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Effect of Fruits Waste in Biopore Infiltration Hole Toward The Effectiveness of Water Infiltration Rate on Baraya Campus Land of Hasanuddin University

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Abstract. The infiltration of water into the soil decreases due to the transfer of soill function or the lack of soil biopores. This study aims to determine the effectiveness of the use of fruits waste toward the water infiltration rate. Observation of the water level decrease is done every 5 minutes interval. Observation of biopore water infiltration rate was done after fruits waste decomposed for 15 and 30 days. Result of standard water infiltration rate at the first of 5 minutes is 2.18 mm/min, then decreases at interval of 5 minutes on next time as the soil begins to saturate the water. Baraya campus soil observed in soil depths of 100cm has a dusty texture character, grayish brown color and clumping structure. Soil character indicates low porosity. While biopore water infiltration rate at the first of 5 minute interval is 6.61and 6.95 mm/min on banana waste; 5.55 and 6.61mm/min on papaya waste and 4.26 and 5.39 mm/min on mango waste. The effectiveness of water infiltration rate is 44.45% and 41.93% on banana; 44.61% and 30.09% on papaya and 15.79% and 28.36% on mango. Study concluded that banana waste causes the water infiltration rate most effective in biopore infiltration hole.

1. Introduction

The amount of rainwater that flows on baraya campus land of Hasanuddin University continues to increase due to reduced of water infiltration into the soil. The water infiltration rate decreases due to the transfer of soil function or the lack of soil biopores. The rainwater that flows on the soil surface will cause flooding in the rainy season; droughts in the dry season and the depletion of underground water reserves. The conversion of land use into a settlement causes the hydrological function of the land to be disturbed [1]. The part of open land also undergoes a process of compaction, and biopore is reduced due to the decrease of soil plants and fauna as the maker of biopore in the soil. The need for water continues to increase and the main source of water comes from rainfall, so there is an effort to absorb the effective rain water into the soil. The infiltration of water into the soil can be facilitated by the presence of biopore created by soil fauna and plant roots [2]. The cylindrical opening of the hole will be a depression store that can with stand the flow of the surface to allow seepage into the soil. The cylindrical hole wall provides additional water-absorption surfaces as wide as the walls of holes created. If the cylindrical hole is filled with organic waste, then the absorption surface will not be damaged or blocked because it is protected by organic waste.

Organic waste continues to grow as the population, market and food industries grow. Organic waste produced by households, including fruits waste. Fruits waste that is often produced by all layers of society that is banana , papaya and mango. Fruits waste is easily decayed and favored soil fauna such as ants, soil insects and worms. Therefore, this research uses banana, papaya and mango waste that is expected to be the driving force of the presence of soil fauna into the biopore infiltration hole.

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Soil fauna such as earthworms will move to search for food sources and traces to form pores. Pores formed into a means of circulation of water and air in the soil.

2. Materials and Methods

This research was conducted on baraya campus land of Hasanuddin University, Makassar for 3 months. The tool used in this research is 'paralon' pipe of 100cm long and diameter of 10cm, drill, ground spoon, knife, ruler and water scoop. The materials used are papaya fruit waste, banana fruit waste, mango fruit waste and water. The implementation of the research consists of the following stages:

2.1. Measurement of water infiltration rate

Measurement of water infiltration rate begins with measuring the standard water infiltration rate then measuring the biopore water infiltration rate. The measurement of the water infiltration rate was carried out using a 'paralon' pipe of 100cm long and diameter of 10cm. Observation of the standard water infiltration rate is carried out on a drop in the water surface which has been filled in full water (mark) into the 'paralon' pipe. Observation of the water level decrease is done every five minutes interval. Observation of the biopore water infiltration rate is done after the fruits waste ei. papaya, banana and mango has been decomposed for 15 and 30 days in infiltration hole.

