EXPERIENCE REPORT
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# Evaluation of the nitrate concentration in groundwater of wells in the regions of Assis and Marília, State of São Paulo

## Avaliação da concentração de nitrato em águas subterrâneas de poços das regiões de Assis e Marília, São Paulo

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## ABSTRACT

**Introduction:** Water is a natural resource of vital importance to all living beings, but when it is polluted it can be the cause of various diseases. A wide variety of pollutants have been found in groundwater and nitrate is the most frequent pollutant. **Objective:** The objective of this work was to determine nitrate concentration in well water samples from public supply systems and collective alternative solutions from 22 municipalities in the Marília and Assis-São Paulo regions. **Method:** A total of 157 water samples from wells registered in municipal health surveillance were collected and the analyses were performed by spectrophotometric method in the UV region, according to physical-chemical methods for food analysis of the Adolfo Lutz Institute. **Results:** From the total of 157 samples analyzed, 141 samples (89.8%) were in agreement and 16 samples (10.2%) were in disagreement with the current legislation. **Conclusions:** It is concluded with the results of this study that the nitrate analysis is extremely important to evaluate the risks to human health and environment. It is suggested the annual monitoring of the wells that presented nitrate concentrations between 5 and 10 mg/L and the promotion of public policies that guarantee the population access to water in accordance with current legal standards.

**KEYWORDS:** Public Water Supply; Nitrate; Contamination; Sanitary Surveillance; Public Health

## RESUMO

**Introdução:** A água é um recurso natural de importância vital a todos os seres vivos, mas, quando está poluída, pode ser a causa de várias doenças. Uma grande variedade de substâncias contaminantes tem sido encontrada nas águas subterrâneas e o nitrato é o poluente de ocorrência mais frequente. **Objetivo:** O objetivo deste trabalho foi determinar a concentração de nitrato em amostras de água de poços de sistemas de abastecimento público e soluções alternativas coletivas de 22 municípios das regiões de Marília e Assis, São Paulo. **Método:** Foram coletadas 157 amostras de água de poços cadastrados nas Vigilâncias Sanitárias municipais e as análises foram realizadas pelo método espectrofotométrico na região Ultravioleta (UV), segundo métodos físico-químicos para análise de alimentos do Instituto Adolfo Lutz. **Resultados:** Do total de 157 amostras analisadas, estavam de acordo com a legislação vigente 141 amostras (89,8%) e em desacordo 16 amostras (10,2%). **Conclusões:** Conclui-se, com os resultados deste estudo, que a análise de nitrato é de extrema importância para avaliar os riscos à saúde humana e ao ambiente. Sugere-se o monitoramento anual dos poços que apresentaram concentrações de nitrato entre 5 e 10 mg/L e a promoção de políticas públicas que garantam à população o acesso à água em conformidade com os padrões legais vigentes.

**PALAVRAS-CHAVE:** Água de Abastecimento Público; Nitrato; Contaminação; Vigilância Sanitária; Saúde Pública

## INTRODUCTION

Groundwater accounts for over 95% of the world's available freshwater resources and is the main source of drinking water for a large portion of the population[1].

Water is a vital natural resource for all living things, but when it is polluted it can be the cause of many diseases, including reproductive, cardiovascular, neurological problems and various types of cancer[2].

Groundwater quality may be impaired by different forms of land use and occupation[3,4]. According to Zoby[5], the lack of sewage treatment, the disposal of solid waste, the construction of wells without adequate technical criteria, farming activities associated with the use of fertilizers and pesticides, leakage and accidents in the handling and transportation of toxic and combustible products, mining activities and cemeteries are the main sources of contamination.

A wide variety of contaminants have been found in groundwater, and nitrate is the most commonly occurring pollutant. This parameter has been used worldwide as an indicator of groundwater contamination due to its high mobility and ability to affect large areas[6].

The presence of nitrate in water has been related to various sources of contamination and, according to Feitosa et al.[7], concentrations above 5 mg/L nitrate are indicative of anthropogenic contamination.

The main diffuse anthropogenic sources of nitrogenous compounds are: application of nitrogenous organic and synthetic fertilizers, use of septic tanks or cesspits, sewage network leaks and influence of contaminated rivers in the well catchment zone[6].

The current legislation, Consolidation Ordinance n. 5, of September 28, 2017, of the Ministry of Health, establishes 10 mg/L $NO_3^-$-N as the maximum allowed value for water intended for human consumption[8]. The São Paulo State Environmental Company (Cetesb) recommends that as of 5 mg/L $NO_3^-$-N (prevention value) preventive and control measures be taken due to possible anthropic action on the groundwater quality[9].

Consumption of water with nitrate concentration greater than 10 mg/L $No_3^-$-N may lead to the onset of diseases like methemoglobinemia and cancer. Metahemoglobinemia or blue baby syndrome is a dangerous disease for babies under six months of age, in which the child gets bluish due to the anaerobiosis caused by inefficient oxygen transport[10].

