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ASSESSMENT OF WATER QUALITY IN DRINKING FOUNTAINS ON A UNIVERSITY CAMPUS: AN APPROACH USING PHYSICOCHEMICAL ANALYSES AND THE METHYLENE BLUE TECHNIQUE

AVALIAÇÃO DA QUALIDADE DA ÁGUA EM BEBEDOUROS DE CAMPUS UNIVERSITÁRIO: UMA ABORDAGEM POR MEIO DE ANÁLISES FÍSICO-QUÍMICAS E DA TÉCNICA DO AZUL DE METILENO

EVALUACIÓN DE LA CALIDAD DEL AGUA EN BEBEDEROS DE UN CAMPUS UNIVERSITARIO: UN ENFOQUE MEDIANTE ANÁLISIS FISICOQUÍMICOS Y LA TÉCNICA DEL AZUL DE METILENO

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ABSTRACT

This study aims to analyze the physicochemical characteristics of water available for human consumption in university campus drinking fountains. Water temperature and dissolved oxygen were measured using a multiparameter meter. The pH was also determined, and the methylene blue technique was used to assess organic matter content. The results remained within established regulatory parameters, confirming the safe quality of the water for consumption.

Keywords: Drinking Water. Water Quality. Methylene Blue. Physicochemical Parameters.

RESUMO

Este estudo tem como objetivo analisar as características físico-químicas da água disponível para consumo humano em bebedouros do campus universitário. A temperatura da água e o oxigênio dissolvido foram medidos usando um medidor multiparamétrico. O pH também foi determinado, e a técnica do azul de metileno foi utilizada para avaliar o conteúdo de matéria orgânica. Os resultados permaneceram dentro dos parâmetros regulatórios estabelecidos, confirmando a qualidade segura da água para consumo.

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Palavras-chave: Água Potável. Qualidade da Água. Azul de Metileno. Parâmetros Físico-químicos.

RESUMEN
Este estudio tiene como objetivo analizar las características fisicoquímicas del agua disponible para consumo humano en fuentes de agua potable del campus universitario. La temperatura del agua y el oxígeno disuelto se midieron utilizando un medidor multiparamétrico. El pH también se determinó, y se utilizó la técnica del azul de metileno para evaluar el contenido de materia orgánica. Los resultados se mantuvieron dentro de los parámetros regulatorios establecidos, confirmando la calidad segura del agua para el consumo.

Palabras clave: Agua Potable. Calidad del Agua. Azul de Metileno. Parámetros Fisicoquímicos.

1 INTRODUCTION

Water is an essential resource for sustaining life across all ecosystems on Earth, making the evaluation of its quality fundamental to safeguarding public health and human survival. Given that water constitutes approximately 70% of the human body, ensuring access to clean water is a global imperative. Accordingly, the United Nations (UN), through Sustainable Development Goal 6 (SDG 6), establishes as a global priority the commitment to guarantee the availability and sustainable management of water and sanitation for all by 2030 (ONU, 2025).

In Brazil, the National Water and Basic Sanitation Agency (*Agência Nacional de Águas e Saneamento Básico* - ANA) monitors water quality across distinct operational uses, including human consumption, recreational practices, and agricultural irrigation, by consolidating data from state environmental authorities. To standardize diagnostic procedures and comparative evaluations nationwide, ANA established the National Water Quality Monitoring Network (RNQA) in 2013. Within this framework, the Water Quality Index (WQI) serves as a primary standard, integrating key physical, chemical, and biological indicators such as temperature, pH, dissolved oxygen (DO), total dissolved solids, biochemical oxygen demand (BOD), thermotolerant coliforms, nitrogen, phosphorus, and turbidity (Brazil, 2020).

In line with international guidelines, the World Health Organization (WHO) emphasizes risk assessment frameworks to identify physical, chemical, and microbiological hazards in drinking water distribution systems (WHO, 2017). Providing safe water remains a core pillar of basic sanitation, direct disease prevention, and public health assurance (Brazil, 2018; Barçante *et al.*, 2014; Xavier; Quadros; Silva, 2022). Adhering to regulatory standards is essential, as adequate water quality directly benefits urban ecosystems, public institutions, and industrial applications (Andrade *et al.*, 2024a).

Water contamination remains a persistent global health issue, with severe socioeconomic impacts in developing regions where untreated effluent discharge degrades public water sources (Barçante *et al.*, 2014). Inadequate sanitation infrastructure accelerates the transmission of waterborne diseases, directly impairing quality of life and human development. According to environmental health assessments, physicochemical parameters reflect the concentration of dissolved substances that modify the natural chemical balance and safety of consumed water (Rocha *et al.*, 2010).

