Escherichia coli as bioindicator of the groundwater quality in Palmerah District, West Jakarta, Indonesia

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Escherichia coli as bioindicator of the groundwater quality in Palmerah District, West Jakarta, Indonesia

M P Dayanti, M F Fachrul*, A Wijayanti

Environmental Engineering Department, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta, Indonesia

*Corresponding Author: melati@trisakti.ac.id

Abstract . The aim of thie research is to determine the quality of groundwater in Palmerah District, West Jakarta (6°11'24.32"S 106°47'49.88"E) by correlation between the depth of the well and the distance of septic tank with the distribution of *Escherichia coli*. The presence of *E. coli* is measured by using the Most Probable Number method. The distribution pattern of the *E. coli* was processed by Surfer Program. Research was conducted in April upto July 2017. The highest amount of *E. coli* always found in the Jati Pulo and Palmerah sub-district which is >1100 MPN/100 ml; while the lowest amount of *E. coli* found in the Kemanggisan sub-district and Slipi sub-district which is <3.0 MPN/100 ml; with every samples is obtained on the condition of pH 5 – 7, DO 0.81 – 7.65, and water temperature of 26 – 34℃. Refering to the Ministry of Health Regulation No. 492 of 2010 on the requirements of drinking water quality; it is shown that the groundwater in Palmerah District is not feasible to be directly consumed. This research provides the initial information to local sanitation to the distribution pattern of *E. coli* within the dense residential area .
Keywords: *E. coli*, lactose broth, presumtive test, most probable number

1. Introduction

Groundwater is one source of drinking water of Indonesia people. The usage of groundwater as a source of drinking water should be free from parameters that could jeopardize to human health and in accordance with of quality standard drinking water, based on Ministry of Health Regulation No. 492 of 2010 the amount of bacteria *E. coli* in drinking water is zero. Coliform bacteria were used to assess the general hygienic quality of water. The thermotorelant faecal coliforms, especially the presence of *Escherichia coli* in water, indicate recent faecal pollution [1]. Many waterborne enteric pathogens are transmitted by the faecal-oral route. Faecal contamination can occur from a variety of sources, including: poor sanitation infrastructure, faulty wastewater treatment facilities, leaking septic tanks, domestic and wild animal feces [2].

Consumption of groundwater and well drilling without suitable conditions increase the vulnerability to contamination, related either to anthropogenic or to natural activities. Degradation and contamination of groundwater are related to the depth and the type of well [3], [4]. The lack of groundwater quality monitoring and of regulations governing the drilling of wells result in the population consuming water that lacks proper treatment. Consumption of water without adequate quality control is a public health concern, because it is often a vehicle for spreading disease [5]. Preventive methods such as proper well site selection and construction are the best way to safeguard water supplies against contamination by fecal material [6]. In aquifers, water can move quickly, allowing transport of microorganisms, with insignificant interaction between these microorganisms and the host rock. In porous aquifers, such as gravel or coarse sand aquifers, permeability results from

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pore space between grains. In this case, although the microorganisms can be easily transported, they also undergo interaction with the sand-gravel matrix, which can reduce pollution loads [7].

Based on the Central Agency on Statistic of West Jakarta City, shows that the density of Palmerah sub-district is the second highest of West Jakarta which is 28,678.03 (person/km^2). The use of well as a source of drinking water in Palmerah sub-district is one of the highest in the area of municipal West Jakarta namely 36,509 head families. Based on the Regional Environmental Agency Province of Jakarta (2015), the groundwater of the Palmerah sub-district have not fulfilled of quality standard.

2. Research Method
The study areas is Palmerah sub district, West Jakarta consisting of 6 sub-district. The sampling was conducted in three period in April up to July 2017), those are Period 1 (April-May), Period II (June) and Period III (July) in 17 sampling points, categorized based on the economy conditions that were high income, middle income, and low income done by questioners. The analysis of research was conducted in the Biology and Microbiology Laboratory of Environmental Engineering, Universitas Trisakti.

Table 1. Location sample points.

