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**Nitrate (NO<sub>3</sub>) Concentration in Well Water Around Plantations in Palembang City**

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**ABSTRACT**

**Background:** Dug well water is one of the main water sources for communities around plantations. Plantation and agricultural activities that use inorganic fertilizers have the potential to increase the levels of nitrate (NO<sub>3</sub>) in well water. Nitrate is a chemical compound that may cause cancer. **Object:** The purpose of this study was to analyze the nitrate concentration in dug wells and the risk of contamination of dug wells due to agricultural activities using fertilizers and pesticides. **Methods:** This study is an observational study with a cross-sectional design conducted from March to May 2025. The number of parameters examined was the nitrate concentration of 15 dug wells using a grab sampling technique; data on the risk of dug well contamination were collected through observation using a checklist. Furthermore, interviews were conducted to obtain information regarding the use of fertilizers and pesticides. Nitrate concentration examinations were carried out in an environmental laboratory using spectrophotometry, while data were analyzed univariately. **Results:** The results showed that the types of fertilizers widely used were urea, NPK, TSP, and manure, and to eradicate pests using insecticides. The results of the examination indicated that nitrate concentrations in well water ranged from 0.306 mg/L to 13,590 mg/L, with 53.3% of wells having a low risk of contamination and 46.7% having a moderate risk. **Conclusion:** The most common type of fertilizer used was chemical (inorganic), while nitrate levels in dug wells were found to be below environmental quality standards, with a low to moderate risk of contamination.

**Keywords:** Contamination Risk, Dug Wells, Nitrates

**BACKGROUND**

Fertilization is the activity of planting, processing, and marketing certain crops on appropriate land with the support of technology, funding, and management to improve the welfare of business actors and the community (Widodo & Mahagiyani, 2022). Fertilization is a plant maintenance effort that plays an important role in supporting growth and productivity, to increase the nutrient content in the soil so that plants obtain the nutrients they need (Norasyifah, 2019).

Dug wells serve as a means of extracting and storing groundwater or water

from aquifers, which is then used as a raw water source. Water sources adjacent to plantations are at risk of contamination by fertilizers and pesticides. Agricultural activities contribute to increasing nitrate concentrations in both surface and groundwater, with the greatest impact occurring in shallow wells.

In the United States, some domestic wells have even been recorded as having extremely high nitrate levels exceeding 1200 mg/L, it condition can cause various health problems, especially for pregnant women and children (WHO, 2016).

According to data from the Central Statistics Agency (BPS) in 2020, around 23.4% of Indonesia's population still uses dug well water as their main water source (BPS, 2020).

Excessive fertilizer use not only increases nitrate levels in soil and water but can also cause public health problems. High nitrate exposure can cause blue baby syndrome, while long-term exposure, even at low levels, can potentially trigger various types of cancer, including those of the digestive system, lungs, bladder, and non-Hodgkin's lymphoma (Dewi et al., 2016). Suka Mulya Village in Sematang Borang District is a residential area located near a plantation, and some residents still use dug wells. This situation has the potential to affect groundwater quality, particularly nitrate levels, due to excessive fertilizer use.

Based on several previous studies, the levels of nitrate, nitrite, and ammonia found in well water ranged between 1,102-14,503 mg/L (Munawaroh, 2024). Another study reported that nitrate and nitrite levels were also found in groundwater around oil palm plantations, but were still below environmental quality standards (Hutagalung et al., 2022). In addition, research conducted in the agricultural area of Tumpukan Village, Karangdowo District, Klaten Regency showed that the average nitrate concentration in dug well water reached 21.57 mg/L, with the highest value being 54.7 mg/L (Dewi et al., 2016).

Although nitrate levels in well water were still found to be below 20 mg/L (the environmental quality standard), continuous use of chemical fertilizers has the potential to increase the concentration of nitrate in dug well water. This study aimed to analyze nitrate levels in dug wells and the risk of well contamination due to

agricultural activities using fertilizers and pesticides.

