DEVOTION Journal of Research and Community Service
Volume 3, Number 14, December 2022
e-ISSN: 2797-6068 and p-ISSN: 2777-0915

ANALYSIS OF THE IMPACT OF BONE SUGAR FACTORY WASTE WATER ON QUALITY OF TEKO RIVER WATER

Andi Zulfikar Efendy, Muhammad Farid Samawi, Maming
Universitas Hasanuddin, Makassar, Indonesia
E-mail: efendyandizulfikar@gmail.com, farids.unhas@gmail.com, maming.gappa@gmail.com

KEYWORDS
Water Quality Status, Teko River, Bone Sugar Factory Effluent.

ABSTRACT
The Bone sugar factory discharges its liquid waste into the Teko River water body. The Teko River is widely used for agricultural and fishery purposes, so it is necessary to maintain the quality of the water to suit its designation. Liquid waste from the Bone sugar factory can affect the water quality of the Teko River. The purpose of this study was to determine the water quality status of the Teko River due to the discharge of waste water from the Bone sugar factory. Observations were made on the water body of the Teko River from the up stream and down stream of the disposal of sugar factory wastewater at 3 stations. Station 1 is the point before the discharge of wastewater, station 2 is the point of discharge of wastewater and station 3 is the point after discharge of wastewater, the recipient of the impact. The results of the research conducted on the Teko river water body showed that the status of water quality at station 1 was the category of lightly polluted, station 2 was in the category of lightly polluted and station 3 was in the category of meeting quality standards. Determination of water quality using the Pollution Index method according to Minister of Environment Decree Number 115 of 2003 using class II river water quality standards according to Government Regulation Number 22 of 2021

INTRODUCTION

The thing that underlies this research is the potential for river water pollution due to the discharge of liquid waste from the sugar factory industry. According to Ningrum (2010), raw materials in the sugar production process use organic materials, resulting in liquid waste containing lots of organic substances. If the conditions for the quality of the liquid waste do not meet the requirements, it will lead to the formation of metabolites which are toxic to organisms in the waters, so there will be a decrease in quality (Ningrum, 2018).

Water is a natural resource that is needed for the livelihood of many people, even by all living things. Not all of the available water can be utilized, because water containing chemicals that are not in accordance with standards tends to cause new problems. Therefore, water resources must be protected so that they can be utilized properly by humans and other living things (Effendi, 2003).

Based on Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management, water class is divided into 4 as follows:

a. Class one is water whose designation can be used for raw drinking water, and/or other designations that require the same quality of water as that use.
b. Class two is water whose designation can be used for water recreation infrastructure/facilities, freshwater fish cultivation, animal husbandry, water for irrigating plantations, and/or other uses that require the same water quality as those uses.

c. Class three is water whose allotment can be used for freshwater fish cultivation, animal husbandry, water for irrigating plants, and/or other uses that require the same water quality as that use.
d. Class four is water whose designation can be used to irrigate plantations and/or other uses that require the same quality of water as that use.

One source of water that is widely used is river water. For this reason, it is important to maintain the quality of the river water. These water uses can be carried out if the physical, chemical and biological criteria are acceptable. According to Darmono (2001), almost every day rivers around the world receive large amounts of sediment inflow both naturally, industrial discharges from household waste, surface water flows, urban areas, and agriculture.

All human activities in fulfilling their life needs such as industrial, household and agricultural activities will produce waste which contributes to a decrease in river water quality (Suriawiria, 2003).

One of the industrial activities in Arasoe village, China district, Bone district is the Bone sugar factory. This sugar factory waste after being treated with WWTP is discharged into a body of water, namely the Teko River. This activity can affect the quality of the river water.

The Bone sugar factory is a sugar factory located in Arasoe Village, China District, Bone Regency. Bone Sugar Factory is a sugar cane-based industry. In this industrial operation includes plantation activities (On Farm) and production process activities (Off Farm). The production process is at the bone sugar factory which has a factory capacity of 2,400 Ton Can/Day (TCD) (Bone Sugar Factory IPLC technical standard document, 2022). In the framework of managing and protecting the environment, before being released into the environment, waste water from the Bone sugar factory must meet the quality standards for wastewater for the sugar industry according to South Sulawesi Governor Regulation Number 69 of 2010.