Sample Points	Sub-district	Location	Coordinate
1	Jati Pulo	RT. 03/RW.01	6°10'47.04"S 106°47'67.54"E
2		RT.11/RW.05	6°10'45.00"S 106°48'30.37"E
3	Kota Bambu Utara	RT.04/RW.02	6°11'01.69"S 106°48'30.20"E
4		RT.06/RW.06	6°11'01.00"S 106°48'30.15"E
5	Kota Bambu Selatan	RT.10/RW.04	6°11'15.80"S 106°48'29.00"E
6		RT.08/RW.09	6°11'17.00"S 106°47'60.00"E
7	Slipi	RT.03/RW.02	6°11'30.03"S 106°48'04.00"E
8		RT.10/RW.06	6°11'44.72"S 106°48'15.15"E
9		RT.02/RW.04	6°12'00"S 106°48'03.00"E
10	Kemanggisan	RT.12/RW.06	6°11'15.38"S 106°47'28.64"E
11		RT.03/RW.09	6°11'31.00"S 106°46'59.69"E
12		RT.01/RW.06	6°11'30.59"S 106°47'30.00"E
13		RT.07/RW.02	6°11'30.29"S 106°47'45.03"E
14	Palmerah	RT.08/RW.13	6°11'44.71"S 106°47'00"E
15		RT.02/RW.12	6°12'03.01"S 106°47'15.00"E
16		RT.01/RW.09	6°12'15.09"S 106°47'29.28"E
17		RT.03/RW.04	6°11'58.00"S 106°47'44.90"E

The parameters that were analyzed in physical parameters is temperature, the chemical parameters is pH and DO (dissolved oxygen). The *Escherichia coli* that wre analyzed byh the Most Probable Number (MPN) methods using 3 series tube, referring to SNI 01-2332.1-2006, they were the presumptive test, confirmed test and completed test, with three times repetition (triplo).

3. Results and Discussion
The result show, that people in Palmerah sub-district use well pump to take the groundwater as the source of clean water. The condition of housing from questioner show that 17.64% depth of the well is <10 m, the wells with 10 – 20 m depth were 35.3% and the wells with >20 m depth were 47.06%. The distance from wells to septic tank are 88.24% <10 m, is not comply with SNI 03-2398-2002.

Table 2. Measurement results of well depth and well distance towards septic tank on total
E.coli.

Sample Location	Sub-district	Depth of wells (m)	Distance towards Septic Tank (m)	MPN / 100 ml			Standard*)
				I	**II**	**III**	
1	Jati Pulo	8	6.5	>1100 ± 0	>1100 ± 0	>1100 ± 0	0
2		8	8.0	180 ± 2,1	166.5 ± 2.4	121.5 ± 1.5	0
3	Kota Bambu	4	3.25	>1100 ± 0	305 ± 4.6	33 ± 0.4	0
4	Utara	20	2.0	276.5 ± 4.6	225 ± 2,4	166,5 ± 2.4	0
5	Kota Bambu	25	5.0	86.5 ± 1.5	>1100 ± 0	68 ± 0.9	0
6	Selatan	10	10	33 ± 0.4	>1100 ± 0	195 ± 2.4	0
7		40	3.0	5.4 ± 0.4	69 ± 7,1	<3.0 ± 0	0
8	Slipi	30	5.0	6.4 ± 0.4	225 ± 2,4	3.6 ± 0	0
9		20	10.0	93 ± 4	65,5 ± 9,3	>1100 ± 0	0
10		30	5.0	16,1 ± 0	5,5 ± 2,7	33 ± 0	0
11	Kemanggisan	30	5.0	93 ± 9.8	9,2 ± 2,5	>1100 ± 0	0
12		30	4.0	>1100 ± 0	240 ± 0	460 ± 0	0
13		30	4.0	<3.0 ± 0	43 ± 0	43 ± 0	0
14		20	5.2	>1100 ± 0	>1100 ± 0	>1100 ± 0	0
15	Palmerah	8	6.5	180 ± 2.1	43 ± 0	121.5 ± 1.5	0
16		8	8.0	93 ± 0	150 ± 0	195 ± 2.4	0
17		4	3.25	93 ± 0	35 ± 0,4	150 ± 0	0

*) the Ministry of Health Regulation No. 492 of 2010 on the requirements of drinking water quality

The highest amount of *E. coli* is >1100 MPN/100 ml which on period I is found in sample point 1, 3, 12, and 14, meanwhile the lowest amount of *E. coli* is found in point 13 with <3,0 MPN/100 ml. On period II, the highest amount of *E. coli* is also found in sample point 1, 14, also 5 and 6, meanwhile the lowest amount of *E. coli* is found in point 10 which is 5.5 MPN/100 ml. On period III the highest amount of *E. coli* is found in sample point 1, 14, also 9, with the lowest amount of *E. coli* is in point 7 which is <3 MPN/100 ml.