In Brazil, drinking water standards are established by the Ministry of Health (*Ministério da Saúde*) through Ordinance GM/MS No. 888 of May 4, 2021, setting strict maximum allowable values for potability (Brazil, 2020; Brazil, 2021). Water temperature plays a fundamental role in controlling chemical reaction kinetics, biological activity, and oxygen solubility (Esteves, 1998). Dissolved oxygen (DO) concentration is inversely proportional to water temperature and directly indicates organic load dynamics, as biological oxygen demand increases in polluted environments. Additionally, pH governs chemical equilibria; for potability, operational guidelines generally recommend pH values within the range of 6.0 to 9.5 (Andrade *et al.*, 2024b; Muniz; Campos; Cantarino, 2024).

The dye reduction technique using methylene blue is a well-established qualitative and semi-quantitative method for assessing organic matter decomposition and microbial activity in aquatic systems. As described by Monteiro and Viadana (2009), the methodology relies on a colorimetric shift driven by oxidation-reduction processes: in the presence of biodegradable organic matter, heterotrophic microorganisms consume dissolved oxygen, creating a reducing environment that leads to the decolorization of methylene blue. Consequently, the rate and extent of color loss are directly proportional to the organic pollution load and biological oxygen demand of the water sample.

Expanding on this principle, Troppmair (1988) highlighted that the anaerobic decomposition of organic substances occurs predominantly through reduction mechanisms, wherein methylene blue acts as an electron acceptor and loses its characteristic blue color under reducing conditions. This process allows researchers to evaluate organic contamination levels and track biological stabilization dynamics in a practical manner. Furthermore, the simplicity, low operational cost, and accessibility of the methylene blue method make it highly suitable for routine water quality screening (Monteiro; Viadana, 2009).

Continuous monitoring against regulatory standards is required to identify distribution network failures and operational risks. By assessing physical, chemical, and organic indicators in university drinking fountains under Ministry of Health Ordinance GM/MS No. 888/2021, this study seeks to verify the potability of supplied water and provide technical baseline data for institutional water safety management.

To achieve this, the investigation evaluates the physicochemical characteristics of drinking water from campus fountains, focusing on temperature, dissolved oxygen, pH, and organic matter content. Specifically, the methylene blue (MB) dye reduction method was applied to evaluate organic matter decomposition and microbial reducing potential, based on

the classic environmental research methodology proposed by Troppmair (1988). The technique relies on the decolorization of methylene blue under reducing conditions caused by aerobic and facultative microorganisms during organic oxidation (Monteiro; Viadana, 2009; Andrade *et al.*, 2024b).

2 METHODOLOGY

2.1 STUDY AREA

This study was conducted at the Chemistry Laboratory of the Institute of Agricultural Sciences (ICA), Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Campus Unaí, Minas Gerais, Brazil. Water samples were collected from three distinct drinking fountains (designated as points P1, P2, and P3) located across the university campus to evaluate the physical, chemical, and biological stability of the supplied drinking water.

2.2 SAMPLE COLLECTION

Water samples were collected in 1,000 mL high-density polyethylene (HDPE) containers. Prior to sampling, the bottles were thoroughly washed, rinsed with distilled water, and purged three times with local sample water. Faucet nozzles were sanitized and flushed for two minutes prior to collection. Containers were filled completely to prevent headspace formation, sealed immediately, and properly labeled with sampling location, date, and time. Samples were transported, protected from light, and analyzed immediately upon arrival at the laboratory. Furthermore, the methylene blue analysis was performed according to standardized procedures.

2.3 PHYSICOCHEMICAL PARAMETERS

The physicochemical parameters evaluated included water temperature (°C), pH, and dissolved oxygen (DO, mg L^{1}). Water temperature, and dissolved oxygen were measured directly using a calibrated AKSO multiparameter meter (model AK88-2). Hydrogen potential (pH) was determined using a benchtop pH meter calibrated with standard buffer solutions (pH 4.00, 7.00, and 10.00). All analytical determinations were performed in triplicate to ensure measurement reliability (Passari *et al.*, 2011).

