	21.87^{a}	21.60^{a}	29.75^{b}
2.	30 DAT	18.00^{a}	19.62^{ab}	23.62^{b}	24.12^{b}	44.62^{c}
3.	45 DAT	18.87^{a}	23.75^{b}	28.87^{c}	27.75^{bc}	46.00^{d}
4.	60 DAT	21.25^{a}	25.37^{ab}	31.62^{b}	31.37^{b}	50.62^{c}

Note: DAT = Day After Transplanting

Table 5. Number of leaves

No	Parameters	Treatment (liquid organic fertilizer concentration)				
	Number of leaves	P0	P1	P2	P3	P4
1.	15 DAT	10^{a}	11^{a}	11^{a}	12^{a}	21^{b}
2.	30 DAT	13^{a}	13^{a}	14^{a}	13^{a}	28^{b}
3.	45 DAT	18^{a}	17^{a}	18^{a}	18^{a}	35^{b}
4.	60 DAT	22^{a}	22^{a}	24^{a}	29^{a}	40^{b}

Note: DAT = Day After Transplanting

The results of observations on plant height parameters in 15, 30, 45 to 60 days after transplanting showed that the P4 treatment (20 mL of liquid organic fertilizer) showed significantly different results compared to other treatments. The same results were also shown in the number of leaves parameter where the P4 treatment gave the highest average. These two parameters showed positively correlated results where the higher of plant growth, the more leaves will be formed. The results of this study are in accordance with

the results of research from [8] which showed that the least number of leaves was in the control treatment and the highest number of leaves was in the vermicompost treatment. Plant growth is always related to the availability of nutrients content. Mineral nutrient were identified had good effect on growth of chillies. Nitrogen as essential part of chlorophyll, helps in protein synthesis. Increase in leaves number and height due to sufficient amount of nitrogen provided an ideal environment and balanced nutrition to plants, which increased number of leaves [9].

The results are extent in agreement with [10] who obtained maximum number of leaves per plant with increasing nitrogen content in liquid organic fertilizer. The greater the content of Nitrogen available in the soil will cause accelerating of carbohydrate synthesis. Nitrogen take an important role in the formation of chlorophyll because Nitrogen nutrients are the main elements for forming leaves substances which are useful for plant photosynthesis activities [11]. High Nitrogen nutrient content makes plants greener so that the photosynthesis process can run perfectly which affects the quality and quantity of the plants. Higher Nitrogen content will stimulate the growth of shoots so that a greater harvest will be obtained because the shoot factor and can stimulate the growth of shoots [12] Nitrogen nutrients increasing the growth of vegetative parts of leaves, stems, and roots, but if excessive it can inhibit the flowering and fruiting process in plants [13]. The following result is the data analysis on chili plant growth parameters; average of root length (chart 1) and average of fresh weight (chart 2).