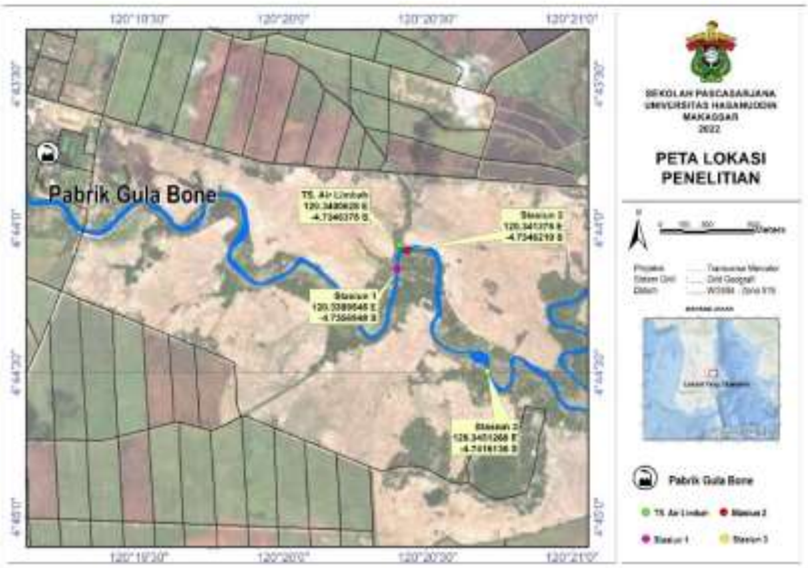
The main parameters for sugar cane milling and sugar refining are BOD, COD, TSS, and pH which is the degree of acidity of a substance with the normal pH specification of water being 6 – 8 (EMDI-BAPPEDAL, 1994). According to Isyuniarto & Andrianto (2009) in Rusdiana (2020), the liquid waste of the sugar industry generally does not contain hazardous and toxic waste, but this waste can increase levels of BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and TSS (Total Suspended Solid) so that it is necessary to handle this waste. According to Hampannavar and Shivayogimath (2010) explained that in general the characteristics of liquid waste produced by the sugar industry have a pH value between 5.2-6.5, COD between 1,000-4,340 mg/L, BOD between 350-2,750 mg/L and TSS between 760-800 mg/L.

Based on the description above, a study will be carried out to determine the effect of Bone sugar factory wastewater discharge on Teko river water quality by analyzing the status of Teko River water quality in the upstream and downstream of Bone sugar factory wastewater discharge at 3 stations.

RESEARCH METHODS

Time and Location of Research

The research was conducted in the water body of the Teko River, Bone Regency. This research was conducted in October-December 2022. This research map of research locations can be seen in Figure 1.



Picture 1
Research Location Map

Sample

Water samples in water bodies are sample water bodies of water from the up stream and down stream streams that are flowed by the sugar factory liquid waste disposal with a total sample of 3 stations. The research sampling point is as follows:

1. Up stream sampling point, before wastewater enters the Teko river water body (Station 1)
2. Sampling point at the outfall, waste water disposal at the Teko River water body (Station 2)
3. Sampling point on the downstream, after the wastewater enters the Teko river water body, the recipient of the impact (Station 3)

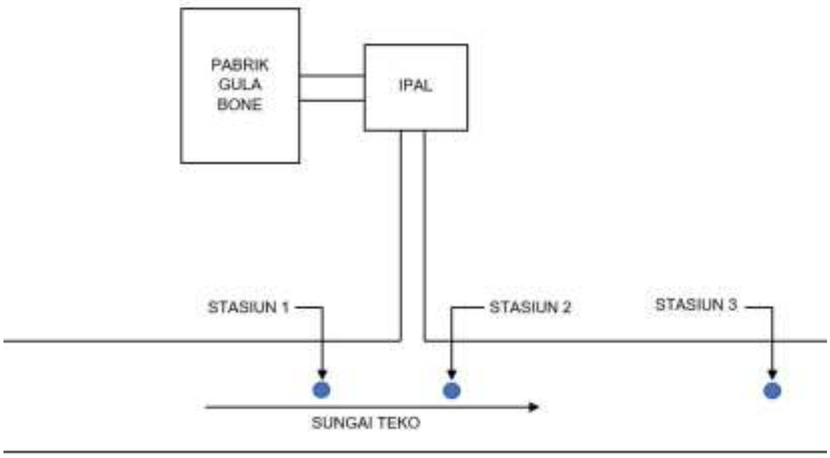


Figure 2
Schematic of Sampling Points

Tools and materials

The tools used are stationery, GPS (Global Positioning System), tape measure, current meter, sample bottles, sampling tools and river water, and tools used to analyze samples in the laboratory.