The range of temperature show in Table 3 is $27 - 31°C$ in period I, $27 - 34°C$ in period II, and $26 - 29°C$ in period III with average is 28.76 °C. The pH range is $4 - 7$ in period I, 5–7 in period II and III which the average is 5.67. Dissolved oxygen range is $1.01 - 3.02$ mg/l in period I, 0.81–7.65 mg/l in period II, and $0.95 - 3.66$ mg/l in period III with average is 2.42 mg/l.

Escherichia coli grows in temperatures between 10 - 45 °C, with an optimum temperature is 37°C, and has an optimum pH for its growth is 7 -7.5, a minimum pH is 4 and a maximum pH is 9 [8], so that E. coli can still grow in water wells in Palmerah Sub-district. Referring to the quality standard by Ministry of Health Regulation No. 492 of 2010, indicating that ground water in Palmerah Sub-district is not feasible to be consumed directly as drinking water.

Table 3. Measurement results on physical and chemical parameters.

Sample Location	Sub-district	Temperature (°C)			pH (unit)			Dissolved Oxygen (mg/l)		
		I	II	III	I	II	III	I	II	III
1	Jati Pulo	27	27	27	5	7	6	1.41	2.01	1.81
2		28	28	27	5	6	6	1.01	0.81	0.95
3	Kota Bambu	31	29	28	5	6	6	2.42	3.22	2.62
4	Utara	28	27	28	4	6	6	1.41	3.62	2.44
5	Kota Bambu	30	29	29	5	7	7	2.01	7.65	3.66
6	Selatan	29	28	27	6	7	6	2.42	4.63	3.51
7		28	29	29	5	6	7	2.01	1.21	1.61
8	Slipi	27	30	28	5	6	6	2.62	4.63	3.42
9		27	28	28	7	6	6	1.81	3.22	3.03
10		28	32	28	4	6	6	3.02	2.42	2.72
11	Kemanggisan	27	29	28	5	6	6	2.01	2.01	2.05
12		29	30	26	6	6	6	1.01	2.62	1.23
13		27	29	27	5	5	5	2.21	4.23	2.43
14		31	29	27	5	6	6	1.81	1.21	1.51
15	Palmerah	31	34	27	6	6	6	2.01	1.81	1.91
16		28	28	27	5	7	7	1.01	1.81	1.51
17		28	28	26	5	6	6	1.41	3.42	2.44
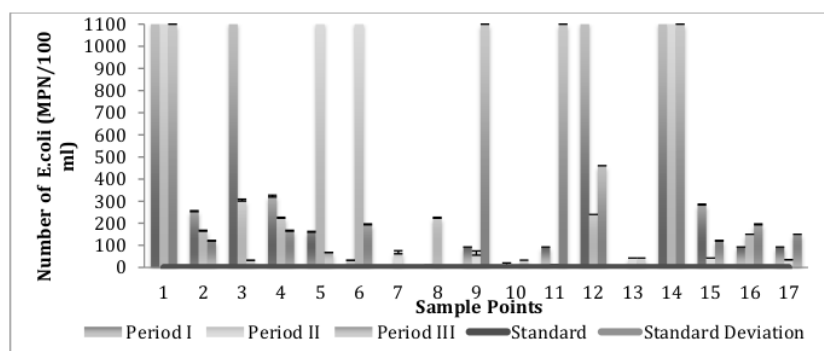
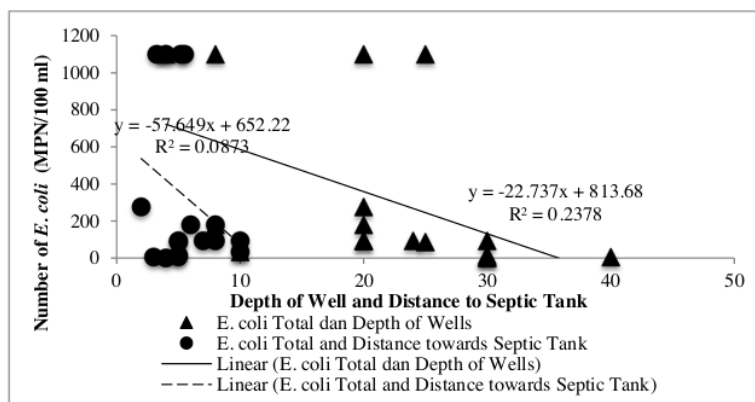**Figure 1.** Numbers of *E.coli*.