2.4 METHYLENE BLUE DYE REDUCTION METHOD

Organic matter content and biological reducing activity were evaluated using the methylene blue (MB) dye reduction technique (Troppmair, 1988; Monteiro; Viadana, 2009). A reagent solution was prepared by dissolving 1g of methylene blue in 100 mL of distilled water. A 0.3 mL aliquot of this solution was added to 100 mL water samples in transparent glass containers and gently homogenized. The samples were stored at controlled room temperature (25°C) and protected from light. Decolorization time was recorded at intervals over a 120-hour monitoring period, with readings performed every 24 hours to track biological oxidation-reduction dynamics. All determinations were carried out in triplicate.

3 RESULTS AND DISCUSSION

The physicochemical parameters evaluated at the three sampling points (P1, P2, and P3) of the Institute of Agricultural Sciences (ICA/UFVJM) are summarized in Table 1. Performing analytical determinations in triplicate is essential in environmental chemistry to minimize experimental errors, lower variance, and provide statistically reliable means for data interpretation (Passari *et al.*, 2011; Campos; Campos, 2007).

Table 1

Physicochemical parameters of water samples collected from drinking fountains

Sampling point	pH (Mean ± SD)	Dissolved oxygen (mg L^{-1}) (Mean ± SD)	Temperature (°C) (Mean ± SD)
Point 1 (P1)	7.19 ± 0.02	8.41 ± 0.32	14.83 ± 1.00
Point 2 (P2)	7.23 ± 0.03	8.20 ± 0.13	14.87 ± 1.29
Point 3 (P3)	7.31 ± 0.02	8.07 ± 0.28	17.37 ± 1.77
Reference values	6.00 – 9.50	NR	NR

Values expressed as mean ± sample standard deviation (n = 3). NR = No established reference range identified for drinking water. The pH range is an operational reference used by Brazilian water utilities, not a mandatory potability limit.
Source: Prepared by the authors, 2026.

The pH values across all sampling points ranged from 7.19 to 7.31, yielding an overall average of 7.24. These values strictly comply with the potability standards established by Ministry of Health Ordinance GM/MS No. 888/2021, setting an operational reference range of 6.0 to 9.5 for water distribution systems (Brazil, 2021).

The near-neutral pH observed in all drinking fountains indicates stable chemical equilibrium within the municipal supply network managed by the Autonomous Water and Sewage Service of Unaí (*Serviço Autônomo de Água e Esgoto de Unaí* — SAAE) (2025).

Maintaining pH within this neutral boundary is crucial for public health and infrastructure maintenance: acidic pH values (6.0) promote corrosion of metal pipes and plumbing joints, releasing toxic metals such as lead or copper, whereas overly alkaline conditions (9.5) cause mineral incrustation and reduce the germicidal efficiency of chlorine disinfection (Andrade *et al.*, 2024a; Muniz; Campos; Cantarino, 2024). Therefore, the recorded pH values demonstrate that the campus water supply is chemically balanced and non-corrosive.

Water temperature exhibited slight spatial variations, recorded at 14.83 °C at P1, 14.87 °C at P2, and 17.37 °C at P3. While Brazilian drinking water legislation does not set a mandatory upper or lower numerical threshold for temperature, monitoring temperature is vital because it directly influences chemical reaction rates, microbial growth kinetics, and gas solubility (Esteves, 1998). The lower temperatures observed at P1 and P2 reflect direct water flow through actively refrigerated cooling coils within the drinking fountains. In contrast, the slightly higher temperature recorded at P3 17.37 °C can be attributed to thermal exchange during longer water retention time in storage reservoirs or internal piping exposed to ambient temperatures before dispensing. Overall, these low-to-moderate temperature ranges favor higher dissolved gas retention and inhibit the rapid proliferation of opportunistic aquatic bacteria (Esteves, 1998).

Dissolved oxygen levels were found to be high across all points: 8.41 mg L^{1} at P1, 8.20 mg L^{1} at P2, and 8.07 mg L^{1} at P3, with a mean DO level of 8.23 mg L^{1}. Although potability legislation does not dictate a minimum DO percentage for tap drinking water, DO serves as a fundamental indirect indicator of organic pollution load (Esteves, 1998).

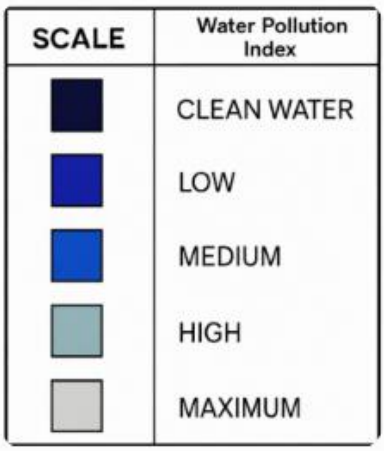
Furthermore, the spatial distribution of dissolved oxygen concentrations showed very little variation across the monitoring points, remaining consistently high throughout the system. The slightly higher concentration observed at Point 1 (8.41 mg L^{1}) compared to Point 3 (8.07 mg L^{1}) is inversely related to the temperature increase recorded along the network, which is consistent with the physical chemistry of gases in aqueous solutions, where gas solubility decreases as temperature rises (Esteves, 1998). Overall, these findings indicate that the municipal distribution infrastructure maintains adequate aeration and prevents stagnation within the evaluated drinking fountains.

