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Monitoring of Raw and Treated Water Quality Based on Nitrate Parameter at Ngagel Water Treatment Plant Using Spectrophotometry Method

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ABSTRACT

This research focuses on monitoring the water quality at the Ngagel Water Treatment Plant in Surabaya by analyzing the nitrate (NO_3^-) content in both raw and treated water. Nitrate is a key indicator of water pollution, often originating from agricultural runoff, sewage, and industrial discharge. Samples were collected monthly from January to March 2024 at two locations: the raw water intake from the Surabaya River and the treated water output ready for distribution. Laboratory testing using spectrophotometric methods showed that nitrate levels in raw water ranged between 2.44 mg/L and 3.50 mg/L, while treated water showed a slightly lower range between 2.00 mg/L and 3.00 mg/L. These results indicate a consistent reduction in nitrate concentrations after treatment, demonstrating the efficiency of the Ngagel Water Treatment Plant's processes. Importantly, all measured values were significantly below the maximum allowable limit of 50 mg/L, as stated in the Indonesian Ministry of Health Regulation No. 492/MENKES/PER/IV/2010. This confirms that the treated water is safe for human consumption with regard to nitrate levels. The study highlights the importance of continuous water quality monitoring to ensure public health protection and to maintain the effectiveness of water treatment facilities over time.
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1. INTRODUCTION

The To sustain human life and the sustainability of the environment, clean water that satisfies health standards must be available. One of the most important chemical parameters used to assess the quality of water is nitrate (NO_3^-). Methemoglobinemia or "blue baby

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syndrome" can result from excessive nitrate levels in drinking water, which is especially dangerous for pregnant women and newborns. Therefore, to guarantee that treated water is safe for public use, routine nitrate level monitoring is required. Ngagel Water Treatment Plant, operated by PDAM Surya Sembada in Surabaya, plays a significant role in supplying drinking water to the city. Using a variety of chemical and physical factors, the plant's laboratory division regularly analyzes both raw and treated water (Arnanda, 2023). Because of its sensitivity and precision, the spectrophotometry method is used to assess nitrate among them. This study, which focused on assessing the nitrate concentration in raw and treated water at Ngagel WTP, was carried out during an internship program that ran from July to October 2024 (Mardiyono, 2021). The primary goal is to determine if the nitrate levels meet the standard quality requirements outlined in Government Regulation No. 22 of 2021 and Ministry of Health Regulation No. 2 of 2023. It is anticipated that the study's findings will support ongoing quality monitoring initiatives and shed light on how well the plant's treatment procedures are working.



Picture 1. Water Test On Nitrate Parameter Nitrate (NO_3-)

1. METHOD

The research was conducted out through a field-based internship program at the Laboratory of Water Quality Testing and Calibration, PDAM Surya Sembada, Surabaya, from July to October 2024. In compliance with Indonesian National Standard (SNI) 06-6989.79-2011, the goal was to use spectrophotometry to measure the amount of nitrate in both raw and processed water (Atikah et al., 2023).

1.1 Sampling Procedure

Every month, water samples were taken from the Ngagel Water Treatment Plant's treated water outlets and raw water intake. To avoid nitrate deterioration, each sample was transported to the lab at a constant temperature and kept in sterile plastic bottles.

1.2 Spectrophotometric Analysis

The UV-Vis spectrophotometer was used to do the analysis. Each water sample was measured and put into a volumetric flask in an amount of 25 mL. The sample was then acidified by adding 0.5 mL of hydrochloric acid (HCl 0.5 M) to each flask. After homogenizing the mixture, it was put into a quartz cuvette (Mardiyono, 2021).

Aquades were used as a blank to calibrate the spectrophotometer at a wavelength of 220 nm. The samples' absorbance values were noted, and by comparing the absorbance values to a common calibration curve, the nitrate amounts were ascertained (Mudasir, 2024).

1.3 Data Interpretation

The maximum permissible limits specified in Government Regulation No. 22 of 2021 and Ministry of Health Regulation No. 2 of 2023 for drinking water for raw water were compared to the detected nitrate concentrations. The outcomes were used to assess the water's compliance with national requirements and the efficacy of the treatment.