2.2. Analysis of water infiltration rate

Analysis of water infiltration rate using Horton method [3]. The water infiltration rate model used by Horton method with the following equation:

$$F = fc + (f0\text{-}fc)\ e^{-kt} \quad (1)$$

where: F = water infiltration rate (mm/min)
fc = constant water infiltration rate (mm/min)
f0 = standard water infiltration rate (mm/min)
e = 2.78
k = constantsta
t = time (min)

The effectiveness of the use of fruits waste toward the water infiltration rate was calculated based on the following formula [3] :

$$E = \frac{\text{Bwar} - \text{Swar}}{\text{Bwar}} \times 100\% \quad (2)$$

where: E = effectiveness of water infiltration rate
Bwar = biopore water infiltration rate
Swar = standard water infiltration rate

3. Results and Discussion

The results of standard water infiltration rate average for 30 minutes of measurement in the three infiltration holes is 1.43 mm/min (Figure 1). While the average of standard water infiltration rate at the first five minutes interval is 2.18 mm /min then decreases at interval five minutes next time as the soil begins to saturate the water (Table 1). The average of standard water infiltration rate in the four infiltration holes is 1.69 mm/min [3]. The water infiltration rate at the first five minutes interval is 2.74 mm/min on media of soil and sand mixture. The water infiltration rate is affected by the amount of soil pores. The observation of soil samples at 100cm depth has a dusty texture character, grayish brown color and clumping structure. Soils with dusty clay textures and clumping structures have low porosity [4]. Porosity is the ratio between the pore volume and the total volume of soil. The pore volume is the total number of cavities or open spaces formed between the grains of soil particles. This pore cavity will later function to absorb runoff water in the biopore hole mechanism.

The results of biopore water infiltration rate average for 30 minutes of measurement in the three infiltration holes is 2.65 and 2.48 mm/min on banana fruit waste; 2.59 and 2.06 mm/min on papaya fruit waste; 1.70 and 2.01 mm/min on mango fruit waste after decomposed for 15 and 30 days (Figure 2). While the average of biopore water infiltration rate at the first five minutes interval is 6.61 and 6.95 mm/min on banana fruit waste; 6.61 and 5.55 mm /min on papaya fruit waste; 4.26 and 5.39 mm /min on mango fruit wastes. The using of fruits waste causes a higher water infiltration rate than without fruits waste in the infiltration hole (Table 1). The biopore water infiltration rate is high due to the increasing amount of pores in the soil. The fruits waste attracts the presence of soil organisms. The banana, papaya and mango fruits waste that are inserted into the infiltration hole are still flavorful and sweet taste encouraging the presence of earthworms, ants, insects and soil microbes. Then the activity of the soil organism causes forms of new pores in the soil. Earthworms can make a path in the ground [5]. The activity of soil organisms causes soil fertility due to available circulation of water and air in the soil [6]. The number and size of biopore will continue to increase following the increase in population and soil fauna activity [7]. The biopore structure is a longitudinal hole branching so that it can smooth water absorption in all directions. Biopore is reinforced by organic compounds derived from soil organisms, so it is quite steady and not easily damaged. Thus, there will always be avenues for pervasive water and air into the soil. In the biopore there is enough organic material, water, oxygen, and nutrients to be suitable for the development of plant roots and soil organisms, including microorganisms that aid in waste generation. Fruits waste is larger in absorbing water than the leaf and vegetable waste [8]. The biopore water absorption rate using fruits waste reaches of 5.77 mm /min, whereas in leaf waste of 4.00 mm /min and vegetable waste of 2.63 mm /min. The interaction of earthworms causes the soil ecology system is very good because the earthworm makes the system of water and air circulation in the soil so that water and oxygen are available [9]. The biopore infiltration hole was developed on the basis of ecohydrological principles, namely by improving soil ecosystem conditions to improve the hydrological function of the ecosystem [1]. The effectiveness of rainwater infiltration needs to be done to reduce the flow of the flooded surface

Table 1. Biopore and standard water infiltration rate

Time of Interval (minutes)	Average of water infiltration rate (mm/min)						
	Standard	Biopore					
		Time of Decomposition (Day*)					
		Banana fruit waste		Papaya fruit waste		Mango fruit waste	
		(15*)	(30*)	(15*)	(30*)	(15*)	(30*)
5	2.18	6.61	6.95	6.61	5.55	4.26	5.39
10	1.87	4.23	3.93	4.29	2.90	2.37	3.05
15	1.37	2.21	1.52	1.97	1.27	1.13	1.28
20	1.19	0.98	0.92	1.07	1.02	0.88	0.82
25	1.02	0.94	0.81	0.86	0.88	0.81	0.77
30	0.94	0.90	0.76	0.75	0.72	0.80	0.75
	1.43	2.65	2.48	2.59	2.06	1.70	2.01