The methylene blue dye reduction assay provided crucial qualitative and semi-quantitative evidence regarding the organic quality of the drinking water supplied at ICA/UFVJM. Methylene blue serves as a redox indicator: under aerobic and oxygen-rich conditions, the compound remains in its oxidized state, displaying a distinct dark blue

coloration. In contrast, when biodegradable organic matter is present, aerobic and facultative heterotrophic microorganisms consume dissolved oxygen during cellular respiration, creating a reducing environment. Under these reducing conditions, methylene blue acts as an electron acceptor and undergoes enzymatic or chemical reduction into its colorless derivative, leucomethylene blue (Troppmair, 1988; Monteiro; Viadana, 2009).

Figure 1

Color scale for the pollution index in samples with methylene blue



Source: Monteiro; Viadana, 2009.

Throughout the 120-hour monitoring period conducted at room temperature, no visible loss of color intensity or reduction occurred in any of the triplicates across points P1, P2, and P3 (Figure 2). According to the colorimetric pollution scale proposed by Monteiro and Viadana (2009), all samples strictly corresponded to the “Clean Water” classification (Figure 1). The complete absence of decolorization over 5 consecutive days indicates an insignificant concentration of biodegradable organic substances and negligible metabolic activity of decomposer microorganisms within the university tap network.

Figure 2

Water samples with methylene blue solution on the 5th day of monitoring (showing no decolorization)



Source: Prepared by the authors, 2025.

The favorable physicochemical indicators - such as near-neutral pH, stable temperatures, and high dissolved oxygen concentrations - combined with the complete absence of methylene blue decolorization, confirm that the water supplied by SAAE (2025) and distributed through the campus drinking fountains is protected against organic contamination and suitable for human consumption. Furthermore, as noted by Monteiro and Viadana (2009), the integration of these parameters serves as an accessible, low-cost, and reliable screening tool for public health and water quality assessment in institutional environments.

4 CONCLUSION

This study evaluated the drinking water quality in campus drinking fountains at ICA/UFVJM using physicochemical analyses and the methylene blue reduction technique. All evaluated physicochemical parameters (pH, temperature, and dissolved oxygen) complied with Brazilian regulatory standards established by Ministry of Health Ordinance GM/MS No. 888/2021. Furthermore, the methylene blue assay demonstrated no organic matter

degradation over time, confirming low microbial activity and high potability safety. These findings provide institutional baseline data for water safety management at UFVJM Campus Unaí.

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REFERENCES

ANDRADE, C. S.; MENEZES, C. P. S.; SILVA, P. A. B.; COUTO, E. C. G.; VIEIRA, H. V. S.; SILVA, D. M.; PEREIRA, M. S. C. Aplicação do azul de metileno na monitoração da poluição hídrica no Rio Preto em contraste com métodos convencionais. In: O FUTURO DAS CIÊNCIAS AGRÁRIAS: inovações e desafios 4. Ponta Grossa: Atena Editora, 2024a. Cap. 1.

ANDRADE, C. S.; SILVA, P. A. B.; MENEZES, C. P. S.; COUTO, E. C. G.; VIEIRA, H. V. S.; SILVA, D. M.; PEREIRA, M. S. C. Análise físico-química da qualidade da água utilizada na Fazenda Experimental Santa Paula (FESP) da UFVJM – Campus Unaí. In: BEM-ESTAR ANIMAL: práticas veterinárias, abordagens e cuidados. Ponta Grossa: Atena Editora, 2024b. Cap. 5.

BARÇANTE, J. M. de P. *et al.* Ocorrência de doenças de veiculação hídrica: a água contaminada como problema de saúde e ambiental. Ambiente & Sociedade, Rio Grande, v. 19, n. 2, p. 6-17, 2014.

