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Evaluation of Wastewater Treatment Toward Physical, Chemical and Biology Parameters in WWTP Lambung Mangkurat Banjarmasin

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Abstract: Wastewater is liquid or filth containing hazardous materials that can endanger human life and other living beings and is also destructive the environment. This research aim to analyze the differences in physical parameters (Temperature and TSS), chemical (pH, BOD, NO_3-N, TF-P, oil and fat) and biology (*E. coli*) before and after treatment. The research design is observational analytic throught cross-sectional approach. The object used is domestic wastewater before and after treatment in WWTP Lambung Mangkurat Banjarmasin. Data collected from WWTP report on 2015. This research use paired t-test and Wilcoxon test. The results in WWTP Lambung Mangkurat showed that average value before and after treatment in TSS ($p = 0.003$), pH ($p = 0.002$), BOD ($p = 0.008$), TF-P ($p = 0.003$), *E. coli* ($p = 0.003$), temperature ($p = 0.059$), NO_3-N ($p = 0.424$), oil and fat ($p = 0.086$). There is a difference before and after treatment in TSS, pH, BOD, TF-P and *E. coli*. Whereas there was no difference in temperature, NO_3-N, oil and fat.

Key words: WWTP Lambung Mangkurat, wastewater, physic parameters, chemical parameters, Biology parameters

INTRODUCTION

Wastewater is liquid or filth from households, industry and other public places that contain hazardous materials that could endanger human life and other living beings as well as disturb the environment. According to the Minister of Environment Regulation No. 5 of 2014 on Wastewater Quality Standard mentioned that domestic wastewater is wastewater that comes from effort and/or settlement activities, restaurants, offices, commercial, apartments and dormitories. For that in 2005 established the feasibility study the Company Wastewater Banjarmasin city which was then on the 24th of August 2006 stood PD PAL Banjarmasin (Local Company of WTP Banjarmasin) (Hidayah and Aditya, 2010; ME, 2014).

Based on data of average incoming water quality examination in PD PAL Banjarmasin 2015, Total Solid Suspense (TSS) in WWTP Lambung Mangkurat is 27.3 mg L^{-1}, for that TSS has suitable with the water quality criteria based on Government Regulation 82 of 2001 that is below 50 mg L^{-1}. BOD 17.41 mg L^{-1}, based on Government Regulation 82 of 2001 BOD has not suitable with water quality criteria namely 3 mg L^{-1}. While *E. coli* amounted to 45,375 amt/100 mL, based on Government Regulation 82 of 2001, *E. coli* has not suit with water quality of 1,000 amt m L^{-1} (LGWTP, 2015).

The high level of domestic WWTP Lambung Mangkurat give a significant impact on the quality of health of people living along the riverbanks as diarrhea and skin diseases. Based on data from 10 diseases in the working area of the WWTP Lambung Mangkurat, there are 1,496 cases of diarrhea and gastroenteritis and 922 cases of dermatitis (Lestari, 2011; CPHC, 2015).

Therefore, wastewater treatment needs to be handled properly and sustainably, so that wastewater into the body of water is safe for public health and the environment (Lestari, 2011). Based on this background, it is necessary to do research on the evaluation of wastewater treatment in WWTP Lambung Mangkurat Banjarmasin which include temperature, TSS, pH, BOD, TF-P, oils and fats and *E. coli*.

MATERIALS AND METHODS

This research is an analytic observational with cross sectional study. The study was conducted at the WWTP Lambung Mangkurat Banjarmasin. The object used is domestic wastewater before and after treatment in WWTP Lambung Mangkurat Banjarmasin 2015. Data processing and analyzing with the SPSS Program consisted of univariate analysis to explain the distribution of each independent variable and bivariate analysis using paired t-test and Wilcoxon test. Instrument used in this research is secondary data quality checks of water in PD PAL Banjarmasin in 2015.

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RESULTS AND DISCUSSION

The object of this research is domestic wastewater before and after treatment in WWTP Lambung Mangkurat Banjarmasin in 2015. The relationship between the temperature, pH, BOD, NO_3-N, TF-P, oil and fat and *E. coli* of the wastewater treatment in WWTP Lambung Mangkurat can be seen in Table 1 and 2.