The materials used to analyze the parameters of TSS (Total Suspended Solid), BOD5 (Biological Oxygen Demand), COD (Chemical Oxygen Demand), pH, sulfide as H2S, oil and grease in the laboratory as well as supporting data from google earth.

Data collection technique

In this study, there are two types of data to be collected, namely primary data and secondary data. Primary data is data that is directly collected from the field from the object under study, while secondary data is supporting data that is not obtained from direct observation in the field either in the form of annual reports or in the form of other publications from related agencies.

Data analysis

Data analysis used descriptive analysis method to determine river water quality. Water quality status uses the pollution index according to Minister of Environment Decree Number 115 of 2003 Appendix II based on river water quality standards according to Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management in table 1. Differences in observation stations using ANOVA analysis

Table 1
River Water Quality Standards and the Like

No	Parameter	Unit	Class 1	Class 2	Class 3	Class 4
1	Total Suspended Solid	mg/L	40	50	100	400
2	Chemical Oxygen Demand (COD)	mg/L	10	25	40	80
3	Biological Oxygen Demand (BOD)	mg/L	2	3	6	12
4	pH	-	6-9	6-9	6-9	6-9
5	Sulfida sebagai H_2S	mg/L	0.002	0.002	0.002	-
6	Minyak dan Lemak	mg/L	1	1	1	10

Source: PP No. 22 of 2021 Appendix VI

The Pollution Index is one of the methods in determining the status of water quality that is used to determine the level of pollution relative to water quality parameters where the index is determined from the resultant maximum value and the average value of the concentration ratio per parameter to the quality standard value (Nemerow and Sumitomo, 1970).

$$PI_j = \sqrt{\frac{(C_i/L_i)_M^2 + (C_i/L_j)_R^2}{2}}$$

Where: (Ci/Lij) M is the maximum value of Ci/Lij
(Ci/Lij) R is the average value of Ci/Lij

Determination of the status of water quality is based on the calculation results of the Pollution Index which is evaluated based on table 2 as follows:

Table 2
Determination of water quality status by Pollution Index method

No	Nilai	Status Mutu Air
1	$0 \leq PI_j \leq 1{,}0$	memenuhi baku mutu
2	$1 < PI_j \leq 5{,}0$	cemar ringan
3	$5{,}0 < PI_j \leq 10$	cemar sedang
4	$PI_j > 10$	Cemar berat

Source: Minister of Environment Decree No. 115 of 2003

RESULTS AND DISCUSSION

The results of observations made on the Teko river water can be seen in Table 3 below:

Table 3
Teko River Water Analysis Results

Parameter	Unit	Quality standards	Station 1	Station 2	Station 3	Method
TSS	mg/L	50	9,33	9,67	9,67	Gravimetri
BOD	mg/L	3	7,09	7,12	1,40	Winkler
COD	mg/L	25	18,90	18,05	3,08	Spektrofometri
pH		6-9	8,27	7,62	7,77	Potensiometri
Sulfida	mg/L	0,002	<0,002	<0,002	<0,002	Spektrofometri
Minyak Lemak	mg/L	1	<0,1	<0,1	<0,1	Spektrofometri

Total Suspended Solids

Total Suspended Solid (TSS) is the amount of suspended solids (mg) in one liter of water. Suspended solids are the cause of water turbidity, such as fine clay, various types of organic matter, and microorganism cells. Suspended solids of industrial wastewater vary greatly, depending on the type of industry. The higher the TSS value, the higher the level of pollution of a waters (Manik, 2016).

Figure 3
Results of TSS Parameter Analysis of Teko River Water

Figure 3 shows that the TSS value of water bodies at station 1 is 9.33 mg/L, station 2 is 9.67 mg/L and station 3 is 9.67 mg/L. There was an increase although not significant at station 2 after the sugar factory wastewater entered the Teko river. From the results of the analysis it was found that the condition of each station on the Teko river complied with class II river water quality standards according to Government Regulation Number 21 of 2022. The statistical test results using Oneway Anova obtained a significant value of 0.897 where α > 0.05 which indicates that there is no real difference in each observation station.

Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) is defined as a measurement of the reduction in water oxygen levels consumed by living things (organisms) in the water during a period of five days in the dark (no photosynthesis process occurs). Reducing oxygen levels is caused by the activities of organisms (bacteria) consuming or degrading organic compounds and other nutrients found in water that require oxygen (Situmorang, 2017).

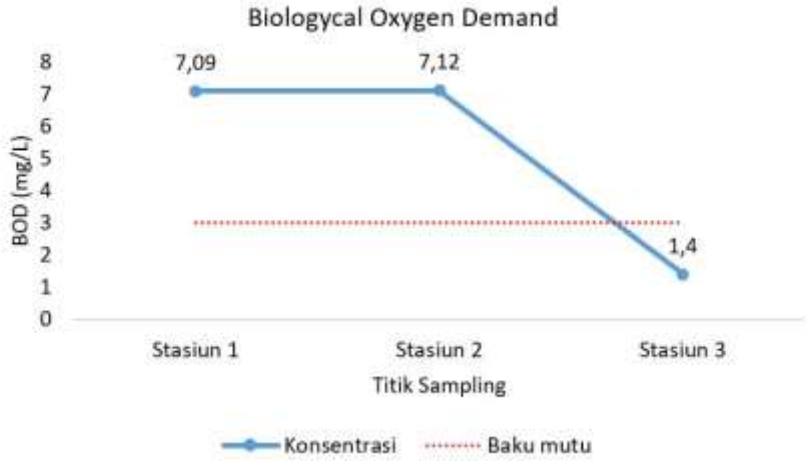


Figure 4
BOD Parameter Analysis Results of Teko River Water

Figure 4 shows that the BOD value at station 1 was 7.09 mg/L, station 2 was 7.12 mg/L and station 3 was 1.40 mg/L. There was an increase although not significant at station 2 after the sugar factory wastewater entered the Teko river. The BOD values at stations 1 and 2 do not meet the quality standards for class II river water, Government Regulation Number 21 of 2022, while at station 3 they meet the quality standards. There is a decrease in BOD value from the previous station. According to Darmono (2001), most rivers can return to normal from pollution because water currents can accelerate the process of waste degradation which requires oxygen. This means that degradation occurs naturally. The statistical test results using Oneway Anova obtained a significant value of 0.001 where α > 0.05 which indicates that there is a significant difference at the observation stations. Because there were significant differences, the Post Hoc Tests Multiple Comparisons were continued to find out which stations were different. From these results it was found that station 1 had a significant difference with station 3 and station 2 had a significant difference with station 3.

***Chemical Oxygen Demand* (COD)**

Chemical oxygen demand (COD) is defined as the need for oxygen to oxidize chemical compounds contained in water. COD testing is carried out to determine the amount of organic compounds that can be oxidized in water using chemical compounds as a source of oxygen (Situmorang, 2017).