BRASIL. Ministério da Saúde. Portaria de Consolidação GM/MS nº 888, de 4 de maio de 2021. Altera o Anexo XX da Portaria de Consolidação GM/MS nº 5, de 28 de setembro de 2017, para dispor sobre os procedimentos de controle e de vigilância da qualidade da água para consumo humano e seu padrão de potabilidade. Brasília, DF: Ministério da Saúde, 2021. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2021/prt0888_07_05_2021.html. Acesso em: 28 maio 2025.

BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância em Saúde Ambiental e Saúde do Trabalhador. Qualidade da água para consumo humano: cartilha para promoção e proteção da saúde. Brasília, DF: Ministério da Saúde, 2018. 51 p.

BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde. Documento de contextualização do processo de revisão da norma de potabilidade da água destinada ao consumo humano. Brasília, DF: Ministério da Saúde, 2020. Disponível em: https://www.gov.br/saude/pt-br/acesso-a-informacao/participacao-social/consultas-publicas/2020/arquivos. Acesso em: 24 maio 2026.

BRASIL. Ministério da Saúde. Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano (SISAGUA). Brasília, DF: Ministério da Saúde, [s.d.]. Disponível em: https://www.gov.br/saude/pt-br/composicao/svsa/saude-ambiental/vigiagua/sisagua. Acesso em: 28 out. 2026.

CAMPOS, L. M. A.; CAMPOS, A. V. L. Tratamento estatístico de parâmetros físicos e químicos de qualidade da água. Química Nova, v. 30, n. 6, p. 1541-1549, 2007. Disponível em: https://www.scielo.br/j/qn/a/NZ64NLV8DKgjKyvf/?lang=pt. Acesso em: 28 maio 2025.

ESTEVES, F. A. Fundamentos de Limnologia. 2. ed. Rio de Janeiro: Interciência, 1998. p. 2-63.

MONTEIRO, Adriano Bortolin; VIADANA, Adler Guilherme. Análise de poluição da água: a técnica do azul de metileno. In: SIMPÓSIO BRASILEIRO DE RECURSOS HÍDRICOS, 18., 2009, Campo Grande. Anais [...]. Campo Grande: ABRH, 2009.

MUNIZ, Beatriz Rodrigues Borges; CAMPOS, Clarissa Guimarães; CANTARINO, Gilmar. Qualidade da água potável: análise do processo de tratamento e monitoramento de parâmetros físicos e químicos. In: Desafios da Engenharia: Tecnologia, Inovação e Perspectiva. Curitiba: Tecnologia, 2024. v. 7, p. 75-86.

ORGANIZAÇÃO DAS NAÇÕES UNIDAS (ONU). Objetivo de Desenvolvimento Sustentável 6: Água potável e saneamento. Brasília, DF: ONU Brasil, 2025. Disponível em: https://brasil.un.org/pt-br/sdgs/6. Acesso em: 24 maio 2025.

PASSARI, Luiza Maria Zampronio *et al.* Análise estatística aplicada à química ambiental. Química Nova, v. 34, n. 5, p. 888-892, 2011. Disponível em: https://www.scielo.br/j/qn/a/8h5cJ3nV8kMf/?lang=pt. Acesso em: 25 maio 2025.

ROCHA, E. S. *et al.* Análise microbiológica da água de cozinhas e cantinas de instituições de ensino na cidade de Feira de Santana (BA). Revista Baiana de Saúde Pública, v. 34, n. 3, p. 12, 2010.

SERVIÇO AUTÔNOMO DE ÁGUA E ESGOTO DE UNAÍ (SAAE). Qualidade da Água. Unaí: SAAE, [2025]. Disponível em: http://www.saaeunai.mg.gov.br. Acesso em: 25 maio 2025.

TROPPMAIR, H. Biogeografia e Meio Ambiente Urbano. Rio Claro: Divisa, 2004.

TROPPMAIR, H. Metodologias Simples para Pesquisas Ambientais. Rio Claro: [s. n.], 1988. 232 p.

WORLD HEALTH ORGANIZATION (WHO). Guidelines for Drinking-Water Quality: Fourth Edition Incorporating the First Addendum. Geneva: WHO, 2017. Disponível em: https://www.who.int/publications/i/item/9789241549950. Acesso em: 24 maio 2025.

XAVIER, Manoel das Virgens Sousa; QUADROS, Helena Costa; SILVA, Monique Santos. Parâmetros para avaliação da água destinada ao consumo humano: uma revisão. Research, Society and Development, v. 11, n. 1, e42511125118, 2022. DOI:

10.33448/rsd-v11i1.25118. Disponível em: https://rsdjournal.org/index.php/rsd/article/view/25118. Acesso em: 24 maio 2025.