Temperature of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Paired t-test show that p = 0.059 (p>0.05).That mean H_0 accepted, there are no difference between average of temperature value before and after treatment in WWTP Lambung Mangkurat. The temperature increase before and after the treatment are 0.14%. Wastewater generally have a higher temperature than the local air temperature. The effect of temperature can be annoying and leave a chemical reaction aquatic life. Waste that has hot temperatures will disrupt certain biota. The level of oxidation agents is greater at higher temperatures and decay ja rang occur at low temperatures (Lestari, 2011; Cordova, 2008).

Based on Table 2, the concentration of the wastewater temperature are 26.6-28°C and it has qualified with criteria of Government Regulation No. 82 year 2001, ranged from 24.64-30.64°C. The decomposition occurs due to the concentration of high temperatures. Decomposition resulting odor that bothered. More and smell of the water cause the higher the concentration of microbes and inorganic substances in the water. If the concentration of microbes on the high water and disinfection is not done. Then, it is possible for the occurrence of waterborne disease (Lestari, 2011; Mulia, 2005; PRI, 2001).

Based on Table 2, it is known that the concentration of the wastewater temperature increases. This rise in temperature caused by the performance WWTP which process wastewater with a more focused treatment to reduce parameters such as BOD, TSS and *E. coli*. Concentration of temperature affect the content of BOD which is when the concentration is not normal temperature it will interfere with the performance of aerobic bacteria to decompose organic matter in wastewater. The optimal temperature for the activity of bacteria is in the range 25-35°C (Cordova, 2008; Maufilda, 2015).

Total Solid Suspense (TSS) of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Wilcoxon test show that p = 0.003 (p<0.05). That mean H_0 rejected, there are a difference between average of TSS value before and after treatment in WWTP Lambung Mangkurat. The TSS percentage decrease before and after the treatment are 62.38%. In wastewater, the solids can be present in dissolved form or suspended. TSS is the amount of weight in mg/L and dried mud in the wastewater after a filtration with membrane measuring 0.45 μ (Cordova, 2008; Mulia, 2005).

Based on the Table 2, that the concentration of TSS in wastewater undergoes treatment has been qualified, ranged from 0.0059-26 mg L^{-1}. Where this value suitable with criteria of Government Regulation No. 82 year 2001 under 50 mg L^{-1}. The high concentration of TSS will cause turbidity so as to disturb the disinfection process

Table 1: Result of Paired t-test and Wilcoxon test of temperature, pH, BOD, NO_3-N, TF-P, oil and fat and *E. coli* before and after treatment

Variables	p-values
Temperature	0.059
TSS	0.003
pH	0.002
BOD	0.008
NO_3-N	0.424
TF-P	0.003
Oil and fat	0.086
E. coli	0.003

Table 2: Difference of temperature, pH, BOD, NO_3-N, TF-P, oil and fat and *E. coli* before and after treatment

	Temperature		TSS		pH		BOD		NO_3-N		TF-P		Oil and fat		*E. coli*	
Months	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Jan.	26.5	26.6	28	16	6.96	7.41	15.8	8.95	0.346	0.298	2.83	1.77	1.6	0	6000	110
Feb.	27.2	27.3	36	15	7.05	7.37	14.2	7.63	0.364	0.348	4.01	0.942	2.1	0	160000	170
Mar	27.8	27.9	28	22	6.87	7.06	18.6	10.7	0.326	0.318	5.55	1.82	2.3	0	160000	168
Apr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	27.2	27.4	25	21	6.96	7.42	9.63	6.05	0.336	0.253	3.41	1.62	2.1	0	580000	500
Jun.	27	27	15	0.0059	6.8	7.15	11.7	7.6	0.1319	0.1199	2.748	1.513	2	1.5	1900000	7800
Jul.	27	27	72	1	7.22	7.75	16.2	22.64	0.4779	0.4977	3.2793	1.5286	4	1.5	2330000	11300
Aug.	27	27	35	13	7.13	7.56	37.45	13.89	0.2079	0.0828	5.8088	2.0901	10.5	2	29000	380
Sep.	28	28	35	19	7.15	7.2	74.7	24.3	0.075	1.2387	6.4587	4.3933	0.005	0.005	51000	500
Oct.	28	28	28	8	7.46	7.16	20.3	12.3	0.1812	0.6901	7.8429	4.6821	2.5	6	9900	50
Nov.	28	28	33	16	6.98	7.48	25.34	10.57	0.1751	2.7812	6.1	2.778	4.5	2.5	22000	2
Dec.	27	27	37	9	6.86	7.22	16.22	8.85	0.2096	1.7856	5.154	2.3664	0.005	0.005	2600	976
Avg.	27.34	27.38	33.82	12.73	7.04	7.34	23.65	12.13	0.26	0.76	4.84	2.32	2.87	1.23	477318,2	1996