Figure 1. Standard water infiltration rate **Figure 2.** Biopore water infiltration rate

Effectiveness of biopore water infiltration rate in infiltration holes is 44.45% and 41.93% on banana fruit waste; 44.61% and 30.09% on papaya fruit waste; 15.79% and 28.36% on mango fruit waste after decomposed for 15 and 30 days. The use of fruits waste in biopore infiltration holes is more effective than without fruit waste [3]. The effectiveness of the use of the fruit waste ranges from 21.30% - 58.58%. This research showed that the effectiveness of the use of banana and papaya fruits waste was not significantly different which was decomposed for 15 days but significantly different from mango fruit waste. Decomposition of fruit waste for 15 days was already provide a significant level of effectiveness enough to absorb water that is 44.45% on banana fruit waste and 44.61% on papaya fruit waste. (Figure 3). The most ideal composting age of organic waste ie 14 days in biopore infiltration hole [8]. The decomposition time on each waste is different because there is organic waste that is easy, medium and difficult degradation [10]. Banana fruit waste that has been mashed and mixed with tofu dregs can be feed ingredients on the cultivation of earthworms *Lumbriscus rubellus* [11]. Papaya fruit waste and crushed cabbage can be feed ingredients on the cultivation of earthworm *Lumbricus rubellus* [12].

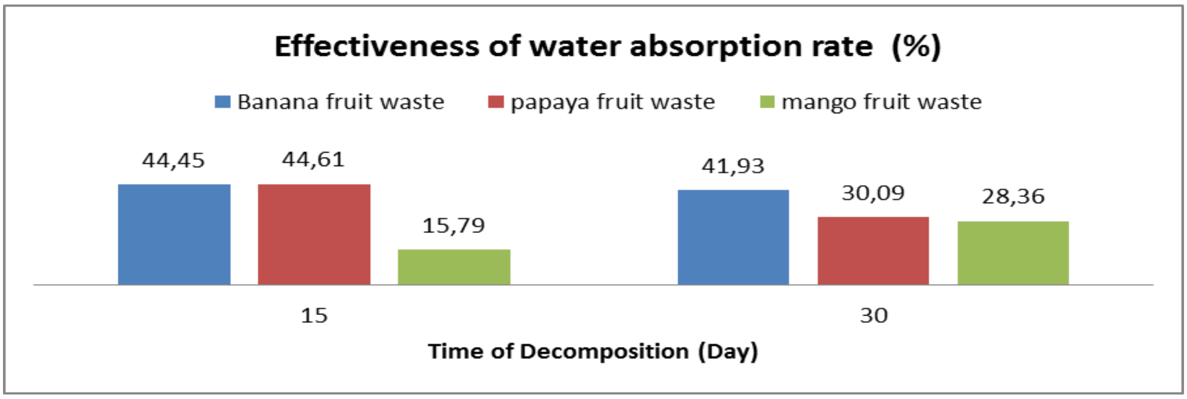

Figure 3. Effectiveness of water infiltration rate (%) in infiltration hole

However, the effectiveness of water infiltration rate on banana fruit waste decomposed for 30 days was different from papaya fruit waste and mango fruit waste (Figure 2). The banana fruit waste has one side of crumb and broad surface, easily destroyed and if stacked there is still air circulation. While the papaya and mango fruits waste have two sides of the slippery surface and if stacked clumps that cause less aeration. The decomposition factors such as particle size, aeration and humidity. The larger surface area will increase the contact between the microbe with the material and the decomposition process will run faster [13]. The rapid composting can occur in conditions of sufficient oxygen [14]. Any organism degrading organic materials requires different environmental conditions and materials [15]. If the conditions are appropriate, then the decomposer will work diligently to decompose organic waste. If the condition is less appropriate or inappropriate, then the organism will dormant, move to another place, or even die.

4. Conclusion

This study concludes that the use of banana fruit waste are more effective in absorbing water in biopore infiltration hole.

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