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Distribution of Escherichia Coli as Soil Pollutant around Antang Landfills

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Abstract. Tamangapa Antang Landfill locates around the residential area and faces an air and water pollution due to an open dumping system in its operation. The system arises a potential pollution in air, water and soil. Sampling was done surround the landfill in two parts, parallel and perpendicular to the ground water flow. This study shows the abundance of E. coli bacteria in soil around the Antang Landfills at depth of 10 to 20 cm ($93x10^5$ cfu/gr of soil) in the direction of groundwater flow. While in other locations the E. coli bacteria is not detected. The abundance of E. coli bacteria is a conjunction factor from landfill and human activities surround the area. The absence of E. coli bacteria in other location highly interpreted that the landfill is the major contributor of pollutant.

1. Introduction

Landfill for Makassar people is an important requirement to create environmental relieve in a big city. If the waste a day in Makassar city is not transferred to the Landfill, the city will be full of waste so it is very disturbing for the public convenience. The production of the waste in Makassar City is constantly and drastically increased [1]. Piles of the waste in the Landfill are the media for breeding of pathogenic and non-pathogenic microbes [2]. Tamangapa Antang Landfill is the center of all Landfills for all areas in Makassar City. Since the opening of Tamangapa Antang Landfill, it is estimated as many as 1.240.000 tons of inorganic and organic waste has been disposed [3]. In its operation, it is doing the Open Dumping way, so it is potentially contaminates the soil.

The location of Tamangapa Antang Landfill located in Bangkala Sub-District, Manggala District, Makassar City, South Sulawesi Province, has been used since 1995 until now with the area of 18.8 hectare. According to the planing, Tamangapa Landfill that was originally designed for the needs of 10 years, but in fact, until now the Landfill is still in use, it means that the age of the Landfill is 21 years, and cannot accommodate the volume of waste that is in Makassar City is reaching 800 tons or about 4,000 cubic per day. Based on the records of the Department of Hygiene and Environment, Makassar with an approximate total population of 1.3 million people, is producing about 3,800 m^3 or equal to 300 tons of public waste every day. Whereas the maximum capacity of Tamangapa Landfill is only about 2,800 m^3 for accommodate public waste every day. Additional landfill is needed for the disposal of 1000 m^3 of the over waste. About 87% of waste in Makassar City is organic waste and about 13% is inorganic waste, such as plastic and paper.

The impacts that can be caused by Tamangapa Antang Landfill are mainly on the shallow-groundwater quality. According to [1], the direction of groundwater flow carrying the leachate at Antang Landfill is in line with the slope of the rock layers, namely Northwest-Southeast. The pollution to shallow-groundwater is caused by leachate from the landfill, and can contaminate the wells of the nearby residents. This

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pollution has been felt by residents around the landfill, especially for those who use the groundwater as a source of drinking water. The leachate movement has spread to the Northwest-Southeast, about 300-450 meters from the Tamangapa Landfill following the flow of the groundwater [4].

E. coli as the pollutant of land around the landfill has been done, but in Indonesia especially in Makassar City, South Sulawesi Province is still lacking. The pollution in the landfill area is not only on water but also on the soil. One of the pollutants that can be detected on the soil is E. coli. Some previous studies only focused on leachate and air pollution. The purpose of this study is to determine how far the distribution of E. coli bacteria can contaminate the soil around the Antang Landfill. The study focuses on the distribution of E. coli bacteria as pollutant of the soil around TPA Tamangapa Antang Makassar, South Sulawesi Province, Indonesia, at Point 0 m for Line A, Line B, Line C and Line D with at the depth of 0 to 10 cm, 10 to 20 cm and 20 to 30 cm [5].

2. Research Methods

2.1 Research Location

The location of this study is administratively included in the Bangkala Sub-District, Manggala District, and Makassar City, South Sulawesi Province, Indonesia. Geographically, Tamangapa Antang Landfill is situated 119°29'10" to 119°29'40" East Longitude and 5°10'20" to 5°10'40" South Latitude. The location of the study area is shown in Figure 1.