B = Value before treatment; A: Value after treatment

for the absorption of some colloidal bacteria may protect the organism from the disinfectant. Disruption will cause the water disinfection process has become a good medium for bacteria to breed which can cause infectious diseases because water is a good medium for bacteria. An infectious disease caused by the water called water-borne diseases. As for some-borne diseases are common in Indonesia. among others. cholera, dysentery and abdominal typus (Mulia, 2005; PRI, 2001; Rais *et al*., 2015).

Based on the Table 2, that the concentration of TSS in wastewater has decreased. The concentration of TSS decrease before and after cause TSS has been through the stages and the finalclarifer primnryclarifer which can decrease the concentration of TSS. Primnry clarifer are solids separation process and initial deposition. Most solids will sink to the bottom like a primary clarifier. While the final is the deposition of advanced clarifer sehing ga lowering the concentration of TSS (GEMI, 2015).

pH of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Paired t-test show that $p = 0.002$ ($p<0.05$). That mean H_0 rejected, there are a difference between average of pH value before and after treatment in WWTP Lambung Mangkurat. The pH percentage increase before and after the treatment are 4.26%. pH is a measure of the acidity that is determined based on the high and low concentration of hydrogen ions in the water. The pH value of the water is used to determine the condition of acid (hydrogen ion concentration) of wastewater. The pH scale ranges from 1-14, pH value range 1-7 including acid conditions. pH 7-14 including alkaline conditions and pH 7 including neutral conditions. pH values either allow organisms to live and grow, as well as biological life is going well. Most microorganisms are sensitive to changes in pH and the like pH between 7-8.5 (Lestari, 2011; Cordova, 2008; WHO, 2011).

Based on the Table 2, that the concentration of pH in wastewater has been qualified, ranged from 7.06-7.75. Where this value suitable with criteria of Government Regulation No. 82 year 2001 are 6-9. The pH value lower than 1-7 mean to be more acidic, so it will be corrosive to the organs of the body when consumed by humans. Acidic water can release metals from pipes such as Cuprum (Cu), Plumbum (Pb) and Zinc (Zn), so the water will contain these substances. With the metal content in the water, it will indirectly affect the aesthetics of the water, which cause a sour taste in the water. Moreover, it can cause health problems in humans, namely acidosis, whereas higher pH values not directly cause health problems, but causes an aesthetic issue seems to onset of a bitter taste in the water (PRI, 2001; WHO, 2011; Singh and Mosley, 2003).

Based on the Table 2, that the concentration of pH in wastewater has increased. The increase in pH is due to the performance of the WWTP which process wastewater with a more focused treatment to reduce parameters such as BOD, TSS and *E. coli*. The pH value affects the BOD content of the wastewater because if the pH value is not normal it will interfere with the performance of aerobic bacteria to decompose organic matter in wastewater (Maufilda, 2015; Pramaswari *et al*., 2011).

Biochemical Oxygen Demand (BOD) of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Paired-t test show that $p = 0.008$ ($p<0.05$). That mean H_0 rejected, there are a difference between average of BOD value before and after treatment in WWTP Lambung Mangkurat. The BOD percentage decrease before and after the treatment are 48.71%. Biochemical Oxygen Demand (BOD) is the amount of oxygen needed by microorganisms in the water to break down (degrade) organic material in the water (Mulia, 2005).

Based on the Table 2, that the concentration of BOD in wastewater has been not qualified, ranged from 6.05-22.64 mg L^{-1}. Where this value not suitable with criteria of Government Regulation No. 82 year 2001 are under 3 mg L^{-1}. If wastes with high BOD values discharged into the waters of the microorganisms contained in the water will begin to degrade organic matter in the waste. This process will spend the oxygen in the water. When oxygen levels decrease would interfere with the survival of fish and other aquatic fauna (PRI, 2001; Maufilda, 2015).