With the increase in nitrate concentration in water in recent years, several studies have been done in Brazil and worldwide to evaluate water quality in relation to this parameter[6,11,12,13,14].

The objective of this work was to determine the nitrate concentration in water samples from public supply system wells and collective alternative solutions from 22 municipalities in the regions of Marília and Assis, state of São Paulo, Brazil.

## METHOD

A total of 157 water samples from wells of public water supply systems and collective alternative solutions registered in the municipal Health Surveillance bodies were collected in clean, dry, 250 mL plastic vials by health surveillance technicians from 22 municipalities in the regions of Assis and Marília. These municipalities belong to the Marília Regional Health Department (DRS) IX and form the Regional Health Care Network 10 (RRAS 10). The collections were made from March to November 2018 and the sampling plan was determined by the municipal health surveillance body, under the coordination of the Health Surveillance Center (CVS) and the Health Surveillance Groups of Assis (GVS-XIII) and Marília (GVS-XIX). The collection points were: direct from the well (154 samples) and from the distribution network (three samples). After collection, the samples were stored in thermal boxes and immediately sent to the Chemistry Laboratory of the Center for Chemical and Bromatological Sciences of the Regional Laboratory of the Adolfo Lutz Institute of Marília.

For the determination of nitrate concentration, analytical grade reagents and deionized water were used to prepare the solutions; the method of analysis was spectrophotometric in the UV region, according to physicochemical methods for food analysis of the Adolfo Lutz Institute[15], tec. 195/IV; the equipment used was the SPECORD S600 spectrophotometer.

## RESULTS AND DISCUSSION

The results of the analyses by concentration range in mg/L $NO_3^-$-N of water samples from 22 municipalities in the Assis and Marília regions are presented in the Table.

The interpretation of the results was based on the Ministry of Health Consolidation Ordinance n. 5/2017[8]. Results above 10 mg/L nitrate as N were considered unsatisfactory.

From the total of 157 samples, 141 samples (89.8%) were in accordance with current legislation and 16 samples (10.2%) were in disagreement.

To evaluate the results, four concentration values were established in mg/L: - $NO_3^-$-N: 0.0-2.5; 2.6-4.9; 5.0-7.0; 7.1-10.0 and > 10.0. The distribution of results in these concentration ranges can be better seen in the Figure.

Considering the value of 5 mg/L of $NO_3^-$-N as prevention, according to Cetesb[9], of the 157 samples analyzed, 33 (21.0%) presented values between 5.0 and 10.0 mg/L, therefore, wells should be monitored annually.

Water samples with unsatisfactory results have shown values ranging from 11.5 to 28.0 mg/L and mean value of 15.8 mg/L of $NO_3^-$-N.

Several studies have detected the presence of nitrate in water samples intended for human consumption. Varnier et al.[6]

**Table.** Results of nitrate analysis as N of water samples from 22 municipalities in the regions of Assis and Marília.

| Municipality | Number of samples by nitrate concentration range as N in mg/L | | | | | Total samples analyzed |
|---|---|---|---|---|---|---|
| | 0.0-2.5 | 2.6-4.9 | 5.0-7.0 | 7.1-10.0 | > 10.0 | |
| Bastos | 1 (25.0%) | 1 (25.0%) | 1 (25.0%) | - | 1 (25.0%) | 4 |
| Campos Novos Paulista | 1 (33.3%) | 2 (66.7%) | - | - | - | 3 |
| Cândido Mota | 4 (44.4%) | 3 (33.3%) | 2 (22.2%) | - | - | 9 |
| Canitar | 1 (20.0%) | 4 (80.0%) | - | - | - | 5 |
| Garça | 3 (100.0%) | - | - | - | - | 3 |
| Guaimbê | 1 (25.0%) | 2 (50.0%) | 1 (25.0%) | - | - | 4 |
| Guarantã | 1 (50.0%) | 1 (50.0%) | - | - | - | 2 |
| Herculândia | 1 (14.3%) | - | 1 (14.3%) | 2 (28.6%) | 3 (42.8%) | 7 |
| Ibirarema | 5 (100.0%) | - | - | - | - | 5 |
| Ipaussu | 5 (100.0%) | - | - | - | - | 5 |
| Júlio Mesquita | | - | 1 (50.0%) | 1 (50.0%) | - | 2 |
| Marília | 21 (47.7%) | 5 (11.4%) | 3 (6.8%) | 7 (15.9%) | 8 (18.2%) | 44 |
| Ocauçu | 1 (33.3%) | - | 2 (66.7%) | - | - | 3 |
| Ourinhos | 10 (100.0%) | - | - | - | - | 10 |
| Pacaembu | 1 (33.3%) | - | 1 (33.3%) | - | 1 (33.3%) | 3 |
| Palmital | 12 (80.0%) | - | 2 (13.3%) | 1 (6.7%) | - | 15 |
| Pompeia | 2 (40.0%) | 1 (20.0%) | 1 (20.0%) | 1 (20.0%) | - | 5 |
| Rinópolis | 1 (33.3%) | - | 2 (66.7%) | - | - | 3 |
| Salto Grande | 1 (20.0%) | 2 (40.0%) | 1 (20.0%) | 1 (20.0%) | - | 5 |
| São Pedro do Turvo | 10 (100.0%) | - | - | - | - | 10 |
| Tupã | - | 2 (28.6%) | 2 (28.6%) | - | 3 (42.8%) | 7 |
| Vera Cruz | 1 (33.3%) | 2 (66.7%) | - | - | - | 3 |
| **Total** | **83 (52.9%)** | **25 (15.9%)** | **20 (12.7%)** | **13 (8.3%)** | **16 (10.2%)** | **157** |