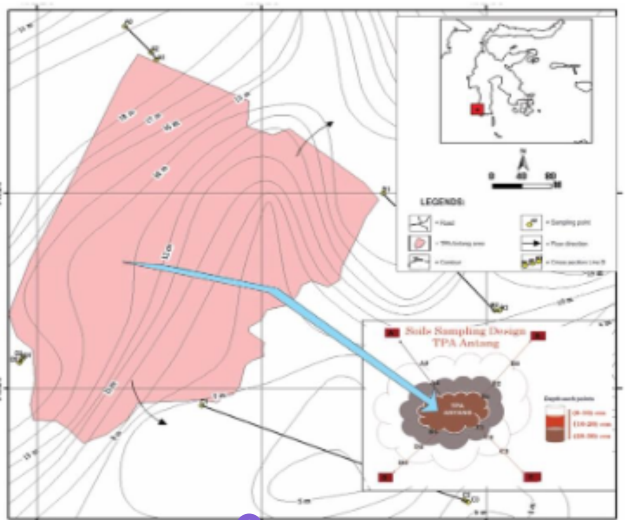

Figure 1. Map and location of sampling point Line A, line B, Line C and Line D at point 0 m at the depth of 0 to10 cm, 10 to 20 cm and 20 to 30 cm on land TPA Tamangapa Antang Makassar, South Sulawesi Province, Indonesia.

2.2. Sampling Point

The soil samples taken were the surface soil (Top Soil) around TPA Tamangapa Antang Makassar, at point 0 m at the depth of 0 to10 cm, 10 to 20 cm, and 20 to 30 cm [5], by dividing four Lines. Two Line are in the direction to the ground water flow, namely: Line A and Line C, and two other Lines are perpendicular to the direction of the ground water flow: Line B and Line D [4], (Figure 1). Twelve soil samples were collected in the study area and analyzed by use of biochemically.

Each sample was collected as many as 0.5 kg by using a stainless steel shovel. Then, the soil samples were put into sterile containers and labeled containing the location, date of taking, and the soil depth, then

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transported the laboratory, stored at 4°C for microbial analysis. When taking the samples, the soil samples are recorded about the soil type, the soil color, the soil conditions and the temperature [6, 7].

2.3. Microbiological analyses

In the laboratory, soil samples were mixed and the coarser particles removed, one gram of soil was suspended in 100 ml water and then serially diluted to five folds that were used for the microbial analysis. After solidification of media, they were incubated at 37ºC for 24 h for bacteria, then colonies were counted and isolates were identified on the basis of cultural, microscopic, and biochemical characteristics with reference to Bergey's manual of systematic bacteriology for bacteria [8].

3. Result and Discussion

3.1. Result

To calculate the number of E. coli bacteria population is using Ec. Broat media with reference to Bergey's manual of systematic bacteriology for bacteria [8], (Figure 2). Mean total bacterial count was $20x10^5$ cfu/gr of soil, $93x10^5$ cfu/gr of soil and $23x10^5$ cfu/gr of soil on Line D. The result of calculating the population of E. Coli bacteria at point 0 m for Line A, Line B, Line C and Line D at the depth of 0 to10 cm, 10 to 20 cm and 20 to 30 cm [5], on land TPA Tamangapa Antang Makassar, South Sulawesi Province, Indonesia (Figure 2).

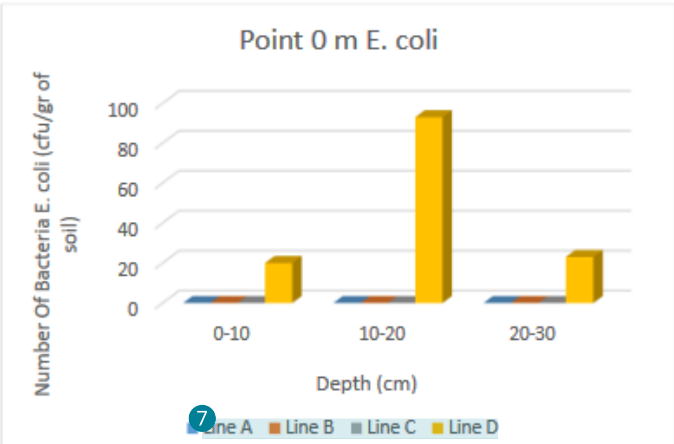

Figure 2. Number of E. coli bacteria (cfu/gr of soil) at point 0 m for Line A, Line B, Line C and Line D with depth from 0 to 10 cm, 10 to 20 cm and 20 to 30 cm on land TPA Tamangapa Antang Makassar, South Sulawesi Province, Indonesia.

Figure 2 show that the population of E. coli bacteria for Line A, Line B and Line C, at point 0 m at the depth of 0 to10 cm, 10 to 20 cm and 20 to 30 cm [5], the soil around TPA Tamangapa Antang Makassar, indicated that there is no bacterial growth. This is because Line A, Line B and Line C contain no soil organic compounds, no oxygen intake, and no nutrients, to support the survival of bacteria, so that the bacteria growth and reproduction cannot breed in the soil.