Based on Table 2, the concentration of BOD in wastewater has decreased. This is because the BOD has gone through the process of biological treatment is in the process Rotating Biological Contrctor (RBC). In the decomposition process occurs RBC pollutant compounds by microorganisms that grow on rotating discs (rotordisk). Microorganisms will grow and attach to rotordisk form a biomass/biofilm. Wastewater will be entered into the system rotorzone series is divided into three zones. The entry of sewage flow from each zone 1 to zone 2 and zone 3 in a zig-zag. Drainage of waste in the tank polygon occurs in zone 3 grafitas because the water level will be lower than zone 2 and 1 (Rahayu and Wijayanti, 2008; RBC, 2015).

In each zone, the waste treated by growing biomass on the disk contained in the zone and then flows to the next zone. Alternately biomass grown on RBC will come

into contact with oxygen in the air at the time of being on the water and the next moment into contact with water and pollutant compounds. At the time of the contact, oxygen is transferred to the water in the zone. Possible concentrations of BOD is not eligible because they have not been optimal absorption of oxygen. water and possible contact with not rotating/interruption of RBC (RBC, 2015).

The NO_3-N of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Paired t-test show that p = 0.424 (p>0.05). That mean H_0 accepted, there are a difference between average of NO_3-N value before and after treatment in WWTP Lambung Mangkurat. The NO_3-N percentage increase before and after the treatment are 192.3%. NO_3-N was the main form of nitrogen in natural waters and is a major nutrient for plant growth and algae. Nitrate nitrogen is very soluble in water and are stable. This compound is produced from the oxidation of nitrogen compounds in the waters perfect (Kamsuri *et al*., 2013; Ali and Soemarno, 2013; Yuliastuti, 2011).

Based on the Table 2, that the concentration of NO_3-N in wastewater has been qualified, ranged from 0.0828-2.7812 mg L^{-1}. Where this value suitable with criteria of Government Regulation No. 82 year 2001 are 10 mg L^{-1}. Nitrate is a form stable compounds and derives its existence from the waste, fertilizers, animal and human feces and so on. High nitrate concentrations can be toxic and can affect people's health, especially for infants can cause "blue baby", i.e., the occurrence of a bluish color because of lack of oxygen. In addition, high nitrate content also has an important role in the formation of compounds cause cancer (PRI, 2001; Ali and Soemarno, 2013; Sudaryanto, 2013).

Based on the Table 2, that the concentration of NO_3-N in wastewater has increased. The increase of temperature is a factor that cause an increase in the concentration of NO_3-N. While the increase in temperature due to the activity of microbes in decomposing material generates energy in the form of heat released into the environment (Cordova, 2008; Maufilda, 2015).

The TF-P of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Paired t-test show that p = 0.003 (p<0.05). That mean H_0 rejected, there are a difference between average of TF-P value before and after treatment in WWTP Lambung Mangkurat. The TF-P percentage decrease before and after the treatment are 52.1%. Total phosphate in the wastewater, a portion of the phosphate in wastewater society is in the form of inorganic orthophosphate (PO, HPO, HrPO) increase as much as 25% of the total phosphate (Suhardjo, 2008).

Based on the Table 2, that the concentration of TF-P in wastewater has been not qualified, ranged from 0.942-4.6821 mg L^{-1}. Where this value not suitable with criteria of Government Regulation No. 82 year 2001 are under 0.2 mg L^{-1}. When the wastewater discharged into rivers/water bodies contains high concentrations of high TF-P. This can lead to silting due to eutrophication. It is also bad for the source of raw water for taps (PRI, 2001; Aritonang *et al*., 2013; Truttim and Sohsalam, 2016).

Based on the Table 2, that the concentration of TF-P in wastewater has decreased. This is because TF - P has gone through the process of biological treatment is in the process Rotating Biological Contrctor (RBC). In the decomposition process occurs RBC pollutant compounds by microorganisms that grow on rotating discs (rotordisk). Microorganisms will grow and attach to rotordisk form a biomass/biofilm. Biomass is grown on a disk contained in the zone and then flows to the next zone. Alternately biomass grown on RBC will come into contact with oxygen in the air at the time of being on the water and the next moment into contact with water and pollutant compounds. Possible concentrations of BOD is not eligible because they have not been optimal absorption of oxygen. in contact with water and may not spin/interruption of RBC (Rahayu and Wijayanti, 2008; RBC, 2015).