detected nitrate above the potability standard in 18.0% of samples from the municipality of Marília, with a maximum value of 16.9 mg/L $NO_3^-$-N. In the research done by Santos[11] in the municipality of Tupã, state of São Paulo, the presence of nitrate was observed in all samples with values ranging from 1.9 to 23.2 mg/L and mean value of 9.8 mg/L $NO_3^-$-N, and 32.0% of the samples analyzed were in disagreement with the legislation in force as they had a concentration above the maximum allowed value. Dovidauskas et al.[16] analyzed water samples from 88 municipalities of northeastern São Paulo state and, although they did not find results above 10 mg/L, some samples presented values above 5 mg/L. According to Cetesb, annual monitoring should be done as a preventive measure.

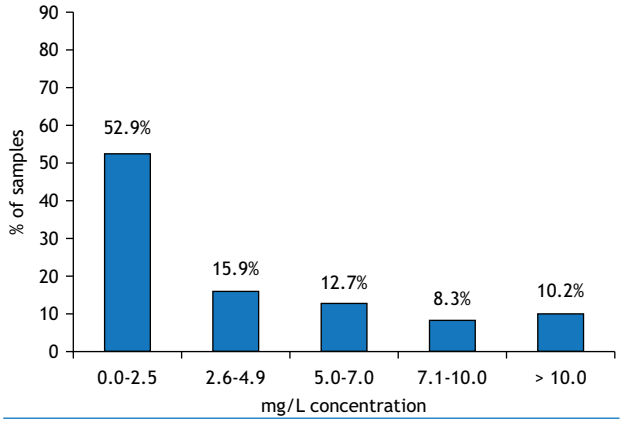


**Figure.** Results of nitrate concentrations in water samples from 22 municipalities in the Assis and Marília regions, by concentration range in mg/L of $NO_3^-$-N.

Other studies have pointed to the presence of nitrate in water samples from different Brazilian regions. In the study by Bezerra et al.[17], the results of nitrate analyses in groundwater from the metropolitan region of Fortaleza, state of Ceará, indicated 37.80% of samples with contents above 10 mg/L. Biguelini and Gumy[1] reported the occurrence of nitrate in water samples from southwestern Paraná state, where 32.35% of the analyzed samples had nitrate levels above the allowed limit. In the study by Lauthartte et al.[18] in the district of Jaci-Paraná, Porto Velho, state of Rondônia, 42.30% of the samples analyzed have shown nitrate ion levels that exceeded the maximum value allowed for human consumption.

Studies conducted in several countries to assess the quality of water intended for human consumption have shown high concentrations of nitrate[2,13,14].

Dirtu et al.[2] carried out a study to evaluate the chemical quality of water samples from eastern Romania and 10.0% of the samples analyzed presented nitrate above the maximum value established by the legislation. Values ranged from 0.17 to 117.29 mg/L. In that study, they also compared the results of the samples analyzed in Romania with samples analyzed in other countries like Macedonia, Albania, Korea, Turkey, Greece, Italy, among others, and the results have shown unsatisfactory nitrate concentrations.

Several studies on the presence of nitrate in water intended for human consumption have shown the growing concern with the quality standards of this water, the potential sources of contamination and, consequently, the impairment of aquifers[11,19,20,21].

## CONCLUSIONS

This study shows the importance of nitrate analysis in assessing the risks to human and environmental health and the need for further research to expand the assessment of public wells, determine sources of contamination and its impact on groundwater.

Considering that 21.0% of the samples presented nitrate values between 5 and 10 mg/L, the need for annual monitoring of these waters stands out.

The results obtained provide subsidies to health surveillance bodies for the promotion of public policies that ensure access to water in accordance with current legal standards.

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## Conflict of Interest

Authors have no potential conflict of interest to declare, related to this study's political or financial peers and institutions.