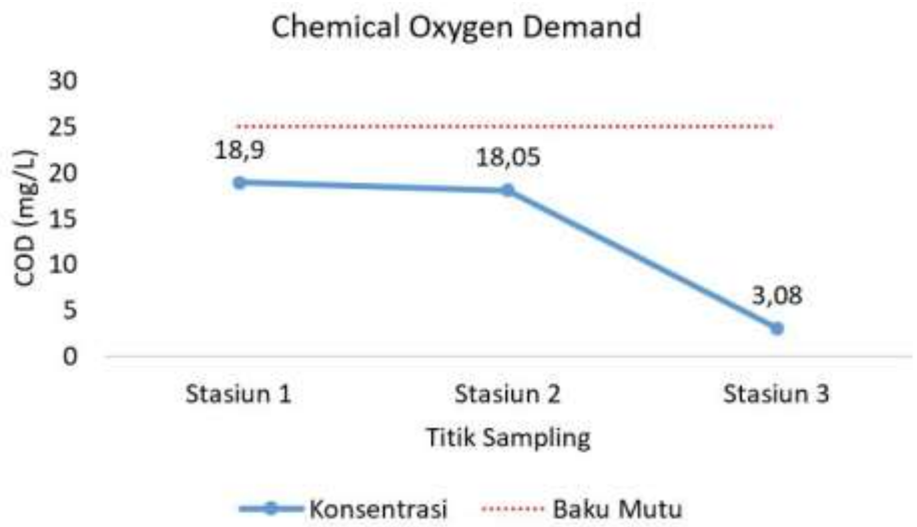


Figure 5
Results of Analysis of COD Parameters of Teko River Water

Figure 5 shows that the COD value at station 1 was 18.90 mg/L, station 2 was 18.05 mg/L and station 3 was 3.08 mg/L, which means that the three stations met the quality standard. There was a decrease in COD values at stations 1 to 2, although it was not significant even though the factory wastewater entered water bodies. This is because there has been natural degradation from station 1 until before the wastewater enters the water body. At station 4 the COD value decreased significantly from the previous station to 3.08 mg/L. According to Darmono (2001), most rivers can return to normal from pollution because water currents can accelerate the process of waste degradation which requires oxygen. This means that degradation occurs naturally. The results of statistical tests using Oneway Anova obtained a significant value of 0.000 where $\alpha > 0.05$ which indicates that there are significant differences at the observation stations. Because there were significant differences, the Post Hoc Tests Multiple Comparisons were continued to find out which stations were different. From these results it was found that station 1 had a significant difference with station 3 and station 2 had a significant difference with station 3.

Acidity

The degree of acidity of water is called pH, including parameters for water quality. Fresh water from the mountains usually has a higher pH. The longer the pH of the water will decrease towards an acidic environment. This is due to the addition of organic matter which then releases CO2 when it decomposes (Sastrawijaya, 2009).

Figure 6
Analysis Results of Teko River Water pH Parameters

Figure 6 shows the pH value at station 1 before mixed with wastewater was 8.27 then at station 2 it was 7.62, after that at station 3 it was 7.77. These results indicate the pH value at each station meets the quality standard.

Sulfida

H2S is produced from the decomposition process of organic materials containing sulfur by anaerobic bacteria, also as a result of reduction under anaerobic conditions to sulfate by microorganisms and as a gaseous contaminant released from geothermal water. The S2- sulfide ion has an amazing affinity for many heavy metals, and the precipitation of the sulfide metals often accompanies the formation of H2S (Achmad, 2004).

Figure 7
Sulfide Parameter Analysis Results

Figure 7 shows the sulfide value at each station of <0.002 mg/L, meeting the class II river water quality standard of 0.002 mg/L according to Government Regulation Number 21 of 2022.

Oil and fat

Oil and grease are contaminants that are commonly found in various waters. Oil does not dissolve in water so the oil will float on the surface of the polluted water. All types of oil contain volatile compounds that evaporate quickly. Within 3-7 days as much as 25% of the oil volume will evaporate and the rest will experience emulsifier. Furthermore, the oil emulsion will be degraded through oxidation, either by photo-oxidation or by microbes. The overhaul of oil emulsions is mostly carried out by microbes and within 3-4 months, only 15-20 percent of the volume of oil remains that contaminates waters (Manik, 2016).

Fat is an organic compound that is relatively stable and difficult to decompose by bacteria. Fats can be broken down by acidic compounds, which produce fatty acids or glycerin. In an alkaline state, glycerin will be released and from fatty acids a basic salt is formed. This basic salt is known as soap, which is also relatively stable like fat (Manik 2016).

Figure 8
Results of Analysis of Oil and Fat Parameters

Figure 8 shows that the value of oil and grease at each station is <0.1 mg/L, meeting the class II river water quality standard of 1 mg/L according to Government Regulation Number 21 of 2022.

Water Quality Status

Conditions The quality of water from one place to another is not the same because it is influenced by several factors. Basically the factors that influence the condition of water quality in an area/place are natural factors and artificial factors (human activity). Natural factors include climate, geology/rock, and vegetation. For artificial factors, more to human activities such as domestic waste, industrial waste, agricultural waste, and various other human activities. In addition to the two factors above, water quality is also affected by time. The factors that affect water quality as mentioned include various processes in it that affect the chemical composition of waters. There are so many processes in nature that affect the conditions and chemical composition of a water source (Sudarmadji, 2016).