Oil and fat of the wastewater treatment in WWTP Lambung Mangkurat: Based on the Table 1, the result of Wilcoxon test show that p = 0.086 (p>0.05). That mean H_0 accepted, there are no difference between average of oil and fat value before and after treatment in WWTP Lambung Mangkurat. The oil and fat percentage decrease before and after the treatment are 57.14%. Oil and fat is the amount of weight layer on the surface of the wastewater that form a membrane so that it can inhibit the oxidation process under aerobic conditions. Oils and fats are organic materials are fixed and difficult to bacteria described (Maufilda, 2015).

Based on the Table 2, that the concentration of oil and fat in wastewater has been qualified, ranged from 0-6 ug L^{-1}. Where this value suitable with criteria of Government Regulation No. 82 year 2001 are under 1000 ug L^{-1}. Oils and fats forming a thin layer on the surface of the water and cover the surface which resulted in limited oxygen into the water this happens because the oils and fats has a specific gravity less than water. Layers of oils and fats also block the sunlight so that photosynthesis by aquatic plants do not last. As a result

of oxygen produced during photosynthesis should not happen and the oxygen in the water is running low (PRI, 2001; Maufilda, 2015).

Based on the Table 2, that the concentration of oil and fat has decreased. This is because the oils and fats have been through a pretreatment for separating oil and grease from wastewater. In addition to decreasing the concentration of oils and fats also occur because it has passed the stage sand filter and a carbon filter which serves to filter solids remaining in the water so the water produced is more clear (RBC, 2015).

***Eschericia coli* (*E. coli*) of the wastewater treatment in WWTP Lambung Mangkurat:** Based on the Table 1, the result of Wilcoxon test show that $p = 0.003$ ($p<0.05$). That mean H_0 rejected, there are difference between average of *E. coli* value before and after treatment in WWTP Lambung Mangkurat. The *E. coli* percentage decrease before and after the treatment are 99.58%. *Escherichia coli* is a bacteria that is normally found in the human intestine and is excreted in large quantities along with healthy human feces. *Escherichia coli* is a bacteria that became the main species of coliform bacteria. *E. coli* has the ability to ferment lactose at a temperature of 44°C. Besides *E. coli* is also the bacteria from feces and presence of these bacteria in water indicates that the presence of fecal contamination in water bodies.

Based on the Table 2, that the concentration of *E. coli* in wastewater has been not qualified, ranged from 2-11300 amt/100 mL. Where this value not suitable with criteria of Government Regulation No. 82 year 2001 are under 1000 amt/100 mL. *E. coli* is a normal intestinal flora in humans and animals which are generally not harmful. However, if the *E. coli* found in other parts of the body organ, it will cause serious illness such as urinary tract infections, bacteremia and meningitis. Water containing *E. coli* when consumed will result menculnya congenital diseases such as diarrhea (PRI, 2001; Melliawati, 2009).

Based on the Table 2, that the concentration of *E. coli* in the wastewater decreased. It is because it has passed the stage of disinfectant/chlorine. The function of disinfection is to kill pathogenic microorganisms in the water so as not to disturb or membah sieve surrounding communities (RBC, 2015).

CONCLUSION

Based on the results of research in WWTP Lambung Mangkurat in Banjarmasin in 2015, there is a difference before and after treatment at TSS ($p = 0.003$), pH ($p = 0.002$), BOD ($p = 0.008$), TF-P ($p = 0.003$) and *E. coli* ($p = 0.003$). Whereas there is no difference in temperature ($p = 0.059$), NO_3-N ($p = 0.424$), oil and fat ($p = 0.086$). WWTP Lambung Mangkurat should always maintenance and repair, still due to the excess of the standard quality parameters such as BOD, TF-P and *E. coli*.

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REFERENCES

Ali, A. and P.M. Soemarno, 2013. Assessment of water quality and water quality status of the river Metro in District Breadfruit Malang. Bumi Lestari J., 13: 265-274.