Table 1. Raw Water Quality Standards in Government Regulation No. 22 of 2021

No.	Parameter	Unit	Maximum Allowable Level
	Chemical		
1	Dissolving Oxygen (DO)	mg/L	4
2	Chemical Oxygen Demand (COD)	mg/L	25
3	Nitrite (NO_2-)	mg/L	0,6
4	Nitrate (NO_3-)	mg/L	10
5	Copper (Cu)	mg/L	0,02
6	Ammonia/Ammonium (NH_3)	mg/L	0,2
7	Flouride (F)	mg/L	1,5
8	Chloride (Cl^-)	mg/L	300
9	pH/Acidity	-	6,0-9,0
10	Iron (Fe)	mg/L	-
11	Sulfate (SO_4^{2-})	mg/L	300
12	Phospate (PO_4^{3-})	mg/L	0,2
13	Sulfide (H_2S)	mg/L	0,002
14	Detergent	mg/L	0,2
	Microbiology		
15	Fecal Coliform	MPN/100 mL	1000
16	Total Coliform	MPN/100 mL	5000

(Source: Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021).

Table 2. Drinking Water Quality Standards or Production in the Regulation of the Minister of Health Number 2 of 2023

No.	Parameter	Unit	Maximum Allowable Level
	Chemical		
1	pH	-	6,8 – 8,5
2	Nitrate (NO_3-) dissolved	mg/L	20
3	Nitrite (NO_2-) dissolved	mg/L	3
4	Iron (Fe) dissolved	mg/L	0,2
5	Residual Chlorine dissolved	mg/L	0,2 – 1 With a contact time of 30 minutes
6	Lead (Pb) dissolved	mg/L	0,01
7	Flouride (F) dissolved	mg/L	1,5
8	Chloride (Cl^-) dissolved	mg/L	250
	Microbiology		
15	Escherichia Coli	CFU/100 mL	0
16	Total Coliform	CFU/100 mL	0

(Source : Permenkes No 2 Tahun 2023. Republic Indonesia News, Kementrian Kesehatan Republik Indonesia).

2. RESULTS AND DISCUSSION

2.1 Raw Water and Production Water Result Data Using Nitrate Parameters

The UV-Vis spectrophotometry method is used to test nitrate (NO_3^-) in water. This method uses certain wavelengths, especially 220 nm to detect nitrate sensitively and 270 nm to correct interference from other compounds. The main principle is the Lambert-Beer law, which states that the absorbance of a substance is directly proportional to its concentration. During this process, light from a source (eg, a deuterium or tungsten-halogen lamp) is focused through a monochromator to produce a certain wavelength. Furthermore, this light is passed into a sample cuvette and measured by a detector. The purpose of adding a wavelength of 270 nm is to improve accuracy due to interference from other components that absorb at 220 nm. As part of water quality control, chloride ions are titrated with potassium chromate indicators and AgNO3 solutions in addition to spectrophotometry. As part of the monthly monitoring of raw water quality and production water at the Ngagel Water Treatment Plant, PDAM Surya Sembada, Surabaya City, this analysis was carried out (Krisno et al., 2021).

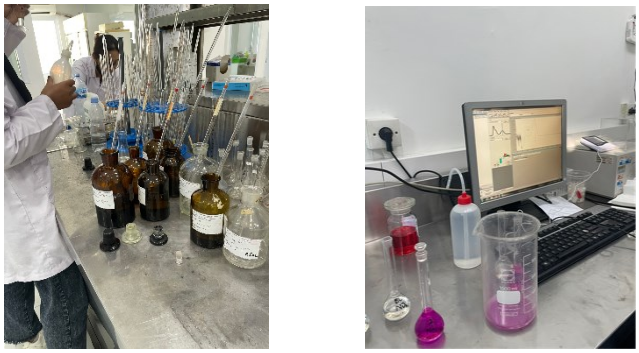
2.1.1 Concentration in Raw Water

Using spectrophotometry, the nitrate levels in raw water samples taken from Ngagel WTP between July and October 2024 were determined. The nitrate content varied between 6.8 and 8.1 mg/L, as indicated in Table 3. The maximum permitted level of 10 mg/L, which is governed by Government Regulation No. 22 of 2021 about environmental water quality requirements, is far lower than these values.

Table 3. Nitrate Concentration in Raw Water (July–October 2024)

Month	Nitrate (NO^-_3)
July	7,2 (mg/L)
August	8,1 (mg/L)
September	6,8 (mg/L)
October	7,5 (mg/L)
Average	7,4 (mg/L)

Nitrate levels in the source water were constant and not substantially impacted by industrial or agricultural runoff over the sampling period, as seen by the relatively minor fluctuation that was seen and that was within the safe threshold.