## **RESEARCH METHODS**

### **Materials and Methods**

The materials and methods used in this study are as follows:

#### **Description of Materials or Research**

**Subjects:** The materials used for this research were notebooks, rope, tools used, namely thermometers, pH meters, containers, label paper, and markers.

**Research Design:** This study was an observational study with a cross-sectional design, conducted from March to May 2025. Water samples were taken from 15 dug wells owned by residents living around vegetable plantations. The well samples were collected using grab sampling. Nitrate concentrations in the dug wells were measured using spectrophotometry, while water temperature and pH were measured directly in the field. Contamination risk data were obtained through observations of the dug well construction.

**Research Procedure:** The research procedure was carried out in several stages, namely: managing permits, ethical approval, taking water samples, and measuring temperature and pH in the field, examining well water samples in the laboratory, then processing data and preparing research reports.

**Instruments and Equipment:** The instrument used for observing the risk of contamination of dug wells is from the Minister of Health Regulation No. 736 of 2010 with risk result categories < 25%: Low (R), 25% - 50%: Medium (S), 51% - 75%: High (T), >75%: Very High (ST).

**Data Collection Methods:** Data was collected by observing the physical condition of dug wells using a checklist and taking water samples from residents' homes. Field tests were then conducted to determine the temperature and pH of the dug well water.

**Data Analysis:** Data were analyzed univariately and presented in tabular form, and calculation of the risk of contamination of dug wells.

**Research Ethics:** The ethical review was conducted at the Ministry of Health Polytechnic of Palembang with an ethical

approval certificate, namely: No. 1046/KEPK/Adm2/VI/2025.

## RESULTS AND DISCUSSION

The results of the categorization of dug well contamination risks can be seen in the following table:

**Table 1.**

Distribution of Dug Well Contamination Risk (n=15)

Contamination Risk	Frequency (n)	Percentage (%)
Low	8	53,3%
Medium	7	46,7%

Based on Table 1 shows that of the 15 wells, they have low and medium risk categories. Based on field interviews, it was discovered that the types of fertilizers used in plantations around dug wells vary. Farmers use organic fertilizers in the form of manure derived from chicken and goat

manure, as well as inorganic fertilizers such as NPK, TSP, and urea. Organic fertilizers improve soil structure and increase soil microbial activity, while inorganic fertilizers provide macronutrients quickly and are readily available to plants (Kementerian Pertanian, 2021).

**Table 2.**

Identification of the Type of Fertilizer Used

No	Types of Fertilizer	Active Ingredients	Fertilizer Use (Plant Parts)	Fertilization Method	Fertilization Time
1	Manure	chicken manure: - N, P, K [9] - N, P, K, Ca, Mg [10]  Goat droppings: - N, P, K [11] - N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O [12] - N, P, Ca, Mg, C-organik [13]	Root	Poured on the ground	Before planting the plants
2	NPK	- Nitrogen (N) - Fosfor (P)	Root	Poured on the	After planting

No	Types of Fertilizer	Active Ingredients	Fertilizer Use (Plant Parts)	Fertilization Method	Fertilization Time
		- Kalium (K)		ground	the plants
3	HSP/TSP	- Phosphate (P <sub>2</sub> O <sub>5</sub> ) 13% - Asam Humat 8%	Root	Poured on the ground	After planting the plants
4	Urea	- N 46%	Root	Poured on the ground	After planting the plants

Based on Table 2, the results of measurements of nitrate concentration, water temperature, ambient temperature, and pH in dug well water include the average, median, standard deviation,

minimum, and maximum values, as well as comparisons with Environmental Health Quality Standards. The measurement results can be seen in Table 4 below:

**Table 3.**

Results of Measurement of Nitrate Concentration, Water Temperature, Ambient Temperature, and pH

Parameter	Mean	Median	SD	Min	Max	SBMKL
NO <sub>3</sub>	4.14	4.02	3.85	0.31	13.59	20 mg/L
Water Temperature	28.09	27.9	1.49	26.3	31.3	±3°C
Ambient Temperature	28.9	28.8	1.68	27.3	33.5	
pH	5.09	4.97	1.38	3.17	7.5	6.5-8.5

Source : Primary Data

Based on Table 3, it is explained that the concentration of nitrate found in dug well water is 4 mg/L, the water temperature is 28.09 °C, and the pH is 5.09. The pH of dug well water is categorized as acidic.