For Line D at the depth of 0 to10 cm is as many as 20 $x10^5$ cfu/gr of soil, at the depth of 10 to 20 cm increases as many as 93 $x10^5$ cfu/gr of soil, while at the depth of 20 to 30 cm begins to decrease to 23 $x10^5$ cfu/gr of soil. This is because at the depth of 0 to10 cm and 20 to 30 cm just contains little soil organic compounds, the intake of oxygen and nutrients are not sufficient to maintain the survival of the bacteria, so that the growth and reproduction of bacteria in the soil will be slow. Whereas, at the depth of 10 to 20 cm contains many soil organic compounds, get sufficient intake of oxygen and nutrients, and have a relative humidity, so that the growth and reproduction of bacteria in the soil will be very quick.

3.2. Discussion

From the results of the study, it can be concluded that the abundant population of E. coli, these results corroborate with findings [8], is on Line D, with the depth of 10 to 20 cm (93 $x10^5$ cfu/gr of soil), 20 to 30 cm (23 $x10^5$ cfu/gr of soil) and 0 to 10 cm (20 $x10^5$ cfu/gr of soil). This is because Line D is located close to the people environment, and is influenced by human activities. The soil around the landfill can be defiled bacteriologically through the permeation of public residual channels, such as septic tank. At the time of sampling in the rainy season, so that soil moisture and temperature conditions favorable for microbial activity to multiply rapidly [5].

Distribution of soil bacterial populations such as E. coli is influenced by several of environmental factors such as humidity, soil pH, temperature, light, soil moisture, and organic compounds [5]. The average soil pH of the landfill ranges from 4.82-6 (Acidic), with an average temperature ranges from (T = 25-36^{0}C). At low pH, the availability of nutrients is so high that bacterial activity will increase. Furthermore the temperature also plays an important role [5], in controlling the metabolic reactions of all human beings like bacteria.

The layers of soil at the depth of 10 to 20 cm contain high soil organic compounds, sufficient humidity to provide an opportunity for microorganisms to decompose the complex organic residues into [5], the simpler ones, so that, the amount of the microbe is generally higher in the layer of soil under the surface, compared to the dry season, according to the studies of [5, 8]. The abundance of E. coli bacteria at the certain depth and the point around the landfill site indicates the effect of the humidity. Line D that is perpendicular to the direction of groundwater flow or leachate indicates that the development of E. coli is not affected by the direction of the leachate flow.

Bacteria E. coli can survive under different environmental conditions such as in soil environment, water bodies and manure [9, 10, 11], or the possibility of bacteria habitat displacement E. coli itself. Bacteria E. coli can survive on the surface soil layer (Top Soil), if in the environment there are plenty of adequate water intake [12].

Provided resource availability and key abiotic conditions are propitious, E. coli populations can survive and even grow in open environments. However, under fluctuating environmental conditions, such as those present in many soils and aquatic environments, growth may be differential and gross bacterial death may ensue if the death rate exceeds the growth rate. Both growth and death rates are determined by the environmental conditions at the local scale and by how the microorganism is able to cope with these local conditions by regulating its gene expression patterns [13].

The availability of carbon compounds is important because it affects bacterial growth E. coli and interconnected with the conditions of origin for the life of microorganism in the soil and in water bodies [14]. The combination of abiotic conditions such as availability of nutrients, soil pH, soil moisture and soil temperature and biotic conditions such as micro flora is a very good situation for bacterial populations E. coli to survive in both conditions [15, 16].

E. coli is a gram-negative, rod-shaped, 2.4 x (0.4-0.7) μm-sized, encapsulated, active and non-spore, and anaerobic facultative bacteria, has a peritrichous flagellum and can grow at optimum temperature of 37^{0}C and maximum pH 9.0. E. coli is distinguished on its serologic characteristics based on (somatic) O, (Capsule) K and (Flagella) H [17].

E. coli bacteria when contaminate into the gastrointestinal tract in large quantities can endanger the health. Although E. coli is part of the normal microbe of the gastrointestinal tract, it is now proven that certain strains are capable of causing a temperate to severe gastroenteritis in humans and animals. E. coli bacteria can cause bloody diarrhea and invade the large intestine, and is present in feces that is filled with leukocytes and erythrocytes [18].

It has been traditionally assumed that E. coli shows natural declines in open environments. However, forming an environmental reservoir of a given size in different conditions, the bacterium can cause risks to

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human health. The factors that determine the rate of survival of particular E. coli strains, and thus the risks, are not (yet) easily predictable, and our capability to understand the effects of the secondary habitat (especially soil and water resources) on E. coli behavior will be paramount to our abilities to manage the organism from both environmental and public health perspectives [13].

4. Conclusion

The study results show that the population of E. coli bacteria in Antang Landfill soil had spread to the under layer of soil surface at the depth of 10 to 20 cm. The largest population of E. coli bacteria is found on Line D, with values of $93x10^5$ cfu/gr of soil.

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