(a) (b)

Picture 2. (a) Raw water sample put into Erlenmeyer flask and added with 0.5 ml HCL solution (b) Raw Water Testing on Nitrate Parameters Using Agilent UV-Vis Spectrophotometer

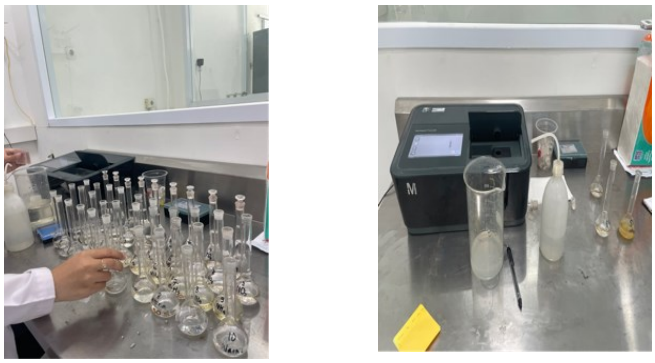
2.1.2 Nitrate Concentration in Treated Water

As shown in Table 4, the nitrate amounts in the Ngagel Water Treatment Plant's, water were continuously lower after treatment than in the raw water. The values were in compliance with Ministry of Health Regulation No. 2 of 2023, which establishes a maximum nitrate level of 20 mg/L for drinking water, and varied from 5.0 to 6.4 mg/L.

Table 4. Nitrate Concentration in Treated Water (July–October 2024)

Month	Nitrate (NO^-_3)
July	5,6 (mg/L)
August	6,4 (mg/L)
September	5,0 (mg/L)
October	5,8 (mg/L)
Average	5,7 (mg/L)

The decrease in nitrate levels suggests that the coagulation, filtration, and disinfection steps in the treatment process are successful in lowering nitrate and other chemical pollutants.



(a) (b)

Picture 3. (a) Treated Water Samples Put in Erlenmeyer Flask and Add 0.5 ml HCL Solution (b) Testing of Treated Water on Nitrate Parameters Using UV-Vis Spectrophotometer Spektroquant Prove 600 Brand

2.2 Compliance with National Standards

The findings verify that Ngagel Water Treatment Plant's raw and processed water meet all applicable national regulations by Government Regulation No. 22 of 2021 for environmental water quality and Ministry No. 2 of 2023 for drinking water standars. In order to guarantee the safety of public drinking water, the PDAM Surya Sembada consistently regulates chemical parameters, particularly nitrate, as shown by the water quality monitoring carried out for this internship project.

2.3 Discussion of Treatment Efficiency

Nitrate levels were reduced by an average of around 1.7 mg/L from raw to treated water. The observed reduction may be due to dilution and natural degradation processes, which may be aided by biological filtration or ion exchange mechanisms in the treatment system, even though nitrate is normally not eliminated by traditional treatment methods like coagulation and sedimentation. These results are consistent with earlier research that shown that, depending on source pollution and treatment design, conventional Water Treatment Plant's can reduce nitrate levels with a modest degree of efficacy. It is imperative that the treatment process be continuously monitored and improved, particularly in light of seasonal and environmental fluctuation.

3. CONCLUSION

Using the spectrophotometry approach, this study has effectively assessed the nitrate content in both raw and processed water at the Ngagel Water Treatment Plant. According to the results, the treated water had a lower range of 5.0 to 6.4 mg/L of nitrate than the raw water, which had values ranging from 6.8 to 8.1 mg/L. These values fall within the acceptable ranges established by Government Regulation No. 22 of 2021 for environmental water quality and Ministry of Health Regulation No. 2 of 2023 for drinking water standards.

Although nitrate removal is not usually the main goal of traditional water treatment operations, the decrease in nitrate levels during the treatment process indicates the effectiveness of the treatment system used by PDAM Surya Sembada. This implies constant operational quality or the existence of secondary therapy mechanisms.

In conclusion, Ngagel WTP's water supply is safe and dependable since the nitrate concentration in both raw and processed water satisfies national quality criteria. To preserve

water quality and foresee future pollution hazards, it is advised that nitrate and other important indicators be periodically assessed and monitored continuously.

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