In this study, determining the status of water quality using the Pollution Index method. This method is used to determine the level of pollution relative to water quality parameters where the index is determined from the resultant maximum value and the average value of the concentration ratio per parameter to the quality standard value. The results of the analysis can be seen in the status of water quality at each station in the following table 4:

Table 4
Water quality status at each sampling point

No	Sampling Point	Mark IP	Water Quality Status
1	Station 1	1,810	light black
2	Station 2	1,798	light black
3	Station 3	0,725	Fulfill

The results showed that the status of water quality in the Teko river at stations 1 and 2 did not experience a change in water quality status, meaning that the impact of waste water from the Bone sugar factory did not affect the quality of Teko river water in terms of water quality status. Based on data from the Bone Regency Environmental Service, which conducts regular monitoring, the water quality status of the Teko river in 2022 at the point of periodic monitoring carried out by the Bone Regency Environmental Service is in the category of fulfilling while at station 1 the category is lightly polluted, which means that there has been a change in water quality status from fills to lightly polluted. From the periodic monitoring point to station 1 of the Teko river through agricultural areas, community settlements and there is industry X which also discharges its waste water into the Teko river water body. Whereas at station 3, the water quality status is in the fulfilling category. This means that the Teko River can still naturally degrade natural pollutants so that it can return to normal conditions. This is according to Darmono (2001) that most rivers can return to normal from pollution because water currents can accelerate the process of waste degradation which requires oxygen..

CONCLUSION

The results of research conducted on the water body of the Teko River obtained the status of water quality at station 1 in the category of lightly polluted, station 2 in the category of lightly polluted and station 3 in the category of meeting quality standards.

REFERENCES

Achmad, R., 2004. Kimia Lingkungan. Penerbit Andi, Yogyakarta.

Darmono. 2001. Lingkungan Hidup dan Pencemaran: Hubungannya dengan Toksikologi Senyawa Logam. UI-Press, Jakarta.

Dokumen Standart Teknis Instalasi Pengelolaan Limbah Cair (IPLC) Pabrik Gula Bone Tahun 2022.

Effendi, H., 2003. Telaah Kualitas Air. EGC, Jakarta.

EMDI-BAPEDAL. (1994). Limbah Cair Berbagai Industri di Indonesia: Sumber Pengendalian dan Baku Mutu. Jakarta: BAPEDAL.

Hampannavar, U. dan Shivayogimath, C. 2010. Anaerobic Treatment Of Sugar Industry Wastewater By Upflow Anaerobic Sludge Blanket Reactor At Ambient Temperature. International Journal Of Environment, 1(4), 631–639.

Keputusan Menteri Lingkungan Hidup Nomor 115 Tahun 2003 tentang Pedoman Penentuan Status Mutu Air.
Manik, K.E.S. 2016. Pengelolaan Lingkungan Hidup. Prenadamedia Group, Jakarta.
Nemerow, N.L. and Sumitomo, H, 1970. Benefits of Water Quality Enhancement. Syracuse University, NY.
Ningrum, S.O. 2018. Analisis Kualitas Badan Air Dan Kualitas Air Sumur Di Sekitar Pabrik Gula Rejo Agung Baru Kota Madiun. Jurnal Kesehatan Lingkungan Vol. 10, No. 1, 1-12.
Peraturan Pemerintah Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.
Rusdiana, E., Mu'tamar, M.F.F., Hidayat, K., 2020. Analisis Faktor-Faktor Penjernihan Limbah Cair Unit Pengolahan Limbah Cair Industri Gula (Studi Kasus PG XYZ). Agroindustrial Technology Journal 04 (01): 1-15 DOl http://dx.doi.org/10.21111/atj.v4i1.4093.
Sastrawijaya, A.T. 2009. Pencemaran Lingkungan. Rineka Cipta, Jakarta.
Situmorang, M. 2017. Kimia Lingkungan. PT. Rajagrafindo Persada, Depok.
Sudarmadji, Hadi, P. dan Widyasuti, M. 2016. Pengelolaan Sumber Daya Air Terpadu. Gajah Mada University Press, Yogyakarta.
Suriawiria, U. 2003, Mikrobiologi Air dan Dasar-dasar Pengolahan Buangan secara Biologis. Alumi, Bandung.