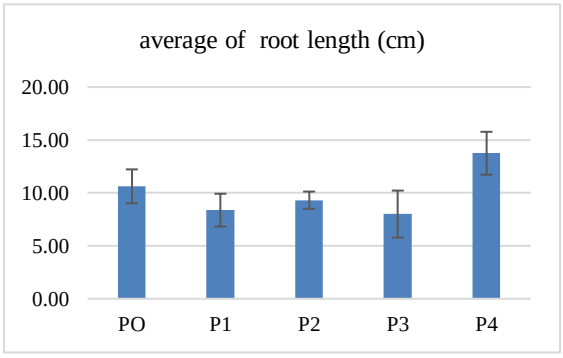

Fig 1. average of root length

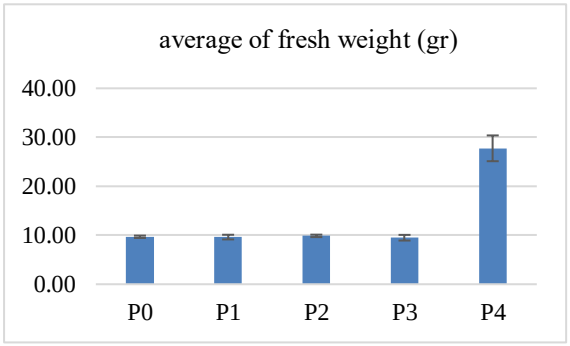

Fig 2. average of fresh weight

Another macro nutrient needed by plants for its growth are phosporus and potassium. The increase in phosphorus caused by the decomposition of microbes that play a role in forming phosphate. The increase in phosphorus levels is the impact of *Lactobacillus sp.* activity which converts glucose into lactic acid. The phosphorus content in the substrate will be used by most microorganisms to build their cells. The phosphorus mineralization process occurs due to the presence of the phosphatase enzyme produced by most microorganisms [6]. Phosphorus nutrients for plants function to produce energy in plant metabolism, stimulate flowering and fruiting, for root growth, and seed formation [14]. Phosphorus nutrients play an important role in the transfer and storage of energy to maintain membrane integrity, cell division and enlargement in plants, lack of phosphorus nutrients in plants can cause plants to become stunted [11] Potassium is used by microorganisms in substrate materials as a catalyst, with the presence of bacteria and their activities will greatly affect the increase in Potassium content [6]. Potassium nutrients function in plant physiological processes such as photosynthesis, accumulation, translocation, carbohydrate transport, opening and closing of stomata, and regulating water transport in plant cells and plant tissues [14].

Observations on the average root length and fresh weight parameters were carried out on chilies aged 60 days after transplanting. Measurements were carried out by dismantling the planting medium and cleaning the plant roots from the remaining soil that was attached. The observation results showed that the P4 treatment produced the highest average for both plant fresh weight and root length parameters. The root systems of plants perform important roles in plant growth [15]. According to [16], the improved root growth in chrysanthemum due to the liquid organic fertilizers abilities to supply soluble organic nutrients and bio stimulants more quickly to the plant, which supported its growth. In the short-term pot experiment, the liquid organic fertilizers significantly promoted root and aboveground growth such as plant height and fresh weight [17]. The following result is the data analysis on chili plant growth parameters; number of flowers (chart 3) and number of fruits (chart 4).