### Discussion

Based on observations of 15 dug wells, the risk of well contamination was found to be low to moderate. This indicates that, in general, dug wells at the study site are at risk of contamination by chemical

compounds used on the plantations. This contamination risk is caused by substandard well construction, which makes it easier for chemical compounds and other disease-causing agents to enter the wells. These results are in accordance with research results which show that the physical condition of the well greatly influences the level of risk of groundwater pollution (Lalusu et al., 2025). Poor physical condition of wells tends to have a high and very high risk of contamination.

The use of fertilizers and pesticides is a common practice among local communities to increase crop yields. Interviews with farmers in Suka Mulya Village revealed that the fertilizers used vary widely, including organic fertilizers such as manure and inorganic fertilizers such as NPK, TSP, and urea. Organic fertilizers improve soil structure, while inorganic fertilizers provide macronutrients that are quickly absorbed by plants. However, chemical fertilizers containing nitrogen, such as urea and NPK, can potentially increase nitrate levels if used excessively (Handayani et al., 2022).

In addition, farmers also use pesticides in the form of insecticides with the active ingredients Metomil, Emamectin benzoate, Cypermethrin, and Profenofos. Uncontrolled use can result in hazardous residues that enter the soil and are carried into groundwater. This is consistent with research showing that pesticide residues can pollute the environment, including groundwater, through seepage from agricultural land (Sari., 2022).

The results of the examination of 15 samples of dug well water showed that all of them had nitrate levels below the threshold of Minister of Health Regulation No. 2 of 2023 (20 mg/L), with the highest value being 13.590 mg/L, the lowest being <0.306 mg/L, and a median of 4.022 mg/L. This finding is in line with research in Depok City, where the nitrate concentration in dug wells is still below environmental quality standards (Handayani., 2022). However, in dug well water in Sleman, nitrate concentrations were found to exceed the standard quality value (Aprianto., 2024). These differences are influenced by geographic conditions, soil type, and agricultural practices in a region. The average temperature parameter of 28.09 °C with an ambient temperature of 28.99 °C is still within the normal range, where temperature affects nitrate levels (Salsabilla et al., 2023). Meanwhile, most samples had a low pH; only 3 out of 15 met the standard (6.5–8.5), with the lowest value being 3.17.

According to research in the Kandang Limun area, the pH of well water reached its lowest value of 4 (Lestari et al., 2021).

The nitrate concentrations found in community wells located near vegetable plantations are due to the use of fertilizers to fertilize the plants. The high nitrite pollution load in some well water in Tembalang, Semarang City, is due to the area's former rice paddy cultivation, which likely contains high levels of nitrogen compounds from improperly used urea fertilizer (Prabowo & Dewi., 2016). Meanwhile, in Makassar City, the nitrate content was found to be an average of 12.878 mg/L and is still below environmental quality standards. Nitrogen fertilizer contamination, including anhydrous ammonia, from organic waste, animal, and human sources, can increase nitrate levels in water. Nitrate-containing compounds in soil are usually soluble and easily migrate with groundwater (Rivai & Syamsinar., 2019).

### Research Limitation

Nitrate content testing is performed only once. The distance between the sampling point and the pollution source is determined using measuring instruments and information from the local community, and the parameter tested was only nitrate.

### CONCLUSION

Based on research results, nitrate concentrations in dug well water remain below environmental quality standards, with the risk of well contamination being categorized as low to moderate. The fertilizers used are organic and chemical. Therefore, other environmental parameters need to be examined.

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