Aritonang, D.O.H., M. Sutisna and M.R. Sururi, 2013. Domestic wastewater treatment using moringa oleifera seeds biokoagulan lam and rapid sand filter. J. National Inst. Technol., 1: 1-12.

CPHC., 2015. The most ten diseases in Lambung Mangkurat. Cempaka Public Health Centre, Lambung Mangkurat University, Banjarmasin, Indonesia.

Cordova, M.R., 2008. Studies of domestic waste water in Housing Bantar Kemang, Bogor and its influence on the Ciliwung River. MSc Thesis, Bogor Agricultural University, Bogor, Indonesia.

GEMI., 2015. Operation manuals, maintenance and improvement of wastewater treatment plants rotordisk system. Guna Era Manufaktura Industry, Jakarta.

Hidayah, E.N. and W. Aditya, 2010. Potential and effects of plants on domestic wastewater with constructed wetland system. J. Environ. Eng. Sci., 2: 11-18.

Kamsuri, A.I., N.P.L. Pangemanan and RA. Tumbol, 2013. Feasibility location of fish farming in Lake Tondano in terms of physical parameters of water Chemistry. Aquacult., 1: 31-42.

LGWTP., 2015. Recapitulation of water quality wastewater treatment plant examination in 2015. Banjarmasin, Indonesia.

Lestari, R.P., 2011. Testing of water quality in Wastewater Treatment Plant (WWTP) Mojosongo Surakarta. Master Thesis, University of Sebelas Maret, Surakarta, Indonesia.

ME., 2014. Regulation of the ministry of environment: Republic of Indonesia Number 5 of 2014 about Wastewater quality standard. Ministry of Environment, Jakarta, Indonesia.

Maufilda, D., 2015. The contents of BOD, COD, TSS, pH and oil or fat in wastewater at the inlet and outlet cold storage industry shrimp (Studies in PT. Panca Mitra Multi Perdana Kapongan-Situbondo). MSc Thesis, School of Public Health, University of Jember, Jember, Indonesia.

Melliawati, R., 2009. *Escherichia coli* in human life. Bio Trends, 4: 10-14.

Mulia, R.M., 2005. Environmental Health. Graha Ilmu, Yogyakarta.

PRI., 2001. Government regulation No. 82 of 2001 on the management of water quality and water pollution control. Precident Republic of Indonesia, Republic of Indonesia, Jakarta, Indonesia.

Pramaswari, I.A.A., I.W.B. Suyasa and A.A.B. Son, 2011. The combination of organic materials (C: N ratio) on the processing of sludge (sludge) waste dyeing. J. Chem., 5: 64-71.

RBC., 2015. Operating instructions and maintenance of the wastewater treatment system (sewage treatment plant). Jakarta, Indonesia.

Rahayu, D.E. and D.W. Wijayanti, 2008. Domestic waste water treatment systems and feces in the WWTP road Jelawat Samarinda. J. Appl., 8: 14-28.

Rais, S.M.K., Z. Maidin and A. Palutturi, 2015. Fraud prevention in implementation in national health insurance Kendari city, Indonesia. Intl. J. Health Med. Sci., 1: 17-21.

Singh, S. and L.M. Mosley, 2003. Trace metal levels in drinking water on Viti Levu, Fiji Islands. S. Pac. J. Nat. Sci., 21: 31-34.

Sudaryanto, W.Y.S., 2013. Historical development of the city of Semarang (Central Java) in the past and the impact of the presence of pollutants in groundwater nitrate in the present. J. Geol. Min. Res., 23: 27-39.

Suhardjo, D., 2008. Decrease in COD, TSS and total phosphate in the septic tank waste Sembada catering Mataram image by using wastewater garden. J. Hum. Environ., 15: 79-89.

Truttim, P. and P. Sohsalam, 2016. Comparison of electrocoagulation using iron and aluminium electrodes for biogas production wastewater treatment. J. Adv. Technol. Eng. Res., 2: 35-40.

WHO., 2011. Manganese in drinking-water. Background document for development of WHO guidelines for drinking-water quality. Geneva, Switzerland, http://www.who.int/water_sanitation_health/dwq/chemicals/manganese.pdf.

Yuliastuti, E., 2011. Assessment of river water quality Ngringo Karanganyar in efforts to control water pollution. Master Thesis, Diponegoro University, Semarang, Indonesia.