Figure 2. Relationship among number of *E.coli* and depth of well and distance to septic tank period I.
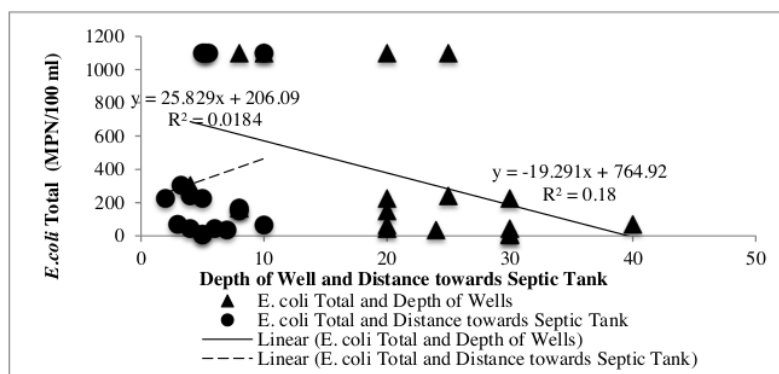

Figure 3. Relationship among number of *E.coli* and depth of well and distance to septic tank period II.
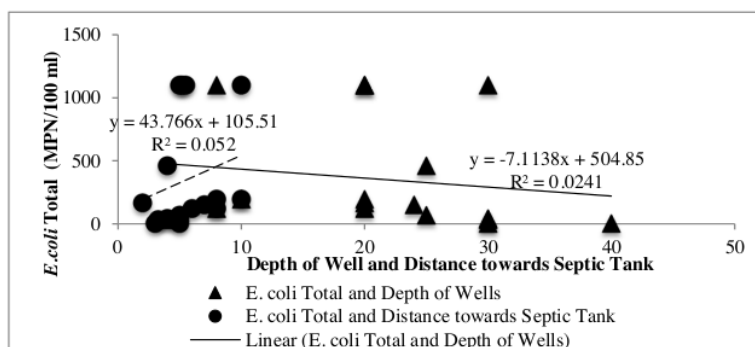

Figure 4. Relationship among number of *e. coli* and depth of well and distance to septic tank period III

Coefficients correlation in graphics show that the strength and direction of a relationship between two continuous variables [9]. The Figure 2 show R^2 0.087 and 0.237, Figure 3 R^2 is 0.018 and 0.18,

and Figure 4 R^2 is 0.052 and 0.024 shows that there is a weak correlation between the number of *E.coli* with the depth of the well and the distance to the septic tank. As the research conducted by [10] on the number of *E. coli* in Kembangan sub-district, West Jakarta, which had the highest *E. coli* number is 1100 MPN/100 ml and the lowest is 11 MPN/100 ml, with R^2 was 0.629 in the amount *E. coli* to the depth of the well and 0.643 in the number of *E. coli* to septic tank distances. This indicates that the deeper the well and the longer the distance to the septic tank, the higher the amount of *E. coli* contained in groundwater [10].

4. Conclusion

Result of this research shows that there is a weak correlation between the number of *E. coli* bacteria with well depth and well distance to septic tank in Palmerah sub-district. The relationship shown in is the closer the well distance to the septic tank and the lower the depth Well the higher the amount of *E. coli*. Based on the result of the research, all samples analysed have *E. coli* amount above the standard so it is not feasible to be consumed directly.

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