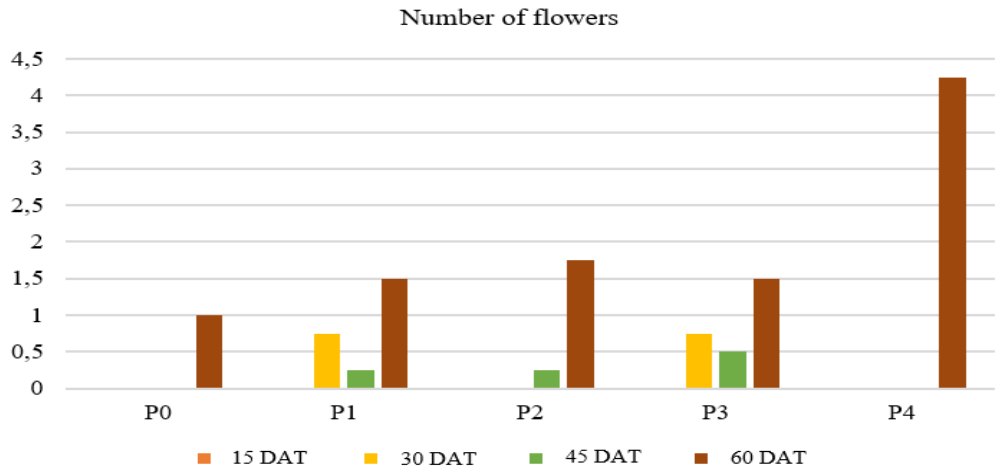

Fig 3. number of flowers

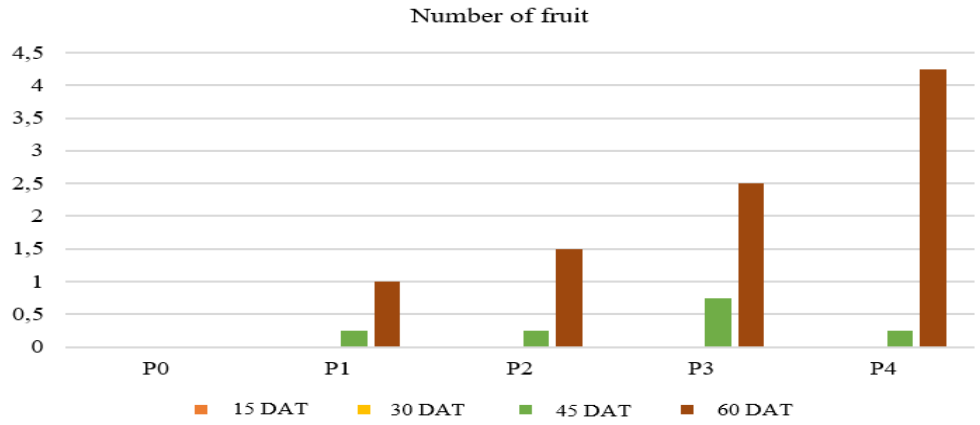

Fig 4. number of fruits

The observation results showed that the chili plants were first able to produce flowers in the first (P1) and third (P3) treatments when the plants were 30 days after transplanting, continued by P2 treatment in 45 days after transplanting. All treatments (P1-P4) could produce flowers at 60 days after transplanting. Meanwhile, the fruit primordia began to form at 45 days after transplanting in treatments P1-P4. The number of fruits formed was dominated by the P4 treatment and P0 (control) couldn't produce any fruit primordia after 60 days after transplanting. [9] stated the highest number of flower and fruits might be due to vigor of plant and more number of leaves per plant. The results are in agreement with those of [18] who reported that the number of fruit per plant increased with increasing nitrogen application. [19] state the organic fertilizer influenced significantly the growth parameter. This might be due to the improvement in soil physical condition for the plant growth along with increased availability of N, P and K at the early stage of crop growth. Nitrogen, phosphorus and potassium contained in organic fertilizer have great effects in plant growth and development. Plant need high concentration of this primary nutrient as any deficiency of these essential nutrients will prevent good plant growth. Thus, sufficient nitrogen, phosphorus and potassium supplied by organic fertilizer help in producing sturdy and taller chilli plant.

IV. CONCLUSION

Fermentation periods has significant effect on nutrient content of liquid organic fertilizer made from goat urine and banana stumps. The best results were in the 3rd week (P2) treatment, fermentation periods of 21 days. The length of fermentation periods required to produce the highest macro nutrient content of Nitrogen, Phosphorus and Potassium. The highest percentage value of the macro nutrients were in P2 (21 days fermentation); Nitrogen (1.83%), Phosphorus (0.56%) and Potassium (1.20%), total percentage were

3.59%. Liquid organic fertilizer in this research has complied with the Decree of the Minister of Agriculture of the Republic of Indonesia No.261/KPTS/SR.310/M/4/2019. The research results also showed that the P4 treatment (20 mL of liquid organic fertilizer) giving the highest value on several parameters (height of plants, number of leaves, fresh weight, root length, number of flower and number of fruits) in the growth of Chili. P1 and P3 treatment could stimulate the appearance of flowers (30 days after transplanting) and P4 was the best treatment in stimulating the growth of chili fruit primordia. Recommendation for fermentation periods in producing liquid organic fertilizer made from goat urine and banana stumps were 21 days of fermentation and for its application in chili were 20 mL/L. Future research could focus on studying the interactions of the microbial consortium found in liquid organic fertilizer made from goat urine and banana stumps.

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